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Of Nature trusts the mind which builds for aye."—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

THURSDAY, JULY 1, 1909.

THE IMPERIAL GAZETTEER ATLAS OF INDIA.

The Imperial Gazetteer of India. Vol. xxvi. Atlas. New edition. Pp. vii+45; 64 plates. (Oxford: Clarendon Press, 1909.)

THIS atlas, which forms the twenty-sixth volume of the series, is practically an epitome of all the information contained in the "Gazetteer," and, as such, it presents to the reader in a concrete form of illustration most of the physiographical conditions of the Indian Empire. The authorities for the information contained in it are of the very highest, and the publisher is Mr. J. G. Bartholomew, which is in itself a guarantee that the maps are of the very best. Geology, meteorology, ethnology, language distribution, and archæology are all included; there are four special maps illustrating the position of the British frontier at different periods, and a series of admirable city maps which might have been extended with advantage.

In the first general map which presents itself the singular position of Ceylon as forming no part of the Indian Empire is curiously anomalous; and inasmuch as Ceylon cannot be wholly left out of account (as in the railway maps, for instance), it would, we think, have added to the appearance, if not to the usefulness of the atlas, to have included it generally. With this doubtful exception the general maps are complete, clear, and most instructive. The special maps are also good, although, of course, it would be easy to suggest other and possibly better methods of presenting the physical features of India than those which have been adopted. The one special map which deals with the subject of vegetation is perhaps the most open to criticism. Here the classification of area by colour, exhibiting the nature of vegetable growth, or the want of it, seems inadequate. There is one green tint in particular, which denotes "grass or sparsely cultivated," which is rather too comprehensive. We find it, for instance, covering wide tracts to the north and south of the Indravati affluent of the Godavari river in the Central Provinces. Undoubtedly this is a grass country, and it is also sparsely cultivated. The grass in the cold-weather seasons is thick and rank along the low-lying flats, bunched with tangled masses of dew-soaked undergrowth, and almost impassable in the hot weather by reason of the stuffy atmosphere which envelops it; but it is always associated with a low scrub (chiefly of various species of dwarf palm) and sheltered by a more or less scattered tree jungle which occasionally rises to the dignity of forest and is never altogether wanting although it thins out on the higher land. This is, in fact, the nature of the "jungle" which covers half the surface of India, distinct from the official forest areas, which contain timber of commercial value or fringe the foot-hills of the Himalayas.

Again, we find the same tint of green overlying many hundreds of square miles of the Baluch highlands where never a tree has been seen for a century, and where it would be vain to look for a blade of grass after the close of summer. It is true that in the spring months a green tint does actually steal gradually over the hill-sides, and it fills in the spaces between the wormwood scrub of the flats. Then, indeed, the flowers bloom freely, and for a period Baluchistan is gay. Then, too, the shepherd takes his sheep to the hills, and the landscape becomes dotted with white specks of scattered flocks. There is grass undoubtedly —for a time—and equally true it is that the land is "sparsely cultivated"; but about the season that the Indravati basin is rank with cane-brakes and undergrowth and swarming with game, the hills of Baluchistan take on their normal aspect of dead, dull stony desolation, and the "dasht" becomes grey and insipid. So far as vegetable growth is concerned the two countries are in utter contrast, although it is true of both that grass grows in them, and that cultivation is sparse. A very considerable extension of the "steppe-desert" tint is required in Baluchistan (where it is not introduced at all), nor is it quite reasonable to ignore the magnificent cultivation of the valleys of the Hari Rud, near Herat, and of the Helmand; or to paint the summit of the Sulaiman range with the colour of the "sandy desert or barren land," considering that the chilghosa forests of these mountains (which are all about these summits) are of great economic importance to the tribes people who make use of them. It will be observed that these criticisms point, not to the maps of India with which the "Gazetteer" is principally concerned, but to the maps of the Indian frontier and trans-frontier. Of the maps of India it is enough to say that they are all admirably clear and most instructive, each in its distinct and separate line of illustration; but inasmuch as the frontier is now very rightly included in all works dealing seriously with Indian problems, it is time that the public were supplied with map information of a class equal to that of the Indian peninsula generally. This is not quite the case in this atlas.

Take, for instance, the map of Baluchistan amongst the "district" series. Were no attempt made at reproducing the orography of that remarkable country the map might pass sufficiently well as a sketch; but the crude representation of the mountain features which at present disfigures the map is absolutely misleading. All the beauty (and it is very beautiful) of nature's arrangement of sweeping flexures and folds which border the trans-Indus highlands; the orderly curves of their looping up where the inset of the Kach Gandava desert occurs (just like the looped-up flexures in hanging drapery) pushing back and forming the massive mountain entourage of Quetta; then sweeping away in graceful flexures seamed with a thousand wrinkles to Karachi, or through Makran to Persia—all this is lost in the graceless disposition of a few fat slug-shaped forms over the yellow surface of the map. This is not the orography of Baluchistan, or Makran, and it is misleading. The traveller who trusted, by following this map, to turn the northern end of the Kirthar range and to walk into Khozdar on the flat plains would be grievously disappointed. The wall of the frontier hills is not even represented as continuous, and even if the scale of the map does not admit of giving full value to many important, but minor, features, there is at least no excuse for fundamental errors such as this. The map is certainly not overcrowded with names, and this fact renders it all the more desirable that those which exist should be correct. The "Central Makran" range is an invention which is hardly permissible. Not only is it not near the centre of Makran, but it is doubtful whether it is, all of it, even in Makran. As regards the frontier, we must, however, be thankful for small mercies. It is something to find a map of Baluchistan which is correct in its political boundaries, and it is a great deal to find a map of Afghanistan which is in almost every respect a far better illustration of the country it represents than that which we have just criticised.

The city maps at the end of the series are wholly admirable, and so are the railway maps which precede them. It would have added greatly to the interest of the series could we have had maps of some of the most ancient, and, historically, the most important, of the cities of the past; Chitor, Ujjain, Udaipur, and many another that we could mention, will always possess an undying interest for the student of India. On the whole, this atlas is an admirable addition to the "Gazetteer," and as it is probably the most useful volume for reference in the whole series, so may we hope that in due time it will become the most accurate.

T. H. H.

ESSAYS ON LEONARDO DA VINCI.

Etudes sur Léonard de Vinci, ceux qu'il a lus et ceux qui l'ont lu. By Pierre Duhem. Seconde Série. Pp. iv+474. (Paris: A. Hermann, 1909.) Price 15 francs.

THIS volume contains four essays, on Leonardo da Vinci's views on the infinitely great and the infinitely small, on his ideas on the plurality of worlds, on his dependence on the philosophy of Nicolaus de Cusa, and on his ideas on the origin of fossils.

When endeavouring to estimate the value of the notes and jottings of the great painter it is necessary to consider the books accessible to him and the problems under discussion among philosophers of his day. M. Duhem has made a detailed study of the works of mediæval thinkers, and he traces the development of the ideas by which Leonardo's mind was influenced, and the advances he made, by which, unfortunately, the world did not profit since they remained locked up in his note-books. The foundation on which every speculation rested was still the philosophy of Aristotle, viewed in many cases through the spectacles of the scholastics, and often influenced by the commentaries of Arabian philosophers. But Leonardo reasoned independently on every subject, and though he often adopted opinions held by his predecessors, he never followed slavishly in their footsteps. This is well illustrated by his attitude with regard to the question whether there might be more worlds than the one of which the earth was the central part, and which was bounded by the starry sphere. Aristotle had denied that there could be more than one universe, because a body can only be at rest in its natural place, so that the earth of a second world would fall down on our earth, and no body can therefore exist outside the starry sphere. The question was a difficult one to the scholastics, because to deny the possibility of the plurality of worlds seemed to involve denying the omnipotence of God; but a curious compromise was proposed by Albert of Saxony, that if there were another world it would have to be concentric with ours, because the centres of gravity of our earth and the other one would have to coincide if there were to be equilibrium, and this could only be the case if the other earth were in the form of a spherical shell—unless we assume a permanent miracle. Undeterred by this, Leonardo in a note considers what would happen if there were, not one, but two centres of gravity. He assumes two worlds of equal size and a heavy body outside the line joining their centres, but at equal distances from these; and he asks how will this body move and where will it come to rest? The answer is that it will move along the perpendicular to the line joining the centres, and be in equilibrium at the point midway between them. Here, as in many other places, he shows that he had a clear idea of the composition of forces, at a time when the fundamental principles of dynamics were unknown.

The writings of the German philosopher Nicolaus de Cusa seem to have made a profound impression on Leonardo, and M. Duhem shows how suggestive they were to him in his studies on the motion of bodies. Leonardo discussed the motion of an arrow shot vertically upwards from the earth, assuming the latter to rotate in twenty-four hours, not because he wanted to prove or disprove the rotation of the earth, but merely as a problem of dynamics. Here, as well as in his general investigation of the motion of a projectile, he found it hard to free himself from old ideas; he believed, for instance, that a cannon ball at first moves in a straight line while influenced by a "violent force," next in a curved path while that force and gravity are struggling for supremacy, until it finally drops to the earth in a straight line. Though he cannot be considered a precursor of Copernicus (he says repeatedly that the earth is at the centre of the universe), he reasons as freely as Cusa about the nature of the stars, and rejects the Aristotelean distinction between the terrestrial elements and celestial matter. He believed the moon to be composed of the four elements which it supports in space in itself and by itself, as the earth does with its component parts. This is much the same as the statement of Copernicus that gravity is a natural tendency of all particles to join themselves into a whole in the form of a sphere, a tendency which is innate in the sun, moon, and planets.

The fourth essay deals with speculations on the origin of fossils. Leonardo did not consider them to be "plays of nature," or to have been carried to the tops of mountains by a deluge, but recognised that they are the remains of animals which actually lived on the spot where the fossils are found.

PARA RUBBER.

Hevea brasiliensis, or Para Rubber. Its Botany, Cultivation, Chemistry, and Diseases. By Herbert Wright. Third edition. Pp. xviii+204. (Colombo: A. M. and J. Ferguson; London: MacLaren and Sons, 1908.) Price 10*s*. net.

A REVIEW of Mr. Herbert Wright's valuable work on Para rubber appeared in NATURE about two years ago. The present edition (third) has been considerably enlarged, and in Mr. Wright's words "has been compiled in consequence of the many advances which have been recently made in methods of cultivation and tapping, coagulating and curing." The text has been increased from 177 pages to 304 pages, and the really well reproduced and instructive illustrations from 86 to 272. Many of the chapters have been re-written and expanded, especially the one on uses of rubber. There is now a separate chapter on the botany of the Para tree, *Hevea brasiliensis*, and one on the effect of tapping on the trees.

Chapter iv. contains a great deal of useful and up-to-date information on planting operations and on catch crops. The advantages and disadvantages of close planting are fully considered. The most general distance now employed is from 15 feet to 20 feet. The main justification for close planting is the increased tapping area which is available in the first few years, but there is a note of warning in the following passage:—

"No one who has seen the uncultivated thirty-year-old trees at Henaratgoda can doubt that such specimens require at the very least a distance of thirty to forty feet if they are to be allowed to continue in their growth and maintain a healthy constitution."

Catch crops, says Mr. Wright, are all very exhausting, and their profitable cultivation is limited to about the first four years.

Considerable space is devoted to a description of the various methods of tapping and tapping implements, but, apparently, the systems employed are far from perfect, as the following passage implies:—

"The adoption of better systems of tapping which obviate the necessity of paring away the tissues wherein the milk accumulates, and drawing supplies of latex by merely cutting and not excising the laticiferous tissues is bound to result in an increased yield since the life of the tapping area is so much prolonged."

At present the average yield per tree per year for the Malay States would appear to be about 2 lb. Most of the trees, however, are still young. The cost of production is about 1*s*. 6*d*. per lb. Various methods of coagulating and treating latex are described: the use of centrifugal machines is more or less experimental; "the principle . . . . of causing a separation of the caoutchouc globules by mechanical means is one which cannot be too strongly impressed on the experimentalist."

There is very little doubt, from Mr. Wright's remarks and his inquiries amongst manufacturers, that plantation Para is inferior in quality to fine hard (wild) Para. A wise manufacturer would not dare to buy 50 tons of cultivated rubber and store for six months, for fear of grave deterioration in quality, but he would buy thousands of tons of up-river fine Para with a full knowledge that it would grow better in storage. Mr. Wright appears to have very little faith in the so-called "synthetic rubber."

Natural rubber consists chemically of very complicated compounds. The "resins" and "proteins" are in themselves highly complex bodies, the components of which are but little understood.

"How can it then be possible, since we do not fully understand the chemical composition of the various components of natural rubber, to have synthetic rubber already on the market?"

Mr. Wright's book is perhaps the most comprehensive and up-to-date work on Para rubber published in this country, and has proved of great utility to practical men in the various branches of the rubber industry.

L. C. B.

ALTITUDE TABLES FOR NAVIGATORS.

Altitude Tables, computed for Intervals of Four Minutes between the Parallels of Latitude 24° and 60°, and Parallels of Declination 24° and 60°, designed for the Determination of the Position Line at all Hour Angles without Logarithmic Computation. By Frederic Ball. Pp. xxxvii+313. (London: J. D. Potter, 1909.) Price 15*s*. net.

THERE are many circumstances connected with actual navigation which tend to make calculation on board ship difficult to the inexpert, and we naturally welcome any effort intended to shorten an onerous task and to introduce greater simplicity. The substitution of tables which give an approximate solution of a spherical triangle, involving only a very easy interpolation, is the form that assistance usually takes, and the main feature in the book before us is to make tables, already published, available for wider limits of latitude and declination. As tables extend, and contrive, perhaps, to serve more than one purpose, complications are likely to arise, and however great an ingenuity is displayed in adapting trigonometrical formulæ to tabular arrangement, if simplicity is sacrificed to ingenuity, the ultimate gain is questionable.

Accuracy is as necessary as brevity of calculation, and it is possible to be so enamoured with the apparent advantages of tables that the chances of misusing them are overlooked. We have a slight fear that the author has not sufficiently considered this point. It is a mistake to cumber the work with many rules, which put too great a strain on the memory. For instance, the rules for determining the "name" of the azimuth; using different methods within ten degrees of the meridian or of the prime vertical; interchanging latitude for declination under certain conditions; all these things are apt to be a little burdensome in a moment of stress or excitement. Further than this, there must come a time when tables do not shorten the work, for the number of interpolations becomes excessive. Tables of double entry are always inconvenient to the computer, and when, as in nautical problems, we get three arguments, latitude, declination, and hour angle, for other values than those in the tables, the process becomes very laborious. In an example given, it is necessary to take out four altitudes with arguments of even degrees of latitude, and of declination, and to make three interpolations between these altitudes. Not a word is said about the signs of the corrections, and it is quite possible to use an incorrect sign. In any case, the attention is kept on the strain more than if a direct calculation of altitude was made from the ordinary trigonometrical formula.

We may ask, too, whether the use of logs. for solving the simplest question in rule of three is not a little overdone. We have a problem, in which is given the difference of altitude for 60′, and it is required to find the proportional amount for 41·6′. The correction is worked out by logs. involving three entries.

But these are little technical points, on which, no doubt, the author's information is a safe guide. He has actual experience to lead him aright, and we are prepared to surrender our opinion to his practical judgment. On a more important point we are entirely with Mr. Ball. We recognise that this is part of an effort to impress, especially, on the Mercantile Marine, the necessity and the advantage of employing modern methods of tried excellence, and the desirability of abandoning obsolete processes. In these days of rapid locomotion at sea, it is more than ever necessary to produce a correct result in the shortest possible time, and when the expenses of ship management are so enormous, it is a matter of prime importance to know the exact position of the vessel, and to ensure accurate landfall. No time must be lost in groping about to pick up a light, no hesitation must be allowed in determining the ship's course and speed. We trust the author will be successful in enforcing the lesson he has at heart.

OUR BOOK SHELF.

Guide to the Whales, Porpoises, and Dolphins (Order Cetacea), exhibited in the Department of Zoology, British Museum (Natural History), Cromwell Road, London, S.W. Pp. 47. (London: British Museum [N.H.], 1909.) Price 4*d*.

THE whale-room in the Natural History Museum is one of the most notable and interesting features of the national collection, and the publication of a new guide to its contents calls for a word of comment. Within fifty pages Mr. Lydekker has compressed not only a series of clues to the models, skins, and other preparations, but has furnished students of zoology generally with a most useful and well-illustrated summary of the chief characters of the Cetacea and of their presumable ancestors. In a prefatory note, Dr. Harmer gives reason for confining exhibits of this order to skeletons and models, but it is to be hoped that the public will always have an opportunity of seeing the skins of some of these impressive animals, in order to judge of their proportions. The only feature of this excellent guide that we could have wished more fully expounded, relates to the puzzling vernacular names of whales that are used by fishermen. The members of our own branch of the international sea investigation are often quite at a loss to know what these names correspond to in scientific nomenclature, and their experience is not unique. The matter has some importance since the cetacean fauna of the north-western seas is probably more familiar to fishermen than to naturalists, and the fisherman's records cannot be stated precisely until we are able to understand the vernacular terms in use.

La Naissance de l'Intelligence. By Dr. Georges Bohn. Pp. 350. (Paris: Ernest Flammarion, 1909.) Price 3.50 francs.

THIS book is the latest addition to the well-known series of volumes entitled the "Bibliothèque de Philosophie scientifique," and, in both matter and style, easily reaches the high standard of excellence set by its predecessors. The author restricts his attention to the psychology of the lower organisms, and has succeeded in giving an extremely interesting account of a part of modern comparative psychology hitherto rendered attractive only at the expense of truth. An implacable foe to the "anthropomorphism" of the last generation of comparative psychologists, Dr. Bohn devotes a large part of the earlier chapters of his book to a full statement and vigorous defence of Loeb's theory of tropisms, relieving it of several serious misconceptions on the part of the critics by distinguishing it from and relating it to the theories of "differential sensibility" and "associative memory," respectively, which were adumbrated by Loeb himself, and are equally necessary to the explanation of many forms of behaviour of lower organisms. From this general standpoint he finds himself in a position to criticise, on the one hand, the modern mechanistic school of the Germans (Beer, Bethe, Uexküll, &c.), who deny *sensations* to animals only to be forced, later on in the argument, to attribute *intellect* to them, and, on the other hand, Jennings and his American supporters, whose theory of "trial and error" is accused (somewhat unjustly, we think) of an anthropomorphic taint. Other interesting points in the book are discussions on the vital rhythms of marine animals, on the criteria of psychism (where the author rejects Yerkes's various criteria—discrimination, docility, initiative—in favour of that suggested by Loeb, viz. associative memory), on the laws of associative phenomena, and on instinct, a term which the author scornfully expels from comparative psychology as being "metaphysical" and useless. Such a method of getting rid of difficulties should not be encouraged. W. B.

The Dyeing and Cleaning of Textile Fabrics. A Handbook for the Amateur and the Professional. By F. A. Owen. Based partly on notes of H. C. Standage. Pp. vi+253. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 8*s.* 6*d.* net.

A HANDBOOK was published some time ago under some such title as "Every Man His Own Lawyer." To what particular class of people such a book is useful it is not easy to say, but it is fairly safe to assume that the work of the legal profession was not materially lessened by its publication. The book above mentioned might with equal aptness have been termed "Every Man His Own Dyer," but the probability is that the people who are successful in dyeing their own clothes will be even smaller in number than those who are satisfied with the result of their own legal efforts.

The first portion of the book is taken up with such general matters as solution, maceration, &c., and here the author drifts into pharmacy. "The ordinary dose of such infusions is 1 to 2 ozs., three or four times per day." He does not explain, however, the connection between the internal application of infusions and the renovation of garments. His remarks on maceration are equally illuminating. "Its object is usually to impregnate alcohol with the principles of a substance which would be but slowly extracted without the aid of heat, such as the *sun or other warm situation.*"

It is a matter for regret that the book should have been published in its present form. It contains many trustworthy and useful recipes for the removal of stains, the cleaning of gloves, &c., but these are associated with so much useless and even misleading matter that their value is greatly discounted.

WALTER M. GARDNER.

Codex of Resolutions adopted at International Meteorological Meetings, 1872–1907. Prepared at the request of the International Meteorological Committee by H. H. Hildebrandsson and G. Hellmann. Pp. 80. (London: H.M.'s Stationery Office, 1909.) Price 1*s.* 3*d.*

PROGRESS in the observational sciences depends to a great extent on cooperation among those engaged in collecting and making generally available the observational data, and in no subject is this more true than in meteorology, in which the number of individuals who have to be brought within the meshes of the general organisation is exceptionally great. Much has been accomplished in the direction of drawing up rules for general guidance, but the lack of a satisfactory index to the various reports in which these are embodied has hitherto made it difficult to find the information bearing on any given point. Recognising this difficulty, the International Meteorological Committee, at its meeting at Southport in 1903, requested the authors to prepare a summary of what had been already accomplished.

The manuscript of the "Codex," which takes the form of a reprint from the minutes of the meetings of all important resolutions, with short explanatory paragraphs interspersed, was submitted for approval at the International Conference of Directors of Observatories and Offices, held at Innsbruck in 1905. Subsequently Dr. Hellmann incorporated the decisions adopted at that meeting, and the German edition of the work was issued by the Royal Prussian Meteorological Institute in 1907. In the English edition, Dr. Shaw has incorporated the resolutions adopted by the International Committee at Paris in 1907, and we have thus a complete summary of the work accomplished by the seventeen international meetings which have been held since 1872, the date of the first conference, held at Leipzig. In view of the large area over which the English-speaking peoples hold sway, the publication of an English edition of the work is very welcome, and should prove of great service to all engaged in meteorological or magnetic work. A full index to the "reports on progress" in particular branches, and to the scientific papers which have appeared as appendices to the minutes of the meetings, is not the least valuable part of the book.

The Balance of Nature, and Modern Conditions of Cultivation: A Practical Manual of Animal Foes and Friends, for the Country Gentleman, the Farmer, the Forester, the Gardener, and the Sportsman. By George Abbey. Pp. xlvii+278. (London: Routledge and Sons, Ltd.; New York: E. P. Dutton and Co., 1909.) Price 7*s.* 6*d.* net.

IN his preface the author, who appears to have had a very large experience in trapping vermin, states that the only natural-history works he has consulted are "Wood's Natural History" and "The Popular Encyclopædia." All we can say is the more's the pity, for had he undertaken a somewhat wider and more modern course of reading we might have been spared such out-of-date statements as that the hedgehog is a member of the same family as the one which includes the mole and the shrewmouse, or that there are two British species of dormice and also of water-shrews. Such errors are possibly excusable in a writer who is not a zoologist; but what can be said of a so-called sportsman or outdoor naturalist who states that only tame red deer are hunted in England, and that wild roebuck are unknown south of Scotland?

But if the text be bad the illustrations, which the author declares to be diagrammatic, are ten times worse, the climax being reached in the figure of the roebuck, which is represented with a long tail!

As regards the economic portions of the work, the author appears to know more of his subject, and we trust his observations will be found of use to the country gentlemen and farmers for whom the volume is specially intended. We must, however, express surprise at the merciless manner in which he advocates trapping and other methods of destruction; and we are still more concerned at the statement on p. 201 that fish-preservation societies scruple not to destroy the kingfisher, especially if they countenance the use of the cruel pole-trap depicted on the same page.

R. 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.]*

Diurnal Variation of Temperature in the Free Atmosphere.

THE following results, which I have recently obtained by a discussion of temperatures obtained in kite and captive balloon ascents, may be of interest in connection with Prof. Clayton's letter (NATURE, February 4) and Mr. Dines's remark that at a height of 1 km. the daily temperature variation becomes insignificant (NATURE, June 17). The daily variation of temperature at a height of 1 km. over Berlin, deduced from 2232 observations made during the five years 1903–7, is given in degrees C. by

$$T = T_s - (4 \cdot 40 \pm 0 \cdot 08) + (0 \cdot 87 \pm 0 \cdot 13) \sin(nt + \theta_1) + (0 \cdot 14 \pm 0 \cdot 10) \sin(2nt + \theta_2),$$

where T_s is the mean surface temperature, and the probable errors are deduced by the method of least squares. The most probable values for θ_1, θ_2, are 197° and 123° respectively, the time being measured from midnight.

The variation deduced from 962 observations, made during the four years 1903–6, in which the wind at a height of 1 km. was 8 metres per sec. and upwards, is given by

$$T = T_s - (3 \cdot 97 \pm 0 \cdot 15) + (0 \cdot 84 \pm 0 \cdot 23) \sin(nt + \theta_1') + (0 \cdot 35 \pm 0 \cdot 15) \sin(2nt + \theta_2').$$

The most probable values of θ_1, θ_2, are 173° and 102° respectively.

The close agreement in the values for the amplitude of the whole day wave for the two cases proves that there is no large error due to the influence of solar radiation on the instruments, and that the variation is a real variation of the temperature of the atmosphere.

The mean daily range is, then, 1·7° C. (or 3·1° F.), compared with a mean daily range of about 5° C. at Kew, where the temperature variation is given by

$$T = T_s + 2 \cdot 56 \sin(nt + 226°) + 0 \cdot 42 \sin(2nt + 45°).$$

The maximum temperature at a height of 1 km. appears to occur from two to three hours later than at the surface in the whole day wave, and two to three hours earlier in the semi-diurnal wave.

The variation at a height of 2 km., deduced from all (1132) observations, is given by

$$T = T_s - (9 \cdot 84 \pm 0 \cdot 23) + (0 \cdot 64 \pm 0 \cdot 31) \sin(nt + \theta_1) + (0 \cdot 25 \pm 0 \cdot 23) \sin(2nt + \theta_2),$$

the most probable values for θ_1, θ_2, being 270° and 72° respectively.

The magnitude of the probable errors precludes the results from being regarded as final. More observations are needed. But it appears certain that we do not get, on this side of the Atlantic, the remarkable diminution in amplitude and change of phase in the diurnal component which Prof. Clayton found in the first 1000 m. at Blue Hill. The amplitude of the semi-diurnal component does show an increase at 2 km. over its value at 1 km., but, having regard to the relatively large probable errors, one cannot attach any real significance to the result. At the same time, it is of interest to find that at 1 km. and 2 km. altitude in these latitudes the temperature variation is as great as it is over the ocean near the equator, where the value of the daily range is about 1·5° C.

Cambridge, June 20. E. GOLD.

Temperature of the Upper Atmosphere.

AN explanation of the existence of an isothermal layer may possibly be found in the fact that carbon dioxide condenses and freezes at low temperatures even when the pressure is low. The strata in which CO_2 circulates, falling as small drops and then evaporating, must be comparable in the irregularity of their temperature gradients with the strata near the earth in which water circulates. The temperature of the bottom of the mist of CO_2 must be approximately a function of the pressure, so it is to be expected that the height of the mist will vary from day to day and from place to place. In particular, it appears that the change of temperature gradient should occur in the tropics at a greater altitude and lower temperature than elsewhere. The observations to which Mr. Cave refers (NATURE, June 17) confirm this part of the theory.

F. J. W. WHIPPLE.

Merchant Taylors' School, E.C., June 28.

The Aëronautical Society.

IN reference to Prof. Bryan's remarks on the aims and objects of the Aëronautical Society of Great Britain in NATURE of May 27, I would point out that the general scientific character of the proceedings of a society is not annulled because one or more writers have fallen into error, any more than it would be reasonable to say that Prof. Bryan is not a profound mathematician because, in a Friday evening discourse at the Royal Institution, he fell into inaccuracy in scientific history, and said that the Aëronautical Society of Great Britain was at one time called the Balloon Society, and changed its name to its present title, the fact being that the Balloon Society was quite a separate affair, which had its meetings at the Westminster Aquarium and discussed every subject under the sun. In that remark Prof. Bryan showed he had not closely followed the work and career of the Aëronautical Society of Great Britain.

During my eight years of honorary secretaryship of the society, amongst the readers of papers and those who made communications will be found Dr. W. N. Shaw, F.R.S., Mr. W. H. Dines, F.R.S., Prof. C. V. Boys, F.R.S., the late Prof. G. F. Fitzgerald, F.R.S., Prof. Bryan himself, Sir Hiram Maxim, Mr. Lawrence Rotch, Dr. Hergesell, Mr. F. H. Wenham, Captain R. F. Scott, Lieut. E. H. Shackleton, Mr. Orville Wright, Mr. Charles Harding, Mr. W. F. Reid, &c. These names vouch for the general high standard of the proceedings of the society in recent years.

While making these criticisms on Prof. Bryan's remarks, I sincerely hope he will continue his own epoch-making aëronautical researches, for the sake of aëronautical science and for the honour of the Aëronautical Society, of which he is a member.

Airth, Sunningdale, June 14. ERIC STUART BRUCE.

I HAVE no desire to do injustice to the Aëronautical Society, neither do I expect its proceedings to be free from all errors. But in view of the fact that mathematical formulæ and physical considerations now frequently enter into papers bearing on aëronautics, I consider that the time has come when the society should realise the importance of dealing more efficiently with papers of a theoretical character than was necessary formerly. As I have communicated my views on this point to the society through Mr. Bruce, a detailed reply may be unnecessary.

I do not wish all aëronauts to be profound mathematicians. I consider that papers dealing with practical aëronautics have been the most valuable feature of the society's work. Many of the eminent writers to whom Mr. Bruce refers have dealt with the practical and experimental rather than the theoretical side of the subject. Further, a distinction must be drawn between inaccuracies made in discourses or discussions at meetings and those which are allowed to find their way uncorrected into print. But when papers are published in a scientific society's journal which deal with questions of a theoretical character or contain formulæ, it is not unreasonable to expect that the authors shall correctly state and properly apply such principles of mathematics, physics, and mechanics as are found in ordinary text-books, and I trust that, as the result of this correspondence, the exceptions will be less frequent in the future than they have been in the past.

May I, in answer to very numerous inquiries, state with regret that it has been impossible, as yet, to publish a detailed account of my Royal Institution lectures, and some time will elapse before the work in which I am interested is in a suitable form for publication?

G. H. BRYAN.

THE DARWIN CELEBRATIONS AT CAMBRIDGE.

A GENERAL account of the proceedings of the Darwin celebrations at Cambridge on June 22–24, and a list of distinguished delegates and other representatives of science who came from the four corners of the earth to proclaim the greatness of Charles Darwin and his work, was given in last week's NATURE. As the chief speeches were delivered on the day we went to press, and on Thursday last, we were prevented from including any report of them in the article, which, however, we are now able to supplement. Short speeches were made in the Senate House on June 23, when the delegates were received by the Chancellor, Lord Rayleigh, and the addresses were presented; and also at the banquet given in the evening of that day.

Eloquent as this testimony was of the universal recognition of Darwin's influence upon scientific work and thought, the scenes in the Senate House and in the new examination hall where the great banquet was held were even more impressive. In each place there was an assembly of naturalists gathered from far and near charged with the spirit which animated Darwin, and alert to respond to any note of appreciation of the man or his work. As more than one speaker remarked, what Newton did to reduce celestial movements to law and order by his discovery of the law of gravitation, Darwin did for the more complex world of animate things. All bodies in the material universe are bound together by the bond of gravitational attraction which decides their past, present, or future paths; and in a similar way the unifying influence in the organic world is the principle of evolution established upon the foundation of natural selection.

The character and dignity of the celebration made a permanent impression upon the minds of all who were fortunate enough to take part in it, and the occasion has been made memorable for the scientific world in general by the publication of a number of works relating to it. One of these, on "Darwin and Modern Science," was noticed in detail last week, and we now take the opportunity of referring to others.

PUBLICATIONS OF THE DARWIN CENTENARY.

Each delegate was furnished with a copy of two publications which will be of lasting value as souvenirs of this memorable occasion. Perhaps the most remarkable of the publications is the beautifully printed volume issued by the Cambridge University Press under the title of "The Foundations of the Origin of Species." This contains the brief abstract of the theory of natural selection written by Charles Darwin in June, 1842, sixteen years before the famous meeting of the Linnean Society at which the theory was first made known to the scientific world. The MS. of 1842, which was afterwards expanded by its author into the essay of 1844, consists of thirty-five pages written in pencil. It had been "hidden in a cupboard under the stairs, and only came to light in 1896 when the house at Down was vacated." It was, as the editor says, evidently written rapidly, and is in Darwin's most elliptical style, with much erasure and correction, the whole being "more like hasty memoranda of what was clear to himself than material for the convincing of others." Mr. Francis Darwin has laid the scientific public under an immense obligation by his admirable introduction and notes, and by the care he has taken that readers should be able to study the sketch exactly as it stood in its original form. Each of the delegates present at the celebration received a copy of this most valuable work, the importance of which in the history of evolutionary theory it would hardly be possible to overestimate.

In addition to this work, a second volume, admirably printed by the University Press, was put into the hands of the guests at the commemoration. This production, which is purchasable by the public at the price of two shillings and sixpence, is entitled "Order of the Proceedings at the Darwin Celebration held at Cambridge, June 22–June 24, 1909; with a Sketch of Darwin's Life." It opens with a brief preface, which records the names of the committee—to whom many congratulations are due for the successful issue of their labours—and also narrates the steps that were taken, beginning with a meeting of the council of the Senate in December, 1907, to organise a celebration worthy of the man who has revolutionised science, and whose influence has made itself felt as a power and an inspiration in every department of intellectual activity. Following the programme of the commemoration proceedings comes a very interesting sketch of Darwin's life, which gives in brief compass the principal events of his career, and the dates of the publication of his various works. This short biography, in the preparation of which the secretaries to the committee acknowledge the assistance they have received from Mr. Francis Darwin, is rendered especially valuable by well-chosen quotations from the "Life and Letters," and from the appreciative comments of Judd, Lyell, Huxley, Schwalbe, Goebel, and Thiselton-Dyer. Good photographic views are given of Darwin's birthplace at Shrewsbury, of the exterior of his rooms at Christ's College, of his house and favourite "Sandwalk" at Down. There are also reproductions of several of the well-known portraits of Darwin and of his wife, including a picture of Charles Darwin and his sister Catherine as children. An excellent likeness of Sir Joseph Hooker, taken in 1897, and an interesting print of H.M.S. *Beagle* in the Straits of Magellan, complete the series.

The Rede lecture on "Charles Darwin as Geologist," delivered by Sir Archibald Geikie, K.C.B., on June 24, has been published also by the University Press, with notes, at the price of two shillings net. Reference was first made in the lecture to the early geological interests of Darwin and the formative influence of Lyell upon his mind. The first volume of Lyell's "Principles of Geology" was published early in 1830. Darwin took the book with him on his voyage in the *Beagle* and studied it, with a result that changed his opinions and began the life-long indebtedness to Lyell which he so sincerely felt and never ceased to express. In four distinct departments Darwin enriched the science of geology with new material during the voyage of the *Beagle*. First, he added to our knowledge of the volcanic history of the globe. Secondly, he brought forward a body of striking evidence as to the upward and downward movements of the terrestrial crust, and drew from this evidence some of the most impressive deductions to be found in the whole range of geological literature. In the third place, he made important observations on the geology of South America; and, finally, he furnished new and interesting illustrations of the potent part taken by the denuding agents of nature in effecting the decay and disintegration of the land. Sir Archibald Geikie proceeded to review Darwin's work under each of these four heads, and to express his appreciation of it. Finally, he sketched the later geological work carried out by Darwin and the geological side of "The Origin of Species."

Another noteworthy outcome of the present commemoration is the special Darwin centenary number of the *Christ's College Magazine*.

The proceedings on June 23 were opened in the Senate House by the following address from the Chancellor of the University, Lord Rayleigh.

The Chancellor's Address.

In opening the proceedings to-day I must first, in the name of the University, bid welcome to the delegates and other guests who have honoured us by their presence. A glance at the list will show that we have assembled here distinguished men from all parts of the world who have willingly responded to our invitation; and, indeed, the occasion is no ordinary one. We have met to celebrate the centenary of the birth of Charles Darwin and the fiftieth anniversary of the publication of the "Origin of Species." I am old enough to remember something of the stir caused by the latter event. To many the results of Darwin's speculations were unwelcome, and it must be confessed remain so, at least in their application to the origin of man. Fifty years ago it would have been thought a strange prophesy if anyone had predicted to-day's celebration. We may perhaps take it as proven that Cambridge is not held so fast in the bonds of mediævalism as some would have us suppose. We are prepared to face whatever strict methods of investigation may teach to be the truth. I need not remind you that on many important questions raised by Darwin's labours opinions still differ, and I imagine that he would proudly recognise as disciples some of the distinguished biologists who meet here to do honour to his name. I do not attempt even the briefest survey of these labours. We shall presently hear appreciations from men of distinction well qualified to instruct us. What appeals to all is the character of the man, loved by everyone who knew him, and admired by everyone with a spark of the scientific spirit. It is a pleasure and a stimulus to think of him, working on in spite of ill-health in his study, in his garden, and in his hot-houses, and from his retirement moving the minds of thinking men in a manner almost without parallel. I esteem myself fortunate that a visit nearly forty-one years ago, which I owed to my friend, now Sir G. Darwin, allows me to picture the scene. I was struck, as were others, with his wonderful modesty. On my propounding some difficulty in connection with colour vision and the theory which attributed the colours of flowers to the preference of insects, I remember that he asked time for consideration before making a reply. His enthusiasm also impressed me much. This characteristic must have remained. Commenting on it only a short time before the death of both of them, Frank Balfour, himself a strenuous and sympathetic worker, remarked to me that he wished he could be as much interested in his own subject as Darwin was in other people's subjects.

During the last generation Cambridge has been active in biological work. We have the men and the ideas, but the difficulty has always been lack of funds. At the present time it is desired, among other things, to establish a chair of genetics, a subject closely associated with the name of Darwin and of his relative Francis Galton, and of the greatest possible importance, whether it be regarded from the purely scientific or from the practical side. I should like to think that the interest aroused by this celebration would have a practical outcome in better provision for the further cultivation in his own university and in that of his sons of the field wherein Darwin laboured.

At the conclusion of the Chancellor's address the presentation took place of the addresses by delegates from America, Austria-Hungary, Belgium, Denmark, Egypt, France, Germany, Greece, Holland, and Italy. Short speeches were then delivered by Prof. O. Hertwig and Prof. E. Metchnikoff.

Prof. Hertwig referred to the influence of Darwin's work upon German biology, particularly at Jena. It was through Haeckel, who hailed Darwinism with delight, and said that evolution was the key of man's destiny, that the theory became predominant in German science. It had been the starting point for all the researches of the younger men, and had entered into the life of the German people. Earlier this year festivals in commemoration of Darwin's work were held in Hamburg, Munich, Frankfurt, and other towns in Germany. The celebration at Cambridge was the acme of these festivals, and would give an immense stimulus to the scientific work of the delegates privileged to be present at it. The influence of Cambridge upon Darwin was great and beneficial, and particular mention must be made of the encouragement received from Henslow. Three bright stars had appeared in the scientific firmament of the University, the last being Darwin and the two others Harvey and Newton.

Prof. Metchnikoff in his address referred to the debt which medical science owes to the theory of organic evolution founded by Darwin. Diseases undergo evolution in accordance with the Darwinian law, and the recognition of this fact led to the science of comparative pathology. It is possible definitely to show that inflammation is an act of defence on the part of the organism against morbid agents, and that this reaction is effected by certain cellular elements, together with a complicated and wonderful nervous and vascular mechanism. The same elements play an important part in resisting disease. The preponderating influence of the cellular action in the mechanism of immunity is admitted by the great majority of observers. Recently experimental medicine has been investigating the phenomena of adaptation in pathogenic microbes, by virtue of which we are able to attack the organism in spite of its defensive powers, and this is most probably effected by the selection of individual microbes endowed with special properties. This has happened with the micro-organism of recurrent fever. With regard to cancer, the theory must be rejected that it is caused by stray embryonic cells, shut off and remaining latent, on the ground of evolution, because the lower animals, which also possess embryonic cells, never suffer from malignant growths except when they are provoked by external agents. It is therefore very probable that cancer in man is equally caused by some external agent, some virus which has been diligently sought, but has not yet been found.

Addresses were then presented by delegates from Japan, Norway, Portugal, Russia, Spain, Sweden, and Switzerland, and by delegates from the British colonies and the British Isles. After the English delegates had been presented, Sir Archibald Geikie, K.C.B., president of the Royal Society, said that the society desired to mark the importance of that occasion by having a special copy of the Darwin medal struck in gold for the acceptance of the University. It will be remembered that the medal owes its existence to the committee of the International Darwin Memorial Fund, which in 1885 transferred to the Royal Society the balance of the fund, in trust, to devote the proceeds from time to time toward the promotion of biological studies and research. The first award was made to Dr. Alfred Russel Wallace in 1890. Lord Rayleigh was the secretary of the society when the medal was cast. It was, therefore, Sir Archibald Geikie continued, a very great pleasure to the Royal Society to have it in its power to hand to Lord Rayleigh, for acceptance of the University, a copy of the Darwin medal.

The following address was then delivered by Dr. Henry Fairfield Osborn, the delegate of the American Philosophical Society:—

Prof. Henry F. Osborn.

Crossing the Atlantic in honour of Darwin and rejoicing in the privilege of uniting in this celebration of his birth, we desire, first of all, to render our tribute to the University of Cambridge.

To no other institution in any country may we turn with such a sense of filial gratitude. In ever widening growth has been the influence of the Cambridge heritage, as pictured more than four centuries ago in the generous mind of Sir Walter Mildmay, the founder of Emmanuel. "Sir Walter," remarked Queen Elizabeth, "I hear that you have erected a Puritan foundation." "No, madam," he replied, "far be it from me to countenance anything contrary to your established laws; but I have set an acorn, which, when it becomes an oak, God alone knows what will be the fruit thereof." Through John Harvard, of Emmanuel, Cambridge became the mother of our colleges. Did not Emmanuel beget Harvard, and Harvard beget Yale, and Harvard and Yale beget Princeton and other descendants to the third and fourth generation? We thus salute to-day the venerable but ever youthful ancestor of many of the American universities, academies, and institutes of science, national and State museums, represented here, and in large part guided by true sons of the true daughters of the Alma Mater on the Cam. Through the survival of the best our political guidance is also passing more and more into the hands of men trained in these same daughter colleges. A son of Yale succeeds a son of Harvard as President of the United States. If your university men are leading the Empire ours are leading the nation.

Noble offspring, too, of the many pious foundations of the old University, of Trinity, of Christ's, are the great men too numerous to name, among whom there especially rise in our minds Newton, Clerk-Maxwell, Balfour, and, above all, Darwin. Newton opened to us the new heavens and Darwin the new earth. Clerk-Maxwell, with Hertz, enabled us to converse across the sea through the blue æther. The well-beloved Balfour set forth Darwinism in embryology; would that his life had been spared for the more difficult problems of our day. If in our hours of struggle with the mysteries of nature these are our leaders and companions, so in our hours of ease and relaxation do we not turn again to sons of Cambridge for spiritual refreshment, to the verse of Milton, of Byron, of Wordsworth and Tennyson, all richly imbued with the nature spirit, or to the no less masterly prose of Thackeray and Macaulay?

Far away are the giant forces of our Republic, the roar of her machinery and her world of trade, yet more apparent than real is the independence of her development. There still prevails the potent unifying influence of mind and motive, bred in quiet places like this, ever creating new generations of leaders in science, in literature, and in government, and ever renewing the strong bonds of friendship and of union.

What can we add to the chorus of appreciation of the great pupil of Christ's, which has come from American college, Press, and pulpit, since the opening of this anniversary year? Only a few words of personal impression.

To us Darwin, more perhaps than any other naturalist, seems greatest in the union of a high order of genius with rare simplicity and transparency of thought. Dwelling on this lucid quality and on the vast range of his observation, from the most minute to the grandest relations in nature, does not the image arise of a perfected optical instrument, in which all personal equation, aberration, and refraction is eliminated, and through which, as it were, we gaze with a new vision into the marvellous forms and processes of the living world? With this wondrous lens our countrymen Cope and Marsh penetrated far deeper into fossil life than their predecessor Joseph Leidy—thus the arid deserts of the Rocky Mountains gave up their petrified dead as proofs of Darwinism. Through its new powers Hyatt, Morse, Packard, and Brooks saw far more than their master Louis Agassiz, and drew fresh proofs of the law of descent from the historic waters of New England. From the very end of the new world, where the youthful Darwin received his first impressions of the mutability of the forms of life, came a clearer vision of the ancient life of Patagonia.

The new vision opened upon a period of great men; and this again suggests a reminiscence. Thirty years ago two of the present delegates arrived in Cambridge as students. They heard Clerk-Maxwell developing his theories before the Cambridge Philosophical Society. Michael Foster was in his prime and lecturing in his inimitable manner. Francis Maitland Balfour had just completed his "Elasmobranch Fishes," and was working five hours a day on his "Comparative Embryology"; his lectures were brilliant and inspiring; his relations with students altogether ideal; in his rooms, among many others, one met Lankester and Moseley, and enjoyed a rare flow of conversation on all subjects except biology. Either as students or as young instructors were Sedgwick, Forbes, Shipley, Weldon, Haddon, Harmer, and others. In this Senate House Robert Browning, Spottiswoode, president of the Royal Society, and Huxley received their honorary degrees. Throughout the winter Huxley was delivering his remarkable lectures, "Darwinism in Comparative Anatomy," suggestive and with occasional flashes of humour, still strong and full of fire, but beginning to show the effect of years of overwork, of public service, and research. About once a week he came among his students. One day an unusual stir or thrill passed along the tables as with him entered Darwin, his first and only visit to a modern biological laboratory. Darwin paused for a few moments' conversation, and one received the strong impression of a ruddy face, benevolent blue eyes, very deep-set beneath the massive overhanging brow—a wonderful effect of kindliness and of the far-off world survey of a great naturalist.

What of Darwin's influence in the future? While it is doubtful if human speculation about life can ever again be so tangential or so astray on ultimate causes as in the pre-Darwinian past of fifty years ago, it is probable, in fact it is daily becoming more evident, that the destiny of speculation is less the tangent than the maze—the maze of several lesser principles, with as many prophets calling to us to seek this turning or that. There are those who, in loyal advocacy of his system, feel that we shall not get much nearer life than Darwin did; but this is to abandon his progressive leadership, for if ever a master defined the unknown and pointed the way of investigation, certainly it was Darwin. In the wonderful round of addresses in his honour of this centennial year and in the renewed critical study of his life and writings, the recognition that Darwin opened the way has come to many with the force of a fresh discovery. It is true that he left a system, and that he loved it as his own, but his forceful, self-unsparing, and suggestive criticisms show that if he were living in these days of Waagen, of Weismann, of Mendel, and of de Vries, he would be in the front line of inquiry, armed with inventive genius, with matchless assemblage of fact, with experiment and verification, and not least with incomparable candour and good-will. This bequest of a noble method is hardly less precious than the immortal content of the "Origin of Species" itself.

In conclusion, we delegates, naturalists, and friends, desire to present to Christ's College, as a memorial of our visit, a portrait of Charles Darwin in bronze, the work of our countryman William Couper, a portrait which we trust will convey to this and future generations of Cambridge students some impression of the rugged simplicity, as well as of the intellectual grandeur, of the man we revere and honour.

The speech next delivered by Sir Ray Lankester was an eloquent appreciation of Darwin's work and an unequivocal vindication of the theory of the origin of species by the preservation of minute variations favourable to existence under prevailing natural conditions.

SIR RAY LANKESTER, K.C.B., F.R.S.

I feel it a great honour to be called upon to speak here to-day, and to stand, on behalf of the naturalists of the British Empire, by the side of the distinguished men whose orations you have just heard.

I think that the one thing about Charles Darwin which the large majority of British naturalists would wish to be to-day proclaimed, in the first place—with no doubtful or qualifying phrase—is that, in their judgment, after these fifty years of examination and testing, his "theory of the origin of species by means of natural selection or the preservation of favoured races in the struggle for life" remains whole and sound and convincing, in spite of every attempt to upset it.

I am not stating more than the simple truth when I say that, in the judgment of those who are best acquainted with living things in their actual living surroundings, "natural selection" retains the position which Mr. Darwin claimed for it of being the main means of the modification of organic forms.

Our admiration for the vast series of beautiful observations and interesting inquiries carried out by Darwin during his long life must not lead us to forget that they were devised by him in order to test the truth of his theory and to meet objections to it, and that they were triumphantly successful. They, together with the work of Alfred Russel Wallace and many of their followers, have more and more firmly established Darwin's theory. On the other hand, no attempt to amend that theory in any essential particular has been successful.

The nature of organic variation and of the character of the variations upon which natural selection can and does act was not, as we are sometimes asked to believe, neglected or misapprehended by Darwin. The notion that these variations are large and sudden was considered by him, and for reasons set forth by him at considerable length rejected. That notion has in recent years been resuscitated, but its truth has not been rendered probable by evidence either of such an accurate character or of such pertinence as would justify the rejection of Darwin's fundamental conception of the importance of minute and ubiquitous variations.

Further, in regard to the important facts of heredity connected with the cross-breeding of cultivated varieties, especially in regard to the blending or non-blending of their characters in their offspring and as to prepotency, it seems to me important that we should now and here call to mind the full and careful consideration given to this subject by Darwin. We cannot doubt that he would have been deeply interested in the numerical and statistical results associated with the name of Mendel. Those results tend to throw light on the mechanisms concerned in hereditary transmission, but it cannot be shown that they are opposed in any way to the truth of Darwin's great theoretical structure—his doctrine of the origin of species.

It has often been urged against Darwin that he did not explain the origin of variation, and especially that he has not shown how variations of sufficient moment to be selected for preservation in the struggle for existence have in the first place originated. The brief reply to the first objection is that variation is a common attribute of many natural substances of which living matter is only one. In regard to the second point, I desire to remind this assembly that Darwin described with special emphasis instances of what he calls "correlated variability." In my opinion he has thus furnished the key to the explanation of what are called useless specific characters and of incipient organs. That key consists in the fact that a general physiological property or character of utility is often selected and perpetuated, which carries with it distinct, even remote, correlated growths and peculiarities obvious to our eyes, yet having no functional value. At a later stage in the history of such a form these correlated growths may acquire value and become the subject of selection.

It is thus, as it seems to me, and as, I believe, to the great body of my brother naturalists, that Darwin's theory stands after fifty years of trial and application.

The greatness of Charles Darwin's work is, and will be for ever, one of the glories of the University of Cambridge. It is fitting on the present occasion that one who speaks on behalf of English men of science should call to mind the nature of his connection with this great University and the peculiarly English features of his life-story and of that fine character which endears his memory to all of us as much as his genius excites our admiration and reverence. Darwin was not, like so many a distinguished son of Cambridge, a scholar or a fellow of his college, nor a professor of the University. His connection with the University and the influence which it had upon his life belong to a tradition and a system which have survived longer in our old English universities than in those of other lands. Darwin entered the University, not seeking a special course of study with the view of professional training, nor aiming at success in competitive examinations for honours and emolument. He came to Cambridge intending to become a clergyman, but blessed with sufficient means and leisure to enable him to pursue his own devices, to collect beetles, to explore the fen country, and to cultivate his love of nature. It was thus that he became acquainted with that rare spirit Henslow, the Cambridge professor of botany, and it is through Henslow and the influence of his splendid abilities and high personal character upon Darwin that Cambridge acquired the right to claim the author of the "Origin of Species" as a product of her beneficence and activity as a seat of learning.

As an Oxford man and a member of Exeter College, I may remind this assembly that in precisely the same way Darwin's dearest friend and elder brother in science, Charles Lyell, had a few years earlier entered at Exeter College, and by happy chance fallen under the influence of the enthusiastic Buckland, the University reader in geology and a Canon of Christ Church. The wise freedom of study permitted and provided for in those long-passed days by Oxford and Cambridge is what has given the right to claim the discovery, if not the making, of Lyell to the one and of Darwin to the other.

Darwin's love of living nature and of the country life are especially English characteristics; so, too, I venture to think, are the unflinching determination and simple courage—I may even say the audacity—with which he acquired, after he had left the University, the wide range of detailed knowledge in various branches of science which he found necessary in order to deal with the problem of the origin of the species of plants and animals, the investigation of which became his passion.

The unselfish generosity and delicacy of feeling which marked Darwin's relations with a younger naturalist. Alfred Russel Wallace, are known to all. I cannot let this occasion pass without citing those words of his which tell us most clearly what manner of man he was and add to his splendid achievements as an intellectual force—a light and a beauty of which every Englishman must be proud. When in old age he surveyed his life's work he wrote:—"I believe that I have acted rightly in steadily following and devoting my life to science."

To have desired to act "rightly" and to be able to think of success in life as measured by the fulfilment of that desire is the indication and warrant of true greatness of character. We Englishmen have ever loved to recognise this noble kind of devotion in our national heroes.

In connection with the celebration, several learned bodies conferred honours upon the Chancellor, and upon Mr. Francis Darwin, F.R.S., and Sir George Darwin, K.C.B., F.R.S. Among these marks of recognition were the following:—Lord Rayleigh (Chancellor), corresponding member of the Senkenbergische Naturforschende Gesellschaft, Frankfurt-am-Main, and honorary member of the University of Moscow; Mr. Francis Darwin, member of the American Philosophical Society, foreign member of the Société Hollandaise des Sciences, corresponding member of the Senkenbergische Naturforschende Gesellschaft, Frankfurt-am-Main, honorary member of the Soc. Cæs. Naturæ Curiosorum, Moscow, honorary member of the University of Moscow, and Fellow of the Kaiserliche Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher, Halle; Sir George Darwin, corresponding member of the Senkenbergische Naturforschende Gesellschaft, honorary member of the Soc. Cæs. Naturæ Curiosorum, Moscow, honorary member of the University of Moscow, and Fellow of the Kaiserliche Leopoldinisch–Carolinische Deutsche Akademie der Naturforscher, Halle.

SPEECHES AT THE BANQUET.

At the banquet on June 23 Mr. Balfour and Prof. Svante Arrhenius proposed the toast which was drunk in silence to the memory of Darwin. In the course of his remarks Mr. Balfour said:—

Charles Darwin's performances have now become part of the common intellectual inheritance of every man of education wherever he lives or whatever his occupation or trade in life. To him we trace in the main the view which has affected, not merely our ideas of the development of living organisms, but our ideas upon politics, upon sociology, ideas which cover the whole domain of human terrestrial activity. He is the fount and origin, and he will stand for all time as the man who has made this great, and, as I think, beneficent revolution in the mode in which educated men can see the history, not merely of their own institutions, not merely of their own race, but of everything which has that unexplained attribute of life, everything that lives on the surface of the globe or within the depths of the ocean. He is the Newton of this great department of human research, and to him we look, as we looked to Newton, to measure out heavens or to weigh suns and their attendant planets. After all, the branch of research which he initiated is surely the most difficult of all. I talk of measuring heavens and weighing suns, but surely these are tasks incomparably easy compared with the problem that attracts the physiologist and the morphologist in dealing with the living cell, be it plant, or animal, or man. That problem of life is one which it is impossible for us to evade, which it may be impossible for us ultimately to solve, but in dealing with which in its larger manifestations Charles Darwin made greater strides than any man in the history of the world has made before or any man has made since.

Prof. Arrhenius then spoke as follows :—

Evolutional ideas are as old as human civilisation. We find traces of them in old Egyptian legends of the growth of mankind, in Hindu myths, as well as in the cosmogony of Herod and in Ovid's Metamorphoses. During the lapse of centuries they were developed by philosophers and astronomers, *i.e.* by the men of the oldest sciences; and in the eighteenth century, when most modern sciences took a distinct shape, those ideas formed important parts of the scientific work of Kant, and still more in the admirable theoretical speculations of Lamarck. But still the finalist school, founded on primitive and mediæval considerations, was in the highest degree preponderant; and the leading biologist at the end of that century, Cuvier, had no conception of evolutionism. Even in Kant's works we find the finalistic ideas prevailing.

To accomplish the now prevailing evolutionary ideas a great work was necessary, in order that these should be developed into a system embracing all the biological sciences with the strictest logic and severest criticism. The attempts made at the beginning of the nineteenth century by many scientific men, amongst whom the name of Charles Darwin's grandfather, Erasmus Darwin, may be recalled, were far from sufficient. The epoch-making work was delivered by Charles Darwin, who, with an unrivalled patience and diligence, as well as a rare impartiality, during nearly thirty years, collected and sifted the enormous material upon which is based his masterly work "The Origin of Species."

It must be said that the time was ripe for the triumph of the conception of evolution, as is clearly indicated by the simultaneous work of Wallace on biology and by the publication of Herbert Spencer's philosophical investigations. Charles Darwin was also immediately followed by enthusiastic and prominent adherers, such as Huxley and Haeckel, who propagated and worked out the new doctrines.

This rapid success also caused a strong reaction from the side of the representatives of the old finalistic ideas, grown strong through centuries. The battle fought between the two parties carried the new ideas into common life, far from the men of science and the philosophers' study. During the last decade of his life Darwin had the good fortune to see his ideas brought to definite victory and generally accepted, not only in the vast domain of biology, which has been spoken of so eloquently this morning, but even by scientific men in general, and by the enlightened public opinion.

Charles Darwin had a clear perception of the far-reaching importance of his ideas. He applied them in elaborate investigations concerning the development of the intellectual and reflective faculties, to the formation of primitive social ideas amongst animals and men, to the genesis of the most elementary moral and religious conceptions, as well as to the fundamental problems of anthropology.

The more these various questions have been discussed the more the doctrine of evolution has grown in strength, and the greater has been the extent to which science has been brought under its beneficent influence. Nowadays there is hardly a science which has not been affected and in many cases thoroughly permeated by it. The sociological and statistical sciences now rest on an evolutional basis; history, and especially the history of culture, has found through it new lines of development; the linguist tries to find the natural laws of development of languages; the lawyer sees the legislative work of past generations and foresees their future modifications from the standpoint of evolution; the criminalist seeks the sources of crime in the influence of heredity and environment; and even the theologian, who for so long a time rejected the new ideas, finds now in them essential points of high ethical charm which he seeks to reconcile with true religion. At the same time, the investigators in exact sciences, where the doctrine of evolution had been adopted earlier than in biological sciences, were inspired to new and successful efforts to use it, as is, for example, obvious from the researches of Sir George Darwin, who, as well as the other members of the family, is a brilliant example of the heredity of intellectual properties.

Science is international; and this momentous movement has been felt in every country in the civilised world. Therefore we, representatives of all sciences, have come from all parts of the world to join you in doing homage to the memory of the greatest of all evolutionists.

All of us are profoundly sensible that the great intellectual revolution which is due to the introduction of evolutionism is the most important event in the development of the human mind, since the mighty political movement which began with the storming of the Bastille 120 years ago. There is, however, this significant difference between that time and this, that whereas in such a period every mighty change in the social, political, and intellectual development of mankind was only effected by strife and horrors of war, to-day, thanks to the civilising progress, this change has been accomplished by reason and persuasion. "The pen has been mightier than the sword." How much may we not congratulate ourselves that we have lived in such a period? In reality, the doctrine of evolution is inconsistent with violence, and we may hope, therefore, that it will give a mighty impetus to the maintenance of peace and a good understanding between civilised nations.

In conclusion, let me say that in thus venerating Darwin's memory all men of science regard him, not only as an ideal man of science, but as a man of science whose power and influence have been enhanced by his integrity and moral worth.

In replying to the toast, Mr. W. Erasmus Darwin related some interesting incidents as to Darwin's kindly and considerate nature in his home life. The toast of "The University of Cambridge" was proposed by Prof. E. B. Poulton, F.R.S., who asked whether the comparative freedom enjoyed by Darwin in his college life would be possible in these days of examination pressure. The vice-chancellor, in responding to the toast, said it was hoped that Dr. Wallace would attend the celebration and receive an honorary degree at Cambridge, but his health would not permit him to accept the invitation. The suggestion had been made (we understand it came from Prof. Meldola) that a message should be sent to Dr. Wallace; and the vice-chancellor announced that the following telegram had been sent :—"The naturalists, assembled at Cambridge for the Darwin celebration, cannot forget your share in the great work which they are commemorating, and regret your inability to be present."

On Thursday, June 24, the concluding day of the celebration, honorary degrees were conferred upon twenty-one of the delegates, and Sir Archibald Geikie delivered the Rede lecture already mentioned. The

Public Orator, Dr. Sandys, spoke as follows in presenting the several distinguished recipients of the degree of Doctor of Science *honoris causa* :—

PRINCE ROLAND BONAPARTE.—Agmen honorum nostrorum ducit hodie imperatoris magni fratris natu minoris nepos, cuius avunculi insignes scientiarum e provinciis inter se diversis palmas plurimas tulerunt. Ipse, Francogallorum in Republica maxima, et Instituti celeberrimi socius et Societatis Geographicae praeses iure optimo est electus. Olim geologiae, botanicae, zoologiae, anthropologiae studiis non sine gloria deditus, non modo gentis suae incunabula, insulam Corsicam, sed etiam orientem versus solem insulas remotiores victor felix exploravit. Idem orbis veteris e scientiarum castris trans aequor Atlanticum pacis satelles est profectus, velut alter Caesar

"victrices aquilas alium laturus in orbem." [1]

EDOUARD VAN BENEDEN, PROFESSOR OF ZOOLOGY AT LIÈGE.—Ductori nostro proximus progreditur Belgarum e gente vicina, Leodiensium ex Universitate insigni, professor praeclarus, Biologiae Archivorum fundator, cytologiae hodiernae conditor, qui, in opere singulari de *Ascaride megalocephala* conscripto, utriusque sexus cellularum nucleos etiam in morphologia idem valere diligenter demonstravit. Idem de vespertilionum, rodentium, crustaceorum, tunicatorum embryologia, deque *Dicyemidorum* formis egregie disputavit. Atqui haec omnia nonnullis vestrum quam nobis notiora sunt; illud autem nobis non ignotum, zoologiae professorem tam illustrem Francisci Balfourii nostri amicum olim fidelem fuisse.

OTTO BUTSCHLI, PROFESSOR OF ZOOLOGY AT HEIDELBERG.—Zoologiae professorem Heidelbergensem ovi cellulae in auctu investigando plurimis praecursorem praeclarum exstitisse constat. Idem *Infusoriorum* de vita tota, cellularum binarum praesertim de coniugatione, opus egregium conscripsit; in aliorum et sui ipsius circa *Protozoa* laboribus recensendis, ceteros superavit; etiam bacteriorum ipsam structuram explicavit; porro, in *Protozois* et *Protophytis* illis quae nomine uno *Protista* appellantur, amylum quomodo conformatum, quomodo distributum sit, aperte demonstravit; olim denique, non sine labore multo et minuto, *protoplasma* non iam reticulatam sed alveolarem quandam formam spumeam habere comprobavit. Nonnullorum fama cito peritura, velut spuma in fluctibus summis evanescit; viri huius in rerum natura penitus explorauda virtutem, "merses profundo; pulchrior evenit." [2]

ROBERT CHODAT, PROFESSOR OF BOTANY AT GENEVA.—Genevensi in Universitate, abhinc annos plus quam centum, plantarum physiologiae chemicae scientiam condidit vir illustris, Horatius Benedictus de Saussure. In eadem doctrinae sede viri tanti vestigiis summa cum laude insistit botanicae professor insignis, quem hodie salutamus. Scientiae illius de principiis praeclare disputavit; experimentis plurimis adhibitis, plantarum cotidie crescentium leges explicavit; fermentorum denique in plantis naturam ipsam patefecit. Idem, florum in scientia universa sollertissimus, non modo herbario celeberrimo inter populares suos praefuit, sed etiam algas virides minutissimas illas, quae patriae pulcherrimae lacus immensos incolunt, arte eximia depinxit, libro egregio descripsit.

FRANCIS DARWIN, HONORARY FELLOW OF CHRIST'S COLLEGE.—Patris illustris e filiis insignibus adest unus, qui patris cum operibus consociatus ultimis, viri tanti vitam et litteras diei in lucem non sine laude protulit. Botanicae provincia physiologica et libris et experimentis suis inter nosmet ipsos praeclare propagata, patris a Collegio propterea honoris causa socius merito est nominatus. Nuper, in libro egregio patris sui in honorem a plurimis conscripto, ipse et patris et sua et aliorum de motibus plantarum inventa luculenter perlustravit. Idem in anno praeterito Societatis Britannicae scientiarum finibus proferendis disputationes oratione egregia auspicatus, plantarum in motibus explicandis, plantis ipsis annorum volventium in serie memoriam quandam tribuebat. Hanc potissimum ob causam, non modo patris, sed etiam proavi, Florae poëtae eximii, ingenium praeclarum utriusque in progenie revixisse crediderim.

KARL F. VON GOEBEL, PROFESSOR OF BOTANY IN MUNICH.—Bavaria ad nos misit Florae ministrum insignem Monacensem, qui, post peregrinationes longinquas in India, in Venezuela, in Australia toleratas, de studiis suis pulcherrimis cum oratore Romano potest dicere :—"haec studia delectant domi; haec studia nobiscum peregrinantur." [1] Florum de biologia universo, florum de formis inter se diversis et originis et loci e natura varia exortis, florum de partibus minutissimis accuratissime describendis, quam praeclare meritus est! Darwini nostri de florum scientia inventa insignia quam penitus perscrutatus est; etiam ipse rerum naturae provinciae illius pulcherrimae in penetralia intima quam feliciter penetravit!

LUDWIG VON GRAFF, PROFESSOR OF ZOOLOGY AT GRAZ.—Salutamus deinceps virum genere insigni natum, Academiae et Berolinensis et Vindobonensis socium, in Universitate Graecina zoologiae professorem iucundissimum, qui liliorum marinorum parasiti cuiusdam anatomiam impeditam primus explicavit; quique non modo opera tria egregia de *Turbellariis* conscripsit, sed etiam de animalium parasitis in universum praeclare disputavit. Hodie vero magis iucundum, immo magis opportunum est, orationem illam eximiam recordari, quam abhinc annos tredecim zoologiae post Darwinum nostrum fortunis describendis dedicavit. Quod autem ad annum proximum attinet, auguramur virum tanta benignitate, tanta comitate praeditum, gentium omnium zoologis in Universitatem suam convocatis praesidem fore sine dubio acceptissimum.

RICHARD HERTWIG, PROFESSOR OF ZOOLOGY IN MUNICH.—Zoologiae professorem insignem Monacensem deinceps contemplatus, protinus videor mihi ante oculos ponere "par nobile fratrum." [2] Cum fratre suo illustri Berolinensi consociatus, quem hodie praesentem honoris causa salutamus, *Medusarum* et *Polyporum* de nervis sensibusque, anemones marinae de embryologia et anatomia, cellularum in universum de morphologia et physiologia, animantium denique de corporis inferioris intervallo quodam interiore quod κοῖλον nominatur, plurima praeclare conscripsit. Ipse, non modo zoologiae studiosis encheiridion doctrinae variae plenum donavit, sed etiam peritiorum in usum de *Radiolariorum* morphologia, de *Actiniariis* a nostratibus e profundo mari reportatis, de *Protozoorum* denique structura vitaque tota, erudite disputavit. Per orbem terrarum totum nota est praeceptoris tanti schola zoologica Monacensis, ex qua, "tamquam ex equo Troiano," [3] tot milites optimi exierunt.

HARALD HÖFFDING, PROFESSOR OF PHILOSOPHY AT COPENHAGEN.—Philosophiae professorem insignem Hauniensem Darwini in honorem legatum esse missum nemo mirabitur, qui ex opere eius novissimo didicit inter philosophiam et rerum naturae scientiam prorsus distinguere perquam esse arduum. Philosophiae in historia sua in tot linguas reddita, quid potissimum spectet, fortasse requiritis. Respondeo :—philosophi cuiusque personam. Etiam in psychologiae studio, quid praesertim praesumit? Personam. Deinde, religionis in philosophia, et officiorum in finibus proponendis, quid demum magis indies ante oculos nostros positum esse existimat? Ordinis magis continui adpetitio, partim in unaquaque persona, partim inter se diversis in personis. Quid denique professorem ipsum, non modo Reginae nostrae, populari suae, sed etiam amicis suis omnibus, tam amabilem reddit? Ipsius persona. Videtis virum sagacem, qui caritate summa adversus omnes imbutus, "omnia sperat"; [4] quique ingenio bene temperato, animo bene librato praeditus, monitum illud Horatianum constanter conservat :—"aequam memento rebus in arduis servare mentem." [5]

JACQUES LOEB, PROFESSOR OF PHYSIOLOGY IN THE UNIVERSITY OF CALIFORNIA.—Oceani Pacifici a litore legatus ad nos advectus est Californiae in Universitate physiologiae professor, veritatis indagator pertinax, qui, experimentis exquisitis adhibitis, rerum earum, quarum in medio animalia versantur, effectus inter se diversos distinguere est conatus. Non modo de caloris sed etiam de coloris et luminis vi, de geminorum origine, echinorum denique de ovi maturitate aut sanguine iniecto aut sale infuso in maius exaucta, quam subtiliter disputavit! Etiam in alia rerum provincia, Horati in saeculo, Epicuri

[1] Lucan, v. 238. [2] Horace, *Carm.* iv. 4, 65.

[1] Cp. Cicero, *pro Archia*, 16. [2] Horace, *Serm.* ii. 3, 243.
[3] Cicero, *De Oratore*, ii 94. [4] S. Pauli *Ep. ad Cor.* 1, xiii. 7.
[5] *Carm.* ii. 3, 1.

(nisi fallor) sectator quidam tractabat "echinos, ut melius, muria."[1]

EDMOND PERRIER, DIRECTOR OF THE NATURAL HISTORY MUSEUM, PARIS.—Sequitur deinceps Francogallorum Instituti celeberrimi et Academiae Medicae socius insignis, qui historiae naturalis Museum Parisiense tutelae suae creditum optime ordinavit. Olim, in philosophiae zoologicae incrementis enarrandis, populari suo, Stephano Godofredo Saint-Hilaire, inter Darwini nostri praenuntios locum praeclarum vindicavit. Ipse postea zoologiae universae describendae opus eximium consecravit. Quid dicam de animalium coloniis ab eodem accuratissime examinatis? quid de vermibus terrenis, quid de maris Mediterranei liliis dilucide descriptis? Illud unum dixerim: mari profundo penitus explorando plus quam semel peregre praefuit, interque rerum naturae interpretes optimos exstitit, qui patriae in gloriam numquam perituram

> "referebant navibus altis
> occulta spolia, et plures de pace triumphos."[2]

GUSTAV ALBERT SCHWALBE, PROFESSOR OF ANATOMY AT STRASSBURG.—Anatomiae professor Argentoratensis, in Aegypto et in America Septentrionali orbis novi et orbis antiqui explorator, anthropologiae provinciam totam peragravit; sensuum humanorum rationem universam explicavit; hominum antiquissimorum capita et ossa hic et illic reperta accuratissime descripsit. Homo est; humani nil a se alienum putat.[3] Stilo perquam lucido praeditus, non modo *Hominem primigenium* sed etiam *Pithecanthropum erectum* litterarum monumentis mandavit. Atqui, si antiquas quoque litteras licet hodie recordari, non de hominis propinquo quodam paupere, non de simia quadam mentis sublimioris nescia, sed de homine ipso donis optimis divinitus donato poëtae antiqui verba illa dicta sunt:—

> "os homini sublime dedit, caelumque tueri
> iussit, et erectos ad sidera tollere vultus."[4]

HERMANN GRAF ZU SOLMS-LAUBACH, PROFESSOR OF BOTANY AT STRASSBURG.—Salutamus etiam botanicae professorem Argentoratensem, virum genere antiquo, genere per annos prope octingentos nobili oriundum, qui arborum et plantarum reliquias antiquissimas saxorum in latebris conservatas opere in illo eximio descripsit, quod etiam in Britannia palaeophytologiae ad studium aditus faciliores plurimis patefecit. Idem, non modo Actis Botanicis edendis iam per annos viginti feliciter interfuit, sed etiam ipse de geographiae botanicae principiis, de floribus parasitis, de fungis et algis, de sinus Neapolitani corallinis, de fragaria, de tritico, de tulipa, de ficu, de aliis denique hortorum nostrorum plantis plurima non sine gloria conscripsit.

> "Patriam obruit olim
> gloria paucorum, et laudis titulique cupido
> haesuri saxis cinerum custodibus, ad quae
> discutienda valent sterilis mala robora ficus";[5]

haec autem generis nobilis progenies, vir iucundus, lepidus, modestus, titulo nostro dignissimus, tot rebus ingenio summo penitus exploratis, omnium bonorum in laude "monumentum aere perennius" invenit.

CLEMENT TIMIRIAZEFF, PROFESSOR OF BOTANY IN MOSCOW.—Meministis fabulosum illum Collegiorum nostrorum unius alumnum, qui ad insulam *Laputa* peregrinatus, incolas eius omnes solis de salute cotidie sollicitos invenit, inque Academia celeberrima Lagadensi professorem quendam venerabilem vidit, qui solis radiis e cucumerum cellulis eliciendis annorum octo labores incassum impenderat. Consilium tam mirum non prorsus absurdum fuisse botanicae professor quidam Moscuensis coram Regia Societate nostra non sine lepore indicavit. Scilicet per longos labores ipse comprobavit non modo solis radios in cucumi esse inclusos, sed etiam fructuum frondiumque omnium partem viridem solis e lumine radios illos tremulos eligere, quorum auxilio carbonium (ut aiunt) in aëre toto diffusum in materiam quandam vivam permutat. Idem spectri (quod dicitur) e parte rubra radios illos exortos esse docuit, qui frondium in vitam mutati, omnium hominum, omnium animalium corpora per tot saecula aluerunt. Ergo de spectri illius exemplo pulcherrimo, de arcu caelesti, verba olim divinitus dicta saeculo nostro sensu novo denuo commendata sunt—"Erit arcus in nubibus, et recordabor foederis sempiterni quod pactum est inter Deum et omnem animam viventem universae carnis, quae est super terram."[1]

FRANTIŠEK VEJDOVSKÝ, PROFESSOR OF ZOOLOGY IN PRAGUE.—Bohemorum in Universitate Pragensi zoologiae professor praeclarus, patriae inter flumina lacusque, spongillarum vermiumque in varietate maxima, studiorum suorum argumenta plurima invenit. Idem, bacteriorum in structura investiganda, etiam nucleum secundum ipsam normam invenisse dicitur. Deinde, de nucleorum natura in universum, deque ovi fecundi reddendi ratione omni, nunc maxime inquirit. Denique, ne laudationis nostrae in fine aculeum quendam desideretis, ne scorpionum quidem genus intactum reliquit.

MAX VERWORN, PROFESSOR OF PHYSIOLOGY AT GOTTINGEN.—Goettingensis Universitas, vinculo antiquo cum Britannis coniuncta, legatum ad nos misit physiologiae professorem insignem, virum ingenio versatili et multiplici praeditum, qui non modo archaeologiae regionem antiquissimam, aevi medii artes, scientiam denique numismaticam temporis subsicivi in deliciis habuit, sed etiam ante omnia scientiae illi magnae quae vitam universam investigat vitam prope totam dedicavit. Peritis notum est (ne minora commemorem) opus illud ingens annorum quattuordecim in spatio iam quinquies in lucem editum, in quo a cellulis singulis exorsus physiologiae provinciam totam ita peragravit, ut non modo scientiae ipsius historiam, philosophiam, psychologiam ipse suo Marte tractaverit, sed etiam aliorum inventa praeclara ingenii sui lumine illustraverit.

HERMANN VON VÖCHTING, PROFESSOR OF BOTANY AT TUBINGEN.—Florae in sacerdote celeberrimo Tuebingensi Darwini nostri discipulum praeclarum agnoscimus, qui plantarum in motibus accuratissime examinandis felicissimus, docet libramento quam exquisito nutet tremulae flos violae, caput aureolum exserat narcissus; quanta sollertia herba quaeque viridis frondes suas ita explicet, ut solis lumen vitale quam plurimum accipiat. Idem, "polaritatis" secundum legem quandam, ostendit in arborum ramis amputatis quantum a parte summa pars ima discrepet; quot quaestiones subtilissimas sapientissimo cuique subiciat rusticus ille simplex, qui ex omni hominum memoria in perpetuum conservat,

> "quos ipse via sibi repperit usus:
> hic plantas tenero abscindens de corpore matrum
> deposuit sulcis, hic stirpes obruit arvo."[2]

HUGO DE VRIES, PROFESSOR OF BOTANY AT AMSTERDAM.—Darwini nostri in memoriam decoramus hodie botanicae professorem Amstelodamensem, virum a Societate Regia numismate aureo Darwini in honorem instituto donatum. Quam pulchre ostendit, quam varium, quam mutabile sit florum genus illud pulchrum quod primula vespertina vel potius *Oenothera* nominatur! Alii, inter quos honoris causa Raium nostrum[3] nominamus, aiunt; "Natura non facit saltus"; hic autem speciem unamquamque, non e fluctuatione tam tarda ut oculorum aciem effugiat, sed e mutatione subita censet exoriri. Natura saltus igitur nonnumquam facit.

CHARLES DOOLITTLE WALCOTT, SECRETARY OF THE SMITHSONIAN INSTITUTE, WASHINGTON.—Trans aequor Atlanticum alter ad nos venit legatus insignis, Instituti celeberrimi Washingtonensis administrator indefessus, Americanorum in Republica maxima explorationi geologicae universae quondam praepositus. Zonae Olenelli, rupium illarum antiquissimarum, in quibus vitae formae fossiles (ut aiunt) repertae sunt, de incolis extinctis praeclare disputavit. Idem Cambriae in saxis, non modo *Brachiopoda* subtilissime examinavit, sed etiam *Trilobites* illos, quorum in oculo uno saxi in caligine aeterna clauso radiorum lucidorum sex milia olim scintillabant. Rerum natura, in magnis magna, in minimis quam immensa!

EDMUND BEECHER WILSON, PROFESSOR OF ZOOLOGY IN THE COLUMBIA UNIVERSITY, NEW YORK.—Populari suo proximus adsurgit Novi Eboraci in Universitate Colum-

[1] *Serm.* ii. 8, 52 f. [2] Juvenal, viii. 106 f. [3] Terence, *Heaut.* 77. [4] Ovid, *Met.* i. 85 f. [5] Juvenal, x. 143 f.

[1] *Genesis*, ix. 16. [2] Virg. *Georg.* ii. 22 f.
[3] John Ray, *Historia Plantarum*, i. (1686) 50, "Cum enim *Natura* (ut dici solet) *non faciat saltus*, nec *ab extremo ad extremum transeat*, *nisi per medium* . . ."; cp. Linnaeus, *Philosophia Botanica* (1770), p. 27, § 77.

biana zoologiae professor, qui saltationes illas *karyokinesis* nomine nuncupatas descripsit, quas ovorum in cellulis dividendis nucleorum fragmenta certatim exercent. In insectis autem nonnullis, docente doctore nostro novo, determinatur sexus, prout nucleorum fragmentum unum aut adest aut abest. Genus femininum tot fragmenta efficiunt; fragmenta uno tantum minora masculinum. Videtis, Academici, discrimine quam tenui genus masculinum a genere feminino separetur, ne dicam superetur.

CHARLES RENÉ ZEILLER, PROFESSOR OF PALÆOBOTANY IN PARIS.—E tot doctoribus supremus adest Francogallorum Instituti celeberrimi socius, palaeobotanicae professor praeclarus Parisiensis, qui iam per annos triginta plantas fossiles (ut aiunt) accuratissime examinavit; Africae, Americae, Indiae, Asiae Minoris flores extinctos non sine summo iudicio, non sine summo ingenio, investigavit. Viri huius auxilio, Florae antiquae e monumentis non iam unum alterumve capitulum perbreve, non iam paginae cuiusque lineae paucissimae, sed novae paginae plurimae, orbis terrarum quasi vitae perpetuae ad catenam continuam anulos novos addiderunt.

> "Sic unumquicquid paulatim protrahit aetas
> in medium, ratioque in luminis erigit oras.
> namque alid ex alio clarescere et ordine debet
> *omnibus*, ad summum donec venere cacumen."[1]

Rerum naturae seriem aeternam claudit *Homo sapiens*: honorum nostrorum seriem hodiernam claudit vir in Flora antiqua sapientissimus, Carolus Renatus Zeiller.

[1] Lucretius, v. *ad finem*.

A NEW ANALYTICAL ENGINE.

THE April number of the Scientific Proceedings of the Royal Dublin Society contains an interesting and very original paper by Mr. Percy E. Ludgate on a proposed analytical machine. Of all calculating machines, the analytical machine or engine is the most comprehensive in its powers. Cash till reckoners and adding machines merely add or add and print results. Arithmometers are used for multiplying and dividing, which they really only accomplish by rapidly repeated addition or subtraction, with the exception alone, perhaps, of the arithmometer of Bollée, which, in a way, works by means of a mechanical multiplication table. Difference engines originated by Babbage produce and print tables of figures of almost any variety, but the process is one of addition of successive differences. The analytical engine proposed by Babbage was intended to have powers of calculation so extensive as to seem a long way outside the capacity of mere mechanism, but this was to be brought about by the use of operation cards supplied by the director or user, which, like the cards determining the pattern in a Jacquard loom, should direct the successive operations of the machine, much as the timing cam of an automatic lathe directs the successive movements of the different tools and feeding and chucking devices. However elaborate the mechanism of Babbage, if completed, might have been, the individual elements of operation would, so far as the writer has been able to understand it, have been actually operations of addition or subtraction only, and, with the exception of the method of multiplication created by Bollée, the writer does not recall any case in which mechanism has been used to compute numerical results except by the use of the processes of addition or subtraction, simple or cumulative. Of course, harmonic analysers and other instruments depending on geometry are not included in the category of machines which operate on numbers.

The simplicity of the logarithmic method of multiplying must have made many inventors regret the inherent incommensurability of the function to any simple base, or, if commensurability is attained for any particular number and its powers by the use of an incommensurable base, the incommensurability of the corresponding logarithms of numbers prime to those first selected. On this account the writer has always imagined that the logarithmic method was unsuited to mechanism, or, if applied at all, could only be so applied at the expense of complication, which would more than compensate for the directness of the process of logarithmic multiplication.

Mr. Ludgate, however, in effect, uses for each of the prime numbers below ten a logarithmic system with a different incommensurable base, which as a fact never appears, and is able to take advantage of the additive principle, or, rather, it is so applied that the machine may use it. These mixed or Irish logarithms, or index numbers, as the author calls them, are very surprising at first, but, if the index numbers of zero be excepted, it is not difficult to follow the mode by which they have been selected. The index numbers of the ten digits are as follows:—

Digit	0	1	2	3	4	5	6	7	8	9
Index number.	50	0	1	7	2	23	8	33	3	14

When two numbers are to be multiplied, the index numbers of the several digits are mechanically added to the index numbers of each of the digits of the other, and, the process of carrying the tens being carried on simultaneously, the time required is very small. For instance, the author gives as an example the multiplication of two numbers of 20 digits each, which will require 40 of these additions, which he shows will require $9\frac{1}{2}$ time units if a time unit is one-tenth of the time of revolution of a figure wheel.

Unfortunately, while the principle on which the proposed machine is to work is described, only the barest idea of the mechanical construction is given, so that it is difficult to judge of the practicability of the intended construction. Whatever this may be, the originality of the method of mixed commensurable logarithms to incommensurable bases seems to the writer so great and the conception so bold as to be worthy of special attention.

Division has hitherto always been effected by the process of rapid but repeated subtraction, following in this respect the method practised with pencil and paper. Having discovered how to harness the logarithm to mechanism, Mr. Ludgate would, it would be expected, have managed to effect division by a logarithmic method, and possibly he could have done so, but here again he has left the beaten track, and by his ingenuity has made division a direct, and not, as hitherto, an indirect or trial-and-error process. Starting with a table of reciprocals of all numbers from 100 to 999, which in a mechanical form is intended to be stored in the machine, he imagines both numerator and denominator of the required fraction p/q to be multiplied by the reciprocal A of the first three digits of q so as to become Ap/Aq. Aq must, then, in every case begin with the digits 100, and it may be written $1+x$, where x is a small fraction. Then $p/q = Ap(1-x)(1+x^2)(1+x^6)(1+x^8)$ . . . a highly convergent series of which five terms will give a result correct to twenty figures at least, and so division is intended to be effected by a process of direct multiplication.

Until more detail as to the proposed construction and drawings are available it is not possible to form any opinion as to the practicability or utility of the machine as a whole, but it is to be hoped that if the author receives, as he deserves, encouragement to proceed with his task, he will not allow himself to become swamped in the complexity which must be necessary if he aims at the wide generality of a complete analytical engine. If he will, in the first instance, produce his design for a machine of restricted capacity, even if it does no more than an arithmometer, he will, by demonstrating its practicability and advantages, be more likely to be enabled to proceed step by step to the more perfect instrument than he will if, as Babbage did, he imagines his whole machine at once. In the writer's opinion, the ingenuity required to arrange a complete analytical engine is really in great part misplaced. Such a machine can only be used and kept in order by someone who really understands it, and it would seem to the writer of this notice more practicable to allow the user's attention to replace the action of operation cards, and leave to the machine the more direct numerical evaluations.

C. V. BOYS.

PROF. D. J. CUNNINGHAM, F.R.S.

THE death of this eminent anatomist occurred on Wednesday of last week, June 23. It was known that Prof. Cunningham had been ill for several months, but the fatal nature of the illness was not at first recognised, and the news of his untimely death in the full vigour of his powers will have come as a shock to many of his friends, and their name is legion.

Daniel John Cunningham was born in April, 1850, at Crieff, where his distinguished father, who was later to become principal of St. Andrew's University, was then the minister. His school days were passed at Crieff Academy. At the age of seventeen he was sent to Edinburgh University, and began the study of medicine. Here he had a brilliant career as a student, and in 1874 took his M.B. degree with first-class honours. In 1876 he proceeded to the M.D. degree, the subject of his thesis being "The Anatomy of the Cetacea"; for this he was awarded a gold medal. His work on this subject was performed in the anatomical department of the university, where he was acting as assistant demonstrator to Prof. Turner; the influence of the master is apparent in the work of the pupil.

In 1876 Cunningham became principal demonstrator of anatomy, a position of much responsibility, as well as of great advantage to the holder from the experience in anatomical work and in teaching which it offers. Of this experience he took full advantage, and his high qualifications were recognised when he was appointed in 1882 to the chair of anatomy in the Royal College of Surgeons in Dublin. This appointment was not long held by him, for in the following year his services were transferred to the much more important chair of anatomy in Trinity College. Here he remained until 1903, when, on the retirement of Sir William Turner from the professorship of anatomy in the University of Edinburgh, it was felt that there was only one man worthy to succeed him, and the invitation which was tendered to him by the Curators of Patronage was, not without some hesitancy, accepted by him.

The hesitancy—even in view of the higher emolument and larger sphere of usefulness which the appointment to his Alma Mater involved—is not difficult to understand. For Cunningham had endeared himself to Dublin by many close ties; he was the centre of a large circle of intimate friends, and his influence and interests were in no way confined within the walls of the university, but extended to all circles of society. For several years he acted as secretary, and for some time as president, to the Royal Zoological Society of Ireland, and the effect of his work is apparent in the splendid condition of their menagerie, which is, for its size, probably the most successful in Europe. He was a constant attendant at the famous Saturday morning breakfasts of the council, and on leaving Dublin for Edinburgh was the recipient of a silver bowl engraved with the signatures of his fellow-members, a testimonial which he prized with pleasurable pride. During four years he was honorary secretary to the Royal Dublin Society. He was frequently consulted on scientific questions by the Viceregal Government, who in 1900 appointed him a member of the commission to inquiry into the condition of the inland fisheries of Ireland. In the same year he was sent out to South Africa as a member of the Royal Commission to inquire into the care of the sick and wounded in the war. He also served on a War Office committee to report on the physical standards required for candidates for commissions and recruits.

But the performance of these public duties was not allowed to interfere with his scientific work. Both before and after his appointment to Dublin his communications on anatomical subjects were numerous and important. His text-books on "Practical Anatomy" and on "Systematic Anatomy"—the latter edited and in part written by himself—have a large circulation. His "Memoir on Cornelius McGrath, the Irish Giant," which was published by the Royal Irish Academy in 1891, is a model of exact anatomical description, and was influential in pointing to the analogies between the conditions of gigantism and those met with in acromegaly, a disease to which attention had shortly before been directed by Marie, who was the first to associate it with tumour of the pituitary body. No less important is his "Memoir on the Surface Anatomy of the Cerebral Hemispheres," which was published in 1892. In 1902 he delivered the Huxley memorial lecture before the Anthropological Institute, the subject of the lecture being "Right-handedness and Left-brainedness."

On his transference to Edinburgh in 1903, Cunningham's activities were in no way diminished, and his influence was immediately felt both in the university and in scientific and medical circles of the city. His genial personality at once won the hearts of the students, who were no less attracted by his powers of exposition. The confidence of his colleagues was manifested by his early election to fill the position of dean of the faculty of medicine. This confidence proved well-merited, for, under his auspices, the scheme of reform of the medical curriculum which had been for years in a condition of suspended animation was re-invigorated, and before long passed through all its stages, which in a Scotch university are more complex and difficult than those of a Bill in Parliament. As a member of the council and as secretary of the meetings, he took an active part in the work of the Royal Society of Edinburgh, and was instrumental in improving the form and character of its published Proceedings. He effected a similar change in the *Journal of Anatomy and Physiology*, of which he became acting editor, and to which he had always, either personally or through his pupils, been in the habit of contributing articles. He continued to take a keen interest in the public services, and was prominent in the movement for the establishment of a medical equipment of the Territorial Force in the East of Scotland.

Cunningham's eminence in science has been recognised on many occasions. He was elected in 1891 to the Fellowship of the Royal Society, and in 1898 served on its council. The Universities of Dublin, Oxford, St. Andrews, and Glasgow conferred upon him their honorary degrees. He was president of the Anatomical Society and of the anthropological section of the British Association, and at various times was examiner in most of the universities of the United Kingdom.

Of Cunningham's personal character it is impossible to speak too highly. Of his fine, manly figure; his frank, open countenance; his clear, honest, kindly eyes; his disposition, genial but firm; his humour, devoid of cynicism; his loyalty to his friends; his gentleness even to opponents, all who had the privilege of knowing him will for ever retain a bright remembrance. As a writer in the *Scotsman* truly says:—"To the University and to science his death is nothing short of a calamity, while to his friends it has brought a sense of desolation."

He was interred on Saturday afternoon at Edinburgh. His remains were escorted from the Church of St. Cuthbert by a long line of students, colleagues, representatives of learned societies, and personal friends, the melancholy procession offering a strong contrast to the gaiety of the city, the traffic of which was arrested by its passage. He lies in the beautiful Dean Cemetery, than which few places contain more distinguished dust. *Requiescat in pace.*

DR. G. F. DEACON.

THE death of Mr. G. F. Deacon, a member of the council of the Institution of Civil Engineers, and eminent for his scientific work in engineering, was announced in last week's NATURE. Mr. Deacon, during his comparatively short life—he died at the age of sixty-six—obtained a considerable reputation as a water-works engineer, and is best known by his connection with the Vyrnwy Reservoir for the supply of Liverpool. In 1876 the need had arisen for an additional supply of water, and Mr. Deacon, who was then acting as municipal and water engineer, was instructed by the corporation to make an investigation as to the locality from which an additional supply could be obtained. After a survey of several sources he finally advised that this could be best obtained from the River Vyrnwy, a tributary of the Severn, situated in North Wales. Mr. Deacon's recommendation was submitted to Mr. Thomas Hawksley and Mr. Bateman, who approved this choice. The Bill promoted by the corporation having received the sanction of Parliament, Mr. Deacon was appointed joint engineer with Mr. Hawksley to prepare the plans and carry out the work. When the works were about half finished, Mr. Hawksley retired, and Mr. Deacon was left in sole charge.

The Vyrnwy works are remarkable as having the largest reservoir in England, and the first to have a high water-tight masonry dam. This dam was formed with blocks of clay slate from the Caradoc beds of the lower Silurian formation, some of which weighed 10 tons. These were set in mortar composed of Portland cement and slate stone crushed fine enough to pass through meshes of one-eighth of an inch. The dam is 1350 feet long, 136 feet high, and impounds the water in a reservoir 5 miles long and covering 1121 acres. The cost of these works was $2\frac{1}{2}$ million pounds, and they were carried out under Mr. Deacon's supervision without the aid of a contractor. A full account of the Vyrnwy works is given in a paper read by Mr. Deacon at the Institution of Civil Engineers in 1896, and contained in vol. cxxvi. of the Minutes of Proceedings.

Mr. Deacon was educated at the Glasgow University, which subsequently conferred upon him the honorary degree of LL.D. He served his time in Napier's shipyard, which led to his becoming one of Lord Kelvin's assistants on the *Great Eastern* when an attempt was made to lay an Atlantic cable. At the age of twenty-two he commenced practice as an engineer at Liverpool, and six years afterwards was appointed municipal and water engineer of that borough. One of the most important services he rendered during this time was the invention of the waste-water meter, by means of which it became possible to locate the place where leakage and waste were going on in the mains or from the service pipes, and thus a very great saving was effected in the quantity of water required. He also devised considerable improvements in the instruments used for measuring the velocity of the flow of water in rivers, and applied the use of electrical mechanism to current meters. He took keen interest in devising and improving the means of making the meteorological observations necessary for determining the yield of rain water.

In 1879 Mr. Deacon resigned his appointment as municipal engineer in order to devote his whole time to the Vyrnwy works. On the completion of these he commenced to practise at Westminster as a consulting engineer, and was connected with many important schemes of water supply, and frequently was engaged in giving evidence before parliamentary committees. In addition to his work as a water-works engineer, Mr. Deacon applied a considerable amount of attention to the application of scientific principles to the solution of problems arising out of the practical work of the engineer.

Mr. Deacon was president of the engineering section of the British Association at the meeting held at Toronto in 1897, also of the Municipal and County Engineers at their meeting in 1878. He was a Fellow of the Meteorological Society, and a member of the Institution of Mechanical Engineers.

NOTES.

THE list of honours announced on the occasion of the celebration of the King's birthday on Friday last includes the names of five Fellows of the Royal Society. Mr. Francis Galton, F.R.S., Prof. J. Larmor, F.R.S., Mr. R. H. I. Palgrave, F.R.S., and Prof. T. E. Thorpe, F.R.S., have received the honour of knighthood, and Dr. W. Schlich, F.R.S., has been appointed a Knight Commander of the Order of the Indian Empire (K.C.I.E.). Other men of distinction in the scientific world included in the list are:—Mr. Edgar Thurston, superintendent of the Government Central Museum, Madras, appointed a Companion of the Order of the Indian Empire (C.I.E.); Prof. W. J. R. Simpson, a Companion of the Order of St. Michael and St. George (C.M.G.); Sir Dyce Duckworth and Mr. Henry Morris, president of the Royal College of Surgeons, have had baronetcies of the United Kingdom conferred upon them; and Mr. James Stuart, who founded the system of university extension and the mechanical workshops at Cambridge, has been made a privy councillor.

ON Monday evening Mr. E. H. Shackleton delivered his first lecture since his return home on the results of his South Polar expedition at a special meeting of the Royal Geographical Society in the Royal Albert Hall. The main facts of the expedition have already been recorded in our own columns and elsewhere, but a large and brilliant audience assembled to hear from the explorer's own lips an account of the experiences of his companions and himself during their fourteen months' sojourn within the Antarctic circle. It is not always easy to realise the meaning of distances between places the position of which is only known in terms of latitude and longitude, and Major Leonard Darwin, who presided over the meeting, performed a useful service for his audience by indicating the extent of ground which would have to be covered by a party starting from London northwards on a journey of the same length as that which took Mr. Shackleton from his winter quarters to within 100 geographical miles of the South Pole. The party would have to march so far as Edinburgh before reaching Captain Scott's record, and onwards to a point 240 miles beyond John o' Groats before reaching the limit of the journey. Mr. Shackleton told his story in a simple and graphic manner, which revealed, without unduly emphasising, the hardships and dangers experienced by his companions and himself on the great southern journey, and by the party under Prof. David which reached the South Magnetic Pole. The Lloyd-Creak dip-circle, he mentioned, worked remarkably well under the severe climatic conditions. The lecture was illustrated by a number of very interesting photographs, while at the close there was a display of "living pictures"—the first ever taken in the Antarctic regions—which afforded a very good idea of the movements of penguins and seals. One scene, which Mr. Shackleton will be well advised to omit in future, illustrated the death of a seal shot by the explorers. After the lecture the Prince of Wales, on behalf of the Royal Geographical Society, presented to Mr. Shackleton a special gold medal, and to a number of other members of the expedition replicas of the medal in silver.

THE next meeting of the French Association for the Advancement of Science will be held at Lille from August 2–7. The secretary of the association should be addressed at 28, rue Serpente, Paris.

THE annual meeting of the Association for the Oral Instruction of the Deaf and Dumb will be held at the Portman Rooms, Baker Street, W., on Tuesday, July 13. Lord Avebury will preside.

MR. F. MUIR and Mr. J. C. Kershaw send home, under date March 12, a description of a Peripatus which they have recently found in Ceram. This is the first time that Peripatus has been found in the Moluccas. The specimens, sixty-three in number, were all females. "In the size of its eggs (0·05 mm.) and in its mode of development and birth it approaches the neotropical group." In its other characters it appears to resemble Melano-Peripatus (the New Britain species found by Dr. Willey). The authors name the species *Peripatus ceramensis*. A description of it, with illustrations, will be published in the forthcoming number of the *Quarterly Journal of Microscopical Science*.

THE issues of the *British Journal of Photography* for June 18 and 25 contain a detailed account of a noteworthy collection of apparatus intended for the easy demonstration of certain optical and visual phenomena specially interesting to photographers. The apparatus, which was designed by Dr. E. Goldberg, of Leipzig, and is now on view at the International Exhibition of Photography at Dresden, is arranged in forty-four small cabinets. Each cabinet is fitted with the requisites for a single experiment, and is accompanied by printed instructions briefly stating the result to be looked for, and indicating the necessary manipulation, which is in every case so simple that the merest tyro can hardly fail of success. The points illustrated include defects of the eye, such as irradiation, chromatic aberration, the blind spot, and Purkinjé's figures; various subjective phenomena of colour; some effects of intermittent illumination; elementary examples of reflection, refraction, dispersion, diffraction, and absorption; colour mixture, with special regard to the devices employed in the modern processes of colour photography.

DURING the course of the discussion on cable rates and Press intercommunication in connection with the Imperial Press Conference, Mr. Marconi gave some interesting information. He remarked it would be injudicious for the Governments concerned to enter into a scheme of State-owned cables without first having investigated the capabilities of a wireless connection between the two countries. In discussing these connections, he said, we should refer to electric communication instead of cable communication. The cost of two stations capable of communicating over distances which have proved practicable—3000 miles—would be about 50,000*l*. for each station. This estimate, of course, is subject to variation. He is, he continued, certainly of opinion that it may be possible in the near future to communicate over greater distances, perhaps 6000 miles, or even more. There is a very interesting theoretical point about communicating a distance of 6000 miles, which is that when the equator is passed the wireless waves may begin to converge again, and it may occur that at the Antipodes messages can be received much easier than half-way to the Antipodes. That remains to be proved. At present the Marconi Company is prepared to take a limited amount of Press messages across the Atlantic at $2\frac{1}{2}d.$ per word. When the stations are completed it is hoped to take a large amount—15,000 or 20,000 words a day. If the amount is considerable the company would be prepared to give a service at 2*d*. a word from Canada to England.

THE new buildings of the Victoria and Albert Museum, South Kensington, were opened in State by the King on June 26. Mr. Runciman, President of the Board of Education, read an address, in which, on behalf of the Board, he thanked the King and Queen for consenting to open the new buildings, and explained the numerous uses of the museum. The address showed that the first object of the founders of the museum was to encourage a high standard of excellence among the craftsmen, manufacturers, and designers of this country. For many years lack of space prohibited a systematic arrangement and classification of the collections. The completion of the new buildings now makes it possible to display the collections in a manner worthy of the ambition which prompted their formation. With this object in view the Board of Education has formulated a scheme for the future organisation and management of the museum. The collections are classified in eight departments. Each department will have its own expert staff, while a separate staff will have charge of the supplementary collections intended for loans to provincial museums and schools of art. In the course of his reply the King said:—"The placing of an expert staff in charge of each section of the museum will have the double advantage of maintaining and developing the more scientific arrangement which has now become possible, and also of bringing about a more accurate knowledge of the history and beauty of the individual exhibits, and of their educational value."

THERE has, so far, been an entire absence of summer weather, and June has proved wet, cold, and almost sunless over the United Kingdom. In England the weather has been especially bad, and the aggregate rainfall is largely in excess of the average. In London the total measurement of rain, not including yesterday, June 30, was 4·29 inches, whilst the average for the month is 2·21 inches. The duration of bright sunshine is only eighty-seven hours, the average for the month being 167 hours, and in some recent years June has had 240 hours of sunshine; in May the sun was shining brightly in London for 297 hours. At Greenwich there have only been three days with the shade temperature above 70°, and there is only one year, 1860, with so few warm days in June during the last sixty-eight years. In June last year there were seventeen days with the temperature above 70°, and in May of the present year there were ten such warm days, the thermometer exceeding 80° on three days, whilst in June the highest temperature was 74°.

The latest contribution of Prof. W. Trelease to the elucidation of the genus Agave, published in the Transactions of the Academy of Science of St. Louis (vol. xviii., No. 3), deals with the Mexican species yielding fibre known as "Zapupe." Although in three cases flowers were not obtainable, five botanical species with local names are distinguished primarily according to the characters of the spines. The species Zapupe, Lespinassei, Deweyana are only known in cultivation, but Endlichiana and aboriginum are indigenous. Bulbils are described for two species, and it is stated that all appear to be freely bulbiferous after flowering, thus affording "pole" plants as well as offsets.

The list of new garden plants for 1908, issued, according to precedent, as appendix iii. of the *Kew Bulletin* (1909), has only recently been received. It furnishes the correct names with brief diagnoses, gives the reference to the original publication and the introducer, and also indicates which plants are in cultivation at Kew and would probably be available for distribution in the regular course of exchange. About one-third of the entries refer to orchidaceous plants, many being garden hybrids, and others mere varieties or forms. Two natural and several garden hybrids are noted under the genus Saxifraga. Messrs. Sanders are credited with the introduction of three palms and the cycad *Encephalartos Woodii*.

An investigation of the medullary rays in the beech, the oak and *Aristolochia sipho*, with the object of tracing the contour of the rays, has been carried out by Dr. K. Zijlstra, who communicates his results in *Extrait du Recueil des Travaux botaniques Néerlandais* (vol. v.). The contours of the rays in the oak and beech obtained by a comparison of tangential sections are fairly regular, being interrupted in places by fibre layers. They show an irregular but distinct increase in height towards the cambium. The height of the rays in Aristolochia stems approximates to the length of the internodes, if, as is assumed, the separate overlying portions are regarded as part of one original ray.

Dr. P. Lowell contributes to the Bulletin of the American Geographical Society (May) the first portion of a description of the plateau of the San Francisco peaks with reference to its effect on tree life. The peaks, which are for the most part cones of volcanic origin, rise out of a plateau having an elevation of 7000 feet. The desert nature of the region has kept it free from human destruction and the dry climate has preserved in a remarkable manner the fossil remains. The altitudinal distribution of the trees forms the chief subject of the paper. The zones of vegetation are said to topographise the country as with contour lines. The yellow pine, *Pinus ponderosa*, dominates the slopes from 6500 feet to 8500 feet. Then the Douglas fir, the silver fir, *Abies concolor*, the curious cork fir, *Abies subalpina*, and the aspen share the ground up to an elevation of 10,300 feet. Higher still, the Engelmann spruce and fox-tail pine, *Pinus aristata*, ascend to the tree limit, about 11,500 feet.

Mr. J. Parkinson contributes to the last number of the Journal of the African Society a collection of folk-tales current among the Yoruba-speaking peoples, which form an interesting supplement to the classical account of this people by the late Major Ellis. Like the Basutos, Pondos, and races beyond the African area, lightning is associated with a bird, and the thunderbolt is the subject of a special cult. The tortoise as the wise, helpful animal here takes the place of the hare, jackal, or frog in Bantu and Basuto tradition, several tales dealing with his cleverness and supplying etiological myths to account for the various marks still to be seen on his carapace.

In the June number of *Man* the Rev. J. Roscoe describes a remarkable cult of the python at Uganda. The floor of its shrine was found to be carpeted with sweet-smelling grass, and on one side was the sanctuary of the serpent and its guardian, the latter being a woman pledged to a life of celibacy. A log and stool for the python, covered with a piece of bark-cloth, lay on the floor of the shrine, and a round hole was cut in the wall for the ingress and egress of the reptile. It had been trained to resort to this shrine, where it was regaled with milk, fowls, and small goats. The snake is supposed to control the river and its fish, and offerings are made to it to ensure success in fishing. During worship a medium is dressed in pieces of bark-cloth, a goat-skin apron, and a cloak of leopard skin. The spirit of the python then is supposed to enter him, when he wriggles about on the ground like a snake and utters prophecies, which are unintelligible to the worshippers, and are explained by an interpreter. The python is also supposed to confer offspring, and if he be neglected punishes his votaries by bringing sickness on their children. When a suitable offering is presented he prescribes the use of certain herbs, which effect a cure. The cult thus presents striking analogies to that of Æsculapius, who, according to Prof. J. G. Frazer, was originally a serpent, the anthropomorphic god provided with a serpent symbol being a later development of the cult.

Miss Nina Layard, already well known for her researches in the Saxon cemetery at Ipswich, describes in the June number of *Man* a series of flint implements discovered by her on the sea-coast at Larne, co. Antrim. This site had already been explored by Messrs. Du Noyer, Knowles, and Gray, whose discoveries have led to protracted controversy, and the age and character of the specimens are still matters of uncertainty. They do not correspond closely with either the palæoliths or neoliths of England, and though many acres of land are covered by these raised beaches, nothing in the shape of a ground weapon has been found. The presence of many flints in a rolled condition leads to the inference that they are older than the formation in which they were found, and the occurrence of these specimens, which many authorities hold to be Neolithic, at such enormous depths in gravel is subversive of all English experience. Miss Layard, in the circumstances, is content to designate them "the older series," because since they were dropped on this shore there must have occurred, not only a gradual sinking of the beach and the formation of gravels 20 feet in depth containing the worked flints, but also a subsequent elevation until the surface of the gravel stands no less than 20 feet above high-water mark. In the same connection, the account in the same number by Mr. Worthington G. Smith of a Palæolithic implement found near the British Museum in 1902 is interesting. It is remarkable in this specimen that an oval flint pebble forms part of the basis of the implement, the maker of the tool, by clever flaking, having designedly left this pebble intact.

The geological section of the Belfast Naturalists' Field Club organised on June 19 an excursion to Scawt Hill for the study of the volcanic neck there. The geological structure of the district is that common to the plateau basalts of County Antrim, and consists of basic lava flows covering Mesozoic beds, and at Scawt Hill occurs the "neck" of one of the volcanoes from which the lavas came. A few years ago one of the members of the section came unexpectedly on a basic dyke traversing the dolerite neck. The neck has been found to be a fine-grained ophitic dolerite. The dyke is a granitoid basic rock, and may be classed as a diabase without olivine. A section of the chalk taken two yards from the dyke showed it to be converted into a typical crystalline limestone with large crystals of calcite. The geologists of the Belfast Naturalists' Field Club made during the excursion the observation that even at a distance from the dyke the band of chalk in contact with the dolerite neck seemed to have undergone a similar change, and to have been converted into hornstone.

IN the *U.S. Monthly Weather Review* of January last references are made to interesting communications by Mr. R. F. Stupart, director of the Canadian Meteorological Service (dated March, 1909), relating (1) to the establishment of new stations in Newfoundland and Labrador, and the proposed extension of storm warnings and weather forecasts to Newfoundland, and (2) to the supply of a complete equipment to several stations in the north of Canada, extending as far as Fort Macpherson (lat. 67° 27′, long. 134° 57′ W.). In connection with the source of "cold waves" frequently experienced in North America, Mr. Stupart thinks that the study of the far north with trustworthy barometer readings will be most valuable. He remarks that the persistent high pressures found there in some seasons apparently owe their origin to upper currents from the equator coming to earth farther north than usual, and that "we may very probably in the future connect the situation in the equatorial regions and trade-wind belts with that in the high latitudes."

THE first complete account of the new method which has been adopted by the Gesellschaft für drahtlose Telegraphie to secure an almost undamped series of oscillations in the secondary circuit of the sender is given by Prof. Fleming in the *Electrician* for June 11. The primary spark is divided into eleven very short sparks of about 0·01 inch in length, which are formed between twelve discs of copper, which may be water-cooled. The damping is so great that not more than two or three oscillations occur in the primary circuit, and the oscillations in the secondary are therefore free oscillations, which are only slightly damped. The device evidently marks a distinct advance in wireless telegraphy.

LAST year in the *Comptes rendus* and in *Le Radium* M. J. Becquerel described experiments on the electric discharge through vacuum tubes which appeared to indicate that, in addition to the canal rays, there existed positive rays which could be deviated by a magnetic field by amounts comparable with those to be expected if the rays were composed of free positive electrons. In the *Journal de Physique* for June, M. A. Dufour describes his own work on the same subject. He has repeated and extended M. Becquerel's experiments, and comes to the conclusion that the observations do not warrant the statement that the deviable rays observed are due to free positive electrons.

MR. R. H. COLLINGHAM contributes an article in *Engineering* for June 18 dealing with Ilgner-operated winding-engines. The principle of the Ilgner system is the employment of a motor-generator set coupled mechanically to a heavy fly-wheel and electrically to the motor driving the mill or winding gear. The motor of the motor-generator is driven off the power mains, and the function of the fly-wheel is to minimise the variation in the load drawn from the source of supply. All the heavy loads which come on the mill are met from the store of energy in the fly-wheel. In order to obtain this result, an automatic slip-regulating device is provided in the rotor circuit of the induction motor driving the motor-generator set, which regulates the amount of slip on the induction motor according to the amperes taken by the stator, the slip-regulating device only coming into operation when the stator current has reached a certain fixed value. When this value has been attained the regulating device increases the slip of the induction motor, causing the speed of the set to drop; the fly-wheel then gives up energy corresponding to the given variation in velocity. By this means the load on the supply mains is kept much more steady than would be the case if no fly-wheel were employed. Mr. Collingham treats especially the mechanics of the problems involved with the view of finding expeditiously the weight of wheel, size of motor, &c., required in given cases.

IN our article upon the Astrographic Congress at Paris (June 10, p. 440) it was stated that Rome was represented by Signor Lias. We are asked by Dr. P. Emanuelli to state that this should have been Signor Lais, who is vice-director of the Vatican Observatory, and was the representative, not of Rome, but of the Vatican.

WE have received from Messrs. Flatters and Garnett, Ltd., of Manchester, a copy of their conveniently arranged catalogue of collecting apparatus, nature-study appliances, cabinets, museum glassware, glass-top boxes, pocket lenses, and so on. The list is well illustrated, and reference to its contents is made easily.

MR. JOHN MURRAY has published a second edition of Mr. R. H. Lock's "Recent Progress in the Study of Variation, Heredity, and Evolution." The first issue of the book was reviewed at length in NATURE of April 18, 1907 (vol. lxxv., p. 578), but it may be pointed out that several alterations and additions have been made in the present edition. A short list of references has been added at the end of each chapter; the different chapters have been revised and supplemented, and a new chapter has been added.

"A SHORT HISTORY OF ENGLISH AGRICULTURE," by Mr. W. H. R. Curtler, is announced by the Oxford University Press for early publication. As the agriculture of the Middle Ages has often been ably described, Mr. Curtler devotes the greater part of his book to the agricultural history of the subsequent period, especially the seventeenth, eighteenth, and nineteenth centuries.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY:—

July 3. 14h. 30m. Uranus in conjunction with the Moon (Uranus 2° 22′ N.).
7. 17h. Mercury at greatest elongation (21° 11′ W.).
8. 3h. 46m. Mars in conjunction with the Moon (Mars 1° 21′ N.).
11. 15h. Uranus at opposition to the Sun.
15. 14h. Saturn at quadrature to the Sun.
18. 17h. 50m. Venus in conjunction with the Moon (Venus 3° 5′ S.).
19. 18h. Mars at greatest heliocentric latitude S.
20. 17h. 39m. Jupiter in conjunction with the Moon (Jupiter 4° 22′ S.).
23. 5h. 17m. Mercury in conjunction with Neptune (Mercury 1° 6′ N.).
25. 19h. Mercury in perihelion.
30. 22h. 4m. Uranus in conjunction with the Moon (Uranus 2° 16′ N.).

Comet 1909*a* (Borrelly-Daniel).—Several observations of this comet are recorded, and an ephemeris for it is given, in No. 4333 of the *Astronomische Nachrichten*. Neither photographs nor eye observations show any remarkable features, whilst the ephemeris indicates that the brightness is declining; on July 16 the comet will be but about one-third as bright as when discovered. The distance from the earth is, at present, about 1·09 astronomical units, and is rapidly increasing.

The Shape of the Planet Mercury.—Referring to a recent statement by Mr. Levander, that the equatorial diameter of Mercury has been shown to exceed the polar diameter, M. R. Jonckheere, in No. 4333 of the *Astronomische Nachrichten*, expresses the belief that the opposite is the case. His observations, made during the most recent transit of Mercury, indicated that the vertical diameter was the greater, the values being, vertical = 9·46″, equatorial = 8·73″; this is supported by other observers, whose results he gives. At present the positions of the equatorial and polar diameters of the planet are not known, but M. Jonckheere contends that the statement that the greater diameter is the one parallel to the celestial equator is, in the face of the evidence to the contrary, inadmissible.

Observations of Sun-spots, 1908.—The results of the first year's regular observations of sun-spots at the Royal Observatory at Capodimonte (Naples) are given by Signor E. Guerrieri in No. 6, vol. iii., of the *Rivista di Astronomia* (Turin). The sun was observed on 304 days, and on five days was seen to be free from spots, whilst the mean daily frequency of spot groups for the year was 5·3. The first half of the year showed an excess of groups in the ratio 3/2, but the analogous ratio for single spots was 4/5; altogether, 1606 groups and 9262 individual spots were observed during the year. The observations are tabulated and discussed in several different ways, and, if continued regularly, will form a useful supplement to the work so ably performed by the other Italian observers.

Observations of Saturn and its Rings.—In No. 4331 of the *Astronomische Nachrichten*, M. Schaer records the observations of Saturn and its ring system made at the Geneva Observatory, with the 40 cm. Cassegrain reflector constructed by himself, during the period September 18, 1908, to January 24, 1909. The chief feature recorded is the discovery of the new dark ring announced on October 7, 1908. This ring was seen, but thought to be the shadow of the bright rings, on previous occasions, but on October 5 it was seen to extend to the right and left, and was therefore judged to be something more than shadow; on October 6 the dark ring was seen to be separated, and the planet, with its usual colour, was seen through the interstice, which was about 3″ to 4″ long and 0·5″ to 1″ broad. In January of the present year the new ring was seen more easily than during the preceding months.

M. Schaer's observations also suggest the presence of a cloudy, absorbing atmosphere, and the occurrence of slight changes in the white ring between the crape-ring and the Cassini division. The invisibility of the rings when their plane passes through the earth is probably due to the masking effect of the newly discovered outer dark ring.

Tables for the Reduction of "Standard Co-ordinates" to Right Ascension and Declination.—In No. 4329 of the *Astronomische Nachrichten* Herr A. Hnatek published a series of tables for the computation of α and δ from the standard coordinates given in the catalogues of the international *carte du ciel*. A few copies of these tables, printed on stout paper, have been prepared, and may be obtained from the publishers for one mark per copy.

The Transvaal Observatory, Johannesburg.—From the *Observatory* (No. 410, p. 262, June) we learn that from July 1 next the institution directed by Mr. R. T. A. Innes is to be known as the Transvaal Observatory, Johannesburg, South Africa. The instrumental equipment is to be increased by the addition of a large refractor for visual work, and a photographic astronomical telescope, the gift of Mr. Franklin Adams, so that this institution will now rank as an astronomical, as well as meteorological, observatory.

The Comets of 1907 and 1908.—In a brochure published by Prof. Kobold, comet observers will find a very useful summary of the cometary phenomena of 1907 and 1908. Observations of fifteen comets were made during those two years, and for each object Prof. Kobold gives a short summary of the observed phenomena, a set of elements where available, and a table of references to the publications in which the observations were severally recorded.

THE ROYAL SOCIETY CONVERSAZIONE.

The ladies' conversazione at the Royal Society is always a brilliant function, and last week the presence of delegates and other distinguished foreign guests from the Darwin celebration at Cambridge added to its interest. The conversazione was held on June 24 in the rooms of the society at Burlington House, and the guests were received by Sir Archibald Geikie, K.C.B., president. Many of the exhibits were also shown at the conversazione held in May, and were described in Nature of May 20 (vol. lxxx., p. 347). Summaries of the other exhibits are given below, based upon the descriptions in the official catalogue, related subjects being here grouped together for convenience of reference.

Dr. W. N. Shaw, F.R.S.: Representation of temperatures and pressures in the atmosphere up to a height of fifteen miles, on July 27 and 29, 1908.—*A. Fowler:* Photographs of the spectrum of scandium. The photographs show the varying intensities of the scandium lines in the arc flame, normal arc, and the arc in hydrogen. Corresponding differences are found in the spectra of sun-spots and prominences.—*Messrs. Zeiss:* Liquid crystals observed under high temperatures with polarised light by micro-projection apparatus.—*Dr. F. Edridge-Green:* Spectroscope for estimating colour perception. In the focus of the instrument are two movable shutters, either of which is capable of moving across the spectrum. By means of the two shutters any given portion of the spectrum can be isolated. Each shutter is controlled by a drum graduated in wave-lengths, so that the position of the edges of the shutters can be known.—*C. E. S. Phillips:* Permanently luminous watch dial and military night compass. The watch dial is transparent (glass), and the figures are painted upon its upper surface. The dial is backed with a compound containing a minute quantity of $RaBr_2$ (radium bromide), which renders it luminous, so that the time may be easily read in the dark. The compass is arranged upon the same principle. By means of a luminous disc and strip, direction may be determined at night.

W. M. Mordey: The effect of electrostatic condensers in preventing or extinguishing arcs. A suitable condenser placed in shunt to an arc, or in shunt to a resistance in series with an arc, will instantly extinguish the arc. If connected in shunt to the contacts before they are separated it will prevent the formation of an arc even in a circuit having considerable electromotive force.—*The Linolite Company:* Metallic filament "tubolite." The metal filament is held at each end by a zig-zag spring to take up the expansion, and is supported by anchors at two intermediate points. The lamp may be placed in any position, and can be run on an alternating current or direct current circuit.—*Hon. C. A. Parsons, F.R.S.:* (1) Model of leakage path device for regulating voltage of alternators. The apparatus depends on the following very simple fact, that while an alternating current cannot *directly produce* a unidirectional field, it can have a strong action in diminishing magnetic flux. When applied to an alternator, the field magnets of the exciter are provided with a leakage path, around which windings carrying alternating current are placed. (2) Some samples of the blades used in steam turbines of Atlantic liners.—*Hon. R. C. Parsons:* (1) "Panflex" spring wheel for motor vehicles. The "Panflex" spring wheel is an invention which has for its object the easy motion of a vehicle when run at low or high speeds. This ease of motion is due to the springs being capable of deflection in every direction. The wheel is not subject to bursts or punctures, prevalent in the case of wheels fitted with pneumatic tyres. The wear and tear is small, and, should a spring break, which is seldom the case in practice, another can be inserted in a few minutes at a very small cost. (2) Working model apparatus for recording the effects produced upon wheels of various descriptions when passing over obstacles. (3) Seismograph apparatus for registering the jolts felt by the body of a motor vehicle when run on "Panflex" or pneumatic wheels.

The Director, Royal Gardens, Kew: (1) Specimens to illustrate the wood *Lignum nephriticum*, and the fluorescence of its infusion. *Lignum nephriticum* is the wood of "Coatli" (*Eysenhardtia amorphoides*), a small leguminous Mexican tree. An infusion of the wood was used medicinally by the Aztecs. Soon after the conquest of Mexico the Spaniards brought the wood to Europe, where it was used for similar purposes, and excited remark owing to the blue fluorescence of the watery infusion of the wood. The phenomenon was first described more fully by Athanasius Kircher (1646), and J. Bauhin (1651), who used cups made of the wood. It was carefully studied by Boyle (1664). During the next century the wood itself was lost sight of; its origin remained unknown until quite recently. Plukenet (1696) suggested, and Dale (1737) and Linnæus stated, that it was the wood of the horse-radish tree (*Moringa pterygosperma*), which is, however, a native of the Old World. Another source that has been suggested is *Pithecolobium Unguis-Cati*, a native of the West Indies. (In charge of Dr. O. Stapf, F.R.S.) (i.) Wood of true *Lignum nephriticum* and cup turned from the same, and samples of infusions, presented to the Kew Museum as "cuatl." (ii.) Medicinal substitutes of *Lignum nephriticum*:—(*a*) wood of *Moringa pterygosperma*, from Scinde; (*b*) wood of *Pithecolobium Unguis-Cati*, from Florida; (*c*) wood of a tree, possibly a species of Imbricaria (Sapotaceæ), from tropical America, received from Paris in 1851 as *Bois néphritique*. (2) Plants of Ecanda (*Raphionacme utilis*), and sample of rubber prepared at Kew from a tuber of it.—*R. A. Robertson:* Photographs (for identification purposes) of the transverse surface of timbers.—*Prof. R. H. Yapp:* Photographs of tropical vegetation. The photographs were, for the most part, taken during the Skeat Expedition to the Malay Peninsula (1899–1900).—*Prof. F. E. Weiss:* (1) Some alien aquatic plants from the Reddish Canal, near Manchester; (2) some South African aquatics grown in the laboratory, University of Manchester.

R. I. Pocock: Warning coloration in some weasel-like Carnivora. Animals which are nauseous or poisonous or dangerous to meddle with commonly have some means of self-advertisement, such as conspicuous coloration or sounding organs, which appeals to the sense of sight or of hearing of their enemies, warning the latter to let them alone; but most mammals are coloured so as to be concealed either from their enemies or from the prey they feed upon. Such concealment is commonly effected by counter-shading, the upper side being dark to tone down reflected light, and the lower side white to counteract shadow, the result being obliteration of the shape and solidity of the body. Some of the weasel tribe, however, form an exception to this rule, being light above and black below, often with the white of the back, as in skunks, or of the head, as in badgers, emphasised by black stripes; and since these animals are known to possess glands which secrete fluids with a fœtid or suffocating odour, and since, also, they are known to be desperate fighters and fearless and extraordinarily tenacious of life, and to feed, for the most part, upon vegetables or upon animal food, for the capture of which concealment is unnecessary, there are strong reasons for believing them to be conspicuously and warningly coloured.—*H. F. Angus:* Stereoscopic photomicrographs. The series comprise eggs of butterflies, moths, and parasites; botanical objects, such as mycetozoa, leaf hairs, &c.—*F. Enock:* Living stick-insects (*Bacillus rossi*). The eggs of these stick-insects are less than one-eighth of an inch in diameter, and much resemble a minute vase. On emerging they are half an inch in length, and quickly stretch themselves along a green twig, which they exactly resemble. Most of the specimens have changed their skins five times, the old skin being generally *eaten*. When mature, these stick-insects attain a length of more than 4 inches, and become of a brown colour, which harmonises with the brown twig on which they rest. They are nocturnal feeders, and exceedingly amicable toward each other, treating each other as sticks, several often clinging together.—*Prof. George H. F. Nuttall, F.R.S., and Dr. Seymour Hadwen:* The discovery of a curative treatment for malignant jaundice in the dog and for redwater in cattle, with a demonstration of the effects of trypanblau upon the parasites. The disease known as malignant jaundice (piroplasmosis) in dogs is exceedingly fatal. It has hitherto resisted all forms of treatment. Both trypanblau and trypanrot injected subcutaneously will cure or prevent the disease. The effect of the drugs is exerted directly upon the parasites (*Piroplasma canis*) which cause the disease. The parasites may be observed to degenerate and disappear from the blood within a few hours after treatment. The parasite of redwater in cattle (*Piroplasma bovis*) is likewise affected by trypanblau.

Dr. C. D. Walcott, Secretary of the Smithsonian Institution: Panoramic views in the Rocky Mountains, U.S., and Canada.—*Dr. A. Smith Woodward, F.R.S.:* Skull of Megalosaurus from the Great Oolite of Gloucestershire. This is the first nearly complete skull of a carnivorous dinosaur found in Europe, and agrees with the skull of Ceratosaurus, from the Jurassic of Colorado, U.S.A., in exhibiting a bony horn-core on the nose. The specimen was discovered by Mr. F. L. Bradley near Minchinhampton.—*Dr. C. W. Andrews, F.R.S.:* Remains of rhinoceros and mammoth from the Thames alluvium under the offices of *Lloyd's Weekly News*, Salisbury Square, Fleet Street, E.C. The specimens exhibited were:—(1) a nearly perfect skull of a young individual of the woolly rhinoceros (*Rhinoceros tichorhinus*), in which some of the milk-teeth were still in use; (2) a maxilla and nearly complete mandible of a young mammoth (*Elephas primigenius*); the first and second molars were in wear, the third not yet having appeared.—*Dr. F. A. Bather, F.R.S.:* Sections of seasonal clay from Stockholm. This clay, which was deposited during the melting and retreat of the great ice-sheet in Sweden, may be described as fossil years and seasons. The alternating bands of dark and light can be easily seen, and Baron G. de Geer (from whom the specimens have been received) believes that each cycle represents a year, the lighter rock having been formed during the melting of the snows in spring. He has traced these bands for great distances, and has been able to map the changing limits of the ice-sheet from year to year through a long period. This is the nearest approach to a definite chronology by years that has yet been made by geologists, but it still needs to be linked up to the chronology of human history.—*Dr. Marie Stopes:* The microscopic structure of fossil plants from Japan. The nodules containing the plants were obtained in the river beds of the mountainous region of northern Japan. They are of Cretaceous age, and contain fossil plants with their tissues so well preserved that the cells can be seen in microscopic sections of the stony matrix. All the plants are new to science, and among them are several specimens of the first petrifaction of a flower hitherto discovered. The nodules contain ferns, gymnosperms, and angiosperms, which form an interesting mixed flora, the first of the kind to be described from specimens showing their anatomical structure.—*Prof. Flinders Petrie, F.R.S.:* Ancient modelled heads of various races. These heads were found in the foreign quarter of Memphis, the capital of Egypt, and represent the various peoples who were known there, 500 B.C. to 200 B.C. The Persian Empire, at that time, brought together all races between Scythia and India, and the Mediterranean peoples were familiar with Egypt before that. The modelling was probably done by Græco-Egyptians. Most of these were found in the excavations of the British School of Archæology in Egypt.

SOME PAPERS ON INVERTEBRATES.

COMMENCING with entomology, mention may be made of a paper on new and little-known North American Tipulidæ, by Mr. C. W. Johnson, published in vol. xxxiv., pp. 115–33, of the Proceedings of the Boston Natural History Society. In addition to the description of a number of new species, the paper contains the diagnosis of the new genus Aeshnasoma, proposed for a large tipulid with antennæ of the type of those of Longurio, but with a wing-venation differing from both that genus and Tipula.

To the March number of *Spolia Zeylanica* Mr. T. B. Fletcher communicates the first part of a monograph of the plume-moths of Ceylon, dealing in this instance with the members of the family Pterophoridæ. There are, it will be remembered, two families of plume-moths, the one already mentioned and the Orneodidæ, or 24-plumed group. Both are regarded by the author as very ancient types, but there appears to be little or no near relationship between the two groups, so that their mutual resemblance may probably be attributed to convergence. Although nothing definite is known in regard to the advantage gained by the splitting of the wings in these moths, the author suggests that when pace is not essential, a light framework of wing supplemented by cilia will be superior to the ordinary lepidopterous wing, in that it gives an equal measure of support with less expenditure of muscular force. In the same issue Mr. P. Cameron describes certain new Ichneumonidæ and Braconidæ reared by Mr. Fletcher from Ceylonese plume-moths.

Part v. of the second volume of Records of the Indian Museum is devoted to the revision, by Mr. E. Brunetti, of two groups of Oriental insects, namely, the flies of the families Leptidæ and Bombyliidæ; the latter paper containing a list of the known Oriental species, of which some are described for the first time.

To the Proceedings of the South London Entomological and Natural History Society for 1908–9 Mr. H. S. Fremlin contributes a paper on the results of experiments to show the effect of physical and chemical agencies on butterfly pupæ. The species forming the subject of the experiments were *Vanessa urticae* and *Abraxas grossulariata*, the total number of specimens treated being just over two thousand. Water and high temperature were the agents for the influence of physical conditions, while the chemical agencies employed were nitric and hydrochloric acids, chloride of lime, sulphur, hydrogen sulphide, and carbon disulphide. In the case of *V. urticae*, the death-rate was excessive when the pupæ were exposed to continuous high temperature, hydrogen sulphide, and carbon disulphide. The pupæ of *A. grossulariata* were in great measure destroyed in the water-laden atmosphere, and in the continuous high temperature failed to develop; hydrogen sulphide, on the other hand, was less harmful than in the case of the other species, although it crippled such adults as developed. Chlorine had a marked effect on the red colour of *urticae*, but showed little result in the case of *grossulariata*.

To the June number of the *Entomologists' Monthly Magazine* Mr. R. S. Bagnall contributes an account of four species of Thysanoptera new to the British fauna, among which *Megathrips nobilis* is also new to science. That species, the largest European representative of the group, was first obtained by Dr. D. Sharp in Wicken Fen during 1896.

Leaving insects for arachnids, we find in the April issue of the Proceedings of the Philadelphia Academy Mr. N. Banks cataloguing a collection of spiders from Costa Rica, with descriptions of new species. The new forms are about seventy in number, in addition to which there are about a score of species not mentioned in "Biologia Centrali-Americana." Of the web-making species, a considerable number are common to the United States, but of the other groups few kinds range so far north.

To vol. xxxviii., part iv., of the *Travaux Soc. Imp. Nat. St. Pétersbourg*, Mr. E. K. Suworow contributes an elaborate account of the anatomy of *Ixodes reduvius*, a tick exhibiting sexual dimorphism in a strongly marked degree. The much smaller males are, for instance, distinguished from the females by a peculiar system of divisions in the external envelope of the body, while there are also histological differences in the hypodermis of the males as compared with that of the females, as well as distinctive features in the mouth-organs.

Three papers published by the U.S. National Museum—two in the Proceedings and one in the Bulletins—are devoted to crinoids. In the first of these (Proceedings, vol. xxxvi., pp. 391–410) Mr. A. H. Clark describes a second collection of these organisms obtained by the S.S. *Albatross*, of which fifteen species, together with four left over from the first collection, are regarded as new, and duly named, one of these forming the type of a new genus. *Eudoxocrinus alternicirrus*, hitherto known only by *Challenger* specimens, has been re-discovered, and its habitat definitely determined, but several other *Challenger* forms have not been met with.

In the second of these papers (Bulletin No. 64) Miss Elvira Wood, of Columbia University, gives a critical summary of Dr. Gerard Troost's unpublished monograph of the fossil crinoids of Tennessee. Dr. Troost, who was born in Holland in 1776, settled in Philadelphia in 1810, where he became one of the founders, and the first president, of the Academy of Sciences. In 1827 he removed to Tennessee, where he became professor of geology and mineralogy in Nashville University, holding that chair until his death in 1850. Only about a month before his death the manuscript of the monograph of Tennessee crinoids was sent to the Smithsonian Institution for publication. After passing through various hands for five years, this manuscript came into the possession of Prof. Hall, in whose custody it remained for upwards of forty years. The long period which has elapsed since it was written rendered re-writing practically imperative, but certain portions have been printed direct from the original MS. Many of the original illustrations have been replaced by photographs or new drawings.

In the third paper of this series (Proceedings, vol. xxxvi., pp. 179–90) Mr. Springer describes, under the name of *Isocrinus knighti*, a new crinoid from the Jurassic of Wyoming.

The molluscs collected on the north side of the Bay of Biscay by the *Huxley* in the summer of 1906 form the subject of an article by Mr. A. Reynell in vol. viii., No. 4, of the Journal of the Marine Biological Association. Out of the seventy-five species collected, sixty-two have been recorded from the British area.

In No. 1678 of the Proceedings of the U.S. National Museum (pp. 431–4) Miss H. Richardson describes and figures a specimen of the curious spiny woodlouse (*Acanthoniscus spiniger*) of Jamaica. Although this isopod is stated to be common in its native island, the type-specimen in the British Museum and the one described by Miss Richardson are believed to be the only examples in collections.

THE RESEARCH DEFENCE SOCIETY.

THE speeches at the annual general meeting on June 25 of the Research Defence Society illustrated the wide and manifold interests of its work. It is, indeed, a national society for telling the truth about a matter of national importance. It defends the good name, the honour, of science against reckless and unscrupulous opponents, and we are not surprised at the welcome that it received. The list of its 2500 members includes a very powerful and thoroughly representative collection of great names. The society has already formed a dozen branch societies, has given many lectures, and has distributed much wholesome and honest literature; it has also published a volume of essays, written with authority, and pleasantly free from all controversy. Thus it has begun well; and the report of its committee is justly satisfied with the work of the past year. We note here two of the points made by speakers at the annual meeting.

Sir James Dewar emphasised this fact, that Germany is far ahead of us in the equipment of great laboratories for research in the "borderland between physiology and chemistry." Money is spent lavishly over the investigation of organic chemical bodies, the discovery and the preparation of new organic drugs. The services of a hundred expert and highly qualified men of science are at the command of a single firm. They receive large salaries, and are free to follow the bent of this or that special study. In the long run, their united work is immensely profitable. Here is commercial rivalry, and more; here is a better understanding of the right conditions of "applied science."

Lord Cromer, president of the society, took as a signal instance of the necessity for experiments on animals the recent discovery of a serum treatment in cases of epidemic cerebro-spinal meningitis, that ghastly disease which goes by the foolish name of "spotted fever." It is an acute septic inflammation of the membranes of the brain and the spinal cord. By experiments on animals it was proved to be due to special germs of the order of diplococci. Flexner and Jobling, working at the Rockefeller Institute, discovered a way of preparing, from immunised horses, a serum containing a direct antidote, and this serum was first used in the spring of 1907. Before that time there was no special treatment of the disease, and the mortality ranged from 68·4 per cent. to 80·5 per cent. The children —it was mostly children—suffered terribly, and died in a few days; and of those who survived many were left, from the intensity of the inflammation, imbecile, paralysed, or blind. By the use of the serum the mortality has been reduced to 36·7 per cent. In Belfast, of 275 cases treated before the use of the serum, 72·3 per cent. died, and of ninety-eight cases treated with the serum 29·6 per cent. died.

The Research Defence Society exists to keep the public informed of such facts as these, and we hope that it will have a long record of such victories over disease.

IS THE ASSOCIATION OF ANTS WITH TREES A TRUE SYMBIOSIS?

THE fact has long been known that some species of ants occur in constant association with certain kinds of trees. Thus members of the dolichoderid genus Azteca are often found inhabiting the interior of the stems of *Cecropia peltata*, and among the Pseudomyrmini *P. bicolor* forms its nests within the spines of the "bull's-horn" acacia. The view has been held by many naturalists, amongst others by Fritz Müller and Bates, that in these cases the benefit is mutual, the tree affording both shelter and sustenance to its occupants, and receiving in return protection from the attacks of the formidable leaf-cutting ants of the genus Atta and of other enemies. Doubts on this point have been expressed by several authorities, among them by Dr. David Sharp, in whose opinion "there is reason to suppose that a critical view of the subject will not support the idea of the association being of supreme importance to the trees."

A careful investigation of the relations subsisting between the arboreal species of Azteca and Pseudomyrma and the trees which they inhabit has lately been conducted in Paraguay by Karl Fiebrig, who has published his results, illustrated by numerous photographic reproductions, in the current volume of the *Biologisches Centralblatt*.[1] His conclusions may be summarised as follows:—

Azteca not only makes use of internodal cavities already existing in the stem of *Cecropia peltata*, but excavates fresh spaces or enlarges existing ones at the expense of living tissues of the tree. Fritz Müller described certain pits in the stem of Cecropia where the wall is much thinner. These spots, he says, are selected by the female ant for the purpose of gaining access to the interior of the stem. But, according to Fiebrig, the ants effect their entrance into new internodal spaces by perforating the partitions in the stem before they have gnawed through the thin bottoms of the pits; moreover, openings to the exterior are often made irrespective of the situation of the pits, and when the latter are perforated the boring is, in certain cases, effected from within, and not from without. Neither the internodal spaces nor the pits can therefore reasonably be considered as myrmecophilous adaptations. Again, the alleged protection against leaf-cutting ants must often be superfluous, since the Cecropia, with its inmates, is apt to be found in marshy situations where these enemies cannot reach it. Most of the trees in Paraguay are subject to the attacks of the leaf-cutting Atta, but, nevertheless, though unprotected by the presence of Azteca, they continue to maintain their existence, even if belonging to introduced, and not native, species. Cecropia itself is not tenanted by ants until it is some years old. The presence of colonies of Azteca does not prevent Cecropia from receiving much damage from the attacks of other insect enemies, and Fiebrig is of opinion that the constant loss suffered by the tree from the depredations of Azteca itself involves a more serious drain upon its vitality than the occasional raids of the leaf-cutters. Finally, the occupation of Cecropia by these ants not only fails to afford protection against enemies other than the leaf-cutters, but even encourages the assaults of such formidable foes as woodpeckers and internally feeding lepidopterous larvæ.

With regard to the association between *Acacia cavena* and *Pseudomyrma fiebrigi*, the author points out that this tree, in common with other species of Acacia, is protected against the ground-haunting Atta by the fact that it grows only in situations which are constantly liable to inundation. The thorns in which the ants take up their abode have frequently been already hollowed out and furnished with apertures of access by lepidopterous larvæ; moreover, the spaces tenanted by the ants are not confined to the thorns, but extend also to the stem. In neither situation do they occur naturally, but in both they are excavated, as in Cecropia, whether by ants or caterpillars, at the expense of the living tissues of the tree.

On these grounds Fiebrig concludes that, at any rate so far as the species observed by him are concerned, the benefits of the association between trees and ants are not mutual, but are enjoyed by the ants alone. There is no doubt that the reasons for his view adduced by Fiebrig are of great weight. At the same time, it cannot be said that these observations are sufficient of themselves to disprove altogether the existence of ant-plant symbiosis.

F. A. D.

[1] "Cecropia peltata und ihr Verhältnis zu Azteca Alfari, zu Atta sexdens und anderen Insekten. Ein kritischer Beitrag zur Ameisenpflanzen-Hypothese." By Karl Fiebrig (San Bernardino, Paraguay).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Dr. G. E. Hale for the degree of D.Sc., *honoris causa*, at the Encænia on June 24:—

Inter Astronomos qui ea quæ in æthere solem circumfuso geruntur investigant nemini cedit Georgius Ellery Hale. Qui vir duodeviginti abhinc annos primus omnium fabricatus est instrumentum illud, ad lucis e solis puncto quovis emissæ naturam cognoscendam aptissimum, quo hodie utuntur omnes fere solis observatores. Hoc subsidio fretus potuit flammas illas excurrentes, quæ solis defectu plerumque cernuntur, sole pleno quasi in pictura exprimere: mox plagas lucidissimo candore fulgentes, quas faculas vocant, eodem modo repræsentare. Idem nuper docuit procellis hunc æthera vexantibus tenuissimas materiæ particulas quasi turbine quodam agitatas vim magneticam miro modo gignere: quæ omnia nemo demonstrare potuit nisi excogitandi peritissimus, in observando patientissimus, in causis cognoscendis sagacissimus. Neque ei satis erat Naturæ arcana reserare, sed Observatoria duo in orbe terræ maxima fere et instructissima condidit atque ornavit: idem Ephemeridem, in qua recentissima de siderum natura ubique reperta pervulgantur, conscribendam curavit. Sodalicium denique maximum instituit quo omnes omnibus ex terris huius militiæ cælestis contubernales congregarentur.

ST. ANDREWS.—Dr. William Nicoll, who has for some years carried out important researches on the parasites of birds, fishes, and other forms at the Gatty Marine Laboratory, has just been elected to the Ernest Hart memorial scholarship.

Dr. J. C. Irvine, lecturer on organic chemistry in the University, has been appointed by the University court to the chair of chemistry in St. Andrews, vacant by the resignation of Prof. Purdie.

The Viscountess Falmouth will present the prizes at the Horticultural College, Swanley, Kent, on Thursday, July 15. Sir John Cockburn will take the chair at 4 p.m.

A distinguished American physicist, Prof. E. F. Nichols, of Columbia University, has been elected president of Dartmouth College, a leading New England institution with more than 1200 students. Dr. Nichols is a graduate of Cornell, and held chairs at Colgate and Dartmouth before being appointed to his present post at Columbia.

The issue of *The Record*, the magazine of the South-Western Polytechnic Institute, Chelsea, London, for May, contains an account of this year's prize distribution, when Dr. H. A. Miers, F.R.S., the principal of the University of London, delivered an address. The report of the principal of the institute, an abstract of which is printed in the magazine, shows that there were 2573 students under his supervision during 1907–8.

The King has consented to lay the foundation-stone of the new buildings of the Imperial College of Science and Technology, South Kensington, on July 8. The building is to accommodate the departments of mining and metallurgy of the Royal School of Mines, geology of the Royal College of Science, and the extension of the engineering department (City and Guilds College), and will be situated on the land in Prince Consort Road lying to the east of the Royal College of Music, and extending so far as Exhibition Road.

The fourth annual issue of the "Girls' School Year Book (Public Schools)" has now appeared. The book becomes year by year more complete, and certainly provides a useful directory for those interested in the education of girls. It is, however, still difficult to understand the editors' method of selection of schools for detailed treatment. Among new features this year are articles on domestic science, teachers' registration, the teaching of music in public secondary schools, and a list of lecturers suitable for schools. The volume is published by the Year Book Press, c/o Messrs. Swan Sonnenschein and Co., Ltd., and its price is 2*s*. 6*d*. net.

A fully illustrated description of the college of engineering of the University of Illinois is contained in the issue of the *University of Illinois Bulletin* for March 8. Descriptions are provided of the work and equipment of the eight departments of the college, as well as those of the engineering experiment station and the school of railway engineering and administration. The college has been organised to give such training to young men as will enable them to do efficient work in the branch of engineering or architecture they may select, to meet the demand for highly specialised instruction and research, and to conduct investigations of value to the industrial enterprises of Illinois and distribute the knowledge gained.

In the course of his recent presidential address to the Society of Chemical Industry, of which a short abstract appeared in Nature of June 3, Prof. Meldola made the following appreciative remarks on the modern methods of laboratory instruction in chemistry:—"It is unnecessary here to dwell at too great a length upon the general practical training, although I should like to add that if the level has been raised, and if our teaching has become more philosophical, we are mainly indebted to a former occupant of this chair, Prof. Emerson Reynolds, who is unquestionably the pioneer reformer in the laboratory teaching of chemistry. I am glad of this opportunity of acknowledging the indebtedness of teachers to Prof. Reynolds, because, amidst the later clamour, his share in the development of chemical teaching has been overlooked." This address is published in full in the current number of the journal of the society.

Evidence of the rapid development of the Chinese Empire will be found in an article in *Engineering* for June 18 dealing with the engineering and mining college at Tang Shan, North China. This college was founded in 1906 for the education of Chinese students, and is in connection with the Imperial Railways of North China, both being under imperial administration. The staff consists of a president (Mr. S. S. Young), four English professors in mechanical engineering, civil engineering, mining, and physical faculties respectively, two Chinese *literati*, and a clerical staff. A four years' course was prescribed, and there are now more than 200 students in regular attendance from various parts of the country. Residential accommodation is provided for 160 students, together with houses for the staff, dining hall, and three educational buildings. All technical lectures are delivered in English. While the equipment is as yet far from being complete, it is indisputable that the existence of such an institution is a factor which cannot be disregarded when considering the future position of the Empire.

Mr. David Boyle, the curator of the Provincial Museum of Toronto, had the degree of LL.D. of the University of Toronto conferred on him on June 12, for his eminent services in the cause of archæology and ethnology. Dr. Boyle has been incapacitated for some time, and as he was too ill to attend the regular Convocation, the authorities paid him the unique compliment of holding a special Convocation at his residence, and of conferring the degree while he was lying in bed. Dr. Boyle was presented by Prof. Galbraith, and in the absence of the president, who had sailed for England, the degree was conferred by the vice-president, Prof. Ramsay Wright. Dr. Boyle went to Canada in 1856, and in the face of great difficulties has built up the fine archæological and ethnological collections in the Provincial Museum of Toronto. He is best known to students as the editor of, and chief contributor to, the annual archæological reports of the museum. They were begun in 1898, and form a valuable record of Canadian archæology and ethnology. The later reports have been duly noticed in Nature. We congratulate Dr. Boyle on this academic honour, which crowns a life of self-sacrificing and poorly remunerated toil for the subjects he has so much at heart.

The proceedings at the inauguration of Mr. R. C. Maclaurin as president of the Massachusetts Institute of Technology have been reported at considerable length in the American Press. One of the chief speakers was Mr. Bryce, who greeted the new president as a fellow-Briton, a fellow-Scotsman, and a fellow-member of Lincoln's Inn. Mr. Bryce said that Englishmen and Scotsmen would naturally be sorry that Mr. Maclaurin was not serving their country "in one of the new institutions which we have lately founded to try to make up for lost time in the promotion of scientific instruction." Still, "a scientific inquirer and teacher helps the whole world by the work which he does anywhere in it." In his own inaugural address, President Maclaurin emphasised the following articles in his creed as an educator:—(1) that the end of education is to fit men to deal with the affairs of life honestly, intelligently, and efficiently; (2) that in the higher education of a large and increasing section of the community science should play a very prominent, if not a leading, part; (3) that science and culture must go hand in hand, science being studied and taught in such a way as to make for that broad and liberal outlook on the world that is the mark of the really cultured man; and (4) that "above all we must preserve in our students the freshness and vigour of youth, and see to it with all care that their natural powers of initiative are improved and not checked by our training."

In recent years there has grown up in connection with local education authorities in all parts of the country systems of scholarships providing for the education of boys and girls of varying ages and attending schools of different grades, and also for young men and women anxious to continue their education after school days are over. The report of the higher education subcommittee on the scholarship scheme of the London County Council, recently adopted by the Council, provides an exhaustive account of the educational facilities offered in London to the sons and daughters of parents of limited incomes who have sufficient ability, as tested by examinations, to profit by continued attendance at school and college. The report indicates that in London, as elsewhere, there has been a disposition to multiply unduly the number of scholarships offered for competition, with the result that in certain districts there has had to be a marked lowering of standard of efficiency so that the scholarships might be filled up. This danger, with others, has been under the consideration of the committee, and steps have been taken in the case of certain classes of scholarship to reduce the number available, so that an efficient standard may be maintained. In framing the regulations which will govern the award of scholarships and exhibitions during the next academic year, the committee has endeavoured to arrange that, so far as possible, "no child or young person shall be debarred by poverty from obtaining the kind of education which will prepare him for the career for which his talents and character best fit him, and that the pecuniary emoluments attaching to the scholarships shall be sufficient to enable students to obtain the kind of education, whether industrial, scientific, or literary, which is best suited to their needs and capacities, but not sufficient to induce them to undertake a particular course of study with the object of securing the pecuniary advantages attaching to the scholarship."

As indicating the wide scope of the London County Council scholarship scheme, which has recently been amended, it may be said that in 1905 the Council awarded (*a*) 2600 junior county scholarships to children between the ages of eleven and twelve, and that the annual cost of awarding one of these scholarships annually was 85*l.*; (*b*) 390 probationer scholarships, each costing 56*l.*, to children of thirteen to fourteen years of age; (*c*) 100 intermediate county scholarships, each costing 129*l.*, to boys and girls of from fifteen to seventeen years of age; (*d*) fifty senior county scholarships, each costing some 200*l.*, to students more than eighteen years of age; and (*e*) various scholarships in science, art, and technology, at an expenditure of more than 18,000*l.* To state the scholarships which are to be offered for competition this year will indicate some of the changes which have been made as the result of four years' experience. There are to be (*a*) 1800 junior county scholarships, costing each the same as in 1905, and 300 supplementary junior scholarships of lower value; (*b*) 300 intermediate county scholarships, but the value of each, for sufficient reasons, has been reduced to 72*l.*; and (*c*) 150 senior county scholarships, each as in 1905, costing 200*l.* But, whereas the total expenditure in 1905 was 283,940*l.*, the amount in 1909 has, notwithstanding the greater wisdom of the conditions of award in the scheme, been reduced to 263,080*l.* The report of the Education Committee gives very satisfactory evidence to show that the object the education authorities in London have in view is to secure a high quality in the results they obtain, rather than to spread an incomplete and rudimentary education far and wide.

A NUMBER of people interested in the teaching of housecraft and domestic science visited Battersea Polytechnic on June 29 to see the domestic economy training department. Since the department was opened in 1894 more than 400 students have obtained diplomas, and are now occupying responsible positions in leading institutions and schools; the present number of students above eighteen years of age in the department is 130. Students of the department attend, in their first year, a course in "science as applied to household work," which includes physics, chemistry, physiology, and hygiene. This course is taken in addition to the purely practical work of the domestic arts. During the second session the scientific basis of knowledge thus obtained is applied in the practice kitchens, laundries, and housewifery rooms and hygiene laboratories. In the third year's course the same subjects are treated in greater detail, special attention being directed to bacteriology and the examination of food-stuffs. The main objects of the science work are:—(*a*) to explain, so far as possible, the chemical composition and properties of the materials dealt with in household work; (*b*) to explain the principal chemical and physical changes taking place in the common household operations involved in cookery, laundrywork, &c.; (*c*) to give a training in the principles of scientific method. Special stress is laid on the fact that household work generally is really an application of a number of facts and principles in chemistry, physics, hygiene, bacteriology, &c., and that, in order to understand the *rationale* of the ordinary household processes, a knowledge of the general principles of the branches of knowledge just mentioned is necessary.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 27.—Sir Archibald Geikie, K.C.B., president, in the chair.—Notes concerning tidal oscillations upon a rotating globe: Lord **Rayleigh**.—The absolute value of the mechanical equivalent of heat in terms of the international electrical units: Prof. H. T. **Barnes**. It is pointed out that the Clark cells used by the author in his determinations of the mechanical equivalent of heat in terms of the electrical units were prepared according to the old specifications. The absolute measurements of the Clark cell now being carried on with such precision in the various standardising laboratories are expressed in terms of the new form of cell with specially prepared mercurous sulphate. There is an important difference between the cells, which Wolff and Waters have shown amounts to 0·03 millivolts. The author has compared a set of modern cells with cells set up according to the old specifications, and finds the same constant difference. Taking 1·4330 international volts at 15° C. as representing the modern cells, then the cells made by the old specifications must be taken as 1·4333 international volts at 15° C. The author's measurements of the mechanical equivalent at different temperatures were calculated on the basis of a value for the Clark cell equal to 1·4342 international volts at 15° C. Re-calculating on the new basis, the value of the mean calorie is found to be 4·1849 joules. This agrees with Reynolds and Moorby's directly determined mean, which, expressed accurately for an interval of temperature between 0° C. and 100° C., comes to 4·1836 joules. Rowland's mean value between 5° C. and 35° C. is 4·185 joules, while the author's value between the same limits of temperature is 4·1826 joules. Thus, assuming the variation of the specific heat of water to be correctly determined, the value of the Clark cell, equal to 1·4330 international volts, brings the electrically determined mechanical equivalent into excellent agreement with the same constant measured by mechanical means.—An approximate determination of the boiling points of metals: H. C. **Greenwood**. Although high temperatures can now be easily attained by means of electric heating, no general investigation of the boiling points of metals has yet been carried out. Moreover, such values as are available have in most cases been deduced indirectly, and are very discordant. In the present investigation apparatus was devised for directly measuring the temperatures of ebullition under atmospheric pressure of a considerable number of metals, allowing of use up to 2700° C. Heating was effected electrically, and the metal, when unaffected by carbon, was contained in a thin-walled graphite crucible on the outside of which the temperature was estimated by means of a Wanner optical pyrometer. The difference in temperature between the internal and external surfaces of the crucible walls was found to be negligible. Accuracy of the temperature measurements was secured by checking the pyrometer against the "black body" melting points of specially purified strips of platinum, rhodium, and iridium. The following values were found:—aluminium, 1800° C.; antimony, 1440° C.; bismuth, 1420° C.; chromium, 2200° C.; copper, 2310° C.; iron, 2450° C.; magnesium, 1120° C.; manganese, 1900° C.; silver, 1955° C.; tin, 2270° C. In dealing with the metals aluminium, chromium, iron, and manganese, which readily combine with carbon, considerable difficulty was experienced in avoiding contact with carbon at the high temperatures in question. This was finally accomplished by the use of graphite crucibles brasqued with previously fused magnesia. In the absence of this protective lining the boiling point was very greatly modified by carburisation. The temperatures indicated for aluminium and manganese were far below those hitherto supposed necessary for ebullition.—Some results in the theory of elimination: A. L. **Dixon**. The eliminant of two quantics $\phi(x)$, $\psi(x)$, each of the n^{th} degree, may be expressed as a determinant the elements of which are (a_s, r_t), where (a, r) is $[\phi(a)\psi(r) - \phi(r)\psi(a)]/(a-r)$, and $a_1, \ldots a_n, r_1, \ldots r_n$ are two sets of n arbitrary quantities. For three quantics $\phi(x, y)$, $\psi(x, y)$, $\chi(x, y)$, each of the form $\Sigma A_{rs}x^r y^s \,(r \lesseqgtr n,\, s \lesseqgtr m)$, the eliminant is a determinant the elements of which are $F(a_s, b_s, \alpha_t, \beta_t)$ where $F(a, b, \alpha, \beta) = (\phi(a, b),$

$\psi(a, \beta)$, $\chi(a, \beta)\}/(a-\alpha)(b-\beta)$, and $a_1, b_1, \ldots, \alpha_1, \beta_1, \ldots$ are two sets of 2 mn pairs of arbitrary quantities. The eliminant of two quantics $\phi(x)$, $\psi(x)$ may be expressed as a Pfaffian

$$\Sigma\pm[1, 2][3, 4][5, 6] \ldots [2n-1, 2n]$$

where $[r, s] = \{\phi(a^2_r)\psi(a^2_s) - \phi(a^2_s)\psi(a^2_r)\}/(a_r+a_s)$. The eliminant of three quantics $\phi(x, y)$, $\psi(x, y)$, $\chi(x, y)$ of the ordinary standard form $\Sigma A_{rs}x^ry^s$, $(r+s \eqslantless n)$ is given by the Pfaffian

$$\Sigma\pm[1, 2][3, 4][5, 6] \ldots [2n^2-1, 2n^2]$$

where

$$[r, s] = (\phi(a_rb_r, a_r+b_r), \psi(a_ra_s, a_r+a_s), \chi(a_sb_s, a_s+b_s))/(a_r-b_s)(a_s-b_r).$$

—The liquidus curves of the ternary system aluminium-copper-tin: J. H. **Andrew** and C. A. **Edwards.** The study of the constitution of alloys is of great theoretical interest, and of some practical value; in fact, it may be said that the heat treatment of a given series of alloys cannot be correctly accomplished without an accurate knowledge of the structural changes which occur with varying temperature and concentration. We are now in possession of accurate data bearing on the constitution of a large number of alloys containing only two elements, but very little work has been published on mixtures of three or more metals. The object of the present research was to throw some light on the properties of ternary alloys, and, incidentally, the effect of impurities on binary alloys. The metals from which the alloys were made had the following degree of purity:—

	Per cent.
Aluminium	99·57
Copper	99·98
Tin	99·98

Freezing-point determinations.—The freezing points of the alloys were determined directly after mixing by means of a platinum + 10 per cent. iridium thermo-junction. The free ends of the wires were connected by a mirror galvanometer and balancing arrangement similar to that described by Messrs. Carpenter and Keeling in their work on the iron-carbon alloys. In order to locate the position of the isothermal curves, more than 400 alloys and melting-point determinations were made. *Conclusions.*—The character of the liquidus curves indicates that no well-defined ternary compound is deposited from any of the liquid alloys. The affinity of tin for either aluminium or copper is not sufficient to overcome the affinity of the last two elements for each other. As a consequence of the above, curves of the melting points of alloys containing a constant percentage of tin bear a striking resemblance to the liquidus curve of the aluminium-copper alloys. Tin is insoluble in by far the greater number of the alloys.—Studies on the structure and affinities of Cretaceous plants: Dr. M. C. **Stopes** and Dr. K. **Fujii.** This paper is the first account to be published of the anatomy of Cretaceous plants petrified in calcareous nodules. As an introduction to the flora, eighteen plants are described, all of which are new. The age of these plants is Upper Cretaceous, as is determined from the ammonites which abound in the matrix of the nodules, and the locality of all the specimens described is Hokkaido, northern Japan. The plants include one fungus, three ferns, eight gymnosperms, and six angiosperms. These numbers seem to represent, roughly, the proportions of the flora of the nodules as a whole, of which many more specimens are in the hands of the authors than are described in the present paper. The most interesting of the plants are:—a new type of gymnosperm, Yezonia, of which the vegetative anatomy is different from that of any known genus; a gymnospermic fructification, also new, which there is good reason to believe belonged to Yezonia; an angiosperm which is included in the Sabiaceæ; an angiosperm of the family Saururaceæ; and the first petrified flower, Cretovarium, which has three carpels surrounded by the perianth. The names of the described plants are:—*Petrosphaeria japonica, Fasciostelopteris Tansleii, Schizaeopteris mesozoica, Niponophyllum cordaitiforme, Yezonia vulgaris, Yezostrobus Oliverii, Araucarioxylon tankoensis, Cedroxylon Matsumurii, C. Yendoii, Cunninghamiostrobus yubariensis, Cryptomeriopsis antiqua, Saururopsis niponensis, Jugloxylon Hamaoanum, Populocaulis yezoensis, Fagoxylon hokkaidense, Sabiocaulis Sakurii, Cretovarium japonicum.* The phylogeny and distribution of these plants is considered so far as possible.

June 17.—Sir Archibald Geikie, K.C.B., president, in the chair.—The nature of the hydrogen flocculi on the sun: Prof. G. E. **Hale.** Photographs of the Hα line in the spectrum of the solar disc, made on Mount Wilson with high dispersion, were shown on the screen. The line appears as follows:—(1) A broad dark line, differing greatly in intensity and width in different regions of the sun. Except in eruptive or rapidly changing phenomena, the differences in width are not very marked. (2) Within the boundaries of the dark line a narrow single or multiple bright line is photographed in many parts of the sun. Sometimes the appearance resembles that of the calcium lines K_2 and K_3—*i.e.* the bright line lying on its dark background is divided into two components by a central dark line. In other regions the bright line is divided into a larger number of components, varying in width and separation. The images of dark hydrogen flocculi, on spectroheliograph plates taken with camera slit about equal in width to Hα, appear to be due, in the main, to local increase in the intensity of the dark line. In some parts of the sun, particularly those where the line is distorted, variations in the width of the line may also play an important part. The increased intensity of the dark line is probably the result of increased absorption. Slides were shown to illustrate the fact that prominences at the sun's brink are frequently recorded as dark flocculi when photographed in projection against the disc. The possible effects of anomalous dispersion were discussed, and photographs were exhibited of the same region of the sun, taken simultaneously with light from the red and violet edges of Hα. The similarity of these photographs apparently indicates that anomalous dispersion is not the prime factor in producing the hydrogen flocculi. Certain minor differences suggest, however, that it may perhaps play a secondary part in modifying their form.—The origin of certain lines in the spectrum of ε Orionis (Alnitam): Sir Norman **Lockyer,** K.C.B., F.R.S., F. E. **Baxandall,** and C. P. **Butler.** The star ε Orionis (Alnitam) is of great importance as offering a possible transition stage between the helium and bright-line stars, and the only outstanding lines of unknown origin were those at 4097, 4379·8, and a conspicuous double at $\left\{\begin{matrix}4647·6\\4650·8\end{matrix}\right.$. In the case of 4097, the clue to the identification was obtained from a spark spectrum of chromium, showing local intensifications of certain lines at one of the poles. Two of these lines were found to be the previously known silicon (iv) lines, 4089, 4116, probably present as impurities in the fused chromium, while one of the remaining two lines was found to coincide with the ε Orionis line at 4097. These four lines are shown under various conditions in the plate, indicating the steps taken in tracing their origin to nitrogen. In the spectrum of nitrogen, under the special conditions which gave the above lines at 4097, 4103, another line was found at 4379·8, which was greatly strengthened in comparison with its intensity in the ordinary spark, and this line coincides with the unknown line in ε Orionis. During the work on the above lines, one of the photographs taken of an alcohol spectrum showed abnormal intensifications on either side of the oxygen line 4649·2, suggesting the presence of a new double. The wave-lengths of the components of this double were determined as 4647·6, 4650·8, coinciding with the wave-lengths of the components of the strong double in ε Orionis. By a series of comparison photographs of spectra under varied conditions, the origin of the double was traced to carbon, and one of the strips of the plate (carbon spark in hydrogen) shows it quite isolated as it appears in the stellar spectrum. Further evidence of the validity of the identification is afforded by the peculiar nature of the components of the double.—Electric induction through solid insulators: Prof. H. A. **Wilson.** This paper contains an account of a series of experiments on the variation of the capacity of ebonite and other condensers, with the time of charging and with the potential difference. It is shown that the capacity

C after a time of charging t is given by the formula $C=C_0(1+B\log(1+pt))$, where C_0 denotes the capacity when $t=0$ and B and p are constants. In the case of ebonite at 30° C. this formula represents the results obtained to within 1 part in 2000. The values of the constants have been found for several substances at different temperatures. The capacity is shown to be independent of the potential difference within the limits of error. It is shown that after the temperature of an ebonite condenser has been changed, then a very slow change in the capacity goes on which continues for more than 100 hours at constant temperature.—The effect of pressure on the band spectra of the fluorides of the metals of the alkaline earths: R. **Rossi.** It was shown by A. Dufour that the band spectra of the fluorides of the alkaline earths show a marked Zeeman effect, and it was thought interesting to see whether these particular bands would also be displaced by pressure, for it is known that the cyanogen bands, which, like most bands, do not show a Zeeman effect, are not displaced by pressure. The large 21½-feet concave grating spectrograph of the physical laboratory of the Manchester University was used, and the bands of the fluorides of calcium, barium, and strontium were found to be shifted by pressure. The order of magnitude of the displacement is about the same as for line spectra.—The components into which the bands are resolved are widened by pressure, and the linear relation between pressure and displacement found by former observers on line spectra seems to hold also for these bands. There does not seem to be any evident relation between the magnitudes of the Zeeman and pressure-shift effect in the case of these bands.—The ionisation produced by an α particle: Dr. H. **Geiger.** The aim of the experiment was an accurate determination of the number of ions produced by an α particle when completely absorbed in air. The most direct way to find the number of ions would be to measure the whole ionisation produced by the α particles from a known quantity of radium C. Since it is, however, practically impossible to obtain the saturation current due to the α particles at atmospheric pressure, it was necessary to adopt an indirect method. This method was briefly as follows: The ionisation due to the whole number of α particles expelled from a known quantity of radium C was measured at a low pressure, allowing only a small definite portion of the range of each α particle to be effective. The ratio of the ionisation produced within this small portion of the range to the ionisation produced along the whole path was then found from an accurate determination of the ionisation curve. It was found that the number of ions produced in air by an α particle from radium C along its whole path is $2{\cdot}37\times10^5$. Since the α particles from different radio-active products differ only in their initial velocity, it was possible by the aid of the ionisation curve of radium C to calculate the number of ions produced by the other products.—A diffuse reflection of α particles: Dr. H. **Geiger** and E. **Marsden.** It was observed that a diffuse reflection takes place when α particles are incident on a plate. The reflected particles were counted by the scintillations produced on a zinc sulphide screen. The effect was found to vary with different metals as reflectors, the amount of reflection being approximately proportional to the atomic weight of the reflecting substance. Using different numbers of thin gold foils as reflectors, it was found that the reflection was a volume effect, and thus similar to the reflection of β particles. Taking a measured quantity of radium C as source, and using a plate of platinum as reflector, it was found that, of the incident α particles, about 1 in 8000 suffers reflection.—The decay of surface waves produced by a superposed layer of viscous fluid: W. J. **Harrison.** An estimate is obtained of the effect of a thin layer of viscous liquid on the decay of waves at the surface of a slightly viscous liquid. The period equation for the motion is of the fourth degree, and has two real and two complex roots in the case of waves of less than a certain length, and four complex roots in the case of waves of greater length. The real roots correspond to dead-beat modes, the complex roots to propagated modes. No general expression of any use can be obtained for the damping, but the equation can be solved numerically in any particular case. In the paper the velocity of propagation and the modulus of decay are given for waves of length 2, 5, 10, 20 cm. at the surface of mercury on which is superposed a layer of glycerine 1 mm. in depth. An estimate is also obtained for the damping when the wave-length is small compared with the depth of the layer. Two other problems in the decay of surface waves are discussed.—The passage of electricity through gaseous mixtures: E. M. **Wellisch.** (1) An experimental method (based on Langevin's method) has been devised in order to ascertain whether there are two distinct mobilities for the positive or for the negative ions produced by Röntgen rays in a mixture of two gases, or of a vapour and a gas. (2) No evidence was found of the existence of the two distinct mobilities; accordingly it is necessary to conclude that the motion of the ion through the medium must involve a mechanism of a character such as to produce a statistical average. (3) Experiments were conducted with regard to the effect produced on the ionic mobilities in air by adding small quantities of vapours. The mobilities showed a marked decrease on the addition of alcohol and acetone, but were not sensibly affected by the addition of the heavier vapours of methyl iodide and ethyl bromide. (4) Experiments were performed with regard to the ionic mobilities in mixtures of a gas and a vapour, the ions being formed from the latter constituent only. As a result of the experiments, it was shown that there must be, at all events initially, a transference of the charge (both positive and negative) from the vapour to the gas molecule. (5) Experiments were performed with regard to the stability of the vapour ions in the presence of hydrogen; it was shown that the vapour molecules can accompany the charge to an appreciable extent, even in the presence of a considerable quantity of hydrogen. (6) The mechanism by which the transference of charge from one molecule to another is effected has been discussed; there is reason to believe that the transference takes place by the medium of a detachable unit of positive electricity. (7) From the experimental results a theory of the mechanism underlying the passage of electricity through gases at ordinary temperatures and pressures has been deduced.—A study of the use of photographic plates for the recording of position: Dr. C. E. K. **Mees.**—The coefficients of capacity and the mutual attractions or repulsions of two electrified spherical conductors when close together: Dr. A. **Russell.** The computation of the electrostatic energy of two spherical conductors when close together is an important problem in spark systems of wireless telegraphy. In this case the formulæ previously given for the capacity coefficients are very laborious to evaluate. By extending a mathematical theorem due to Schlömilch, an approximate formula is obtained for the sum of a certain infinite series. By using this theorem, it is shown that when the spheres are close together the ordinary series formulæ for the capacity coefficients can be written in forms which can be readily computed to any required degree of accuracy. The author has re-computed and extended in this way Kelvin's table for the capacity coefficients of two equal spheres when the least distance between them does not exceed half the radius of either. When the spheres are at microscopic distances apart, the formulæ become very simple. Kelvin's table also for the rates at which the capacity coefficients of two equal spheres alter with the distance between them, when this distance does not exceed half the radius of either, has been re-computed and extended. When the spheres are very close together the laws of attraction and repulsion are simple. Let the radius of each sphere be a, let x denote the least distance between them, and suppose that the ratio V_1/V_2 of the potentials of the two spheres is not nearly equal to unity, and that x/a is very small compared with unity. In this case the mutual force between the spheres is attractive, and is given by

$$\frac{a(V_1-V_2)^2}{8x}\text{ approximately.}$$

If the potentials of the spheres be equal, the repulsive force between them is, to a first approximation, given by Kelvin's formula for the repulsive force between two equal spheres when in contact. When the charges on the spheres are $+q$ and $-q$ respectively, and x/a is small compared with unity, the attractive force between them is given by

$$\frac{2q^2}{ax\{\log_e(a/x)\}^2} \text{ approximately.}$$

—The effect of previous magnetic history on magnetisation: E. **Wilson**, G. E. **O'Dell**, and H. W. K. **Jennings.** It is well known that if a piece of iron be subjected to a considerable magnetising force, and then be tested for permeability corresponding to a lower force, the permeability so obtained may differ widely from the permeability which would have been obtained had the material been previously demagnetised. The principal object of this paper is to examine the effect of previous history upon the dissipation of energy by magnetic hysteresis. A ring of iron was carefully demagnetised, and the hysteresis loop No. 1, corresponding to a force H, was obtained. The force was then increased to a value H_1 for the purpose of producing previous history, and removed. A hysteresis loop No. 2, corresponding to the force H, was then obtained. As is well known, this loop shows a reduced permeability. The ring was carefully demagnetised, and a hysteresis loop No. 3 obtained as follows. A magnetising force supplied by an additional coil was gradually increased, until on reversal of the original force H a change of magnetic induction exactly equal to that observed in the case of loop No. 2 was obtained. Two loops (Nos. 2 and 3) have now been obtained, each having the same change of magnetic induction and the same net change of force H. The change from loop No. 1 to loop No. 2 has been brought about by inter-molecular force, whereas the change from loop No. 1 to loop No. 3 has been brought about by the application of an externally applied constant force. If the effect of inter-molecular force were capable of being exactly equivalent to that of the externally applied constant force, one would expect to find that the energy required to perform a complete cycle would be the same in each case—that is, the area of loop No. 2 would be equal to the area of loop No. 3. The experiments show that within certain limits the area of loop No. 2 is greater than that of loop No. 3, the difference depending upon the magnitude of the reversed force H and the previous history.

Mineralogical Society, June 15.—Principal H. A. Miers, F.R.S., president, in the chair.—Carnotite and an associated mineral-complex from South Australia: T. **Crook** and G. S. **Blake.** The carnotite of Radium Hill, near Olary, South Australia, occurs in a definitely crystalline condition. The crystals are tabular and orthorhombic in symmetry. The carnotite of Colorado, though not so definitely crystalline, also contains tabular crystals which are orthorhombic in symmetry, and probably identical in mineral characters with those of South Australia. From the general characters of these crystals it appears that carnotite is a mineral belonging to the uranite group, and that it may be regarded as the vanadium analogue of autunite. The black lodestuff in which the Radium Hill carnotite occurs is heterogeneous in constitution. It consists essentially of ilmenite, which is impregnated with magnetite, rutile, carnotite, and a mineral which is possibly tscheffkinite. The evidence provided by a study of the complex does not necessitate the view that new minerals are present, such as that to which the name "davidite" has been given.—The species pilolite, and the analysis of a specimen from China: G. S. **Whitby.** The specimen examined is from a new source, and possesses the formula $Al_2O_3.2SiO_2,2(MgO.2SiO_2),7H_2O$, a formula which is simpler than those given by Heddle and by Friedel to the pilolites which they investigated. The author considered that, for the present, the term pilolite should be applied to those varieties of mountain leather and mountain cork which (1) cannot be referred to asbestos, on account of their large water-content; (2) cannot be identified with serpentinous asbestos, on account of the relatively small amount of magnesia which they contain; and (3) hold their water in such a way that, when it has been expelled by heating, it is gradually re-absorbed to its original amount from the atmosphere.—Phenakite from Brazil: Dr. G. F. Herbert **Smith.** Crystals of phenakite recently discovered at the gold mine, San Miguel de Piracicaba, Brazil, all display the new form $\{23\bar{5}2\}$ noted by other observers, and another, $\{45\bar{9}6\}$, lying near it. The tetartohedral character of the symmetry is clearly marked.—Preliminary note on the occurrence of gyrolite in Ireland: F. N. A. **Fleischmann.** The mineral gyrolite, though well known as occurring in the basalts of the western islands of Scotland, has not hitherto been recorded from Ireland. Specimens have now been found in the basalts and dolerites in the neighbourhood of Belfast. The mineral occurs in small spherical aggregates, forming a crust on faroelite; it is associated with apophyllite, and occasionally with chabazite. The chemical composition and the optical characters of the mineral agree with those of gyrolite. The mineral is found only in the harder and denser layers of the basalt, and never in the soft, highly amygdaloidal layers.

Zoological Society, June 15.—Dr. A. Smith Woodward, F.R.S., vice-president, in the chair.—The organ of Jacobson in Orycteropus: Dr. R. **Broom.** Orycteropus has a long narrow organ of Jacobson which opens into the naso-palatine canal. The arrangement of the cartilages is quite different from the type found in the higher Eutheria, and there is also a marked difference from the arrangement in Dasypus. The general structure comes nearest to that of the marsupials, though there are a number of striking differences.—Some points in the structure of the lesser anteater (*Tamandua tetradactyla*), with a note on the cerebral arteries of Myrmecophaga: F. E. **Beddard.**—Decapod Crustacea from Christmas Island, collected by Dr. C. W. Andrews: Dr. W. T. **Calman.**—An abnormal individual of the echinoid Amblypneustes: H. L. **Hawkins.**—The decapods of the genus Gennadas collected by H.M.S. *Challenger*: S. **Kemp.**—Notes on a young walrus (*Odobaenus rosmarus*) recently living in the society's gardens: Dr. P. C. **Mitchell.**—Notes on the viscera of a walrus (*Odobaenus rosmarus*): R. H. **Burne.**

Royal Meteorological Society, June 16.—Mr. H. Mellish, president, in the chair.—Interdiurnal variability of temperature in Antarctic and sub-Antarctic regions: R. C. **Mossman.** The author discussed the day-to-day difference in the mean temperature of successive days at a few places in the Antarctic regions for which the necessary detailed daily observations are available. The greatest mean annual temperature variability, viz. 5·9°, was recorded during the "drift" of the *Belgica* in the ice pack, this high value being closely followed by a mean of 5·3° at the South Orkneys. In the Victoria Land region, Ross Island and Cape Adare have a somewhat lower temperature variability of 4·5°, the values of the southern station being higher in summer and autumn and lower in winter and spring than at the northern station. South Georgia occupies an intermediate position between a continental and an oceanic climate in its curve of variability, the mean monthly values varying according to the proximity of the pack ice. At this station the seasonal values show a small variation, and this is also the case at Ushuaia, in Tierra del Fuego. The variability at the Falkland Islands and New Year's Island is very small, pointing to the conserving influence exerted by the insular conditions which prevail at these places. The maximum variability occurs in winter, and the minimum in summer, at the three Antarctic stations, as well as at South Georgia and the South Orkneys. The smallest variability at any season for any station occurs at the South Orkneys in summer, being only 1·4°. It is at this season that cloud amount and fog frequency are at a maximum, while, at the same time, rapidly moving cyclonic disturbances are of infrequent occurrence.—Temperature records during balloon ascents: E. **Gold** and Dr. W. **Schmidt.** The authors described experiments made with the view of ascertaining if appreciable errors could enter into the temperatures recorded in balloon ascents owing to errors in the alcohol-carbonic acid method of testing the apparatus.—The exposure of thermometers: L. C. W. **Bonacina.**

EDINBURGH.

Royal Society, June 7.—Prof. Crum Brown, vice-president, in the chair.—The anatomy of the Weddell seal: Prof. D. **Hepburn**. Dr. W. S. Bruce, leader of the Scottish National Antarctic Expedition, had been fortunate to catch a young male seal only two or three days old, and it was this young specimen of the Weddell seal the anatomy of which was described in detail. Attention was particularly directed to the abdominal cavity, and especially to the peritoneal arrangements and the organs of alimentation. The length of the animal was 51·5 inches, and the length of the intestine 50 feet.—Lower Palæozoic Hyolithidæ from Girvan: F. R. Cowper **Reid**. The description was based on specimens in Mrs. Gray's collection. Nearly all the species were new; ten well-defined species of Hyolithes were established, also three of its subgenus Orthotheca. Two other forms were referred to Ceratotheca, and five new species of Pterotheca were recognised. The affinities of these new species were found to be rather with the Scandinavian than with English members of the group. The rich development of the Hyolithidæ in the Girvan district as compared with other British areas was noticed, and a marked feature of their stratigraphical distribution was the abundance of species in the Blaclatchie beds.—The atomic weight of platinum: Prof. E. H. **Archibald**. The experimental feature of the paper was the extreme care taken to ensure absolute purity of the platinum salts of chloro- and bromo-platinic acids used in the determination. Assuming the values given by the International Committee for the atomic weights concerned in the calculation, the author found the atomic weight of platinum to be not far from 195·25.—Group-velocity and the propagation of waves in a dispersive medium: G. **Green**. The aim of the paper was to develop the idea of group-velocity contained in Kelvin's paper of 1887 on the waves produced by a single impulse in water, &c., and to remove difficulties raised by Kelvin in later papers as to the applicability of Osborne Reynolds's and Rayleigh's dynamical interpretation of group-velocity. The idea of group-velocity used was essentially the same as the principle of "stationary phase" used by Lamb in his investigation of ship waves, but applied in this paper to the Fourier trains which constitute any wave-disturbance. The whole investigation was useful in directing attention to the manner in which group-velocity was concerned in the modification of an initially regular group of waves, or of any disturbance initially confined to a finite portion of a dispersive medium, and in showing, thereby, that the idea of group-velocity contained the explanation of the *modus operandi* of dispersion.—The theory of Jacobians in the historical order of development up to 1860: Dr. T. **Muir**.—*Nematonurus lecointei*, a deep-sea fish first discovered by the *Belgica*, and found again by the Scottish National Antarctic Expedition: Prof. Louis **Dollo**. The one specimen obtained by Dr. W. S. Bruce was found in lat. 62° 10′ S. and long. 41° 20′ W. at a depth of 1775 fathoms, and it constitutes the first macrurid found in the Antarctic seas. The corresponding Arctic zone has yielded eight species in six genera. The results were regarded by Prof. Dollo as unfavourable to the theory of bipolarity.—An experiment with the spark gap of an induction coil: Dr. Dawson **Turner**. When the spark gap is just long enough to prevent the easy passage of the spark, a dielectric rod or plate brought near the positive electrode facilitates the discharge, but when brought similarly near the negative electrode it has no obvious influence on the passage of the spark.

PARIS.

Academy of Sciences, June 21.—M. Bouchard in the chair.—Dimethylcamphor and dimethylcampholic acid: A. **Haller** and Ed. **Bauer**. Camphor forms a sodium derivative when treated with sodium amide, from which the monoalkyl and dialkyl derivatives are readily obtained. The mixture of monoalkyl and dialkyl derivatives can be separated by taking advantage of the fact that only the mono-derivatives combine with hydroxylamine to form an oxime. Dimethylcamphor, heated with sodium amide, gives an amide, probably dimethylcampholamide, from which the corresponding acid has been obtained.—The strata of the island of Elba: Pierre **Termier**.—The new Daniel comet: M. **Javelle**. Observations of this comet were made at Nice on June 16, 17, 18, and 19. The comet was nearly circular, with a diameter of 1·5′. There was a faint nucleus of magnitude 11 to 12.—Observations at the Observatory of Marseilles of the comet 1909*a* (Borrelly): Henry **Bourget**. Nucleus scarcely perceptible, of about 10·5 magnitude.—Observations of the comet 1909*a* (Borrelly-Daniel) made at the Observatory of Besançon with the bent equatorial: P. **Chofardet**. Observations made on June 17 and 19. Diameter, 1·5′; nucleus, very faint; magnitude, 11 to 12.—A question of minimum: S. **Sanielevici**.—The series of Dirichlet: Marcel **Riesz**.—Flight and the shape of the wing: L. **Thouveny**.—An experimental method for aërodynamical researches: A. **Rateau**. The surfaces or models to be studied are placed in a very homogeneous air current moving with a definite velocity. The results of experiments on a thin rectangular plane are shown graphically, and it is shown that there is no possible angle of inclination of the plane between 29° and 36°. This discontinuity was quite unexpected.—The heat of polonium: William **Duane**. The sensitive differential calorimeter used in these experiments has been described in an earlier paper; 0·2 gram of polonium salt gave off 0·0117 calorie per hour. Polonium and radium in quantities which give the same ionisation currents give off practically the same quantities of heat. This fact is favourable to the hypothesis that the heat given off by these bodies is due to the kinetic energy of the α rays.—The ionisation of air by high-tension electric mains: L. **Houllevigue**. The observed case of a hailstorm following exactly the direction of a high-tension cable has been explained by the suggestion that the wire emits torrents of ions carrying large electric charges. Direct experiment fails to confirm this hypothesis. The number of ions, positive and negative, existing in the neighbourhood of a high-tension wire is sensibly *nil*. Indeed, the high-tension lines appear to reduce the number of ions in the immediate neighbourhood rather than increase them.—A new form of the characteristic equation of gases: A. **Leduc**.—A new application of the superposition, without confusion, of small electrical oscillations in the same circuit: E. **Mercadier**. The original experiments were carried out with a complete metallic circuit; similar experiments have now been successfully carried out between Paris and Lyons, using a single telegraph wire with earth return.—A galvanometer for alternating currents: M. **Guinchant**. The galvanometer described was designed to replace the telephone in Kohlrausch's method of measuring the resistance of electrolytes. The accuracy of the measurements is of the same order as when the telephone is used.—The action of some organo-magnesium compounds on methyl-2-pentanone-4: F. **Bodroux** and F. **Taboury**. The reaction is complex, as employing the reagents in molecular proportions there is always a considerable proportion of unaltered ketone in the reaction product, together with the ethylene hydrocarbon corresponding to the tertiary alcohol which should normally have been produced. The tertiary alcohol is formed with a yield varying from 40 per cent. to 60 per cent. of the theoretical.—Some derivatives of thioindigo: M. **Béchamp**.—Elateric acid: A. **Berg**.—Pseudomorphine: Gabriel **Bertrand** and V. I. **Meyer**. Cryoscopic methods indicate that pseudomorphine is derived from two molecules of morphine with the loss of two atoms of hydrogen, and its formula would thus be $C_{34}H_{36}N_2O_6$.—The crystalline schists of the Ural: L. **Duparc**.—The elaboration of the nitrogenised material in the leaves of living plants: G. **André**.—The influence of time on the anti-virulent activity of the secretions of vaccinated animals and the relative immunity of the tissues: L. **Camus**.—The influence of a prolonged stay at a very high altitude on the animal temperature and the viscosity of the blood: Raoul **Bayeux**. The body temperature and the viscosity of the blood, under the influence of high altitudes, undergo modifications which are proportional to the stay at the high altitude.—Hay fever: Pierre **Bonnier**.—The tectonic relations of the earthquake in Provence: Paul **Lemoine**.—A geological sketch of the regions situated to the east and north-east of Tchad: G. **Garde**.—The geology of the Peloponnesus: Ph. **Négris**.—The position of the localities which appear to have been most troubled in the earthquake of June 11, 1909: M. **Jullien**.—The oxydases of the waters of Chaldette (Lozère): F. **Garrigou**.

NEW SOUTH WALES.

Linnean Society, April 28.—Mr. C. Hedley, president, in the chair.—The geology and petrology of the Canoblas, N.S.W.: C. A. **Süssmilch** and Dr. H. I. **Jensen**. The Canoblas are a group of extinct volcanoes in the vicinity of Orange, N.S.W. The western tableland here has an elevation of about 3000 feet. The surface of the tableland is a peneplain, above which rise residuals of a still older plain. This peneplain was cut out of a series of folded Devonian and Silurian rocks, and has since been elevated to its present altitude (3000 feet). The Canoblas Mountains proper consist of lavas and tuffs, deposited upon the peneplain.—Observations on the development of the marsupial skull: Prof. R. **Broom**. A fairly complete series of the diprotodont *Trichosurus vulpecula*, and an interesting early stage of the polyprotodont *Dasyurus viverrinus*, have been studied.—Notes on the synonymy and distribution of certain species of Australian Coleoptera, with descriptions of new species of Tenebrionidæ: H. J. **Carter**. The paper comprises notes upon the synonymy and distribution of a number of species referable to the three families Buprestidæ, Tenebrionidæ, and Cerambycidæ, accumulated during a recent visit to Europe, and especially to the museums in Brussels, Paris, London, and Oxford, together with the descriptions of twenty-one species of Tenebrionidæ proposed as new.

CALCUTTA.

Asiatic Society of Bengal, May 5.—A Goniomya from the Cretaceous rocks of southern India: H. C. **Das-Gupta**.—Coptis: I. H. **Burkill**. The author endeavours to determine the source of the roots of Coptis sold in India. Three kinds are sold, one, as is well known, coming from the Mishmi hills, and being derived from *Coptis Teeta*, Wall, the other two imported over-seas, and possibly being, respectively, roots of *Coptis Teeta*, var. *chinensis*, Fine and Gagnep, and of *Coptis anemonaefolia*, Sieb. and Zucc. Plants of *Coptis Teeta* in cultivation at the Lloyd Botanic Garden, Darjeeling, have been studied, and figures drawn from them.—Morphological and physiological differences between Marsilea left on dry land and that growing in water: Nibaran Chandra **Bhattacharjee**. *Marsilea quadrifolia* does not fruit when growing in water, but only on dried earth.—Notes on the history of the district of Hughli before the Mohammedan period: Nundo Lal **Dey**.—The drug astukhudus, nowadays *Lavandula dentata*, and not *Lavandula Stoechas*: I. H. **Burkill**. It is probable that the importation of *Lavendula dentata* into India began with the Portuguese trade. Before that, *Lavendula Stoechas* from Asia Minor served as the drug astukhudus from the time when the Mohammedans introduced it.—The Manikyala tope: H. **Beveridge**.—First notes on *Cymbopogon Martini*, Stapf: I. H. **Burkill**. The two varieties, Motia and Sofia, are to be distinguished from one another by the absence or presence of the chemical body carvon, by the angle at which the leaves arise, and by different preferences in the matter of climate.

CAPE TOWN.

Royal Society of South Africa, May 19.—Dr. L. Crawford in the chair.—The possible existence at Kimberley of oscillations of level having a lunar period: Dr. J. R. **Sutton**. The outstanding seismic feature of Kimberley is the diurnal variation of level whereby the crust of the earth rises and falls once a day under the influence of some solar action as yet uninterpreted. This matter was discussed in a paper read before the Royal Society of South Africa last July. The present discussion is concerned more with variations of level depending upon the gravitational influence of the moon. The observations do not cover a sufficiently extended period to admit of an exhaustive analysis, but, so far as they go, they imply perhaps that when the moon is south of the equator its attractive force causes the whole of the enormous protuberant mass of the earth's crust forming South Africa to oscillate periodically east and west during the course of the lunar day. This oscillation tends to mask whatever true lunar tide there may be in the solid earth. Only when the moon is nearest to the earth does the pendulum move in such a manner as to suggest that there is such a tide.—The rainfall of South Africa. The possibility of prediction over the south-west: A. G. **Howard**. For this investigation, which extended over five complete years, three stations were selected, so as to secure a triangle of observations, and at each the rise or fall of the barometer in twenty-four hours was noted, together with the direction of the wind at L'Agulhas. From a consideration of the various conditions, which fell under twenty-six heads, and were worked out daily during five complete years, it was found possible to construct a table for prediction purposes. This was applied to the rainfall for the year 1908, and the element of error under each condition of barometer was:—(1) when the pressure was decreasing generally, 5·23 per cent., and (2) when the pressure was increasing generally, about 11 per cent., proving the argument that it is possible to predict rainfall over the district from the date suggested.

DIARY OF SOCIETIES.

MONDAY, JULY 5.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Captain Tilho's Explorations in the Lake Chad Region: Lieut. Mercadier.

WEDNESDAY, JULY 7.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

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THURSDAY, JULY 8, 1909.

RUWENZORI AND CENTRAL AFRICA.

(1) *Il Ruwenzori: parte scientifica: risultati delle osservazioni e studi compiuti sul materiale raccolto dalla spedizione di S.A.R. il Principe Luigi Amedeo di Savoia, Duca degli Abruzzi.* Vol. i., Zoologia e Botanica. Pp. vii+603; 74 plates. Vol. ii., Geologia, Petrografia e Mineralogia. Pp. xxi+286; 40 plates. (Milan: Ulrico Hoepli, 1909.) Price, 2 vols, 50 lire.

(2) *Résultats scientifiques des Voyages en Afrique d'Édouard Foà.* Publiés sous les Auspices du Muséum d'Histoire naturelle. Avec Préface de M. Edmond Perrier. Pp. xli+742. (Paris: Imprimerie Nationale, and Plon-Nourrit et Cie., 1908.)

(1) IN 1906 the Duke of the Abruzzi, already famous for his exploration of the lofty mountains of Alaska, resolved to do what no other traveller had done—make a thorough examination of the range of snow mountains in equatorial Africa known as "Ruwenzori." The number of snow peaks, their altitudes, extent of glaciation, and exact position on the map remained still unknown, although Ruwenzori had been revealed to geographical knowledge for nearly twenty years. Although no previous explorers had had the monetary resources of this prince of the House of Savoy, and consequently been able to fit out such a perfectly organised expedition, yet it must be noted that most of the Duke's predecessors suffered from sheer bad luck in the way of weather, or difficulties arising from the disturbed condition of the natives. Otherwise the Duke of the Abruzzi might have been forestalled as conqueror of these virgin peaks. But in any case it is doubtful whether any previous traveller was so perfectly trained to make every use of his opportunities as the Duke of the Abruzzi, who, apart from his carefully chosen staff, selected to deal specially with geology, biology, and photography, was himself a highly trained surveyor, scientific geographer, and alpinist.

The result has been, of course, a complete settlement of the position, height, configuration, and petrological structure of these "Mountains of the Moon"—not, as we now learn, the highest point on the African continent—in that respect they are only third in rank—but surely the most impressive and remarkable among African mountains. The general geographical and meteorological results of the expedition were given in one large volume at the close of 1908 (published in English and Italian). In the two volumes under review, the geological and biological collections and observations of the Duke's expedition are dealt with by a large number of authors, the whole work being edited by Dr. Alessandro Roccati (who has also written on the geology and petrology) and published in Italian only. The volumes are magnificently produced, and are of the highest importance scientifically. They deal justly, even generously, with the work of previous explorers, or with the opinions and researches of British, French, and German authorities (*inter alios*); but why did not Dr. Roccati get some one to go carefully through the proof sheets with him before publication? The two volumes abound in the most ridiculous press errors, wherever the Latin, English, German, or French languages are employed. English is the worst maltreated. The English authors quoted are sometimes made to express themselves in a very puzzling manner.

Ruwenzori was shown by the Abruzzi expedition to be a mountain chain mainly of archæan, crystalline rocks (gneiss, mica-schists, granite, &c.), cut athwart by a curved band of Palæozoic volcanic greenstones (amphibolite, diorite, diabase, &c.). In the upper valleys of the Bujuku, Mubuku, Mahoma, and other streams, born from the snow peaks and the glaciers, there is a lacustrine alluvium (which ought to be interesting of exploration for possible Pliocene or Pleistocene fossils). There are two or three calcareous deposits. The lower stream valleys are bordered by ancient and recent moraines. At the southern base of the Portal Peaks (south-east of Ruwenzori) there are three small dykes of basalt. Elsewhere in the distant foothills to the east and south of Ruwenzori there are plain evidences of recent volcanic activity in the intrusions of basalt, the stratified tuff, the craters of dead volcanoes (often filled with lovely crater lakes), the hot springs and the frequent earthquakes. This volcanic belt links on with the still smoking and devastated region of Mfumbiro and Lake Kivu, and is no doubt synchronous in origin with the volcanic activities of equatorial East Africa and of North Nyasa.

The work under review has much that is interesting to record on the former extension of the Ruwenzori glaciers. The volumes confirm the observations of Scott-Elliott, Moore, the present writer, and other travellers as to the signs of glacier action at comparatively low altitudes (7000 feet and less). If these deductions be correct, similar signs ought to be present (and should be looked for) on the Abyssinian, North Nyasa, Mlanje, Rhodesian, and Drakensberg Mountains. But if these indications of a Glacial period or periods are found in tropical Africa, and if, moreover, they are proved to be coincident in time with the Glacial periods of Europe and North America, will this not tend to dispose of the idea now in vogue that there has been a gradual shifting of the poles of the earth's axis, carrying with it the more or less glacial conditions gathered round the poles to various parts of the earth's surface? This last theory certainly explained more easily the former existence of a vegetation in both the present polar regions sufficiently dense to become transformed in course of time into coal-measures, a vegetation which could not have flourished with a six months' winter-night in every year.

Dr. Roccati thinks that Ruwenzori was at one time a lofty island of archæan rocks rising up out of the waters of an immense fresh-water sea—the Victoria Nyanza, Ibrahim (or Kioga), Albert Nyanza, Albert Edward, Dweru, and Semliki combined. He attributes this idea in its inception to the studies of Mr. C. W. Hobley, a Commissioner in the British East African service who has done so much to increase our knowledge of Equatorial Africa.

The Duke of the Abruzzi established definitely the existence in the Ruwenzori range of six great *massifs* of snow-crowned, glaciated peaks. These are not placed in a continuous chain, but rather in a cluster, almost a broken amphitheatre, with Mts. Speke and Baker in the middle and the snowless Portal Peaks (11,000–12,000 feet) on the eastern side. It is from the south-east that the Ruwenzori giants are most broken down and most approachable. All the snow peaks are grouped within a few miles of one another, but beyond them, to the north, are lofty, snowless hummocks, perhaps rising to 9000 or 10,000 feet, which prolong the chain northwards in the direction of Lake Albert.

The loftiest of the snow-crowned *massifs* or mountains (Mt. Stanley) rises to 16,815 feet at its highest point (the Margherita Peak). The next highest *massif* is Mt. Speke (16,080 feet). After that Mt. Baker (15,988 feet), Mt. Emin (15,797 feet), Mt. Gessi (15,647 feet), and Mt. Luigi di Savoia (15,299 feet).

In possessing all these separate snow-crowned *massifs*, Ruwenzori differs from Kilimanjaro (with only two) and Kenya (only one), besides in the fact that its origin is due to a slow upheaval of the earth's crust, and not—as is the case with the other two great snow mountains of Africa, and their neighbours, Meru and Elgon—to an outburst of volcanic energy.

In the zoological collection made by the Duke was a fine specimen of a leopard obtained at Bujongolo (about 12,000 feet altitude), on the east side of Ruwenzori. It measured about 7 feet 2 inches in total length, and of this measurement the tail only occupied about 2 feet 3 inches. These are rather the proportions in tail and body of a jaguar than of a leopard. The markings, moreover, in the large size and completeness of the rosettes recall the jaguarine type, and still more the boldly marked leopards of Sinai, Persia, and China, and the Central Asian Ounce. The canine teeth in *Felis pardus ruwenzorii* are proportionately much longer than in other African leopards (except in one example from the Abyssinian Mountains). In this point (but not in skull peculiarities) the Ruwenzori leopard resembles the peculiar "*fontanieri*" leopard of China. Prof. Lorenzo Camerano, who describes *F. pardus ruwenzorii*, does not seem to be aware that Mr. Lydekker a year or so ago described a similar type from the Toro country at the north-east base of Ruwenzori. The present writer also saw a large leopard skin of this description in the possession of the Rev. Mr. Teggart (C.M.S.) in eastern Toro in June, 1900. This skin appears in the background of a seated man on p. 587 of the "Uganda Protectorate."

The second volume of "Il Ruwenzori" contains a good deal of interesting material on the subject of the Colobus monkeys (a group which seem to retain points of affinity with the Semnopithecines of Asia, the Archæolemurine forms of Madagascar, and even the Cebidæ of America); of Grant's zebra, and the classification of the "quagga" subgenus of equines; of the Central African buffaloes; and of the squirrels, dormice, mice, and crested rats (Lophuromys) of Ruwenzori. A few new birds are described, and numerous molluscs. A noteworthy contribution to "Il Ruwenzori" is Prof. F. Silvestri's essay on the Myriapoda—the Diplopoda especially—obtained by the Abruzzi expedition.

A very large and important collection was also made of earthworms and of parasitic worms, the latter derived from the intestines of beasts, birds, and reptiles.

The botanical section of this work is also of high interest, as it illustrates very conclusively the alpine and subtropical flora of Ruwenzori—the giant groundsels, strange lobelias, the heaths, junipers, and ferns—filling up many gaps left in the work of previous travellers.

(2) Not equally valuable in the scientific study of Africa is the work so sumptuously produced by the Paris Museum of Natural History. The results of M. Édouard Foà's journeys, to have acquired proper significance and reward from the public interested in African geography and ethnology, should have been published ten years ago. His remarks would then have been more apposite; his discoveries would not have been forestalled by later and more scientific travellers. As it is, M. Foà was at no time what might be called a trained observer, except in regard to astronomical and meteorological observations and records. His ethnology and his natural history strike the critical reader as hazy, inexact, too generalised, too little founded on direct personal observation, too much influenced by traditional opinions. His vocabularies of native languages are full of errors, and are, moreover, quite displaced in interest by the serious treatment of these Zambezian, Central African, and East Congo languages by a host of British, French, and Belgian missionaries and officials. Amongst inaccuracies, too (perhaps on the part of the editors), is the presentation of an obvious Bushman (pp. 142 and 143) as a Yao. [The original of this mis-named picture is in the possession of the Royal Anthropological Institute.] Some of the notes on the Bushmen would be interesting and valuable were they not so devoid of actuality, of names, places, and dates. Apparently M. Foà did encounter some of the mysterious "Vaalpens" in the valley of the northern Limpopo (though he does not give them that name—see pp. 113, 114), a race the existence of which (as a "pygmy" type distinct from the Bushman) has been asserted by Prof. Keane and denied by Mr. Selous. It is interesting to note that M. Foà comments on the complete absence of steatopygy among these north Limpopo Bushmen (? Vaalpens), and the rest of his description rather accords with what Prof. Keane has collected relative to the Vaalpens.

There are portions of M. Foà's essays on the lion and the African elephant which strike one as new, interesting, and derived from original observation, mixed up, however, with much unnecessary padding. He is able to supply two good photographs of the rare Angas's Tragelaph and some fresh information about that handsome creature. He discovered in Central Zambezia what is probably a new subspecies of Burchell's zebra (or, as Mr. R. I. Pocock would say, quagga), which seems in its narrow striping an intermediate form between the zebra and the quagga groups (see also on this subject "Il

Ruwenzori"). M. Foà made considerable collections of fish in Central Africa, of mollusca, insects, spiders, ticks, and crustaceans. He also brought back Medusæ from Tanganyika. These Medusæ serve as a text for a very interesting article by M. Charles Gravier on the Medusæ of the Victoria Nyanza, of Tanganyika, and of the Niger basin. Perhaps the most important contribution to this *recueil* is the treatise by M. Louis Germain on the molluscs of Tanganyika, notably those collected by M. Foà. M. Foà's own remarks on the tsetse fly are worthy of attention. H. H. JOHNSTON.

THE PLANET MARS, 1890–1901.

La Planète Mars et ses Conditions d'Habitabilité. By Camille Flammarion. Tome ii., Observations faites de 1890 à 1901. Pp. 604. (Paris: Gauthier Villars, 1909.) Price 12 francs.

IN the year 1893 we had the great pleasure of giving our readers some account (vol. xlvii., p. 553) of the very excellent and complete summary of the observations of the planet Mars, made between the epochs 1636–1890, compiled by the distinguished French astronomer, Monsieur Camille Flammarion. This work, containing no fewer than 604 pages, presented us with a most interesting survey of the progress made in enumerating and deciphering the markings observed on the planet's surface. It commenced with the earliest known observation of the planet, namely, that of the Neapolitan astronomer Fontana, on August 24, 1638, who wrote:—

"1636. Martis figura perfecte spherica distincte atque clare conspiciebatur. Item in medio atrum habebat conum instar nigerrimæ pilulæ.

"Martis circulus discolor, sed in concava parte ignitus deprehendebatur.

"Sole excepto, reliquis aliis planetis, semper Mars candentior demonstratur."

The volume concluded with the observations made in the year 1890, including the first photographs of the disc of Mars made by Prof. W. H. Pickering at Mount Wilson, California, on April 9.

In Martian cartography the year 1890 seems to-day a very long time ago. The pioneers did their work well, and the great tradition which fell on the shoulders of those who were busy with Mars up to 1890 was well maintained, and a great amount of new knowledge secured. Since that year the attack on the planet, to unravel the secrets of its visible features, has been no less severe, and to-day the knowledge gained is only a new incentive to further research.

If we were to be asked to state three or four of the more recent and most important discoveries in relation to the planet Mars, we should be inclined to say as follows:—

(1) That the dark areas on the planet which were considered to be seas have been shown to be traversed by permanent lines, and that, therefore, the water surface explanation had to be abandoned (Pickering and Douglas, 1892).

(2) The successive development of the canals according to the Martian seasons (Lowell).

(3) The photography of the canals themselves (Lampland, 1903–5).

(4) The photography of the spectrum of water vapour in the Martian atmosphere (Slipher, 1908).

While the above may be considered as four of the important results secured since 1890, there is a host of many other valuable advances which will be found recorded in the volume under review.

Monsieur Flammarion has done his work exceedingly well, and, with masterly instinct, describes, fits together, and discusses the observations, made between the years 1890 and 1901 by a very great number of workers, in a logical and interesting manner.

Before commencing to give in detail the observations of the first epoch, 1892, he rightly refers at some length to the fine memoir published in 1896 by the celebrated Italian astronomer, M. Schiaparelli, the discoverer of the canals. This memoir is devoted to a discussion of his observations of the Opposition 1883–4, while a sixth memoir, published in 1899 and here referred to, contains his observations made at the Opposition of 1888.

Space does not allow us, nor indeed is it necessary, to enter into any detail into the successive series of observations which are here marshalled together. The reader must be left to peruse the volume himself and form his own conclusions, but even he will be astonished at the wealth of matter which is brought together under one cover.

As in the previous work, there is a great number of illustrations accompanying the text, and these add materially to the understanding of the changes of Martian features.

At the end of the volume, M. Flammarion, with the help of M. Antoniadi, has constructed a key-map of the surface features of the planet, which gives us an idea of the complicated system of markings which is the result of the observations up to the year 1901.

As has been mentioned above, some important additions to our knowledge of Mars have resulted from observations of more recent date, and we can only suppose that M. Flammarion has in hand vol. iii., which will, we hope, in due course be published, and be as valuable a contribution to astronomical science as its two predecessors.

In conclusion, we may quote M. Flammarion's remarks with regard to the habitability of Mars, since the subject has recently been prominently brought forward:—

"Mais il me semble que, dans toutes ces interprétations, je suis moi-même un peu terrestre. Il y a sans doute là d'autres éléments, non terrestres, mais *martiens*, ou, tout au moins, des conditions toutes différentes de celles de notre habitation. Que cette planète soit actuellement le siège de la vie, c'est ce dont témoignent toutes les observations. Mais il nous est encore impossible de nous former aucune idée judicieuse sur les formes que cette vie a pu revêtir, formes assurément differentes de nôtres. Un mystère impénétrable enveloppe encore aujourd'hui ce passionnant problème, qui est, en définitive, quoi qu'on en passe, le but, peut-être inaccessible, de toutes les recherches de l'Astronomie planétaire. Mais ne désespérons jamais! Qui sait ce qui sommeille dans l'inconnu de l'avenir?"

WILLIAM J. S. LOCKYER.

THE GEOMETRY OF FORCES.

Geometrie der Kräfte. By H. E. Timerding. Pp. xii+381. (Leipzig: B. G. Teubner, 1908.) Price 16 marks.

In this admirable volume Prof. Timerding gives a systematic and original treatment of the geometry of forces and force-systems in which for the first time, so far as we are aware, an adequate knowledge of modern geometrical research has been utilised in a text-book of mechanics.

Ever since the great work of Plücker, that large and most attractive department of mathematics known as the geometry of the linear complex has been found to be intimately connected with the geometry of forces. It is sufficient to recall the fact that whenever six forces applied to a free body are in equilibrium, the forces must lie respectively on six rays of a linear complex. In chapters viii. and ix. of Timerding's book now before us we have an admirable treatment of the application of the theory of the linear complex to the theory of systems of forces. The many interesting matters set forth in these pages show how greatly the advancement both of the geometrical theory and the dynamical theory is promoted by their association.

The statical and dynamical significance of the linear complex is closely connected with the fact that each ray of the complex is reciprocal to that screw of which the axis is the axis of the complex, while the pitch of the screw is the parameter of the complex. Many of the geometrical properties of the complex follow directly from this general principle. For example, on p. 107 it is shown that four linear complexes have two real or imaginary rays in common. This is an immediate consequence of the fact that one cylindroid can always be found of which every screw is reciprocal to any four given screws. As there are two screws of zero pitch on the cylindroid, these lines are, of course, the two common rays of the four linear complexes defined as being reciprocal to each of the given screws. We congratulate Prof. Timerding on his recognition of the proper place for the linear complex in the forefront of a text-book on the geometry of forces.

The theory of screws has received in this volume a treatment even more ample than that which it has already received in the works of Fiedler, Schell, Budde, Minchin, and more recently in the "Encyclopädie der mathematischen Wissenschaften." The excellent work of Harry Gravelius, "Theoretische Mechanik Starrer Systeme," contains a complete account of the theory of screws up to the date of its publication in 1889. Much of the work done on the subject in the succeeding decade has been available for the "Geometrie der Kräfte." It may, however, be remarked that certain developments of the theory which have appeared since 1900 have not been included in Prof. Timerding's volume. The theory of screw-chains, by which the theory of screws has been extended to any material system, is also not discussed. A suggestive reason for this omission is given in the preface (p. vii), where Prof. Timerding says that, in his opinion, the theory of screw-chains would require a new and voluminous treatment of the whole of mechanics in which the rigid body would appear as the first element.

Observing that the laws for the composition of twists and wrenches are identical, the author, as others have done, uses the word *dyname* to signify either a twist or a wrench. For a large part of the subject the use of the abstraction signified by the word dyname is very convenient, and considerable use has been made of the important labours of Study on the geometrical theory of dynames.

In an interesting chapter on "Die Reyeschen Strahlencomplexe" the author brings into its due prominence the fundamental importance of the "Geometrie der Lage" in kinematics. This chapter contains many admirable theorems, and we could only wish that such instructive and beautiful ideas as are here set forth were more generally introduced into the teaching of mechanics. Due acknowledgment is made throughout the work of the important contributions to the geometrical theory of forces by the late Prof. Charles J. Joly.

The chapter on the cylindroid may be specially commended, and prominence is given to the theorem that the projections of any point on the generators of a cylindroid lie on an ellipse. We may, however, note that the proof here set forth is not that by which the theorem was discovered, as shown in the original volume on the theory of screws published in 1876.

A sufficient account is given of the various systems of screw coordinates, and, following the analogy of the resolution of forces, Prof. Timerding uses notation which divides the coordinates of a screw into two groups of three each. It is, however, often convenient to use the six symmetrical coordinates of a screw referred to six co-reciprocal screws.

We are glad, indeed, to commend this most excellent work to the attention of teachers and students of theoretical dynamics. We are sure that if the book were translated into English it would form a very valuable supplement to the existing English books. It would give the student an adequate idea of the extent to which modern geometrical theory and the theory of forces act and react on each other to the vast benefit of both.

Robert S. Ball.

THE DISTRIBUTION OF GOLD ORES.

Gold: Its Geological Occurrence and Geographical Distribution. By J. Malcolm Maclaren. Pp. xxiii+687. (London: *The Mining Journal,* 1908.) Price 25*s.* net.

Dr. Maclaren begins his preface with the remark that "the writer who would add one more treatise to the literature of the study of ore-deposits must needs show justification." Any apology for the publication of his useful book is, however, quite unnecessary, for the increase by four times of the gold yield of the world during twenty years has been attended by a voluminous and scattered literature. Students of mining geology will be grateful to any author who undertakes the great labour of compiling a summary of recent work on gold and its distribution.

The longest and most valuable section of Dr. Maclaren's book is occupied by an account of the geological structure and mining history of all the chief goldfields of the world. This part of the work occupies 514 pages. The goldfields are classified by continents. Those of Europe are described first, and in proportion to their economic importance receive longer notice than those of Australia and South Africa. The longest section is that on the goldfields of North America. Each field is noticed separately; the descriptions are necessarily short, but they are concise, and are accompanied by useful reference to recent literature. The minor fields are described at relatively greater length than the others; and thus Kalgurli, with its "Golden Nile," is dismissed in four pages, including a full-page map and another figure. This distribution of space is, however, probably the most useful, as the less-known fields are often very instructive and their literature is less accessible. The author has travelled extensively, and his accounts of many fields have the advantage of personal knowledge and original information. The descriptions of the fields are therefore inevitably of unequal merit.

Among the most interesting sections are those on the mines of New Zealand—though as a New Zealander, it is strange that the author places Reefton in Westland, and spells the name of the founder of the New Zealand school of mining geologists Uhlrich—of Queensland (the author was once on the staff of its Geological Survey), and of Mysore. The historical introduction to the Mysore gold mines is of especial interest, and the author rejects the view that the ancient mines there can have been those from which Solomon and the Phœnicians obtained their supplies of gold. Dr. Maclaren remarks that India was then a civilised State, which needed more gold than it produced; and the Israelites could only have obtained gold there by barter, for which they had nothing to offer. This conclusion, therefore, strengthens the view that the Ophir of the Phœnicians must be in southern Africa, and that the gold probably came from the prehistoric mines of Rhodesia.

Dr. Maclaren's account of the separate goldfields is preceded by an introduction on the chemical and physical properties of gold, on natural and artificial compounds of gold, and on the theories of the formation of gold ores. The speculative section of this introduction is remarkable for the author's advocacy of somewhat extreme positions. Thus he denies the origin of any important ore deposits by other agencies than meteoric waters. He admits that there may be some magmatic water; but even when he allows that the gold is due to magmatic emanations, he holds that the water in which it is dissolved comes from a superficial source. He also holds to the once popular view that alluvial gold and gold nuggets are formed by growth *in situ* in the gravels from percolating gold-bearing solutions. He defends this view especially on the ground of the crystalline character of much alluvial gold; he quotes competent authorities who deny this fact, but affirms it from his own experience. The author does not explain why, on this precipitation theory, nugget formation is so local, and why the nuggets are so constantly found just below the outcrop of reefs containing nuggety patches of gold. He admits that the nuggets of Western Australia are derived from gold-quartz veins, and the evidence for the similar origin of the nuggets from Victoria—which contains the most famous of nugget-yielding goldfields—seems to the writer overwhelming.

Another doubtful hypothesis advanced by the author is the absence of any undoubted, valuable pre-Cretaceous placer deposit. He rejects, or quotes with apparent approval those who reject, the alluvial origin of the gold in various Mesozoic, Palæozoic, and Archæan conglomerates and sedimentary deposits; and he then argues that the absence of pre-Cretaceous detrital gold is due to the rocks having been lowered into a zone saturated with alkaline waters which removed the gold in solution and re-deposited it in veins.

Though many geologists may be disposed to differ from the author in some of his conclusions as to the formation of gold ores, they will be no less grateful to him for this valuable and trustworthy summary of the voluminous gold literature issued during the past twenty years. J. W. G.

SWINE IN AMERICA.

Swine in America. A Text-book for the Breeder, Feeder, and Student. By F. D. Coburn. Pp. xv+614. (New York: Orange Judd Co.; London: Kegan Paul and Co., Ltd., 1909.)

JUST as it might be said of the British fat bullock that he has followed the turnip, so it might be said of the American fat hog that he has followed the corn, *i.e.* Indian corn. In the United States there are 56 millions of swine—there are only three and a half millions in the United Kingdom—and far more than half these are to be found in the great corn States which are drained by the Mississippi and its tributaries. Iowa comes first with $8\frac{1}{2}$ millions, and Illinois and Nebraska next with $4\frac{1}{2}$ and $4\frac{1}{4}$ millions. Altogether there are about eighty million pounds' worth of swine in the United States, the duty of which it is to convert corn and other crops and by-products into more marketable commodities, and eventually to feed, not only the Americans, but also some part of the industrial population and the armies and navies of the rest of the world.

An industry so vast can do with many a text-book, and Mr. Coburn has produced one for those who breed, rear, and feed the raw materials for the American packing houses. Many experiments have been carried out in the States on the rearing and fattening of swine, and the gist of these is embodied in Henry's "Feeds and Feeding," which, however, is a book dealing rather with principles than with the details of management, and a book, therefore, for the student rather than for the farmer. Mr. Coburn's is a farmer's book. He has collected Henry's and many other data, and set them forth in such a way that the nutritive effect and economic value of every important feeding stuff and by-product is dealt with, whether these foods are fed separately or with others. The effects of bulky and succulent foods and of concentrates, and of these consumed separately and jointly, are fully considered. Thus, for instance, a farmer having a lot of corn is told what proportion of alfalfa, or roots, ought to be fed along with corn to attain the best economic results. This part of Mr. Coburn's book is valuable.

In the earlier chapters Mr. Coburn deals with the various races and breeds of swine in the States, and also with the principles of breeding; but, as may be inferred from the following quotation, although he writes at some length, he does not get much beyond the current nebulous ideas held by stock-breeders on these subjects:—

"There exists in some sections of Old Mexico a type of 'hog' which is the product of crossing a ram and a sow, and the term 'Cuino' has been applied to this rather violent combination. The ram used as a sire to produce the Cuino is kept with the hogs from the time he is weaned. . . . The Cuino reproduces itself and is often crossed a second and third time with a ram."

A number of the illustrations are not accurate representations of the breeds they refer to, but are rather artist's ideals.

OUR BOOK SHELF.

A Text-book of General Pathology for the Use of Students and Practitioners. By Prof. J. M. Beattie and W. E. Carnegie Dickson. Pp. xvi+475. (London: Rebman, Limited, 1908.) Price 17s. 6d. net.

In the preface the authors state that this volume is based on the teaching of the Edinburgh school of pathology, where the first chair of pathology in the United Kingdom was founded, and as such we welcome its appearance. At the same time, we do not note any features particularly novel, either in the subject-matter or in its arrangement, and in some respects the book seems to be lacking as a text-book of general pathology. Thus the important factor of heredity in disease, and shock and collapse, are not even mentioned, and we do not understand why a discussion of the nature of gout and the chemistry of uric-acid metabolism "do not come within the scope of the present volume."

The opening chapter deals all too briefly with the cell in health and disease. An excellent summary of modern views on cell-structure and cell-division is presented to the reader, but the section on the chemistry of the cell is mainly occupied with the recommendations of the Chemical and Physiological Societies on protein nomenclature.

The chapters which follow deal respectively with general retrogressive processes, disturbances of the circulation, inflammation and repair, progressive tissue changes, animal parasites, and immunity.

An excellent account is given of fatty change, and modern views respecting it are succinctly stated. Lardaceous disease is similarly well treated, but we do not understand why authors will persist in employing the terms "waxy" and "amyloid" to designate it, for "lardaceous" has the claim of priority; it is official in the "Nomenclature of Diseases" of the Royal College of Physicians, and the material present is universally known as lardacein.

The chapter on inflammation and repair gives all essential details on this important subject. The classification of tumours, admittedly a difficult subject, adopted by the authors is that advocated by Adami. This seems to us unnecessarily complex for the medical student and practitioner. The structure of tumours is given at some length, and the chief views on the causation of tumours are summarised. As regards the latter, one or two points brought out by recent research have been omitted. For example, the occurrence of heterotype mitosis in malignant growths is referred to, but Bashford and Murray's criticism of Farmer, Moore, and Walker's work in this connection does not appear, and in discussing the supposed sarcomatous metamorphosis of carcinoma no mention is made of the fact, which now seems certain, that it is the connective tissue stroma of the carcinoma which is thus transformed, and ultimately overgrows the carcinomatous elements. The vegetable parasites are omitted, as these are dealt with in text-books of bacteriology, but an excellent and fairly full account is given of the animal parasites, protozoan and metazoan. Immunity is discussed in twenty-five pages, and the essentials of the subject are conveyed to the reader.

On the whole, the book may be regarded as a very useful text-book of general pathology. It is excellently got up, and a word of praise must be bestowed on the illustrations, 162 in number (also four coloured plates), the majority of which are the work of Mr. Richard Muir, and as a rule depict very clearly the subjects they represent, though it may be questioned whether so many are really necessary, as they tend to distract the student from an examination of the actual specimens themselves.

(1) *Der Bau des Weltalls.* By Prof. Dr. J. Scheiner. Dritte, verbesserte Auflage. Pp. 132. (Leipzig: B. G. Teubner, 1909.)
(2) *Die Planeten.* By Dr. Bruno Peter. Pp. 131. (Same publishers, 1909.) Price 1.25 marks each.

(1) The series "Aus Natur und Geisteswelt" is well known. It consists of a number of little treatises, in which men of science occupying prominent positions have attempted to explain in an accurate and comprehensive manner the results of past inquiries, and the position to which our knowledge has extended in various directions. In the former of the two specimens before us, Dr. Scheiner gives the substance of six popular lectures delivered in Berlin to a number of high-school teachers in the course of which he attempted to describe so much of the universe as comes within the range of our telescopes. He endeavoured to bring home to his audience the magnificent scheme of distances on which the planetary and stellar systems are planned; he traced the detection of proper motion of the fixed stars, and showed how the sun's movement in direction and amount can be determined. The phenomena of the sun are explained in some detail, preparatory to the examination of the spectra of stars, a subject which is discussed somewhat fully, as might be expected from a member of the staff of the Potsdam Observatory. Herein, as the author points out, he is on the sure ground of observation. But in his last chapter he approaches the more speculative subject of the origin and constitution of the universe. The subject is handled with skill, and, notwithstanding the limited space to which the author is restricted, he has succeeded in making his subject both clear and interesting. We do not wonder that the little work has passed through three editions, for, apart from that longing to satisfy an intelligent curiosity which appeals to so many, the material is put in a very attractive form, which should appeal to many readers.

(2) Dr. Peter has a simpler subject, in which the facts have been many times detailed, and he has little scope for either originality of treatment or lucidity of arrangement. As the planets extend in order from the sun, so he must follow them from Mercury to Neptune. A Vulcan is hinted at within Mercury's orbit, but the

hypothetical planet outside Neptune does not attract comment. Since the satellites of Jupiter and Saturn come under notice, more attention might have been given to the moon and to the phenomena of eclipses. The plan of the book, however, aims rather at the description of the surface than of the motion of the planets, though naturally the tale of the discovery of Neptune is told once again. It might seem that there is scarcely room for such a book, considering the number of popular works that are extant, but there is some difficulty in keeping even these works abreast of the time. As an example we may quote the sentence, "Bestimmt sieben, wahrscheinlich sogar acht Monde umkreisen Jupiter." Notwithstanding the recent issue, there is here opportunity for correction in the next edition.

Untersuchung und Nachweis organischer Farbstoffe auf spektroskopischem Wege. By J. Formánek, with the collaboration of E. Grandmougin. Pp. 252. Second edition. Part i. (Berlin: Julius Springer, 1908.) Price 12 marks.

THE first edition of this work appeared in 1901 in a single volume. In part i. of the new edition which is now before us, subject-matter to which only forty-two pages were devoted in the first edition has been elaborated and added to so largely that it occupies the whole of part i. The introduction deals with spectroscopic methods in general, but more particularly with absorption spectra of coloured solutions and the influence of solvents, concentration, reagents, temperature, &c., on the latter. Then follow chapters on the spectroscope, general observations on the relationship between colour, absorption, fluorescence, and constitution of coloured compounds and dyestuffs, and on the relationship between chemical constitution and absorption spectra of dyestuffs belonging to individual classes. The latter include di- and tri-phenylmethane dyestuffs, quinonimide dyestuffs, fluorindene and triphendioxazine, acridine dyestuffs, and anthraquinone dyestuffs. No mention is made in this part of the azo-dyes, or the dyes of the indigo group, while of natural dyestuffs only alizarin is mentioned. It is to be presumed, however, that these important classes will receive due consideration in part ii., which represents the practical part of the work.

Although a vast amount of work has been done by different observers on the absorption spectra of the organic dyestuffs, the information is so scattered as to be difficult of access to the ordinary individual, and this is probably the main reason why this important subject has hitherto not received the attention which it merits. There is, however, ample testimony that this particular application of the spectroscope is being more and more appreciated by the manufacturers of dyestuffs on the one hand, and the users on the other. This is borne out by the fact that such an eminently practical body as the Société industrielle de Mulhouse has made a pecuniary grant to the author to enable him to publish the new edition. Prof. Formánek has made a life-long study of his subject, and a comprehensive and up-to-date book on this particular application of spectrum analysis, such as the present edition promises to be, would be much appreciated. It is to be hoped that the completion of the work will not be long delayed.

On the Calculation of Thermochemical Constants. By H. Stanley Redgrove. Pp. viii+102. (London: Edward Arnold, 1909.) Price 6*s.* net.

THERE are a number of physical properties of substances, *e.g.* molecular heat of combustion, refractivity, &c., which are chiefly additive in character, so that their values can be calculated if we know the necessary fundamental constants. It is, however, also well known that these properties, while still remaining additive, involve factors depending on the constitution of the molecule, *e.g.* method of linking, ring-formation, &c., all of which should be taken into account in the calculation of the value of the particular property in the case of any given substance. It is the thorough-going application of this principle in the calculation of thermochemical constants, extended so as to include, not only the specific thermochemical values of double and triple bonds, but also the thermal value of the "strain" in ring-compounds and of the single bond in chain-compounds, that the book under review expounds. The author's method of calculation has already appeared in several articles published in the *Chemical News,* on which the present monograph is based.

The author's method will best be understood from the following:—Let H be the value of a hydrogen atom *plus the link joining it to a carbon atom.* Let C be the value of a carbon atom, *not* including the value of its valencies; let L_1, L_2, L_3, be the values of the single, double, and triple bonds respectively. Knowing the constants for four hydrocarbons, it is possible to calculate the value of the following:—$C+4H=\alpha$, $2H-L_1=\beta$, $4H-L_2=\gamma$, $6H-L_3=\delta$. These are the "fundamental constants" for carbon and hydrogen. Moreover, the formula of any compound can be written in terms of these fundamental constants, and the theoretical value so obtained can then be compared with the experimental number.

This method the author has illustrated by the calculation of a large number of heats of combustion of substances belonging to different groups of compounds, and, with comparatively few exceptions, excellent concordance with the experimental numbers has been obtained. In this fact the method has its justification.

In an interesting section the author discusses also the relation between heats of combustion of ring-compounds and von Baeyer's strain theory, and he shows that in general there is perfect agreement. No simple relationship, however, has been obtained between the angle of deviation and the thermal equivalent.

The book is one which deserves and will no doubt obtain the attention of all who are interested in the relations between the thermochemistry of compounds and their chemical constitution; and the method of calculation is, moreover, one which will not improbably find application in the case of other physical properties of an additive character. It is an important addition to the literature of thermochemistry. A. F.

An Angler's Season. By W. Earl Hodgson. Pp. xii+299. (London: A. and C. Black, 1909.) Price 3*s.* 6*d.* net.

A BOOK from Mr. Hodgson is always worthy of the angler's attention, and "An Angler's Season" is no exception to the rule. Dealing as he does solely with salmon and trout, and almost entirely with Scotch waters, the author's season begins in January and ends in October, and to each month a chapter is allotted; throughout there is much good reading, a deal of sage advice, and some controversy. Early in February Mr. Hodgson is already at issue with the dry-fly fisherman, and his attack on the "Hampshire method" waxes furious, but he says nothing of those who fish with the dry fly in Aberdeenshire waters and find the method successful. Fault is also found with some anglers for their "habitual indifference to the weight of a basket" and their love of nature; surely an angler is no worse for also being a naturalist, or at least taking an interest in the natural history of fishes. A study of what naturalists have written would have shown the danger of Mr. Hodgson's theory that taking large fish only, and restoring all of smaller size to the water, would have the effect of increasing the average weight of the stock of fish in three years' time, and would, we think, have prevented the red flesh of some trout being attributed to richer feeding rather than to a differently constituted *menu*. We think, too, that the theory set forth to account for the absence of a run of salmon in some rivers of the east of Scotland in May, June, and July is somewhat strange, and cannot be maintained in the light of our present knowledge of the salmon's life-history.

There are throughout the book numerous practical hints of value upon such subjects as flies and baits, and as to the time and place for fishing under various conditions of water and weather; in the last chapter there is also a most thrilling tale of a riverside adventure. The illustrations, reproduced from photographs, are excellent, but are almost invariably separated by many pages from the corresponding text, and there is a good index. L. W. B.

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 New Departure in Seismology.

ON the photographic records obtained from British Association types of seismograph it has been noticed that when the films have been moving slowly (60 mm. per hour) there have been slight thickenings in the trace, while if the recording surface has been moving quickly (240 mm. per hour) the line which ought to be straight is slightly wavy. These irregularities, which have hitherto received but slight attention, are so small that they may be easily overlooked. When the thickenings were first observed it was supposed that their existence was due to a flickering at the source of light or to some irregularity in the movement of the record-receiving surface. When, however, it was observed that these markings frequently occurred at the same time at different stations, as, for example, at Shide and Bidston, the conclusion was that they were due to movements of the ground, and might be the surviving phases of large movements with origins at a distance.

A very good illustration of this is given by comparison of the times of occurrence of the after-shocks which followed the earthquake of January 14, 1907, in Jamaica, with the times at which suspicious irregularities were found on the seismographic traces at Shide and Bidston. Between January 14 and July 5, 148 shocks were noted in Jamaica. Forty-three minutes after the occurrence of fifty-one of these shocks irregularities were found on the films at the stations mentioned. As forty-three minutes is the time we should expect a "surface" wave to travel sixty-seven degrees, or from Jamaica to England, the inference is that the slight irregularities represent movements which had their origin in Jamaica. Corresponding markings, with the exception of one at Göttingen on July 5, do not appear in the registers from European stations, which are not more than six or seven degrees farther from Jamaica than Britain.

Another instance of the recording of after-shocks are the markings seen on seismograms after the disaster which, on December 28, 1908, ruined Messina and Reggio. Between December 29 and January 30 at Mileto, forty miles from Messina, 225 shocks were noted. Eight of these reached the Isle of Wight, while on January 1 and 13 at Göttingen, Hamburg, and Laibach, only two were noted. The reason that so small a number travelled a considerable distance indicates that the originating impulses were weak. That a larger number should be recorded in Britain than at comparatively near stations is not so clear.

With smoked paper recording surfaces, whether the multiplication of recording levers be 10 or 200, a certain slackness in joints and elasticity of pointers prevents any record of motion being obtained until a certain amplitude of ground motion has been reached. With photographic recording apparatus where a light source is far from a recording surface, a thick line may obscure any minute movement. These instruments are therefore unsuitable as recorders of very small movements. This, at any rate, has been my experience.

The British Association type of instrument, when properly adjusted and installed, does, however, pick up these neglected movements—a result which is shown very clearly in the registers for this year.

It seems to me that beneath observatories all over the world earth-messages may be passing every few minutes, but these are not recognised because instruments generally in use are not capable of recording the same. To investigate this possible new departure in seismology, old types of instruments will have to be improved or new ones adopted. JOHN MILNE.

Shide, Isle of Wight, July 2.

Tables of Bessel Functions.

A COMMITTEE of Section A of the British Association for the Advancement of Science, appointed to undertake the further tabulation of Bessel functions, is at present considering the advisability of unifying and completing the existing tables with the view of the publication of a complete table of Bessel functions.

The committee would be glad of information as to existing tables of Bessel and Neumann functions with a real or complex argument, in addition to the following, of which the members are already aware:—

(1) *Meissel's Tables* (reprinted in Gray and Mathews' treatise on Bessel functions) giving $J_0(x)$ and $J_1(x)$ from $x=0$ to $x=15\cdot5$ at intervals of 0·01 [12 places]; also a table of the first 50 roots of the equation $J_1(x)=0$ to 16 places.

(2) *British Association Tables* (1889, 1893, 1896 Reports) giving $I_0(x)$ and $I_1(x)$ from $x=0$ to $x=5\cdot1$ at intervals of 0·001 [9 places]; also $I_0(x)$ to $I_{11}(x)$ from $x=0$ to $x=6\cdot0$ at intervals of 0·2 [11 and 12 significant figures]; also a table of $J_0(x\sqrt{i})$ from $x=0$ to $x=6$ at intervals of 0·2 [9 places]. (Part of these tables are reprinted in Gray and Mathews.)

(3) *Tables of* $J_n(x)$ *in Gray and Mathews* from $n=0$ to $n=60$ and from $x=0$ to $x=24$ at intervals of unity [18 places].

(4) *B. A. Smith's Tables* giving $Y_0(x)$, $-Y_1(x)$, $(\log 2-\gamma)J_0(x)-Y_0(x)$ and $(\log 2-\gamma)J_1(x)-Y_1(x)$, from $x=0$ to $x=1\cdot00$ at intervals of 0·01 and from $x=1\cdot1$ to $x=10\cdot2$ at intervals of 0·1 [4 places: error not exceeding 2 in the last place]. (*Messenger of Maths.*, vol. xxvi., 1897, and *Phil. Mag.*, vol. xlv., 1898.)

(5) *Aldis' Tables* of $I_0(x)$, $I_1(x)$, $K_0(x)$, $K_1(x)$ from $x=0$ to $x=11$ at intervals of 0·1 [16 places]. (Roy. Soc. Proc., 1896 and 1899.)

(6) *J. G. Isherwood's Tables* of $K_0(x)$ to $K_{10}(x)$ from $x=0$ to $x=5$ at intervals of 0·2 [5 significant figures]. (Manchester Lit. and Phil. Soc., vol. xlviii., 1904.)

The committee will be grateful to be allowed, through the medium of NATURE, to invite any readers who are aware of the existence of tables of Bessel functions other than the above to make known this fact.

Communications should be addressed to the secretary of the committee, Dr. L. N. G. Filon, University College, Gower Street, W.C. M. J. M. HILL.

University College, Gower Street, W.C.

Baskets used in Repelling Demons.

IN the issue of NATURE published on May 27 Mr. Kumagusu Minakata inquires regarding the use of baskets in repelling demons in countries other than Japan. In Calcutta, and I believe in other parts of India, it is customary when a new building is being erected to set up on the highest part of the scaffolding a pole, to the top of which a round basket and a scavenger's broom are attached. The basket and broom are apparently recognised as emblems of the low-caste "sweeper," and therefore as being disgusting objects. They are supposed to ward off ill-luck from the building. Their use in this instance may thus be compared to the use in many countries of obscene objects or gestures as a protection against malicious spirits or the evil eye. N. ANNANDALE.

Indian Museum, Calcutta, June 13.

THE SINHALESE PEOPLE AND THEIR ART.[1]

TO many it will appear that in this work Dr. Coomaraswamy has attempted too much; certainly the three purposes for which he tells us the book has been written have so little in common that a book which even in measure shall satisfy all three cannot be otherwise than loosely knit and somewhat amorphous. This volume, we are told, is written "first of all for the Sinhalese people as a memorial of a period which at present they are not willing to understand. . . . Secondly it is meant for those in East and West who are interested in the reorganisation of life, and especially of the arts and crafts under modern conditions. Thirdly, an endeavour has been made to render it as far as possible of value to the anthropologist, and to students of sociology and folklore." It seems very doubtful whether the Sinhalese people, with the possible exception of a few of the "educated" of whom Dr. Coomaraswamy speaks with scant sympathy, will appreciate the effort made for their benefit, and though there is much of interest to the folklorist and anthropologist in this sumptuous volume, it is as a work of art done for art's sake that the work is most interesting and valuable, and certainly few will be found to imitate Dr. Coomaraswamy's example at a time when publishers tell us *éditions de luxe* do not sell.

Not only the contents of the book preach the gospel of art, but, as it has been printed by hand on handmade paper, it is itself an excellent example of the point of view which, since this is a pioneer work, the author has been free to express with the least possible constraint. It is, indeed, in the fact that so much new ground is broken that the high merit of this volume lies, for it is certainly the first time that a detailed account of the arts and crafts of a small area in the East has been given, and it is well to remember that the culture here described was really limited to some two million people, inhabiting, roughly, two-thirds of an island, itself about the size of Ireland.

The arts and crafts of Ceylon, as they exist at the present day, represent the result of the action of western influence on the mediæval conditions which prevailed until the British occupation of Kandy, less than a century ago. It is with the remains of this late-lasting mediæval culture that Dr. Coomaraswamy mainly deals, and we are thus given an account of the work of the craftsmen of a feudal period in which there was no great attainment in fine art, brought about by the genius of a few men, but in which there was a widely spread popular art largely based upon early Indian traditions, for "Sinhalese art is essentially Indian, but possesses this special interest, that it is in many ways of an earlier character, and more truly Hindu—though Buddhist in intention—than any Indian art surviving on the mainland so late as the beginning of the nineteenth century. The minor arts and the painting are such as we might expect to have associated with the culture of Asoka's time, and the builders of Barahat. . . . It was the art of a poor people, the annual income of whose kings did not in the eighteenth century amount to 2000*l*. in money, besides revenue in kind."

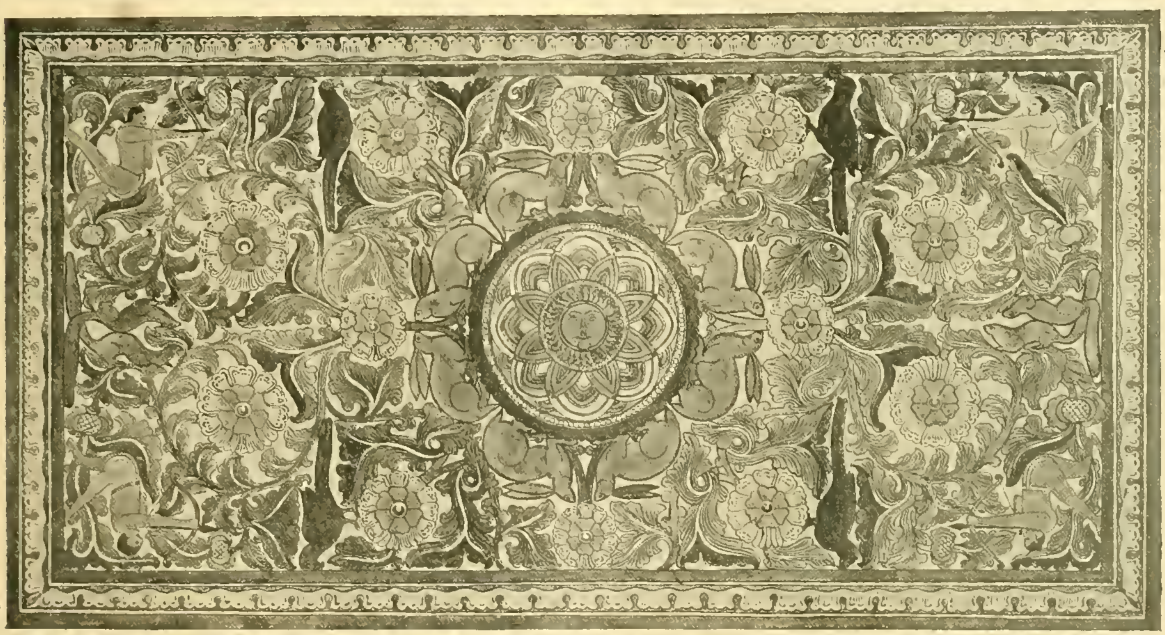

FIG. 1.—Verandah Ceiling Painting, Dalada Maligawa, Kandy. 19th Century. Now destroyed. From "Mediæval Sinhalese Art."

The first chapter of Dr. Coomaraswamy's book is devoted to the Sinhalese people and their history. The next chapters discuss the social organisation of Sinhalese society, and while the difficult question of caste is but lightly touched upon, considerable space is devoted to the personal services rendered to the king and his high chiefs. This account shows how true was Knox's narrative, and it is pointed out that Sinhalese villages were self-contained to such a degree as to be dependent upon the outside world for little but salt. The religion of the people is rapidly sketched, and certainly too little stress is laid on the large element of demonism—"devil-worship"—in the actual working religion of the Sinhalese. A most interesting account is given of the *nētru mangalaya*, or "eye ceremony," by which the image in a temple is dedicated. This consists essentially in the painting of the eyes of the image, when the figure, before this, "not accounted a god but a lump of ordinary metal" (Knox), becomes so full of power that in some cases

[1] "Mediæval Sinhalese Art." By Ananda K. Coomaraswamy. Pp. xvi+340; 53 plates. (Broad Campden, Glos.; Essex House Press, Norman Chapel, 1908.) Price 3*l*. 3*s*. net.

anyone interfering with it is smitten with sickness. In this ceremony a mirror was held to receive the first glance (*belma*) of the image while the eyes were being painted.

An account of the teaching of drawing as practised at the present day serves as an introduction to a consideration of the *motifs* employed in Sinhalese decorative art. Although there is an immense amount of new material in this section, it may be doubted whether it would not have been rendered more valuable to all, as it certainly would have been to the anthropologist, if greater attention had been paid to the history of the evolution of the individual elements of decoration; for instance, the *makara*, which bulks so largely in Sinhalese art, and which occurs on the Barahat Stupa, *circa* 200 B.C., is dismissed in rather less than half a page of print, while the *hamsa* fares even worse. These and many other conventional elements were most skilfully combined, and the beauty of the results attained is seen in plate xvi. (here reproduced in Fig. 1), of a nineteenth-century ceiling painting from the Dalada Maligawa, Kandy, representing a forest scene.

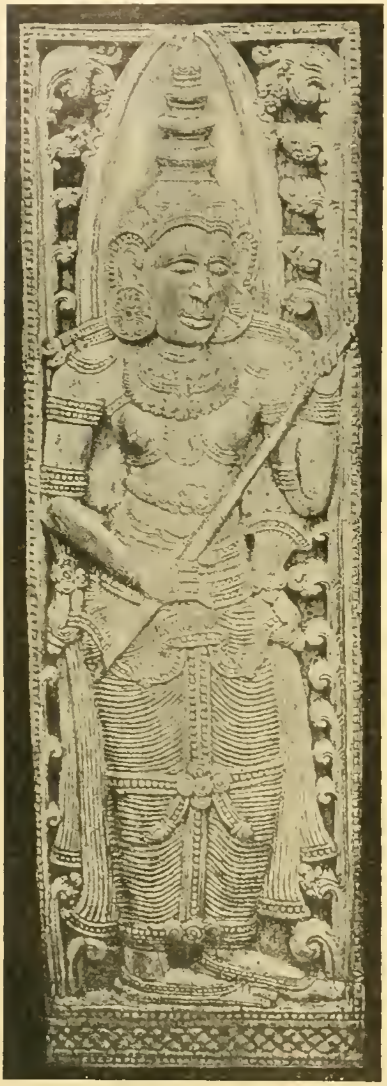

FIG. 2.—Guardian Deity from a Temple Door Jamb, Ivory. Height of plaque, 10¼ inches. Colombo Museum Collection. From "Mediæval Sinhalese Art."

There are chapters on architecture, woodwork, stonework, figure sculpture, and painting, the reduced colour plates of some of the wall paintings in Degaldoruwa Vihara, Kandy, being extraordinarily faithful reproductions of the originals, the spirit of which they have preserved to a surprising degree.

An interesting conjecture is made in chapter x., which suggests that ivory was comparatively little used in Indian art on account of the Hindu reluctance to use the products of dead animals; Buddhists had no scruples of this sort, and so ivory was always valued and used in Ceylon even in temples, with the result that ivory carvings are perhaps the most beautiful and pleasing fruit of the Sinhalese art impulse, rivalled only by some of the superb inlay metal work still existing on the temple doors. Fig. 2 represents an ivory carving in the Colombo Museum of a guardian deity from the jamb of a temple door.

In the last two chapters Dr. Coomaraswamy shows that, in the present stage of our knowledge, it is only possible to indicate the main sources which have influenced Sinhalese art. The most widely exerted influence in Indian art is that due to the Asokan Buddhist missions, the culture which these dispersed being early Indian; thus Sinhalese art is largely the result of the evolution of an early Indian art, in part sheltered by the geographical position of Ceylon from that Hinduism which overwhelmed it upon the mainland. But in post-Asokan and mediæval times this art was continually exposed to Indian influence; "indeed, until the close of the period of mediæval conditions, the relations between Southern India and Ceylon were similar to those obtaining in the Middle Ages between France and England." This leads to the suggestion that the famous rock paintings at Sigiri, the like of which are found only at Ajanta, are due to a school, representatives of which were to be found both in India and Ceylon. The fine bronzes recently found by Mr. H. C. P. Bell at Polonnarua and now in the Colombo Museum, though of a later date, point in the same direction, for the whole feeling of these is Hindu. To sum up, Dr. Coomaraswamy sees in Sinhalese art "an early stratum of indispensable barbaric decorative motives, . . . then a main stream of North Indian Buddhist influence; and thereafter the influence of continued reliance upon and intercourse with India, especially Southern India, accounting at every period for the strong admixture of purely Hindu with Buddhist *motifs*." With this conclusion few will quarrel, though Dr. Coomaraswamy says all too little concerning the earliest stratum. It remains only to direct attention to the number and excellence of the photographs by Mrs. Coomaraswamy, and to indicate that it is owing to her energy that the remains of the moribund art of Sinhalese embroidery have been brought together to form chapter xv.

C. G. S.

A DISCUSSION OF AUSTRALIAN METEOROLOGY.[1]

THE meteorology of the southern hemisphere presents a specially attractive field of study. The large area of water surface conduces to much simpler conditions than are to be found to the north of the Equator, and here, if anywhere, the meteorologist may hope to discover the fundamental principles underlying the general movements of the atmosphere. On the other hand, he has to face the relative paucity of data. The meteorological organisations of the three great land areas are still young, and our knowledge of what is happening over the sea is woefully small as compared with the completeness with which we are able to track down changes occurring over the great trade routes of the North Atlantic. The present discussion forms a recapitulation and a completion of work published from time to time from the Solar Physics Observatory, of which abstracts have appeared in previous numbers of NATURE (lxx., p. 177; lxxiv., p. 352). At the outset we congratulate Dr. Lockyer on his success in bringing together a vast amount of information and on the skill with which he has marshalled the facts deduced therefrom.

[1] Solar Physics Committee. A Discussion of Australian Meteorology, by Dr. W. J. S. Lockyer, under the direction of Sir Norman Lockyer, K.C.B., F.R.S. Pp. vii+117; 10 plates. (London: Wyman and Sons, Ltd., 1909.)

The opening chapters deal exclusively with Australian conditions. Pressure observations are considered first. The mean amplitude of the difference between a number of conspicuous minima and the succeeding maxima in the curves showing the annual variation, amounts to more than seven-hundredths of an inch. When the curves for those stations for which long records are available are compared, they all show a marked similarity, and the important generalisation is arrived at that simultaneous excess or defect of pressure in any one year is a marked feature of the whole Australian continent, and is not restricted to any one particular portion of this area. Coming next to the rainfall observations, an examination of the curves leads to a similar conclusion. Years of low rainfall are, broadly speaking, years of deficiency over the whole continent, and in years of excess the excess is also general. Moreover, a comparison of the rainfall and pressure curves suggests very strongly that periods of high pressure are periods of low rainfall, and *vice versa*. These are generalisations of great importance, for they introduce a great simplification, and correspondingly facilitate the further study of Australian weather conditions. In view of the few data available in proportion to the area considered, a meteorologist, arguing from analogy, might be disposed to regard these as hasty generalisations. The extraordinary variability of rainfall in other parts of the world is well known, and for its adequate study a large mass of information is essential. When the necessary figures are forthcoming we find that even within the narrow limits of our own islands there are very conspicuous differences between the north of Scotland and the south of England. Australian conditions are, however, different. As Dr. Lockyer points out, the weather of the continent is dominated primarily by anticyclones travelling from west to east. In years of high pressure these anticyclones are found to embrace a wider area, and thus the low-pressure systems which skirt their edges and bring rain to the northern districts in summer, and to the southern ones in winter, affect the land area to a smaller extent.

In discussing these questions of correlation, whether it be between variations of the same element at different places or between different elements, Dr. Lockyer uses the similarity between two curves as his standard of measurement. The points of resemblance to which he directs attention are, indeed, striking. At the same time, the reader feels a desire for a more definite expression of the relation between the elements under comparison. When we come to the correlation between the Australian curves and those for other parts of the world, which takes up much of the later part of the work, this becomes more imperative. Thus, on p. 72, after discussing the striking resemblance between the pressure changes at Adelaide and those of Bombay or Batavia, we read, "While the Cordoba curve is nearly the inverse of Adelaide—the curve for the Cape seems to be intermediate, being more inclined to be similar to the Australian type of variation than that of South America." The intermediate between two curves which are inverse to one another should be a straight line. If it is meant that the Cape curve follows now the variations of Adelaide and now those of Cordoba, it becomes a matter of importance to have some means of comparing the degrees of similarity in the two cases. Superpose any two arbitrarily drawn curves showing fluctuations of approximately the same amplitude, and we are sure to find that some of the maxima and minima agree. Can we say by how much the correlation between the curves we are discussing exceeds that between curves drawn arbitrarily?

The question of periodicity naturally comes in for discussion. After eliminating a variation of short period by taking means of groups of four years, Dr. Lockyer claims that the smoothed curves for Australia show a periodicity of nineteen years. It is true that there are conspicuous maxima in 1868 and 1897, and minima separated by about the same number of years, but this does not of itself prove a recurring periodicity, and the case is not advanced by drawing a "hypothetical" curve through the points of maximum in which an intervening secondary maximum is disregarded and replaced by a principal minimum. The occurrence of a similar interval between the maxima in the pressure curve for South America, but of other epoch, is suggestive, but the question of the connection between the two continents remains one for further study.

A highly suggestive and interesting chapter on the air movements over the three great land areas of the southern hemisphere points out some interesting similarities between the pressure distribution and the incidence of rainfall of the three continents. The volume also contains an interesting comparison of the flow of the Murray river with the rainfall, and of the frequency of southerly "Bursters" with the variations of pressure. The work thus ranges over a wide field. It offers much that is new, and brings together from a common point of view much information that has hitherto been scattered in a number of individual papers. R. G. K. L.

POSSIBILITY OF AN EXTRA-NEPTUNIAN PLANET.

M. GAILLOT has contributed an admirable note on this subject to the *Comptes rendus* (March 22). A summary of his calculations is set forth so clearly as to be easy to follow, and if we have one regret it is that he has not published the discordances between observed and tabular positions that necessarily form the basis of his work. We suppose that the *Comptes rendus* do not admit masses of tabular matter, and we wish to express the hope that M. Gaillot will publish this information somehow or other.

A review recently appeared in NATURE (June 17, p. 463) on Prof. W. H. Pickering's calculations. We there maintained that Prof. Pickering's supposed planet "O" could not possibly produce sensible perturbations in Uranus. Now, M. Gaillot and Prof. Pickering both locate their hypothetical planets in the same part of the sky. M. Gaillot's mass is five times that of the earth, or two and a half times that of Prof. Pickering's "O." A reader of the previous review will see that M. Gaillot's planet would, therefore, produce in Uranus inequalities exceeding a second of arc. We suspect that Prof. Pickering has made some numerical mistake in estimating the mass of his planet "O," and, if he can rectify this, we should then have two independent researches in practical agreement. M. Gaillot's result is, however, sufficiently confirmed by the analogy from inner planets developed in the previous review.

The important question now arises, "Are the observed discordances sufficiently large to point unmistakably to some unknown planet?" It is clear that an inequality with a coefficient of one second of arc appears to exist in the observations; but the elliptic constants of the orbit of Uranus are arbitrary, the observations are liable to small errors, and the theory of the action of known planets is not perfect. All this shows how unsafe it would be to assert the real existence of the inequality which would in its turn demonstrate the existence of an unknown planet. We may draw an analogy from the moon. The real existence of a term with coefficient nearly three seconds and period sixty-four years is now generally admitted in the motion of the moon. This term was first defined in 1904, and the case for its real existence was not a strong one until Prof. Newcomb arrived in 1909 at an almost identical conclusion from the totally different evidence of occultations. The term in the motion of Uranus must therefore be doubtful for the present. We are not entitled to do more at present than hope that it is real, and that a corresponding planet will reward M. Gaillot's admirable work. This doubt is fully admitted by M. Gaillot.

"Ces résultats ne doivent être acceptés d'ailleurs qu'avec une extrême réserve. En effet, les différences entre les positions observées d'Uranus et celles qui sont calculées a l'aide de nos Tables ne dépassent guère les limites des erreurs probables des observations augmentées de celles qui résultent des imperfections de la théorie. . . ."

It is noteworthy that, like Prof. Pickering, M. Gaillot bases his hypothetical planet upon Uranus and not upon Neptune. It appears, therefore, that the motion of Neptune is in good agreement with the tables, and that no extra-Neptunian planet can exist of a mass and epoch to produce sensible inequalities in the motion of Neptune since its discovery. This is an important negative result; in fact, if it be assumed that the unknown planet has a mass at least one-third that of Neptune, a considerable part of the ecliptic is excluded from the domain where this planet can possibly be found.

THE SORBY RESEARCH FELLOWSHIP.

IT will be remembered that the late Dr. H. C. Sorby, F.R.S., of Sheffield, bequeathed a sum of 15,000*l.* to the Royal Society of London to be held in trust for the establishment of a professorship or fellowship for original scientific research, the testator expressly desiring the professorship or fellowship thus founded to be associated with the University of Sheffield. Accepting this trust, the council of the Royal Society appointed a committee to confer with representatives of the University of Sheffield with the view of drawing up a scheme for giving effect to the intentions of Dr. Sorby's will.

A scheme, prepared by this committee for the establishment of a "Sorby Fellowship for Scientific Research" to be associated with the University of Sheffield, has now been approved and adopted by the council of the Royal Society, and by the senate and council of the University of Sheffield. This scheme provides for the administration of the income of the fund by a joint committee consisting of four persons appointed by the council of the Royal Society, one person appointed by the council of the University of Sheffield, and two by the senate of that University.

The object of the fellowship is not to train students for original research, but to obtain advances in natural knowledge by enabling men of proved ability to devote themselves to research; and in making an appointment the committee will pay special attention to the capacity for original work of a candidate, as shown by the work already done by him, and to the likelihood that he will continue to do valuable work. Each appointment will be in the first instance for five years, subject to the control of the committee, but may in special circumstances be prolonged for further periods if the committee is satisfied with the fellow's work.

The fellow will be required to carry out his research, when possible, in one of the laboratories of the University of Sheffield, and provision is made under the regulations for the setting aside of a sum not exceeding 50*l.* a year to form an apparatus fund, from which grants may be made from time to time to the fellow for the purchase of special apparatus and material required in his research. The stipend of the Sorby Research Fellow will probably be about 500*l.* per annum, and it is hoped that the committee will be in a position to make the first appointment to the fellowship early in the coming autumn.

PROF. T. W. BRIDGE, F.R.S.

WE regret to record the death, on June 30, of Dr. T. W. Bridge, Mason professor of zoology in the University of Birmingham. By his death the University is deprived of one of its oldest and most experienced teachers, and zoological science has lost one of those workers who, under the influence of Balfour and the Cambridge school, have contributed largely both by example and precept to our knowledge of vertebrate morphology.

Prof. Bridge was born in Birmingham in 1848, and after studying science at the Birmingham and Midland Institute, went in 1870 to Cambridge as assistant to Mr. J. W. Clark, then director of the Museum of Zoology. In 1872 he was elected to a foundation scholarship at Trinity College, and appointed demonstrator in zoology under the late Prof. Newton. After his graduation in 1875, he spent six months at Naples working in the zoological station, where, on the advice of F. M. Balfour, he carried out research into the "abdominal pores" of fishes. In 1879 he was appointed professor of zoology in the Royal College of Science at Dublin. In 1880 he became one of the original professors at the Mason College, Birmingham, holding the chair of biology; and when this chair was divided in 1882 he retained the title of Mason professor of zoology and comparative anatomy, and kept the same position when the Mason College became a University in 1900.

The original work carried out by Prof. Bridge dealt chiefly with the osteology of ganoid fish, the "poriabdominales" of vertebrates, and the air-bladder of Teleosts. The most important of these memoirs are undoubtedly those dealing with the last subject, and the large paper by Profs. Bridge and Haddon, published in the Philosophical Transactions in 1893, on the air-bladder of Siluroids, has become a classic. This work was the first thorough investigation dealing with the structure and physiology of this organ which had appeared since Weber's original discovery and fundamental treatise on the air-bladder published in 1820. In certain Siluroids, Weber found that extraordinary apparatus which still bears his name. He described in a few families the vertebral elements that link the air-bladder with the ear, and concluded that the apparatus subserved the function of hearing in these fish. What was now required was a systematic inquiry into the variation of this mechanism and into the use or uses of it; and it is this monographic treatment that we owe to Prof. Bridge and his collaborator. They investigated 100 species of Siluroids, and concluded that this highly specialised mechanism was employed, not for audition, but for the registration of varying hydrostatic pressures. These memoirs not only advanced our knowledge of this interesting structure, but threw light on many points of ecological interest in connection with other physostomatous Teleosts.

Prof. Bridge's most recent work was his article on fishes in the "Cambridge Natural History" (1904). This article has proved one of the most useful treatises on this subject both to teachers and students. The value of his work was recognised by his election into the Royal Society in 1903.

We must not conclude this short article without bearing witness to the great success of Prof. Bridge as a teacher. He excelled, to no common degree, in grounding his pupils in the elements of zoology. As examination candidates his students showed unusual accuracy, and, in the main, a wide knowledge. Those of them who were able to go further and undertake some piece of research found in him not only a stimulus, but an unwearied guide and a sagacious critic.

NOTES.

M. G. DARBOUX has been re-elected president of the Société des Amis des Sciences, MM. Aucoc and Picard vice-presidents, and Prof. Joubin general secretary. The society was founded in 1857 by Baron Thenard with the view of assisting unfortunate inventors, men of science, and professors and their families. Among the names of past-presidents of the society occur those of Thenard, J. B. Dumas, Pasteur, and others. Since its foundation the society has distributed in pensions and grants more than two and a half million francs. This year eighty pensions have been granted to old savants or their widows. The society has assisted the education of some seventy children, and made grants to thirty-five widows. The work of the society should appeal to all who benefit from the work of men of science. Information as to the society may be obtained from the treasurer, M. Fouret, 79 boulevard Saint-Germain, Paris.

WE learn from *Science* that the people of Honolulu have guaranteed already half the money asked for by the Massachusetts Institute of Technology for the maintenance of an observatory which the institute proposes to establish at the brink of Kilauea for the study of volcanic action.

THE Geologists' Association is arranging a long excursion to the Arenigs, from July 28 to August 7, under the direction of Mr. W. G. Fearnsides. The excursion secretary is Mr. E. Montag, 4 Queen's Road, Rockferry, Birkenhead.

THE Vienna correspondent of the *Times* announces that during excavations near Willendorf on the Danube by the prehistoric section of the Austrian Natural History Museum, a chalk figurine, 11 centimetres high, representing a female figure, was discovered in a stratum containing instruments and weapons characteristic of the Stone age.

THE maps of the cadastral survey of Egypt have just been used to determine accurately the area of land planted with cotton and its distribution. Each plot in which cotton was sown was marked on the maps (scale 1/2500), so that not only the area and position were recorded, but, since the land-tax has been recently re-assessed with the aid of these maps, the distribution of cotton on land of different degrees of fertility was also determined. The total area was 1,466,530 feddans, or 1,522,258 acres.

THE Naples Academy of Sciences (mathematical and physical section) offers a prize of 1000 lire for the best essay containing a systematic exposition of our present knowledge of the geometrical configurations of the plane and of spaces, considered in relation to the theory of substitutions, with, if possible, some new results. The memoirs are to be sent in anonymously not later than June 30, 1910.

IN *Travel and Exploration* for July Mr. H. Massac Buist discusses what the nations are doing in the progress of aviation, and refers to the annual prize offered by him to the Aërial League for the best essay by a member of that body dealing with the attention that is being devoted by the leading civilised nations to the advancement of aërial locomotion. The first competition is to close on January 31, 1910. In his article the author shows that while Governments are mainly devoting their attention to the construction of dirigibles, aëroplane machines are, to a large extent, being developed by private enterprise.

WRITING in the *Oxford and Cambridge Review*, with a foreword by Lord Montagu of Beaulieu, Mr. R. P. Hearne advocates the introduction of aviation as a form of sport at the older universities. It is pointed out that such a scheme would produce a school of skilled aviators whose experience would be of great value in future developments of aërial navigation. While the possibility of an Oxford and Cambridge flying race is suggested, we would point out that, in view of the fact that the great majority of Varsity men cannot afford to spend 1000*l.* on a motor-driven machine, the man of moderate means might participate in the sport by gliding down a suitable incline selected on the Gogmagogs, Madingley Hill, or Royston Heath.

THE number of records of earthquakes obtained at Shide, Göttingen, Hamburg, and Laibach between January 1 and April 30 this year were, respectively, 98, 65, 61, and 33. Each of these earthquakes extended over wide areas, and was recorded at more than one station. At Shide the instrument employed is of the type adopted by the British Association. At the other stations the records were made on smoked paper or by photographic arrangements with a high multiplication.

THE annual general meeting of the Royal Society of Arts, the 155th since the foundation of the society in 1754, was held on Wednesday, June 30, Sir William H. White, K.C.B., chairman of the council, in the chair. The Prince of Wales was re-elected for the ninth time in succession president of the society, and the council, with certain additions and alterations, was re-elected. The principal business of the meeting was the reading of the annual report, which recorded the proceedings of the society during the past year. Reference was made to the failure of the renewed attempt made by the managers of the London Institution to amalgamate with the society. The number of the society's members is now 3490.

THE *Times* announces that in July of next year there will be held in Brussels, in connection with the International Exhibition of 1910, the first International Congress of Administrative Sciences, under the direct patronage of the Belgian Government. The term "administrative sciences" is defined by the congress committee as meaning the sum of theoretical knowledge relating to the services, the organisation, the machinery, and the action of Governments, and to the most practical methods to be employed by them. The honorary secretary to the British committee of the congress is Mr. G. Montagu Harris, Caxton House, Westminster, S.W.

THE recent notices issued by the committee of the International Aëronautical Exhibition at Frankfort show that many valuable prizes, in addition to those we have already mentioned, have been placed at its disposal, including one by the German Emperor; three prizes are also offered for the best kinematographic films of natural flight. A series of scientific lectures will be delivered, the first being on July 12, by Major v. Parseval, who will describe his air-ship and its potentialities; many other well-known men of science have also fixed the dates of their lectures. The physics of the upper air will be discussed by Profs. Assmann, Hergesell, Süring, and others. A list of the lectures and prizes already arranged is published in the first number of the exhibition journal *Ila*, this title being a contraction of Internationale Luftschiffahrt Ausstellung.

WE are indebted to the author, Dr. K. J. Bush, for a copy of notes on the molluscan family Pyramidellidæ, published in the June number of the *American Journal of Science*. These notes may be regarded as in some degree supplemental to the article on the same group contributed by Mr. P. Bartsch to vol. xxxiv. of the Proceedings of the Boston Society of Natural History.

THE crinoids of the family Comasteridæ undergo revision at the hands of Mr. A. H. Clark in No. 1685 of the Proceedings of the U.S. National Museum, no fewer than five new genera, of which three are based on new species, being named and described in the course of the paper. The communication relates, to a great extent, to material collected by the *Albatross*.

POLYCHÆTOUS annelids from Monterey Bay and San Diego, California, are discussed by Dr. J. P. Moore in the June issue of the Proceedings of the Academy of Natural Sciences of Philadelphia, the collections on which the paper is mainly based having been obtained from San Diego in 1902 and 1903, and from Monterey Bay in 1903 and 1904. The total number of species mentioned is sixty-four, of which twenty-one are believed to be new to science. Many other forms doubtless remain to be described, as at both localities collecting was almost entirely restricted to inter-tidal limits, although a few hauls were made with the dredge.

DARWINISM looms large in the June number of *Neue Weltanschauung*, in which the opening article is devoted to a biography of Dr. August Weismann, accompanied by an excellent portrait of that distinguished biologist and evolutionist. There is also a notice of an interesting Darwin exhibition recently opened at Carlsruhe, and arranged by Prof. Walther May. The exhibits are divided into three sections, one historical and biographical, the second theoretical, and the third bibliographical. In the first are included a series of pictures illustrative of the life of Darwin and of the influence of the environment on the organism, while the second is devoted to pictures and specimens illustrative of Darwin's observations and teaching.

THE fresh-water crustaceans of Algeria and Tunis form the subject of the first paper in the June number of the Journal of the Royal Microscopical Society, this communication being based on the collections made by the author, Mr. Robert Gurney, in February and March, 1906. Although the Algerian fresh-water crustaceans have been better worked out than those of any other part of Africa, the author finds that even here our knowledge is far from complete, while still more remains to be done in Tunis, especially in the Tell, or coast-district. A very large number of species were collected, of which several are described by the author as new, the ostracods being omitted and reserved for a future communication. Perhaps one of the most interesting of the forms discovered during the visit is the malacostracan *Cirolana fontis*, described by the author in the *Zool. Anzeiger* for 1908 on the evidence of three examples found under stones at the mouth of a spring near Biskra.

As the result of a biological survey of the Belgian coast undertaken by the Royal Museum of Natural History of Belgium, Mr. G. Gilson, the director of that establishment, has been enabled to describe a new and interesting parasite which in autumn frequents the nursing-chamber of the females of the schizopod crustacean *Gastrosaccus spinifer*. Seeing that the schizopod occurs in great swarms at some distance from the shore, it is a matter for surprise that the discovery of the infesting parasite should have been so long delayed, especially as the latter is of relatively large size. The parasite is itself a crustacean, referable to the group of epicarids, a section of isopods which have become degraded in accordance with the requirements of a parasitic existence. Although nearly related to Dajus, Mr. Gilson is of opinion that the new species should represent a genus by itself, and accordingly proposes the name *Prodajus ostendensis*. The paper, of which we have received a separate copy, is published in vol. xliii., pp. 19–92, of the *Bulletin scientifique de la France et de la Belgique*.

A COPY of the Milroy lectures on disinfection and disinfectants, delivered by Prof. R. Tanner Hewlett, and reprinted from the *Lancet*, has been received. In these three lectures Prof. Hewlett decided not to deal with the details of the various methods of practical disinfection, for these are to be found sufficiently described in every text-book of hygiene; he has rather set himself to discuss the scientific principles embraced in the practice of disinfection. He first refers to the natural processes which reduce or destroy specific micro-organisms, such as dilution (by air, water, &c.), sunlight, desiccation, filtration (as in soil); he then turns to the defensive mechanisms with which nature has endowed the human body; and after making a brief reference to the application of internal disinfectants, he passes to a consideration of the disinfection of the infectious material outside the body. References are made to school disinfection, the requirements of an ideal disinfectant, the nature of the processes of disinfection, and the standardisation of disinfectants on the basis of their germicidal values. During the past few years much controversy has arisen upon the value of various methods of gauging the relative germicidal powers of disinfectants, and although advance has been made, we are still some distance from the goal of a satisfactory scientific method; it is important that this matter should be placed upon a sound basis, for, as Prof. Hewlett points out, the use of a disinfectant engenders a sense of security which, in the case of an inefficient one, is unreal, and may lead to disastrous results. The market is flooded with inefficient disinfectants, and there is at present no legal restraint upon their sale.

WE have been favoured with the report of the director of the Royal Botanic Gardens, Ceylon, covering the reports of the various subordinate officers connected with the gardens. Dr. Willis refers very hopefully to the introduction of American machinery for tilling the ground, owing to the success attending the trial at the experiment station in the north of the island. The growth there of Ceara rubber has been excellent, and in consequence nurseries of *Manihot dicholoina* have been formed. The Government chemist, Mr. M. K. Bamber, gives some particulars of analyses of young and old cacao leaves. In the young leaves potash and phosphoric acid accumulate to the extent of 35 per cent. and 10 per cent. respectively, but very small quantities are present in old leaves, which contain a large amount of silica combined with lime and magnesia.

MR. N. N. WORONICHIN, who has been studying the distribution of the algæ in the Black Sea, communicates a preliminary account to the botanical section (No. 7) of *Travaux de la Société impériale des Naturalistes de St. Pétersbourg* (vol. xxxvii., part iii.). Three vertical zones of distribution are distinguished. The littoral zone is narrow, as there is no appreciable ebb and flow; *Ralfsia verrucosa*, *Corallina virgata*, *Rivularia polyotis*, are the chief forms in certain bays, and in others species of Ulva and Enteromorpha are the most general. The second zone comprises depths from two to eight fathoms, where *Cystoseira barbata* is everywhere the dominant species. A third zone ranges from ten to thirty fathoms; *Polysiphonia elongata* is the chief formation down to twenty-five fathoms, then *Zanardinia collaris* is dominant, and lower *Antithamnion plumula*.

A SERIES of short papers by Dr. J. N. Rose relating to xerophytic plants of the unrelated but morphologically similar families of the Crassulaceæ and Cactaceæ is collected in vol. xii., part ix., of Contributions from the United States National Herbarium. A Mexican plant, formerly described from barren specimens as an Echeveria, is made the type of a new genus, Thompsonella. Another plant from Vera Cruz restores the species *Echeveria carnicolor*. Three new species of the same genus are recorded from Guatemala. The re-discovery of the Cuban species of tree cactus, *Cereus nudiflorus*, is interesting; other new species are an arboreal Pereskia, a remarkably spiny Echinocereus, and a Nopalea. Dr. Rose also describes a leguminous tree resembling a Cercidium, but sufficiently distinct to be placed in a new genus, Conzattia. The photographs illustrating the habit of these plants are admirable.

THE scenery of the Greater Antilles forms the subject of an interesting paper read by Sir H. H. Johnston at the Royal Geographical Society, and published in the June number of the *Geographical Journal*. The subject provides ample scope for the author's well-known powers of observation and description. Reference is made to the striking character of the royal palms, *Oreodoxa regia*, in Cuba, an avenue of which "looks like a column of white marble pillars crowned with a gerbe of glossy green fronds." The palmetto, *Sabal palmetto*, and two other palms with fan-shaped leaves, Thrinax and Coccothrinax, are prominent in the landscape of the plains and foothills. Tall cacti contribute largely to the scenery of eastern Cuba, especially on sandy flats. In the island of Haiti the agaves aroused the author's admiration. With regard to Jamaica, the author presents a sketch of the vegetation in January; he also offers a word of advice in the matter of retaining such natural beauty spots as Fern Gully.

WE have received revised editions of two useful little manuals:—(1) "Observing and Forecasting the Weather," by Mr. D. W. Horner; and (2) "Some Facts about the Weather," by Mr. W. Marriott. The first is intended for those who may wish to obtain some knowledge of the weather without the use of instruments. For such persons the work contains much useful information; the chapters on clouds and optical phenomena, from which successful forecasts may often be drawn, are especially interesting, as are also the sections on old weather proverbs and the popular fallacy of the moon's influence. The work is accompanied by some good typical illustrations. The second pamphlet gives "some of the results which have been obtained from present-day systematic meteorological observations in the British Isles," and is of special interest to those possessing instruments for an ordinary climatological station. It contains useful information referring to each of the meteorological elements, the use of synoptic charts, and particulars of average and extreme values; it also deals with special subjects, *e.g.* electrical phenomena and the investigation of the upper air, and contains many useful illustrations. The work will be acceptable to many who may wish to obtain accurate general weather knowledge without reference to more pretentious instructions and text-books.

THE *Electrical Review* for June 18 contains a list of the electric tramways, railways, and power companies of the United Kingdom. We note that the following towns head the list of those having electric tramways:—Manchester 105, Glasgow 95, London 86, Liverpool 59, Bradford 55, and Leeds 54 miles of track. The leading electric railways are:—the Liverpool and Southport with 35, the Newcastle and Tyneside with 30, the Metropolitan with 26, and the Metropolitan District with 24 miles of double track. The greatest power companies are:—the Newcastle-on-Tyne with a station capacity of 47,000 kilowatts, and the Durham Collieries with 11,000 kilowatts. One of the points which a study of the list brings out is the great popularity of electric traction in the northern towns as compared with the indifference in the south.

BY means of quotations from the "Atomistic" of 1862 and the "Weltleben" of 1881 of Robert Grassmann, Dr. F. Kuntze shows in the *Physikalische Zeitschrift* for June 15 that more than forty years ago the brothers Hermann and Robert Grassmann had worked out the details of an electronic theory to which the electronic theories of the present day bear some resemblance. According to the Grassmann theory, the smallest æther particle consists of a pair of entities to which symbols $+E$ and $-E$ are assigned. The pairs repel each other according to the inverse fourth-power law. When glass is rubbed with silk the $+E$ is attracted to the glass, the $-E$ to the silk, and the two bodies become electrified. Light is due to the oscillations of the pairs as pairs, electricity to the oscillation of the constituents of each pair. Heat is the oscillation of matter and the æther pair together. Matter in the same way consists of pairs of elements, and chemical combination of two substances is the attraction of the positive matter element by the negative part of the æther pair, and the negative matter element by the positive part of the æther pair. The positive and negative parts of a pair are supposed to keep apart owing to the motion of each round the other, as in a binary star.

AN interesting article on the mechanical testing of cast iron appears in the *Bulletin de la Société d'Encouragement pour l'Industrie nationale* for May. The author, M. Ch. Frémont, deals first with the historical aspect of his subject, giving drawings of early apparatus, and then proceeds to describe special machines of his own with which he has made many tests on small specimens for the determination of the coefficient of elasticity, the elastic limit, and the breaking strength. The results and plotted diagrams are given, and from these the author arrives at the following conclusions:—the testing under static bending of cast-iron samples of greatly differing strengths shows that the coefficient of elasticity varies considerably, from simple to triple proportion; the capacity for elastic bending of cast iron is inversely proportional to its strength; the elastic limit under static bending varies very greatly, being from 0·45 to 0·80 of the breaking strength.

MOST of the engineering and shipbuilding periodicals for the week ending June 26 contain reference to the new rules which are on the point of being issued by Lloyd's Register of British and Foreign Shipping. The revised rules are framed to include vessels up to about 680 feet in length, and they cover all the vessels previously classed by the society excepting the large Cunard steamers *Lusitania* and *Mauretania*. The most important modification in the new rules is in the basis for determining the "transverse number" and the "longitudinal number." The former number is now to be found by adding the breadth and depth only, and the latter by multiplying the length by the sum of the breadth and depth. It is also of importance to notice that all the sections in the tables conform to the standards of the Engineering Standards Committee. This is a very wise move, and is much to be commended. Another step in the right direction has been taken in the adoption of a unit for scantlings of one-fiftieth of an inch instead of one-twentieth as in the old rules. This not only conforms with the decimal system, but, as 0·02 inch is practically half a millimetre, a close connection with the metrical system is secured. As Lloyd's Register covers between 70 per cent. and 80 per cent. of the world's shipping for insurance purposes, the new rules cannot fail to influence the shipbuilding and steel industries in this and most foreign countries.

A note in the *Bulletin de l'Institut Pasteur* for May 30 (vii., No. 10, p. 453) announces the discovery by Carlos Chagas, of Rio de Janeiro, of a new human trypanosome parasite (*T. cruzi*), conveyed by a bug (Conorrhinus), and causing an often fatal illness among miners and others in the State of Minas.

The Bulletin of the Johns Hopkins Hospital for June (xx., No. 219) contains an interesting historical essay, by Dr. Gerster, on the life and times of Gerhardt van Swieten, physician to the Empress Maria Theresa, who was born in Leyden in 1700 and died in 1772 at Schönbrunn.

A comprehensive note on the cartography of the Philippine Islands is given by Prof. Guido Cora in *Bollettino della Soc. Geogr. Ital.* as a notice of the recent map of the islands compiled from original sources by Mr. C. W. Hodgson.

We have received from the Nottingham Free Public Library a copy of a simply arranged supplementary science catalogue of the central lending library dealing with books in most branches of science published between 1901 and the present year.

Mr. R. B. Henderson, assistant master at Rugby School, has written an introduction to the study of moths and butterflies for the Rugby School Natural History Society, entitled "The Scaly-winged." It will be published immediately by Messrs. Christophers.

We have received vol. vi. of "Contributions from the Jefferson Physical Laboratory." It consists of a reprint of twelve papers which have appeared in the Proceedings of the American Academy of Science or in other periodicals during the past twelve months. Five of these papers have already been noticed in these columns.

In the announcement in Nature of May 27 (p. 375) of the resignation by Mr. H. H. Clayton of his position at the Blue Hill Meteorological Observatory, it was stated that he had been in charge of the observatory since 1894. This statement does not express the position exactly. Mr. Clayton has served for many years as observer or meteorologist, and his researches have added to the reputation of the observatory, but the director is Prof. Lawrence Rotch, who founded the observatory in 1885, and provides for its material support.

The June number of the *Stonyhurst Magazine* contains an illustrated description of the Milne seismograph used in the National Antarctic Expedition in H.M.S. *Discovery* under Captain R. F. Scott, R.N., in 1904. The seismograph is now a permanent loan to the observatory at Stonyhurst from the Antarctic committee of the Royal Geographical Society. The instrument stands at Stonyhurst on a solid stone pillar fixed in 12 inches of concrete; its position is lat. 53° 50′ 40″ N. and long. 9m. 52·88s. W. of Greenwich. A new recording apparatus has been secured, and there is every reason to hope that useful observations will be made at the new station.

OUR ASTRONOMICAL COLUMN.

Comet 1909*a*, Borrelly-Daniel.—Further observations of comet 1909*a* have revealed no striking features either in its form or in its behaviour. In No. 4334 of the *Astronomische Nachrichten* M. Chofardet records the observations made at the Besançon Observatory, and states that on June 17 and 19 the comet was of magnitude 11·0 or 12·0, had a round, diffused head of 1·5′ diameter, and a vague condensation which could be seen occasionally by oblique vision.

A New Form of Comparison Prism.—In all spectroscopic work where a comparison prism placed over the slit is used, the dark band between the compared spectra, produced by the edge of the prism, constitutes an inconvenience which may prove a source of error. To remedy this defect, Prof. Louis Bell has employed a specially designed compound prism, in which the light from one of the sources is reflected from the fine edge of a thin layer of silver, whilst that from the other source is allowed just to miss the edge. Thus the line of demarcation is practically eliminated. The method of preparing such compound prisms is described, and illustrated by diagrams, in No. 4, vol. xxix., of the *Astrophysical Journal* (p. 305).

Halley's Comet.—No. 4330 of the *Astronomische Nachrichten* contains two search-ephemerides for Halley's comet. The first is by Dr. Holetschek, who discusses the probable date of perihelion and gives three ephemerides, one for May 16·45, 1910, and the others for thirty days before and after respectively. At the previous apparition, in 1835, the comet was discovered 102 days before the perihelion passage, when its distances from the sun and earth were 1·9 and 2·4 astronomical units respectively; the corresponding distance from the sun will occur, according to Dr. Holetschek's data (T = May 16·45, 1910), on February 3, 1910. The second ephemeris has been computed by Herr L. Matkiewitsch from the data given in the essay which won the Astronomische Gesellschaft prize; the positions now given vary considerably, at different epochs, from those previously referred to in these columns (Nature, No. 2046, January 14, p. 320).

The Polarisation of the Solar Corona.—In the June number of the *Bulletin de la Société astronomique de France* M. Salet discusses at length the photographs obtained at the 1905 eclipse with a polariscopic camera. These photographs show the coronal radiations to be strongly polarised right down to the moon's edge, thereby indicating that reflected light is being dealt with; but the spectroscopic observations indicate that radiations directly from a light-source are in question. M. Salet suggests that the apparent contradiction may be explained by the theory that the bright radiations observed spectroscopically are due to metallic vapours rendered fluorescent by the intense solar radiation. In this condition metallic vapours give band spectra, and the superposition of these might, if small dispersion were employed, produce the appearance of a continuous spectrum such as has been observed. In support of his theory M. Salet quotes the observation of Sir Norman Lockyer at the eclipse of 1882, that the coronal spectrum appeared to be formed of superposed bands, and directs attention to the discovery of magnetic fields by Prof. Hale, which, with a rotating sun, afford the conditions necessary for his theory.

THE SOLAR CONSTANT AND THE APPARENT TEMPERATURE OF THE SUN.—In a note published in No. 7, vol. lxix., of the Monthly Notices (p. 611), Dr. Féry discusses the measurement of the solar constant and of the sun's mean temperature. One of the greatest difficulties in these researches is to evaluate the atmospheric absorption, which in published researches has varied from 1·5 to 4; it is generally accepted now as having the value 2·4.

Having designed an instrument for measuring terrestrial high temperatures, MM. Féry and Millochau applied it to the determination of the solar temperature by Stefan's law. More than 750 observations were made at different altitudes, and at the summit of Mont Blanc the zenith transmission was found to be 0·91; with this correction the temperature at the centre of the sun's disc was found to be 5550° absolute, and the mean temperature 5360° C. Before dispatching it to India, this instrument was restandardised at the National Physical Laboratory, and, on a clear, dry day, gave eight concordant readings, from which the temperature at the centre of the disc was found to be 5153° absolute; on this day the zenith transmission at Teddington was, therefore, 0·74, or the absorption was 26 per cent.

Employing the accepted value of the constant (2·4), the recent researches give 5920° as the mean temperature of the sun; but Dr. Féry thinks this is too high, and, therefrom, deduces that the accepted value of the solar constant is too high. The Mont Blanc measures would indicate 1·65 as the value.

THE NATIONAL CONSUMPTION OF WATER.

AN important paper on the increase in the national consumption of water was read by Mr. W. R. B. Wiseman before the Royal Statistical Society on April 27. The paper is of considerable interest, and must have entailed a large amount of time and thought on the part of the author. The historical part, which deals with the early history of water supply in England, treats the question, not only from the general point of view, but gives many interesting details of the early methods adopted and the difficulties met with in many individual towns; in fact, it is not too much to say that the early beginnings of the water supply of all the principal towns in England are reviewed shortly in the paper. It is obvious that, as the object of the paper is to deal with the more modern questions which arise in connection with this subject, the author could not devote very much space to historical details. We can, however, judge that on this subject he has only touched the fringe of the information he has acquired, and it may perhaps not be too much to hope that he may return to this part of his subject at a future date.

The life of Sir Hugh Myddelton and the description of the work carried out by him of bringing the water from the springs of Chadwell and Amwell, in Hertfordshire, by means of the New River, for the supply of London are well known to most of us, and possibly the author of this paper may have material for the making of a story as interesting and romantic in connection with other towns.

The author says he was "tempted" to investigate the estimates of the population in the pre-censal period in order to determine whether the great increases in the population in the nineteenth century were abnormal or otherwise, as upon the answer to the query one must be guided in the provision of water supplies for future populations. As was to be expected, he found such an inquiry not of great value. He has, however, put together some interesting information as regards the growth of many towns, and has dealt with the reasons for the very rapid growth of several of them. From a general review, the conclusion arrived at is that "the nineteenth century was in no wise abnormal, and that a steady increase in the already considerable population may be expected throughout the twentieth century."

The author describes at some length the methods adopted for checking the waste of water in early days, and particularly the system adopted in Liverpool in 1868 of localising the waste by metering the supply in various districts.

Of course, the supply of water per head of population is the important question when dealing with the amount of water required, and the tables given of the supplies in a large number of towns show the variations which exist, and which extend from about sixty gallons as a maximum to below ten gallons as a minimum, leaving out one special case with small population which runs up to 124 gallons per head. The numbers all relate to total supply, which includes domestic, trade, and municipal demands. The statistics given show much greater uniformity of supply in the different towns than would have been anticipated, and it is evident from them that waste of water is carefully looked after in England, and all possible precautions taken to avoid it. If the consumption is compared with what is common in many of the large towns in the United States, where the water supply goes up to 200 gallons and more per head, it will be evident that the precautions taken in England have given very satisfactory results. The opposition to the use of water meters in the United States is probably the reason why leakage and waste continue on a large scale. This opposition is principally due to the view that, on sanitary grounds, it is not well to restrict the supply of water, but, as Mr. F. P. Stearns stated in his presidential address to the American Society of Civil Engineers, "no one has yet demonstrated the sanitary advantages of a leaky faucet or a defective ballcock."

Table No. 5 is a valuable one. It gives, first, the population of more than 120 cities, towns, or districts in England for two or three years, with intervals, sometimes large and sometimes small, between the years. It then gives the total supply in each of these water areas during the years mentioned, dividing it up under the heads of domestic, trade, and municipal, the daily supply per head of population then following under the same heads.

Considerable space is devoted to the reasons which have caused an increase in the supply of water per head for domestic, trade, and municipal purposes. As regards domestic, it is, of course, well known that the displacement of old methods of sewage disposal by the introduction of the water-carriage system was the first cause of the great increase of the water supply. The increased and increasing use of fixed baths must also largely augment the consumption, as the water used for a bath by one person may vary from thirty to one hundred gallons. The author gives various other reasons for the increase in the domestic supply. As regards municipal supply, attention is directed to the increase in consumption due to the public baths, wash-houses, street conveniences, &c. The author states that he has endeavoured for some time past to collect data which will give some idea of the relative proportion of the water supply needed for particular works or industries, but the results have been too meagre to justify definite conclusions. He, however, deals in a general way with the amount of water used in a large number of industries, among which are breweries, distilleries, paper works, textile industries, and many others, and the information given is of an interesting character. The conclusion is that, on the whole, the rate of increase of water supply is greater in recent times than in those more remote. There probably would have been no doubt about this conclusion in anyone's mind, but, although this may be the case, it does not detract from the value of the information which has been collected in this paper to prove it.

The moral drawn is that, with the increasing amount of water required, there will be an increasing competition for the remaining first-class upland reservoir sites, which will become fewer and fewer as time goes on, and it is therefore desirable that steps should be taken at an early date to create some central authority "which should be charged with the duty of water conservancy in its widest application, and for that purpose should engage in a close and exact study of the water resources of the country." The author then goes more fully into the details which ought to be dealt with by such a body.

This proposal is, of course, not new, although of great importance. It was dealt with by Mr. E. P. Hill in a paper which he read at the Institution of Civil Engineers on November 27, 1906. In the beginning of that paper he said, "the water supply of the country is really a national matter, and it should be considered as a whole, and a town should not be allowed to appropriate a particular area unless it can be shown that in a general survey of available sources of supply that area can economically, from a water point of view, be allotted to it."

The value of the paper would have been increased if some information had been given as regards what is being done in other countries in connection with systematic investigation of water resources. There is no doubt that such an investigation is of more value and of greater necessity to the United Kingdom, where the population per acre is large, than to some of those countries which are at present rather sparsely inhabited, but which, at the same time, spend money on proposals such as have been suggested. In the United States this work was undertaken as a national one some years ago, a beginning having been made in 1894–5 by a grant of 12,500 dollars. This amount was gradually increased, until the grant in 1905–6 was 200,000 dollars. Since then there has, we believe, been some variation in the amount voted for this purpose.

Considering the large amount of work which the author must have gone through to prepare this paper, it may seem almost ungracious to suggest that he should add anything further to it as regards other countries, but he has shown such a large capacity for putting information together that we hope he may be tempted to even further research in connection with this subject.

MAURICE FITZMAURICE.

THE WAR AGAINST TUBERCULOSIS.

THE National Association for the Prevention of Consumption and other Forms of Tuberculosis was well advised to open its exhibition or collection of object-lessons in the Borough of Stepney. It may safely be said that the Whitechapel Art Gallery never had any company of more interested sightseers than the thousands who, at this exhibition a few weeks ago, examined and discussed death-rates, ventilation, graduated labour and the apparatus used in performing it in the treatment of consumption, apparatus for the treatment of tuberculous diseases, playgrounds, pathological specimens, back-to-back houses, overcrowding, food-stuffs and the principles of nutrition, methods of disinfection, and the like.

Any interested onlooker would have seen at once that the official conferences and set discussions constituted, after all, but a small fraction of the educational work that was being carried on. Here was an exhibition of which the main object was not to direct the attention of the public to any patent medicine or "all curing" nostrum, but how to regulate their daily life, how to avoid disease, and how to get the best food value out of their weekly wages, be these great or small. Nevertheless, the promoters of this exhibition, realising what an opportunity they had, also gathered together a number of medical and municipal delegates interested in the matter, to discuss the best means of preventing and curing tuberculosis.

Even those dropping in casually found an enthusiastic band of demonstrators, nurses from dispensaries and hospitals, attendants from graduated labour homes, from sanatoria and similar institutions, all hard at work explaining to small groups of interested men and women the meaning of the exhibits of which they were in charge. It was interesting to see the keenness with which both teacher and listener tackled the subject; and that these demonstrators were doing their work well was apparent from the numerous and intelligent questions that were put at the end of the demonstrations. Even to the sharp, shrewd Londoner the importance of ventilation, of cleanliness, of light, of suitable feeding, have been small, but a few exhibitions and demonstrations such as those seen and heard in Whitechapel Art Gallery will soon change all that; and the President of the Local Government Board has done nothing better for some time than in giving his countenance and support to what promises to be a really living movement.

What is the object and what are the lessons insisted upon at these conferences? Anyone visiting the exhibition would have it brought home to him in some way or other that between 1858 and 1907 there had been a fall in the annual death-rate due to tuberculosis from 2700 per 1,000,000 living to 1150 per 1,000,000 living. He would also see that, were the fall to continue at the same rate, tuberculosis would be an extinct disease early in the 1940 decade. Although this is too favourable a state of things to look forward to, as there will always remain a certain substratum of tuberculous patients and foci that it will be almost impossible to reach, tuberculosis should undoubtedly be an almost negligible quantity in our death-rate by that time.

How has this fall been brought about? In the first place, even before Koch was able to prove the presence of the infective agent, the tubercle bacillus, in tuberculous lesions, it was realised by those who were studying the disease most closely that it could be transmitted from one person to another, and that crowded and badly ventilated rooms were, therefore, fruitful centres of infection. This was a very great step forward, the full effect of which, however, was not felt until Koch gave his wonderful demonstration of the presence of the tubercle bacilli. He isolated the infective agent—this tubercle bacillus; its life-history was studied, and its relation to the tissues of the animal body during the course of the development of the disease, demonstrated. In the history of the treatment of any infective disease little progress has been made in fighting against it until the causal agent has been demonstrated. Once this stage has been reached, however, the fight waged against infective disease of all kinds has become more and more effective. In the case of tuberculosis, the attack can now be delivered along many parallels. Every patient is looked upon as a possible centre of infection, and before setting about the cure of the patient those dealing with the case have set themselves the task of attacking the bacillus from every quarter and at every point. It is realised that the first thing to be done is to secure it, or kill it, if possible, immediately it leaves the patient, especially, of course, in the sputum, as it comes from the lungs.

In the case of tuberculosis, isolation, in the ordinary sense of the term, is out of the question, but although the patient cannot be segregated from his fellows—and in many cases it would be both unwise and cruel so to do—he should be carefully trained to isolate himself, so far as the tubercle bacillus is concerned, by taking every precaution to prevent any undisinfected material from getting beyond his immediate vicinity. More is necessary, however, than the mere killing of the bacillus as it leaves the human body; some attempt must be made so to build up the strength of the patient that his tissues may be capable of carrying on war with the bacillus either on fairly level terms or on terms in favour of the patient. This can only be done by ensuring good hygienic conditions—plenty of fresh air, light, good food, work enough with plenty of rest. Given these conditions, and the tubercle bacillus has a bad time of it; remove the conditions, and the bad time falls to the patient. It has been stated above that it is often unnecessary to segregate consumptive patients; it must be remembered, however, that in the late stages of the disease, when the patient is weak and when the various discharges from the body, sputum and other excreta, may contain enormous numbers of the infective bacilli, it may be advisable, and even necessary, in the patient's own interests as well as of those who daily come in contact with him, to keep him in hospital, to make his last days, or even weeks or months, as easy and as pleasant as possible for him. Moreover, under these conditions the destruction of the enormous number of tubercle bacilli coming from the body is a comparatively easy matter.

Those interested in the treatment of tuberculosis have for long been convinced that good feeding and fresh air are factors of prime importance in such treatment. Up to a few years ago, however, the results obtained, though very much better than any obtained under the old methods of treatment, were in certain respects extremely disappointing. The patients were not properly classified for treatment, and many died who apparently ought to have lived. Those who went to Whitechapel to learn would find that the treatment of consumptives under Dr. Paterson at

Frimley is a very different thing from the treatment carried on in the early days of sanatoria. Patients are no longer stuffed and rested indiscriminately. They are given work, rest, and food on a carefully graduated system; they are taught how to treat themselves—what to do and what to avoid. The sanatorium treatment, however, deals with but a small proportion of the cases; tuberculosis must be tackled on a much more extensive scale. Calmette in Lille and Philip in Edinburgh, seeing the importance of bringing the treatment of tuberculosis to the working classes and even the very poor, have organised what is now known as the dispensary system, in which are combined an intelligence department, an ambulance service, a training school, an out-patient and in-patient hospital service, and a sanatorium department. In Edinburgh the result has been a fall in the death-rate beyond that of other cities equally or more favourably situated, except in that they have not been provided with this well-organised system.

It is recognised that prevention of tuberculosis is certainly more important than its cure, and all interested in this question must realise what enormous impetus has been given to the whole movement by the energetic action taken by the President of the Local Government Board. His keen interest in the Milk Bill, in the Washington Congress on Tuberculosis, and in the Whitechapel Exhibition, his grasp of principles and the wealth of detail contained in his opening address at that exhibition, gave evidence of complete conviction and determination to act up to his conviction. All this marks a great advance in the public treatment of the question in this country. Medical men have long suspected that tuberculous milk was a prolific cause of abdominal consumption amongst their little patients. They have known how readily delicate children recovering from measles, whooping cough, inflammation of the lungs, and similar conditions, have been infected, sometimes from tuberculous patients, at other times, however, under conditions where infection from the human subject appeared to be impossible, and they now welcome with enthusiasm any legislation that will render impossible the spread of tuberculosis by the milk from infected cattle. Medical officers of health, aware of the insanitary conditions under which a large proportion of the population, not only urban, but rural, live, hail with satisfaction the idea that in any well-considered action they may take they will now, not only be commended, but helped. The National Association for the Prevention of Consumption has done well, not only to follow Ireland and America, but to improve upon the methods adopted in those two countries. Nothing but good can be the outcome of this movement, and we hope that the seventy thousand visitors to the Whitechapel Art Gallery will be followed by hundreds of thousands, who will have the opportunity of seeing this or a similar exhibition at the "White City" or on its tour through the large and populous centres of England, and perhaps even of Scotland.

VISION IN RELATION TO HEREDITY AND ENVIRONMENT.[1]

THE Francis Galton Eugenics Laboratory at University College, London, has already done much valuable work in many directions under the supervision of Prof. Karl Pearson. With the assistance of Miss Barrington, a useful inquiry has been made into the question of the inheritance of vision and the relative influence of heredity and environment on sight. The paper is a mathematical investigation of statistics culled from a variety of sources. Of these, two communications by Dr. Adolf Steiger, of Zürich, on the corneal curvature, and the report on 1400 school children issued by the Edinburgh Charity Organisation Society, afford the best material. Other contributory material of less value is taken from reports on the refraction of London elementary-school children by Dr. A. Hugh Thompson and the Education Committee of the London County Council, and on the eyesight of 500 Glasgow school children by Dr. Rowan. Throughout, the difficulty which specially besets such statistical investigations is present in the fact that all the material is intensely selected. There is no means of supplementing it by a knowledge of the distribution of astigmatism and other errors of refraction in the community at large. Thus, in dealing with percentage statistics of the heredity factor in myopia, the authors say that "the distribution of parents of the normal and the proportion of myopes to the normal in the general population (or at any rate in the 'universe under discussion') must be found before any appreciation of the effect of heredity can be made."

The first moot point which arises in dealing with the inheritance of refraction concerns the determination of the unit to be used to obtain a quantitative scale. It is now customary to measure the refraction in terms of the refractive power of the correcting lens instead of, as formerly, in terms of its focal distance. When the variations of the mean values in the population are small compared with the mean value in the individuals under discussion, it matters little which unit is adopted. This is true of corneal refraction (3 per cent.), but untrue of corneal astigmatism (75 per cent.). The difficulty is overcome by using, whenever possible, the method of contingency, fundamentally, or for purposes of control.

Investigation of the inheritance of corneal astigmatism leads to the conclusion that it is certainly inherited, as evidenced by minimum limits of 0·3 to the parental and of 0·4 to the fraternal coefficients, but the material is neither sufficient nor sufficiently classified to determine with any degree of certainty the accurate value of the inheritance coefficients. The authors point out that "there is a splendid field for a man who will measure the corneal astigmatism in a non-selected population." As this would be an easy and accurate task with the ophthalmometer there ought to be no difficulty in getting it carried out. Investigation of corneal refraction shows that it is inherited at the same rate as other physical characters in man. In dealing with the inter-relations of refraction, keenness of vision, and age, the results show how much more influence myopia has on visual acuity than hypermetropia, and that refraction defects contribute more than half the abnormality of keenness of vision. They further show that there is not the least doubt of a sensible relationship of age to each of the several categories of eye defect. It is probable that a great deal of hypermetropia, hypermetropic and mixed astigmatism disappears, probably owing to growth, between six and ten, thus swelling the number of emmetropic eyes, but that after this age there is not sufficient evidence to say whether these categories vary or not. Myopia and myopic astigmatism increase throughout, but this increase does not balance the total gain due to rectification by growth; it may be caused by continued action of some environmental factor, or by a growth factor.

The general conclusions derived from the slender data of this first study are as follows:—There is no evidence whatever that overcrowded, poverty-stricken homes, or physically ill-conditioned or immoral parentages are *markedly* detrimental to the children's eyesight. There is no sufficient evidence that school environment has a deleterious effect on the eyesight of children. Though changes of vision occur during school years, they are phases of one law of growth, a passage from hypermetropia to emmetropia and myopia of the eyes of "unstable stocks." There is ample evidence that refraction and keenness of vision are inherited characters, and that the degree of correlation between the eyesight of pairs of relatives is of a wholly different order to the correlation of eyesight with home environment. Intelligence as judged by the teacher is correlated with vision in only a moderate manner (p. 16). We scarcely think that the data justify so strongly worded an *ex cathedra* statement as that made by the authors in conclusion:—"The first thing is good stock, and the second thing is good stock, and the third thing is good stock, and when you have paid attention to these three things fit environment will keep your material in good condition. No environmental or educational grindstone is of service unless the tool to be ground is of genuine steel—of tough race and tempered stock."

[1] University of London. Francis Galton Laboratory for National Eugenics. Eugenics Laboratory Memoirs. V. A First Study of the Inheritance of Vision and of the Relative Influence of Heredity and Environment on Sight. By Amy Barrington and Karl Pearson, F.R.S. Pp. 61. (London: Dulau and Co., 1909.) Price 4s.

CHILD EMPLOYMENT AND EVENING CONTINUATION SCHOOLS.

ANOTHER appendix volume, No. 20, to the report of the Royal Commission on the Poor Laws and Relief of Distress has been published (Cd. 4632), and incidentally indicates the directions which educational effort should take in this country in order to ensure the provision in future years of better educated workmen in the various industries on which the success of this country depends.

The report is by Mr. Cyril Jackson, chairman of the Education Committee of the London County Council, who acted for the commission as a special investigator to inquire and report on the main occupations followed by boys on leaving public elementary schools in certain typical towns; the opportunities of promotion in such occupations or of training for other occupations; and the extent to which such boys subsequently obtain regular employment (skilled or unskilled) as adults. Mr. Jackson was given power to make any feasible suggestions of a remedial character indicated by the facts, and he limited his investigations to a consideration of the prospects of permanence and educative value for adult industry of the occupations entered upon by the boys with whom he was concerned.

As regards the methods of inquiry adopted, it may be said that Mr. Jackson was able, from the sources of statistical information he found available, to obtain an idea of the various occupations in which there was an apparent excess of boys who could not when adults be absorbed in the same branch of industry. He afterwards, by interviews and by the distribution among employers of special forms to be filled up, obtained some further information as to these occupations; but he met with many difficulties, and only a small proportion of the forms were returned to him. In addition, a form of industrial biography for young men was issued to obtain direct evidence of the length of time boys remain in particular occupations and the age at which they were displaced if they have been in boys' work which does not lead to permanent employment as adults; but a third only of the forms circulated were filled up and returned—"Lads are always suspicious of anything which they think is prying into their affairs, and they believe there must be 'something behind,'" says Mr. Jackson.

There has been a steady diminution in the number of boys employed under fifteen during the last quarter of a century. With the recent stimulus given to secondary education, and counting on the zeal of new education authorities, there is reason to believe the decrease may be even more marked in the next census return. There are, however, exceptions to this decrease. The census general report of 1901 states, "while owing to the restriction of child labour, the total number of boys under fifteen years, returned as employed, showed a decrease of 12·9 per cent. on the numbers enumerated in 1891, the number of messenger boys at the same ages declined by only 5·1 per cent." It is, however, satisfactory to note how few are the trades in which an actual or a proportional increase in the number of boys is shown. As Mr. Jackson says, messenger boys have a very short life as such, and this form of occupation ceases as soon as the boys begin to require higher wages. It is unfortunate, therefore, that it should be just in this class that the decrease in boy employment is least marked.

The problem presented by the results of Mr. Jackson's inquiry is very grave in character, and the various statements of it collected in the present volume may be commended to the careful consideration of those who administer our educational affairs. Similarly, the opinions here collated of schoolmasters, of men working in boys' clubs, &c., of trades unionists, of distress committees, and others, deserve earnest study.

The analysis of the numerous forms received by Mr. Jackson proved a long and difficult task, and he is to be congratulated upon the important facts he has been able to gather together. The information respecting the capacity of boys, the wages they are able to earn, and the precise conditions regulating boy labour in specially selected industries, will repay careful deliberation, and may with advantage occupy the time and immediate attention of the members of education committees throughout the country.

Of especial interest are the conclusions arrived at and the suggestions which Mr. Jackson makes at the end of his report. The following excerpts will serve to show the vital importance of early legislation to ensure some efficient system of further education for all boys and girls during their adolescent years, whether they themselves desire it or not.

The evidence as to the difficulty boys find in getting into permanent work of a satisfactory kind seems overwhelming. Every inquirer gives the same impression.

The work of an errand boy or a telegraph messenger is bad for the boy, so is the work of a boy in a warehouse or factory who is employed to fasten labels to bottles, to fill packets of tea, or the like. It is not so much a question of a skilled trade not being taught as of work which is deteriorating, absorbing the years of the boy's life when he most needs educational expansion in the widest sense.

Mere skill of hand or eye is not everything. It is character and sense of responsibility which requires to be fostered, and "not only morals, but grit, stamina, mental energy, steadiness, toughness of fibre, endurance," must be trained and developed. Work which is monotonous kills development, and work which is intermittent destroys perseverance and power of concentration. The waste of boys' brains, character, and strength is ultimately not only destructive of the individual, but a serious economic loss to the community. It is probable that boy labour is not really cheap at all, owing to the undeveloped responsibility and carelessness of the young, but if the unskilled men who spring from them have been mentally and physically stunted, the loss to the employers is enormous, for they cannot earn a sufficient wage to live properly, and their output is below that required from an adult citizen.

In the large industries there should be a readjustment of conditions, but probably the initiative must come from an extension of State regulation of boy labour. This can be most easily effected by further raising the age of school attendance, or by a system of compulsory continuation schools. It must be recognised that much boys' work is wholly uneducative, and deteriorates instead of developing the man, and that this must be prevented. One of the largest industries—the textile—is still partly based on half-time child labour. It is probable that the operatives are really more to blame for this than the employers, many of whom are not very satisfied as to the advantages of child labour. The old contention that the manipulative skill required compelled the employment of children of twelve, because after that age their fingers lose suppleness, is not now heard so frequently.

One thing which appears likely to be of far-reaching benefit to the boy is increased education. Thus Mr. Kittermaster gives as his remedies:—

(1) Boys should be kept at school until the age of fifteen instead of fourteen.

(2) Exemption below this age should only be granted for boys leaving to learn a skilled trade.

(3) There should be school supervision until sixteen, and replacement in school if not properly employed.

Prof. Sadler and the Rev. Spencer Gibb suggest compulsory half-time schools, or, at any rate, some compulsory school until sixteen or seventeen. Mr. Gibb would like to see further amendments of the Shop Hours Acts so as to avoid the possibility of excessive hours of labour on certain days of the week. He points out, also, that the present Acts need to be more thoroughly enforced.

This inquiry seems to show that these reforms are necessary. The raising of the age of exemption would strengthen the boy, and he would be kept longer under discipline, and would become both steadier in character and more intelligent. It can hardly be seriously contended that the boy of the working man is really more fit for life than the public-school boy at the age of fourteen who is admittedly unready at that age.

It must not, however, be supposed that the present education given in the schools is all that can be desired.

There is a widespread feeling that it is too academic, and must be made more practical. In any case, it must aim at developing character and intelligence rather than merely imparting book knowledge.

If it is urged that further time for schooling is commercially impossible, it must be remembered that our great trade rivals, the Germans and the United States, have compulsory continuation schools or a higher exemption age. In Germany it is the custom for parents to put their boys to a skilled trade, and apprenticeship is as flourishing there as ever it was. "The Imperial Law on the 'Regulation of Industry' of 1891 decreed that the masters in any branch of industry were bound to allow their workers under the age of eighteen to attend an officially recognised continuation school . . . for the time fixed as necessary by the authorities." The local council might make such attendance obligatory for all male workers under the age of eighteen. Every raising of the school age or Factory Act limiting child labour has been in turn objected to as fatal to industry, but the community has very quickly adapted itself to the new conditions.

The removal of the supply of cheap boy labour under fifteen would probably lead to very useful readjustments of industry and to the substitution of mechanical labour for some of their work and for a greater employment of adult labour. It is, of course, true that to start boys at fifteen instead of thirteen or fourteen will not prevent a period of transition from boys' to men's jobs, but it will give a better chance of skill to the boy. A better and longer education should give the boys firmer and more disciplined characters and a greater power of adapting themselves to new work. Increase of efficiency, even in unskilled labour, means increased wage to the mutual benefit of employer and employed. It is the over-supply of unskilled labour which is not worth a good wage which is the real difficulty.

Again, in skilled trades proper there is little doubt that there is room for more boys, and they are not supplied now with the best material available. It is probable that labour exchanges for boys leaving school would be of very great value in securing that all the more intelligent and able boys had a chance of securing good openings. It is the ignorance of the boy which so often leads him into employment which is not suited to him.

Further, some better grading of wages is most desirable. At present, comparatively high initial wages are often paid to tempt boys into an unprogressive occupation. The value of the old apprenticeship scales lay in their attempt to make the wage increase with the capacity, but the low initial earnings have been the reason of the unpopularity of apprenticeship with the more needy and less far-sighted. It is quite possible that the boy leaving school at fifteen will still not earn more than he now does at fourteen. There is little doubt that in that case the employer would gain, because he would get a better article, but the boy would also gain, because he would be a better article and more fit to develop into a still higher efficiency, commanding better wages later. It is better that he should be paid less in his early years and be worth more as an adult. Under existing conditions he is bribed by large wages to spend his time on uneducative work which gives him no opportunity afterwards, and he is unfit to spend wisely the large wages which he receives. The present system demoralises the boy. The temptation to leave one job to get higher wages in another is almost irresistible, and the resulting instability is detrimental to himself and not economical to his employer, who is perpetually trying to train new boys.

EVOLUTION IN APPLIED CHEMISTRY.[1]

EVERY chemist, to be worthy of the name, should in his own work be a specialist; but there are few amongst us to whom it has been given to produce in their own particular line of research results of deep general interest. Our distinguished president, Sir William Ramsay, is one of the privileged few; I am one of the many, whose scientific results are like the grains of sand, the importance of which lies in their aggregation.

But a chemist, to be worthy of the name, should also be able to step forth from his own small sphere of activity and to look upon his science and allied domains of human thought as a whole, to contemplate its history and its future, its aims and progress, and to glean a few useful truths from such considerations. This is what I shall try to do.

The simple daily wants of mankind in a primitive condition are all supplied by nature. It is the progress of civilisation which led to the necessity of transforming her gifts, and thus created a chemical industry. Human chemical work supplements the chemical work of nature, and is therefore subject to the same governing laws. It is strange that no attempt has yet been made to trace the many coordinated points which exist between biology, the science of life, and chemistry, the science of molecular changes, without which life is an impossibility.

The subject is extensive enough for a book. I cannot hope to do justice to it in a short lecture, but I shall try to point out some of the relations existing between the results of biology and applied chemistry.

Biology as a science is of very recent date. The manner in which our forefathers tried to gain an insight into the overwhelming variety of the vegetable and animal kingdoms was purely systematic. Linnæus, de Candolle, Cuvier, and others, enabled us by their systems to classify nature, but they did not teach us to understand it. Hardly a century ago the dawn of a deeper insight began to rise on the horizon of science, and just fifty years have elapsed since that memorable meeting of the Linnean Society in which the flaming truth of evolution was given to humanity by one of the greatest minds that ever stood up amongst men. Botany and zoology, the pedantic histories of plants and animals, became suddenly united in biology, the great science of life, itself a living thing, capable of development and evolution.

Evolution is no longer a working hypothesis of natural science; it has become a new way of thinking, a method of harvesting everlasting truth from the fleeting changes of passing life. It is not applicable to living plants and animals only, but to everything that is capable of growth, alteration and improvement. Why should this method not be extended to the study of human achievements, of science as a whole? Why not to applied chemistry, which is so full of changes, and more vigorous in its growth and development than many another discipline?

It seems to me that England, the country which has given to all the other nations the invaluable gift of evolution, is the classical soil on which an attempt might be made to apply it in a new manner. It may help us to understand, and therefore to forgive, the struggle for existence, which in chemistry and its applications is as rife as amongst the organisms of the deep sea or the tropical forest. Looking at that struggle with the calm soul of the man of science, we shall easily recognise the underlying promise of the survival of the fittest and of certain progress in coming days.

As a rule, one takes it for granted that anything applied must have existed before its applications. It is not so with applied chemistry. Chemistry as a science is, as we all know, a comparatively new creation. Its applications, on the other hand, have existed since times immemorial, and may be traced back to the very beginnings of human civilisation. The men who in the past devoted their thought and energy to problems which we now call chemical had to reach their ends with the help of sound empiricism. Though their progress was slow it was sure, so that to this day we have sometimes occasion to marvel at their successes. More than that, we may safely say that some of our best industrial methods would never have been discovered if we had had chemical theory only to guide us. Science itself stands on an empirical basis—we cannot draw general conclusions unless we have well-established observations to start from.

It is perhaps not superfluous to remember these facts at the present time, when the brilliant success of theoretical chemistry is apt to make us forgetful of the services derived from purely empirical methods of research. Empiricism investigates without foregone conclusions,

[1] Address to the combined sections of the Seventh International Congress of Applied Chemistry on Monday, May 31, by Prof. Otto N. Witt, of Berlin.

whilst theoretical science verifies logical deductions. Science forces nature to divulge its secrets; empiricism is quite content to pick up the treasures it may come across in its ramblings through unexplored regions. Nature is still full of unknown treasures. Why should we cease to search for them? Why should we expect success only from logical deduction?

It is true that the scientific method of invention is a quicker road to success. Rapidity is everything in our times. Whirling along in a motor carriage to a well-known destination is distinctly more agreeable than tramping on foot in the glaring sun of a summer's day; but you cannot pick the flowers blooming by the roadside or stumble over hidden treasures at the rate of sixty miles an hour. The two methods of progress have both their own peculiar advantages, and should both be followed. Now and then they will meet, and make success doubly certain.

One of the best combinations of empiricism and theory is the examination of old empirical industrial processes by the methods and in the light of modern chemical science. A great deal of valuable information has been obtained in this way; much more remains to be discovered. It is this conviction which led me to propose to the last congress at Rome that a special section should be established in these congresses for the history of applied chemistry. The history of chemical science, as it exists now, is almost entirely devoted to theoretical systems and to the life of those who created them. The history of industrial methods is not so complete as one might wish it to be.

So far as the history of our nineteenth-century chemical industry goes, the materials for studying it are not wanting. The patent literature of the various countries is in itself an inexhaustible source of information, which can be largely supplemented from text-books and endless files of periodicals; but it is not so if we begin to inquire into the applied chemistry of previous centuries. The mysterious communications of the mediæval alchemists have been frequently examined; but Pliny remains our almost exclusive source of information about the chemical arts of the antique world. Yet these arts were many and highly developed, and Pliny's information was distinctly superficial.

How much more might be gathered about the chemistry of past times has been shown by the researches of such men as Berthelot and Edmund von Lippmann, who combined the accomplishments of distinguished chemists with those of the Orientalist in the study of Arabic and Hebrew authors. Who knows what a host of information may yet be lying dormant in unread Egyptian papyri and palympsests?

But the sovereign means of discovering these lost secrets is in the careful study and analysis of the products which ancient times have fortunately left us as proofs of their skill and knowledge. How much has been done in that respect by that one great master, Marcellin Berthelot, who found in such work the recreation of the later years of his life? How much more remains still to be done?

Thus we may hope to know at some future time more of the accomplishments of past generations than we do at present; and we may also hope that some of the methods thus re-discovered will awake to fresh life like mummy wheat, which is said to take root and grow if you plant it in fresh soil. Have we not greeted with delight the *terra sigillata* of the Romans, when the process for its manufacture was re-discovered by Fischer, a Bavarian potter, and has not a considerable industry sprung from the resurrected use of lanolin, or wool-fat, which was a panacea of the Greeks two thousand years ago?

Yet such discoveries will remain inheritances from the dead, and the cases of their resurrection to life will not be numerous; but we have living empiricism at our doors, which we allow to die and to sink into oblivion, without attempting to study it and to learn the lesson it has to teach—a treasure of information of incalculable magnitude hoarded up in the course of centuries by the skill and patience of countless millions of men who were, and are, as keen in the study of nature as they are reluctant to draw general conclusions from their observations.

This great treasure is the industrial experience of the Eastern nations. It is an undoubted fact, and if it were not, a single visit to the South Kensington Museum would prove it, that the people of Persia, India, China, Japan, the inhabitants of Burma, Siam, Cambodja, and the innumerable islands of the Pacific, are possessed of methods for the treatment and utilisation of the products of nature which are in many cases equal, if not superior, to our own. These methods must be to a large extent based upon chemical principles. Is it not strange that we know so little about them, and that little generally only indirectly through the accounts of travellers who were not chemists? If all these peculiar methods were fully known and described by persons who have seen them applied and watched their application with the eyes of a chemist, it would certainly be, not only of interest, but also of the greatest utility to our own industry; for it is the elucidation of empirical methods which, in the new light that science sheds upon them, leads to new departures and to progress. Who can deny the advantage which the industry of cotton dyeing and calico printing derived from the study of the Turkey-red process, which a century ago was bought as an Eastern trade secret by the French Government and generously placed at the disposal of European dyers? Would the making of porcelain have been invented in Europe if the impulse for it had not come from the East? Is there no connection between the introduction of Chinese porcelain and the invention of Delft, the curious observations of Réaumur on devitrification, and even the work of that great and original genius, Josiah Wedgwood? And would that supreme triumph of the application of pure chemical science to industry, the synthesis of indigo, ever have been accomplished if indigo, as a natural dye-stuff, and its extraordinary method of application by vat-dyeing, had not come to us from the East? What a stir has been created, even in these very latest days, by the extension of this ancient Eastern method of dyeing to other shades than those of indigo!

We live in a period when the intellectual nations of the East wake up from their political sleep of centuries, when they issue from their seclusion and demand their share of Atlantic civilisation; but their awakening means going to sleep for their industrial methods. These methods, ingenious as they undoubtedly are, cannot compete with ours in being applicable on a manufacturing scale. So our processes are transferred to the coasts of the Pacific, and their own methods are abandoned and forgotten. The Eastern industries cannot keep pace with ours, not because they are inferior in their results, but because they toil on foot whilst ours are motoring. In this struggle for existence the fittest means the quickest and the cheapest.

Yet I am certain that many a new and good result might be obtained from the combination of Eastern and Atlantic achievements. Examples of such happy blending are not missing. See what that great and original English inventor, Lord Masham, the very type of an Atlantic genius, has made of the wild silks of India!

It seems to me that these international congresses ought to make it one of their important duties to watch over the intellectual wealth of the past and to collect it before it disappears for ever. Let the chemists of all countries who flock together in these gatherings entrust to their keeping the old indigenous industrial methods of their nations; let the reports of these congresses, which are distributed over all the world, become a treasure-trove of ancient motives for new development!

If we consider how our present chemical industry has been evolved from empirical processes such as our ancestors practised them, and as they still exist in the countries of the East, and even in some parts of Europe, we can easily observe a gradual transformation similar in many respects to the one that living nature had to go through in evolving the present types of plant and animal life. It is here that the parallels between biology and chemistry offer themselves. They are interesting, and not useless to consider. It would be strange indeed if we could not gather some acceptable hints from surveying the broad expanse of the human toil and thought of centuries.

One of the most characteristic changes that have taken place is the transformation of handicraft into manufacture.

We have replaced personal skill by division of labour in chemical work just as much as in all the other branches of human industry. In so doing we have certainly unconsciously copied nature. Do not her earliest creations, the unicellular organisms, in which one cell is made to fulfil all the functions of life, resemble the patient craftsman, who works at the object that he wants to turn out from the beginning to the end, and then, with a last loving glance, hands it over to his client? And are not our factories of the present day comparable to the complicated organisms of the later epochs of creation, with their many coordinated and subordinated organs that work in unison, and in their joint activity are much more powerful than their tiny unicellular ancestors?

One of the most interesting chapters in the evolution of animated life is the gradual transformation of aquatic organisms into those living in the air and on solid ground —a tremendous change, and one which could only be effected by many and varied attempts and by means of the most marvellous adaptations. Right into the midst of our epoch, when the conquest of land as a permanent dwelling-place for plants and animals is practically accomplished, reaches the perpetuation of intermediate forms, which can adapt themselves to land or water, as the circumstances may require.

Now what is the lesson we can learn from the study of this wonderful development in comparing it to what has happened in our own industry? I think it is obvious and of the greatest importance. It is this, that no industry, and especially no chemical industry, can be transplanted, such as it is, from the place in which it has been successfully developed, into any other without having to undergo a complete change, which taxes to the utmost the organising and inventive power of those who make the attempt.

This is a truth too often forgotten in our times, when the keenest struggle for success is rife everywhere, and people who have to suffer from the competition of factories established in other countries are apt to vent their grief in uncharitable accusations. Yet how frequent are the examples, when manufacturers, who have risen to great prosperity, suffer tremendously by transferring their own business into some new locality. In many cases it is merely a move in their own country, yet it means, generally, a far-reaching adaptation to altered conditions; but if it becomes a question of transplanting a manufacture from one country into another, it must be quite a new creation if it is to be a success. As a new creation it should command our respect, and though it may be inconvenient it should not be disparaged. It was the destiny of aquatic organisms to conquer land as a dwelling-place, and it is the destiny of the industrial countries of the present day to carry industry to the nations that are ready to receive it.

There are, fortunately, no two countries alike in this world, and most of them differ, from a manufacturing point of view, more than land and water for plants and animals. Whenever an industry leaves its native country it has to be re-modelled. Take, for instance, the gas industry, which was born in England, and has been carried by English enterprise over all the world. No sooner it crossed the channel and was established in France and Germany than it had to be materially transformed, not in its principle, but in the constructive details and the dimensions of the necessary plant. Our coal was different from yours, our fire-clay had to be prepared and worked differently for the production of the necessary retorts, our condensers and gas-holders had to be altered and encased to withstand the sudden and wide changes of temperature of a Continental climate, our yields proved lower, and the economy of the process was materially different. Still greater changes awaited the gas industry on the other side of the Atlantic. Though the United States are possessed of good gas-coal, the freights for it to the New England States proved to be too high. On the other hand, anthracite was incomparably cheaper there than it is with us, and the same was the case with mineral oils of a high boiling point. All this led to the successful substitution of carburetted water-gas for the illuminating gas of Europe. At present we try hard to acclimatise this American adaptation of the gas industry both in England and Germany. Brilliant as the work done by gas specialists in connection with these attempts undoubtedly is, the success is, to say the least, indifferent, and will remain so until the water-gas question will again have undergone so complete a transformation and adaptation to European industrial conditions that it will once more be paramount to a new creation.

Another example. Just at the present time a new country is about to join the concert of industrial nations. Norway, in the rocky solitudes of which the bear was wont to ramble and the elk and the reindeer to graze, the blue fjords of which knew no other craft than fishing smacks and occasional pleasure yachts, is beginning to develop a chemical industry of vast dimensions. Will that industry be similar to the one existing in this country or in Germany? Certainly not. Its factories will have no chimneys, no fires. They will be activated by the "white coal," the force of roaring torrents. Our engineers have pondered over the problem of economically transforming heat into electricity; the task of the Norwegian manufacturer is just the reverse. One of the fundamental problems of our German chemical industry is the utilisation of our overwhelming wealth of sodium and potassium salts; the Norwegians neutralise their synthetic nitric acid with limestone, because they have no cheap alkali. Many other points of the same kind might be mentioned, but I think these are sufficient to show that, whatever that new Norwegian industry may prove to be, when fully developed it must be different from what the world has seen so far.

The first activity which the human race develops in taking possession of wild districts is agriculture, and we know full well that no two countries are alike in their agricultural methods and results. An agricultural country has to develop a dense population, and, in its work, the peculiarities due to its soil and its climate, before it can attempt to create an industry. The blending of the old agricultural interests with the newly acquired industrial ones means in itself a convulsion. Is it then probable that so fundamental a change may be brought about by the mere importation of a miserable copy of what has been born and nurtured to maturity on other soil and under another sun?

If we study the life of plants and animals we are struck by the marvellous economy reigning everywhere. There are few physiological processes which can be called wasteful. Every bye-product of the more important chemical reactions that take place in the organisms of plants and animals is utilised and made to serve some purpose. In plants, for instance, the refuse of the chemical work of the protoplasm seems to be deposited as encrusting material in the enclosing cellulose. The encrusted cell is then made to serve as a mechanical support for the body of the plant, whilst new and more vigorous cells are formed to fulfil the functions of life. Some of the bye-products of the chemical work of the plant are transformed into dye-stuffs, others into perfumes, both with the object of attracting the insects which are necessary for fertilisation. Everywhere in animated nature we see the principle of storing up food, either to serve in cases of need or to provide for a future generation. Even in those cases where nature seems to be wasteful, as, for instance, in producing germs and seeds in far greater numbers than seem to be required for the continuation of the species, the seeming superabundance is merely a wise calculation of the probabilities for the development of the germs. More marvellous, perhaps, than any of these examples is the economical use of the energy required for sustaining the functions of life. So far as I am aware, there is not a single engine of human invention which can utilise the energy supplied to it in so perfect a way as, for instance, a horse utilises the calories contained in its food for the production of mechanical power; and though the mechanical equivalent of light as a form of energy is, so far as I am aware, yet an unknown constant, we may safely say that the perfection with which living plants utilise the energy of sunlight for carrying out the endothermic reactions upon which their nutrition and growth depends is far superior to the methods which we have so far discovered for similar purposes.

Are not these principles of economy which so universally pervade living nature also the very essence of all industrial chemistry? Are not such considerations as economy of energy in its various forms, high yields, and the avoiding, or, if unavoidable, the utilisation of bye-products the fundamental principles which we try to instil into the mind of the young chemist about to begin his career as a manufacturer? The history of applied chemistry is teeming with examples where the survival of the fittest means neither more nor less than a victory of economy.

We all know that that marvellous creation of human ingenuity, the closed ring of industrial chemical processes working in connection with Leblanc's method of producing soda, is practically extinct on the Continent and materially reduced in its importance in England. This fate it had to suffer, because it was a wasteful process—wasteful in its utilisation of material and wasteful in its consumption of energy. The skill and resource exerted in its invention and constant improvement will for ever be gratefully remembered; but they were unable to check the progress of the Solvay process, which is more economical in its use of energy, and of the electrolytic methods for splitting up the alkaline chlorides, which produce no bye-products.

The progress of industrial chemistry does not always depend on the introduction of more perfect, but also more complicated, machinery and plant into the factories. Of course, every chemical process requires thorough working out from a mechanical point of view, and many of the most brilliant successes of our modern chemical industry are mainly due to a clever adaptation of mechanical means to a chemical end; but, taken as a whole, the real progress of the chemical industry does not so much consist in the improvement of the apparatus as in the simplification of the fundamental chemical reactions. More than once a seemingly insignificant chemical alteration of an industrial process has produced the same or a better effect than the introduction of the most ingenious and costly plant.

That the great principle of economy is not only applicable to the material necessary for carrying out chemical reactions, but perhaps even more to the energy consumed by them, is a distinctly modern idea. It is not so very long since we have begun to have, if I may say so, a conscience for fuel. Previous generations took it for granted that industrial work consumed coal, and that the necessary coal had to be provided and to be paid for. We are now awake to the fact that the quantity of fuel required for an industrial process is very much dependent on the way in which it is made to do its work.

Of course, the calorimetric effect of any given fuel is a constant, and it is also true that we can never utilise more than a certain proportion of it; but this proportion may vary considerably. It was alarmingly small almost through the whole of the nineteenth century, and we may congratulate ourselves upon its present ascendent tendency. A striking example of the transformation of our views about fuel and its proper use is the history of the smoke question. There was a time, both in England and on the Continent, when smoke was considered a necessary evil which had to be suffered. After a while smoke began to be looked upon as a nuisance, and war was declared against it by those who suffered from its disagreeable properties; but now we know that smoke is a waste, and that nobody has better cause to wage war against it than he who produces it. A smoking chimney does not only carry visible unburned carbon into the atmosphere, but in nine cases out of ten also invisible carbonic oxide and methane, with all the latent energy they contain. Smoking chimneys are thieves, and their misdeeds should not rise unavenged to heaven.

But even chimneys that are innocent of incomplete combustion may be guilty of stealing energy if they allow the gases of combustion to escape into the atmosphere with a higher temperature than is necessary to activate the draught. The lost energy of such gases may be trapped and recovered by the regenerating and recuperating apparatus now so largely used by many industries. Regenerative gas-heating is not only a sure prevention of smoke, but also the most powerful means of economising heat, and therefore one of the greatest acquisitions of modern industry. It is perhaps not saying too much that the saving of national wealth effected by it may amount to a sum sufficient to pay the aggregate national debts of all the civilised nations. Uncivilised nations are blessed with neither national debts nor heat-regenerating appliances.

My last comparison between biology and applied chemistry I should like to choose from a chapter which one might call biological sociology, though I am not aware that that name is commonly given to it. It treats of the wonderful phenomena of symbiose and aggregation.

Symbiosis is, as we now know, of very frequent occurrence. Plants or animals of totally different nature and organisation, or even plants and animals, may combine for joint life and activity with the object of helping and protecting each other in the great struggle for existence. What neither of them would be able to fulfil or obtain by its own strength and power they can do with ease and certainty in their faithful allegiance. Gregariousness—the flocking together of organisms of the same kind—arises from the same spirit of mutual help and protection.

There is a great deal in human life and institutions, in our morals, politics, and science, which reminds us that the human race, as an intrinsic part of animated nature, has also inherited its all-pervading tendency for combining forces; and what is thus apparent in the doings of mankind in general cannot be absent in the special field of activity which forms the object of our exertions. The various forms of chemical industry are essentially symbiotic. They depend upon each other for their success and progress. A solitary chemical factory in a country otherwise devoid of chemical industry is a practical impossibility. Chemical works come in shoals if they come at all. The maker of acids and alkalis wants other chemical enterprises to use his products, and these, again, are constantly on the look-out for customers. The more varied and numerous the factories are, the more they prosper, in spite of their complaints of growing competition.

The chemists themselves are gregarious. They form societies and academies and institutes and syndicates by the score, and who can deny the fact that brilliant results have been achieved by such combinations of forces? If we remember, in terms of unmeasured gratitude, the great originators of our science and its applications, we cannot forget the help rendered to its progress by such institutions as the Royal Society and Royal Institution, the French, Italian, and German academies, the leading chemical societies, and the innumerable universities in all parts of the world, the rapid growth and extension of which is the true gauge of our progress.

Last, but I hope not least, in this list of brilliant aggregations stand our congresses as a new, but most successful, creation. They represent a modern form of symbiotic effort amongst chemists, which is the more remarkable because it is international. They proclaim the great truth that science knows no boundaries and frontiers, that it is the joint property of all humanity, and that its adherents are ready to flock together from all parts of the world for mutual help and progress. It is the great truth proclaimed by one of our past presidents, Marcellin Berthelot—"La science est la bienfaitrice de l'humanité entière"—which our congresses might write on their banner, for it expresses the spirit which led to their foundation and ensures their success.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. H. KOBOLD, professor of astronomy at the Kiel University, has been called to the similar post at Berlin.

MR. J. E. BARNARD has been appointed lecturer on microscopy in the department of general pathology and bacteriology, King's College, London.

DR. G. S. WEST has been appointed to the chair of botany and vegetable physiology in the University of Birmingham, rendered vacant by the retirement of Prof. Hillhouse.

PROF. W. W. PAYNE has retired from the chair of astronomy at Goodsell Observatory, which he founded at

Carleton College, Northfield (Minn.), in 1877, but retains the co-editorship of *Popular Astronomy*. Dr. H. Wilson, his co-worker, has been appointed to the professorship.

Dr. C. Gordon Hewitt has accepted the appointment as entomologist to the Dominion of Canada in succession to the late Dr. James Fletcher, and has resigned, in consequence, his post as lecturer in economic zoology in the University of Manchester. He will leave England in September to take up his new duties at Ottawa.

We learn from the *Westminster Gazette* that the heirs of the late Herr Heinrich Lanz, head of the Mannheim engineering firm, have given a million marks for the establishment of an academy of sciences at Heidelberg, which will stand in the same relation to the university as the similar institutions in Leipzig and Göttingen stand to the universities in those cities.

Lord Strathcona has just presented the sum of 100,000*l.* to the McGill University, Montreal, of which he is Chancellor. Of this amount, 90,000*l.* is needed to complete and equip the new medical buildings, the old buildings having been destroyed by fire in 1907. The remaining 10,000*l.* is intended as a subscription to the fund for increasing salaries throughout the University.

At the meeting on June 28 of the council of the University of Paris, the rector, M. Liard, announced, we learn from the *Revue scientifique*, a gift by M. Henry Deutsch of 500,000 francs, and an annual grant of 15,000 francs, towards a scheme for the creation of an aërotechnical institute. He also announced a donation from M. Basil Zakaroff of 700,000 francs for the foundation of a chair of aviation in the faculty of sciences of the University.

The Belfast University Commissioners have made the following, among other, appointments to professorships and lectureships in the Queen's University of Belfast:—professor of economics, Mr. Thomas Jones; professor of botany, Mr. D. T. Gwynne-Vaughan; lecturer in organic chemistry, Dr. A. W. Stewart; lecturer in physics, Dr. Robert Jack; lecturer in bio-chemistry, Dr. J. A. Milroy; lecturer in geology and geography, Dr. A. R. Dwerryhouse; lecturer on hygiene, Dr. W. James Wilson.

New buildings in connection with the Merchant Venturers' Technical College, Bristol, were opened by Lord Reay on June 24. The college will, for the future, provide the faculty of engineering in the newly established University of Bristol, and in consequence of this arrangement certain changes in the curriculum and time-table will in all probability come into effect at the beginning of next session. These probable modifications are outlined in a short illustrated prospectus of the day classes of the college which was published recently. There are departments for the study of many branches of engineering, including civil, mechanical, electrical, mining, and motor-car engineering, the last-named subject being in charge of a special professor.

A new departure has been made in connection with the faculty of engineering of the University of Liverpool. A special course on refrigeration has been introduced into the honours school of mechanical engineering. The general theory and actual testing of refrigerating machines is included in the course on heat engines, but, in the final year of an honours student's four years' work, a course of lectures and laboratory work on heat engines and refrigerators is provided. In addition, a special optional course has been arranged on refrigerating machinery and cold storages, comprising the design of refrigerating machinery, the construction of cold storages, ice-making plants, and the general practice of refrigeration. This experiment, which constitutes, it is stated, the first attempt in this country to establish special instruction on refrigeration, will be watched with interest.

The programme of the Summer School of University Extension Students, which is to be held this year at Oxford from July 30 to August 23, covers a sufficient range of subjects to appeal to the most diverse tastes. Pure science scarcely takes the prominent place accorded to it in previous years; we notice, however, that one section of the work arranged is entitled "Italy's Contribution to Science," and will include lectures on Galileo, Vesalius and others, by such well-known authorities as Prof. Osler, Prof. A. Macalister, and Mr. Marconi. In addition to the general course on Italy, lectures and classes have been organised for economic and political science, and a special class on practical map-making will be conducted by Mr. N. F. MacKenzie. Application for tickets, and all inquiries in connection with the meeting, should be addressed to Mr. J. A. R. Marriott, University Extension Office, Examination Schools, Oxford.

We learn from the *Pioneer Mail* that a vesting order relating to the Tata Research Institute has been issued. The order recapitulates the bequests of the late Mr. Tata, and enumerates other gifts which have been made for the purposes of the institute; it then proceeds to outline the scheme for the government of the institute. The Viceroy is to be an *ex-officio* patron, and the heads of local Governments of India are included as vice-patrons. There will be also a court of visitors, on which the Government of India and the Government of Mysore will be represented, and Messrs. Tata, the sons of the benefactor, will be members during their lives. The director-general of education, the directors of public instruction to local Governments, and professors of the institute will be *ex-officio* members. There will be a council of twelve, a senate, and a standing committee of the court of visitors. The council, on which four professors will serve, will be the executive body of the institute, its proceedings being subject, however, to review by the standing committee referred to. There are now, we learn from the same source, ample resources at the disposal of the governing body of the institute. The sum available for initial expenditure includes building grants of 5 lakhs and $2\frac{1}{2}$ lakhs respectively from the Mysore Durbar and the Government of India respectively, with $1\frac{1}{2}$ lakhs from the Madras Government to be spread over three years, and there are in all 13 lakhs practically in hand. As the endowment is on a liberal scale, the financial future of the institute is assured. It may be added that the actual buildings are estimated to cost Rs. 6,57,000.

The new buildings of the University of Birmingham were opened by the King and Queen yesterday as we went to press. The following message upon this development of university work has been sent by Mr. Chamberlain to the *Birmingham Gazette*:—"The University formally opened by their Majesties in person to-day is the crowning point of the work undertaken by our city, and endows us with an institution we have long contemplated. His Majesty's consent to perform the opening ceremony is one more example of his constant interest in all that concerns the welfare of his subjects. It singularly enhances the importance of the occasion and distinguishes with his Royal approval the work which has thus been accomplished. Nothing in the history of education in this country is more surprising than the recent growth of university institutions. Formerly our ancestors were satisfied with the three universities of Oxford, Cambridge, and Durham in the whole of England and Wales; now in the last twenty years we have added to them other universities to provide for the wants of the towns and districts which are of provincial importance, and we have found that with the growth of these bodies has come the demand for instruction of the higher kind. Accordingly in many towns a fully equipped university has been established, and higher education has been placed within reach of all. By the generosity of our citizens and the munificence of some personal friends we in Birmingham have been enabled to provide and equip the principal technical departments of our university on a scale which previously has been unattempted in this country; but what we have accomplished is only the beginning. Much still remains to be done. The buildings are complete, and the endowments are altogether inadequate; the foundations have been laid, but the building up of the structure lies with the citizens of Birmingham."

A scheme is being developed to provide an interchange of University students between the United Kingdom, Canada, and the United States. The object is to provide opportunities for as many as possible of the educated youth of these countries to obtain some real insight into the life and customs of other nations at a time when their own opinions are forming, with a *minimum* of inconvenience to their academic work and the least possible expense, with the view of broadening their conceptions and rendering them of greater economic and social value. Lord Strathcona has consented to become president for the United Kingdom. The list of vice-presidents includes the names of the Chancellors and Vice-Chancellors of many British universities, the Prime Minister, the Lord Chancellor, and other well-known men. A large and representative committee has also been appointed. Additional objects of the movement are to increase the value and efficiency of present university training by the provision of certain travelling scholarships for practical observation in other countries under suitable guidance. In addition to academic qualifications, the selected candidate is what is popularly known as an "all-round" man, the selection to be along the lines of the Rhodes scholarships. It is hoped to afford technical and industrial students facilities to examine into questions of particular interest to them in manufactures, &c., by observation in other countries and by providing them with introductions to leaders in industrial activity. It is proposed to establish two students' travelling bureaux, one in New York and one in London; to appoint an American secretary (resident in New York) and a British secretary (resident in London), to afford every facility to any graduate who wishes to visit the United States, Canada, or the United Kingdom for the purpose of obtaining an insight into the life of those countries. It is hoped to provide twenty-eight travelling scholarships, fourteen of these being available for universities in the United Kingdom, ten for universities in America, and four for universities in Canada. The total cost of the scheme, inclusive of the maintenance of two travelling bureaux and the provision of twenty-eight scholarships per annum, is estimated at 13,500*l.* for a period of three years, equivalent to an annual expenditure of 4500*l.*, the relative annual expenditure being estimated at 2400*l.* in the United Kingdom, 600*l.* in Canada, and 1500*l.* in the United States. Promises of support may be sent to the hon. secretary, Mr. Henry W. Crees, at the University Club, Birmingham, and it is hoped that all interested in promoting the success of an educational scheme of far-reaching significance in the English-speaking world will contribute financially.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 24.—Prof. J. Cossar Ewart, vice-president, in the chair.—Pressure perpendicular to the shear planes in finite pure shears, and on the lengthening of loaded wires when twisted: J. H. **Poynting.** When a solid is subjected to a finite pure shear the lines of greatest elongation and contraction are not the diagonals of the rhombus into which a square is sheared, but lines making, respectively, $\pm\epsilon/4$ with the diagonals of the square, where ϵ is the angle of shear, and these lines are at right angles to the order of ϵ^2. If we assume that a pressure P is put on along the lines of greatest contraction, and a tension Q along the lines of greatest elongation, we may put $P=n\epsilon+p\epsilon^2$, $Q=n\epsilon-p\epsilon^2$, where n is the rigidity and p is a constant to the second order of ϵ. For equilibrium a pressure $R=(\frac{1}{2}n+p)\epsilon^2$ is required perpendicular to the shear planes. This is zero only if $p=-\frac{1}{2}n$, a supposition for which there is no apparent reason. To keep constant volume a stress may be needed $S=q\epsilon^2$ perpendicular to the plane containing P and Q, a pressure if q is positive. Suppose that a wire is twisted by a torque with axis along the axis of the wire. To keep the volume constant at every point it would be necessary to apply the system of forces R and S from outside. If this system is not applied we may expect the wire to change in length and diameter by amounts calculable in terms of the elastic constants. The change in length should be an increase $dl=Sa^2\theta^2/l$, where S is a function of the constants, given in the paper, a is the radius, and θ is the twist in length l. Such a lengthening has been found to exist for piano-steel, copper, and brass wires when loaded enough to straighten out kinks. For the piano wires tested S was of the order 1, and for the copper and brass wires of the order 1·5. The lengthening of a steel wire 0·97 mm. diameter and 2·3 metres long for a twist of one turn in the length was about 0·0019 mm. This lengthening on twisting should be taken into account in accurate determinations of the rigidity.—The wave motion of a revolving shaft and a suggestion as to the angular momentum in a beam of circularly polarised light: J. H. **Poynting.** When a shaft of circular section is revolving uniformly and is transmitting power uniformly, a row of particles originally in a line parallel to the axis will lie on a spiral of constant pitch, and the position of the shaft at any instant may be described by the position of this spiral. The motion of the spiral onwards may be regarded as a kind of wave motion. Its velocity with a given speed of revolution will only be the "natural" velocity $\sqrt{(n/\rho)}$ of twist waves along the shaft for a certain torque on the shaft. For any other torque the velocity is "forced," and forces from outside must be applied to maintain it at every point where the twist is changing. The group velocity of waves of this kind is zero. Taking a uniformly revolving tube as a mechanical model of a beam of circularly polarised light, and assuming that the relation between torque and energy holding for the model holds also for the beam of light, the angular momentum delivered per second to unit area of an absorbing surface upon which the light falls normally is $P\lambda/2\pi$, where P is the pressure of the light and λ is its wave-length. In light-pressure experiments P is detected by the torque produced on a disc at the end of an arm about 1 cm. The value is therefore about 100,000 times as great as the torque on the same disc, due to the angular momentum. If the angular momentum of circularly polarised light only has this value, there does not appear to be much prospect of detecting it at present.—The effect of a magnetic field on the electrical conductivity of flame: Prof. H. A. **Wilson.** This paper contains an account of some experiments on the change in the conductivity of a Bunsen flame produced by a magnetic field. The current through the flame was horizontal, and the magnetic field was also horizontal, but perpendicular to the current. The ratio of the potential gradient in the flame to the current was taken as a measure of its resistance. The results show that $\delta R/R=AH^2+BH$, where H denotes the magnetic field, R the resistance, and A and B are constants. The velocity of the negative ions can be calculated from the term AH^2, and the result is 9600 cm./sec. for 1 volt per cm., which agrees with Mr. E. Gold's results obtained by an entirely different method. The term BH is presumably due to the upward motion of the flame gases, but its value is about fifty times greater than the value calculated from the ionic theory.—Studies of the processes operative in solutions; xi., the displacement of salts from solution by various precipitants: Prof. H. E. **Armstrong** and Dr. J. V. **Eyre.**—The thermal conductivity of air and other gases: G. W. **Todd.** The paper gives an account of a determination of the thermal conductivities of air and other gases at atmospheric pressure. The conductivity was obtained from observations of the steady flow of heat between two horizontal circular metal plates maintained at different temperatures, the upper one at the temperature of steam and the lower one at room temperature. The upper plate was fixed, and the lower one could be moved up and down so as to vary the distance between them. If the temperatures of the plates are kept constant, the quantity of heat passing per second from the upper plate to the lower, when the distance between them is x, is given by $Q=K/x+R+Ex$, where the constant K is proportional to the thermal conductivity, R is the heat radiated, and Ex is the effect due to the edge. The latter is negligible when x is small compared with the radius of the plates, so that the relation between Q and x is given by a rectangular hyperbola. Hence the relation between Q and $1/x$ is a straight line the slope of which gives K, from which the conductivity is determined. The intersection of this line with the axis of Q gives the value R of the radiation. The value of the conductivity so obtained was independent of the nature of the surfaces of the plates, and also independent of the dimensions of the plates, the latter proving that convection currents were absent or negligible. The conductivities of some gases other than air were determined by comparing the rates of flow of heat through them with the rate of flow through air when the plates were at a fixed distance apart. The paper concludes with a calculation of the "radiation constant," from a determination of the absorption coefficient of the surfaces of the plates when painted black, and the radiation R.—The possible ancestors of the horses living under domestication, part i.: Dr. J. C. **Ewart**. By some naturalists it is believed that domestic horses are the descendants of a Pleistocene species (*Equus fossilis*)—now represented by the wild horse (*E. przewalskii*) of Mongolia—by others, the horses living under domestication are said to be a blend of a coarse-headed northern species allied to Prejvalsky's horse, and a fine-limbed southern species which in prehistoric times inhabited North Africa, or a blend of a Prejvalsky-like northern species and a southern species closely allied to *E. sivalensis* of the Pliocene deposits of India. The examination of the skull, teeth, and limb bones of horses found at Roman settlements and in the vicinity of pile-dwellings indicates that domestic horses originally belonged to several distinct types, viz. (1) a type characterised by long limbs, by a long face, broad and convex between the orbits, and strongly deflected on the cranium, and by the crown of the fourth premolar being from before backwards about 2·5 times the length of the grinding surface of its "pillar"; (2) a type with slender limbs, a fine, narrow, slightly deflected face, and the crown of the fourth premolar about three times the length of its "pillar"; (3) a type with fairly slender limbs, a long, narrow, somewhat deflected face, and the crown of the fourth premolar about twice the length of its "pillar"; (4) a type characterised by short, broad metacarpals, a short face, broad and flat between the orbits, and nearly in a line with the cranium, and by the crown of the fourth premolar being twice the length of its "pillar"; and (5) a type with short, wide metacarpals, the face long and strongly deflected, and the crown of the fourth premolar about 1·5 times the length of its "pillar." Only the varieties characterised by molars with short "pillars" are dealt with in this communication. The possible ancestors of the short-pillared varieties are *Equus sivalensis* of Indian Pliocene deposits, *E. stenonis* of the Pliocene deposits of Europe and North Africa, and a new species, *E. gracilis*. Arabs, barbs, thoroughbreds, and other modern breeds with a long deflected face, broad and prominent between the orbits, and the limbs slender, seem to have mainly sprung from *E. sivalensis*, while certain unimproved breeds with a deflected face, but very short "pillars," are probably related to *E. stenonis*. Exmoor, Hebridean, Iceland, and other ponies of the "Celtic" type, as well as ponies found in the south of France, the West Indies, and Mexico, characterised by a fine narrow skull, slender limbs, and the absence of ergots and hind chestnuts, are regarded as the descendants of *E. gracilis*, which includes (1) the small species of the English drift described by Owen as a fossil ass or zebra (*Asinus fossilis*); (2) the small species of French Pliocene and Pleistocene deposits known to palæontologists as *E. ligeris*, and the small species of North African Pleistocene deposits known as *E. asinus atlanticus*, and hitherto believed to be closely related to, if not the ancestor of, zebras of the Burchell type. By crossing experiments evidence has been obtained of the wide distribution of horses of the *E. gracilis* type; that broad-browed Arabs and thoroughbreds, with the face nearly in a line with the cranium, are mainly a blend of a southern variety of *E. gracilis* (*E. caballus libycus*) and a horse of the "forest" or Solutré type, and that heavy breeds have not inherited their coarse limbs from a species closely allied to the wild horse of Mongolia.—The alcoholic ferment of yeast-juice; part iv., the fermentation of glucose, mannose, and fructose by yeast-juice: A. **Harden** and W. J. **Young**. (1) Mannose behaves towards yeast-juice, both in the presence and in the absence of added phosphates, substantially in the same manner as glucose. (2) Fructose resembles both glucose and mannose in its behaviour, but in presence of phosphate is fermented much more rapidly than these sugars, and the optimum concentration of phosphate is much higher. (3) Fructose has the property of inducing rapid fermentation in presence of yeast-juice in solutions of glucose and mannose, containing such an excess of phosphate that fermentation is only proceeding very slowly. No similar property is possessed by glucose or mannose. These properties of fructose indicate that this sugar when added to yeast-juice does not act merely as a substrate to be fermented, but bears some specific relation to the fermenting complex. All the facts are consistent with the supposition that fructose actually forms a part of the fermenting complex. When the concentration of this sugar is increased, a greater quantity of the complex would be formed, and, as the result of this increase in the concentration of the active catalytic agent, the juice would become capable of bringing about the reaction with sugar in presence of phosphate at a higher rate, and at the same time the optimum concentration of phosphate would become greater, exactly as is observed.—The electrical reactions of certain bacteria applied to the detection of tubercle bacilli in urine by means of an electric current: C. **Russ**. The aim of these experiments was to ascertain whether bacteria suspended in an electrolyte are transmitted during electrolysis to either electrode, with the view of the recovery of pathogenic bacteria from a pathological fluid by such means. During electrolysis of certain salts in which bacteria were suspended, the organisms were found to migrate to one electrode; in some instances there was no migration. The effect was noticed to occur with killed as well as with living bacteria. By testing certain organisms in the same (but a small) series of electrolytes some differences of effect were found, though this line of inquiry was not pursued. To utilise this bacterial movement, an electrolyte in which tubercle bacilli had shown marked kathodic aggregation was added to tuberculous urine, and the kathode arranged in the form of a bacterial trap. After electrolysis tubercle bacilli entered the trap, which was eventually withdrawn, and the organisms recognised in a stained film prepared from its contents. A series of such urines was tested in this way, and in each case tubercle bacilli were found in the trap. In the final experiment a number of tubercle bacilli (estimated at 500) were added to 100 c.c. normal urine, and their detection attempted by separate investigators by means of the centrifuge and current. By the centrifuge none were found, while the current recovered 128 bacilli. The results of this preliminary investigation may be summarised as follows:—Certain bacteria under the influence of a suitable current aggregate at one or other electrode. The aggregation varies with the nature of the electrolyte, and is probably due to affinity between the products of electrolysis and the bacteria. It occurs with killed as well as with living bacteria. The aggregation by electrical currents affords a means of collection and examination. The differences in behaviour of various bacteria are such as to suggest the possibility of utilising the method for purposes of specific discrimination, but in this particular the data hitherto obtained are not sufficient to warrant definite statements.—The effect of the injection of the intracellular constituents of bacteria (bacterial endotoxins) on the opsonising action of the serum of healthy rabbits: Dr. R. Tanner **Hewlett**. In this investigation the effect of the endotoxins of the *Bacillus typhosus*, *Micrococcus pyogenes aureus*, and *B. tuberculosis* on the opsonising action of the serum of normal rabbits has been studied. The endotoxins were prepared by the Macfadyen process, the rabbits were inoculated subcutaneously, and the specimens for counting the number of bacteria ingested by leucocytes were prepared in the usual manner. Human leucocytes were employed, and the counts were made on fifty cells. (A) *Typhoid Endotoxin*.—The results for this endotoxin are approximate only, as agglutination and bacteriolysis are complicating factors. The amount of endotoxin injected was 0·1 mgrm., prepared from an avirulent strain. One day after injection a decided negative phase had developed (opsonic index about 0·2), two days after injection the index was rising (1·4), and attained a maximum on the third day (3·3), after which it fell. Dilution of the serum to 1 in 5 and 1 in 10 tended to increase phagocytosis. (B) *Staphylococcus Endotoxin*.—Endotoxin prepared from an old laboratory strain in a dose of 0·1 mgrm. produced a rise in the opsonic index to 1·6, which persisted for some weeks. Endotoxin (0·1 mgrm.) prepared from a recently isolated strain produced a rise to 2·5. An equivalent dose of staphylococcus vaccine (1000×10^6 cocci) produced a rise of the opsonic index to

1·8, which fell subsequently to a point lower than that with either endotoxin. Estimations of the opsonic indexes made with the recently isolated strain gave results higher than those obtained using the old strain. With another endotoxin, varying doses (0·1, 0·01, and 0·001 mgrm.) all produced marked rise in the opsonic indexes, the rise corresponding with the dose. (c) *Tubercle Endotoxin.*—Injection of 0·002 mgrm. of endotoxin caused a rise in the opsonic index to 1·9 sixteen days after. A similar dose of German tuberculin R. produced hardly any effect. A large dose (1·0 mgrm.) of endotoxin caused a marked negative phase (index 0·5) forty-eight hours after injection, with a subsequent rise to 1·8. Endotoxin (1·0 mgrm.) prepared from tubercle bacilli previously extracted with ether also produced a negative phase, with a subsequent rise to 1·5. (D) *Keeping Power of Endotoxin Solutions.*—Experiments were performed with staphylococcus and tubercle endotoxin solutions which had been kept for seven weeks after preparation; there was little diminution in activity. Other experiments indicate that the solutions deteriorate but little for three to six months after preparation. (E) "*Negative Phase.*"—Experiments indicate that endotoxin produces decidedly less "negative phase" than a vaccine.—The occurrence of protandric hermaphroditism in *Crepidula fornicata*: J. H. **Orton.** *Crepidula fornicata* is a streptoneurous gastropod belonging to the family Calyptræidæ. Individuals of this species associate together permanently in linear series, forming "chains." The chains may consist of from two to twelve individuals. The sex relations of the individuals were noted in about 300 chains. It was found that the individuals which occur at the attached ends of the chains are always females, those occurring near the top of the chains are males, while those about the middle often possess the secondary sexual characters of both sexes. In intermediate positions in the chains occur forms which, in their secondary sexual characters, are intermediate between females and hermaphrodites on the one hand, and between hermaphrodites and males on the other. Thus the chains present a transitional series, beginning with the males, which are the youngest individuals, and ending with the females, which are the oldest individuals. Microscopical examination of the gonad has shown that there is as complete a transitional series in the primary sexual characters as occurs in the secondary ones. All the adults are sedentary, but the young are able to move about freely. One thousand young ones have been examined, and found to be all males. There is, therefore, no doubt that all the individuals begin life as males, and change gradually in the course of their life-history into females. It is highly probable, from known descriptions of allied species, and from observation on species of allied genera, that protandric hermaphroditism is common in the Calyptræidæ. Further, it seems probable that the family will present a series in the evolution of protandric hermaphroditism. If such a series be found there is little doubt that a study of the earlier stages would lead to the discovery of the nature of the sexes, *i.e.* in Mendelian terms, whether the male is heterozygous and the female homozygous, or *vice versâ*. Ten other streptoneurous hermaphrodites are known. It would seem, therefore, that one of the chief distinctions between the Streptoneura and the Euthyneura is beginning to break down.—Sensitive micro-balances, and a new method of weighing minute quantities: B. D. **Steele** and K. **Grant.**—The polarisation of secondary γ rays: Dr. R. D. **Kleeman.**—The absorption of homogeneous β rays by matter, and on the variation of the absorption of the rays with velocity: W. **Wilson.** The experiments were made with the view of determining the manner in which the absorption coefficient of the β rays varies with the velocity. Radium, which gives out rays the velocities of which vary between very wide limits, was used as a source of radiation. A beam of rays from the radium passed into a magnetic field, by means of which approximately homogeneous rays could be brought into an electroscope. The velocities of the rays could be determined from the strength of the magnetic field. Screens of metal of different thicknesses were interposed in the path of the rays, and it was found that the law of absorption was not exponential, but approximately linear, except for large thicknesses of absorbing material. Various experiments were made to show that this was not due to the experimental arrangement, but was a real effect. The fact that the β rays from uranium, actinium, &c., are absorbed by matter according to an exponential law is shown to be a proof, not of their homogeneity, but of their heterogeneity. Groups of rays can be built up which represent the properties of these rays with respect to absorption. Further experiments were made on the change of velocity of the rays after passing through absorbing material, and it was found that the velocity of the rays, contrary to the view expressed by H. W. Schmidt, is appreciably reduced as they penetrate matter. The law of absorption of the β particles when measured by the ionisation method involves a considerable number of factors, and, as might be expected, no simple relation could be found between the absorption of the rays and their velocity.—Experimental researches on vegetable assimilation and respiration; v., a critical examination of Sachs' method for using increase of dry weight as a measure of carbon dioxide assimilation in leaves: D. **Thoday.**—The reproduction and early development of *Laminaria digitata* and *Laminaria saccharina*: G. H. **Drew.** The processes of reproduction and early development in both *L. digitata* and *L. saccharina* are very similar. The plant is the gametophyte, and is monœcious. The reproductive areas occur as dark patches on the lamina, and consist of gametangia embedded among paraphyses. The gametangia contain small spherical gametes, 0·003 mm. in diameter, and a number of globules of an oily substance. When mature, the gametangia rupture at their distal extremity and liberate their contents. The liberated gametes develop two flagella of different lengths, which are inserted close together; they are phototactic, and move in the direction of the longer flagellum. Cultures from the reproductive areas were made in a culture solution consisting of various salts dissolved in sea water. The solution was sterilised by heat, and all flasks, pipettes, &c., were sterilised by boiling. Division cultures containing the planogametes were made, and eventually cultures free from growths of the Ectocarpaceæ and other algæ were obtained. In such cultures, stages of isogamous conjugation, resulting in a spherical zygospore, were observed. Later a process grew out from the zygospore, and expanded at its end, and then the cell contents passed along this process, forming a spherical mass at the expanded end. This became cut off by a cell wall, and the remains of the zygospore degenerated. The cell thus formed developed chromoplasts, increased in size, and divided, producing typically a chain of cells each having an outer and an inner cell wall. This stage probably represents the sporophyte (2x) generation. Any cell of the chain may then rupture its outer cell wall, and by repeated divisions give rise to the laminaria plant which emerges from the ruptured exosporium. The young plant consists of a flattened lamina made up of cubical cells, having at its base a number of colourless unicellular rhizoids. The stipe is developed from the basal part of the lamina. The disc-shaped expansion develops at the base of the stipe and partially envelops the primary rhizoids; the hapteres arise as outgrowths from this disc.—The germicidal action of metals, and its relation to the production of peroxide of hydrogen: Dr. A. C. **Rankin.**—Surface flow in calcite: G. T. **Beilby.**—A preliminary note on *Trypanosoma eberthi* (Kent)—(*Spirochaeta eberthi*, Lühe), and some other parasitic forms from the intestine of the fowl: C. H. **Martin** and Miss Muriel **Robertson.**—The spectrum of magnesium hydride: Prof. A. **Fowler.** The author has previously discovered that many of the band lines peculiar to the sun-spot spectrum are identical with lines composing the green fluting attributed to magnesium hydride by Liveing and Dewar. The present paper gives the results of a further investigation of this spectrum with high dispersion, together with details of wave-length determinations. The principal results may be briefly summarised as follows:—(1) No sufficient reason has been found for modifying Liveing and Dewar's conclusion that the spectrum is produced by the combination of magnesium with hydrogen. (2) Lines are shown at short intervals in all parts of the spectrum from the extreme red to λ 2300, and definite groups of flutings begin at 5621·57, 5211·11, 4844·92, 4371·2, and near 2430. (3) From photographs of the magnesium arc in hydrogen at low pressures, taken with a 10-feet concave grating, the positions of close upon 2000 lines, composing the three principal bands, have been determined. The wave-lengths were derived from the interference standards of Fabry and Buisson, but have been corrected to Rowland's scale to facilitate comparison with solar spectra. (4) Twelve of the series of lines which compose the green band have been traced, and it is shown that none of the formulæ which have been proposed is sufficiently general in its application to represent all of these series within the limits of error of measurement. For the longer series the closest approximation is given by Halm's equation. (5) The identification of magnesium hydride in the sun-spot spectrum has been fully confirmed, and is clearly demonstrated by photographs submitted for reproduction. (6) It is shown that many of the bright interruptions of the dark background of the spot spectrum are not bright lines, but merely clear interspaces between lines or groups of lines in the spectrum of magnesium hydride. (7) The presence of the magnesium hydride flutings, together with flutings of titanium oxide and calcium hydride discovered at Mount Wilson, accords with the view that spots are regions of reduced temperature, and that their darkness is at least partly due to absorption. (8) The investigation of the possible presence of lines of magnesium hydride in the ordinary solar spectrum is for several reasons inconclusive, but there is evidence that very few, if any, of the thousands of faint lines tabulated by Rowland are to be accounted for by this substance.—The discovery of a remedy for malignant jaundice in the dog, and for redwater in cattle: Prof. G. H. F. **Nuttall** and S. **Hadwen.**—The comparative power of alcohol, ether, and chloroform, as measured by their action upon isolated muscle: Dr. A. D. **Waller.**

EDINBURGH.

Royal Society, June 21.—Dr. Burgess, vice-president, in the chair.—The pharmacological action of protocatechyltropeine: Prof. C. R. **Marshall.** Like most other tropeines, this substance paralyses, but only for a short period, the so-called vagal endings of the heart; it also depresses the neuro-muscular junctions in voluntary muscle and the muscular tissue itself. Its most interesting action, however, is upon the respiration. Medium doses, intravenously administered, rapidly paralyse the respiration. This effect is generally transitory, and is not concomitant with other effects produced by the compound. Tappeiner and Pohl have observed similar transitory effects after intravenous injection of other derivatives, and Pohl's explanation, which ascribes the effect to paralysis of the respiratory centres, was shown to be the true one for protocatechyltropeine. The relation between chemical constitution and pharmacological action as exemplified in the tropeines was considered, and an attempt made to show that definite action could not with certainty be attributed to the two constituent groupings of the tropeines.—The toot poison of New Zealand; an investigation into its pharmacological action: Prof. C. R. **Marshall.** This poison, which includes three definite species of Coriaria, has proved a serious hindrance to the rearing of stock in New Zealand. The active principle, isolated by Easterfield and Aston, is a glucoside named tutin. The effects produced are chiefly stimulation of the medullary centres and epileptiform convulsions, which are mainly of cortical and pontine origin. Pontine convulsions are very susceptible to anæsthetics. A fall of temperature always occurs after the administration of tutin. The substance also depresses the sentient centres, and in man causes loss of memory. Coriamyrtin and picrotoxin have a similar action, but are more powerful, and in some respects more transient in action, than tutin.—Hydrolysis of salts in amphoteric electrolytes: Miss H. H. **Beveridge.** The two principal methods in general use for determining the degree of hydrolysis of salts—catalysis of methyl acetate and electrical conductivity—give results in the case of salts of amphoteric electrolytes which are not at all concordant. The hydrolysis of anthranilic hydrochloride was therefore investigated by several independent methods. Of these, the solubility, distribution between two solvents, catalysis of diazo-acetic ester, and electromotive force all pointed to the catalysis values being correct, while values obtained from depression of the freezing point and electrical conductivity differed widely from these. The divergence was due, not to any abnormality in the degree of ionisation of the salt, nor to the speed of the ions, but might be explained by the assumption of some association of molecules and ions.—Seismic radiations, part ii.: Dr. C. G. **Knott.** Following up results regarding reflection and refraction of seismic disturbances given twenty years ago (see also *Phil. Mag.*, 1899), the author calculated the surface disturbances which accompany the reflection of the various types of elastic wave at the surface of an elastic solid. When the incident wave is condensational there is always a reflected distortional wave as well as a reflected condensational wave, and a simple harmonic disturbance produces at the surface a simple harmonic disturbance along a line differing at most incidences by a few degrees from the direction of the incident disturbance. When, however, the incident wave is distortional there is, after a certain critical angle, no reflected condensational wave. For incidences greater than this critical value the original simple harmonic motion of the incident wave is not, in general, accompanied by a simple harmonic motion of each particle of the surface, but each point of the surface is thrown into elliptic motion of all degrees of ellipticity from circle to straight line. Details were worked out for certain assumed values of the elastic constants. The results indicate how misleading in certain cases is the phrase "emergence angle," much used by seismologists.

PARIS.

Academy of Sciences, June 28.—M. Émile Picard in the chair.—Integral equations of the first species: Émile **Picard.**—The gases of volcanic fumaroles: Armand **Gautier.** The gas samples were collected under experimental conditions designed to exclude the possibility of the admission of atmospheric oxygen, and to preserve gases alterable by water, such as carbon oxysulphide. Gas taken from fumaroles at Vesuvius near the top of the cone was found to consist of hydrochloric acid, carbon dioxide, hydrogen, oxygen, and nitrogen. No sulphur compounds could be detected, and carbon monoxide, oxides of nitrogen, hydrocarbons, and fluorides were absent. Gases collected from fumaroles on Vesuvius eighteen months after an eruption showed hydrochloric acid to be absent, and 0·5 to 2·0 of carbon monoxide present. It was noted that, although no halogen acids could be detected, the gases leaving the fumaroles rapidly attacked steel and copper.—Ordinary carbon: H. **Le Chatelier** and M. **Wologdine.** By modifying the graphitic oxide reaction, graphite has been proved to be present in carbon from acetylene and in other varieties of carbon produced at moderately low temperatures, hitherto assumed to be free from graphite. Carefully purified amorphous carbon from various sources has a density of about 1·8.—The existence of trachytes with quartz (bostonites) in the Mont-Dore *massif*: A. Michel **Levy** and A. **Lacroix.**—The polished stonework in the Haut-Oubanghi: A. **Lacroix.** The ornaments are made of worked and polished quartz; the process of manufacture is described in detail, and shown to be strikingly analogous with similar work in Neolithic deposits.—The origin and evolution of fresh-water shrimps of the family of Atyidæ: E. L. **Bouvier.**—The hydration of potassium carbonate: M. **de Forcrand.** A thermochemical paper.—The action of metallic oxides on methyl alcohol: Paul **Sabatier** and A. **Mailhe.** Alumina, at temperatures about 300° C., furnishes a large yield of methyl oxide; thoria and titanium dioxide at 350° behave similarly; oxides of chromium and tungsten give a mixture of methyl oxide and formaldehyde, the latter being partially split up into carbon monoxide and hydrogen. Other oxides give the latter reaction exclusively.—Observations of the comet 1909*a*, made at the Observatory of Lyons with the bent equatorial of 32 cm. aperture: J. **Guillaume.**—The variations of brightness of Encke's comet and the sun-spot period: J. **Bosler.** The graphical comparison of the variations in brightness of Encke's comet and the number of sun-spots shows that the two phenomena are clearly related.—Comparison of the spectra of the centre and the edge of the sun: H. **Buisson** and Ch. **Fabry.**—The physical and historical interpretation of some markings on the moon's surface; from the eleventh part of the photographic atlas published by the Observatory of Paris: P. **Puiseux.**—An extension of the theory of continued fractions: A. **Chatelet.**—The calculation of the roots of numerical equations: R. **de Montessus.**—Remarks on a note by M. Petit on a new wave detector for wireless telegraphy and telephony: E. **Tissot.** It is suggested that the arrangement of a fine metallic point resting on a crystal of natural pyrites is really one of the thermoelectric detectors.—Comparison between the α rays produced by different radio-active substances: Mlle. **Blanquies.**—The temperature of the oxyhydrogen flame: Edmond **Bauer.** This was found to be 2240° C.—The "initial re-combination" of the ions produced in gases by α particles: M. **Moulin.**—The magnetic transformation of lead: M. **Loutchinsky.** The coefficient of magnetisation is ten times greater in lead crystallised by fusion than in lead hammered out or drawn into wire.—The practical method for the simultaneous calculation of atomic weights: G. D. **Hinrichs.**—The bromide of dimercurammonium, NHg_2Br: H. **Gaudechon.**—The formation of oxygen compounds of nitrogen and their metallic combinations (iron and lead) in the production of ozone for the sterilisation of water: Ed. **Bonjean.** The amount of oxides of nitrogen produced in commercial forms of ozonisers is sufficient seriously to attack lead and iron pipes used in the construction. This has not been considered in the design of sterilisation apparatus on the commercial scale.—The separation of graphite in white cast iron heated under pressure: Georges **Charpy.** Carbon arising from the decomposition of iron carbide produced at temperatures between 700° C. and 1100° C., and under pressures rising to 15,000 atmospheres, separates in the form of graphite.—Contribution to the study of uranyl chloride: Œchsner **de Coninck.**—A new alkaloid extracted from the bark of *Pseudocinchona africana*: Ernest **Fourneau.** The crystallised alkaloid studied has the composition of quebrachine ($C_{21}H_{26}N_2O_3$), and resembles this alkaloid in many of its properties. They differ in rotatory power, quebrachine being dextrorotatory and the new base lævorotatory.—The formation of lactones from acid alcohols: E. E. **Blaise** and A. **Kœhler.** An ϵ-octolactone can be prepared from the acid $C_2H_5.CH(OH).(CH_2)_4.CO_2H$ by slow distillation in a vacuum, but the ζ-lactone could not be prepared from the next higher homologue in the same way. If the dehydration is attempted by heating with 50 per cent. sulphuric acid, a migration of the hydroxyl group takes place, a γ-lactone being formed in both instances.—Soluble starch: Ch. **Tanret.**—The action of hydrogen peroxide upon crystallised oxyhæmoglobin: J. **Szreter.**—The cholalic acids: Maurice **Piettre.**—Regeneration in species of Syllis: Aug. **Michel.**—The mechanism of the immunity of snakes against the salamandrine: Mme. Marie **Phisalix.**—Concerning a note of M. Devaux entitled "The Relation between Sleep and the Retention of Interstitial Water": Raphael **Dubois.** The author points out that this note confirms his results on the phenomena accompanying sleep in hibernating animals.—The metamorphosis of the splanchnic muscles in the Muscideæ: Charles **Pérez.**—The ratio of the weight of the liver to the weight of the body in birds: J. **de La Riboisière.**—The glacial origin of Loch Lomond and Loch Tay: Gabriel **Eisenmenger.**—The hydrology of the *Bracas* (Basse-Pyrénées) and of El-Torcal (Andalousie): E. A. **Martel.**—The earthquake at Corinth on May 30, 1909: D. **Eginitis.**

NEW SOUTH WALES.

Linnean Society, May 26.—Mr. C. Hedley, president, in the chair.—Metasomatic processes in a cassiterite vein from New England: L. A. **Cotton.** The vein examined lies some six miles south-west of Inverell. A transverse section, about 11 inches in width, was taken and cut into six pieces, in planes parallel to the plane of the vein. Sections were then cut, and a series of four analyses made. Of the latter, three were of the vein, while the fourth was of the country rock, an acid granite. Examination of the slides showed that the central part of the vein was highly siliceous. The remaining slides of the vein-material showed an abundance of a peculiar pale mica of a paragonite-sericite nature. This mica was found to replace the quartz, felspar, and biotite of the acid granite. Fluorite was also found as a secondary mineral, and it is possible that a small amount of topaz was present.—Note on the Guyra Lagoon, N.S.W.: L. A. **Cotton.** The Guyra Lagoon lies immediately to the west of the town of Guyra. It is surrounded by low basalt hills, except for a depression in these to the south-east. The lagoon, which, before 1902, had held water so far back as the oldest settlers in the district could remember, is now dry. There has been no diminution in the rainfall to account for this. It is thought that the changing of the limited catchment area from pastoral to agricultural country may account for the present dryness of the lagoon. Field observations seem to indicate that the depression is a crater-lake.—Note on diurnal variations in the temperature of camels: Dr. J. B. **Cleland.** During the examination of a certain number out of 500 camels in the north-west of Western Australia, a wide diurnal variation in their temperatures, sometimes of 7° F., was met with. This would seem to be due to the high temperature of the atmosphere during the day, coupled with the fact that camels only visibly perspire at the back of the neck over a small area, and the coolness of the nights. The wide diurnal range suggests a resemblance to cold-blooded animals.—Some rare Australian Gomphinæ (Neuroptera: Odonata), with descriptions of new species: R. J. **Tillyard.** The present paper brings up to date our knowledge of Australian Gomphinæ. Five new species are added to the list, and the male of *Austrogomphus risi*, Martin, of which only the female was known, is described.—Studies in the life-histories of Australian Odonata; i., life-history of *Petalura gigantea*, Leach: R. J. **Tillyard.** The species is one of the few remaining forms of a very ancient family.

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THURSDAY, JULY 15, 1909.

REGENERATION.

Experimental-Zoologie. Part ii., Regeneration: Eine Zusammenfassung der durch Versuche ermittelten Gesetzmässigkeiten tierischer Wieder-erzeugung. By Dr. Hans Przibram. Pp. viii+338; 16 plates. (Leipzig and Vienna: Franz Deuticke, 1909.) Price 14 marks.

THE second part of Dr. Hans Przibram's "Experimental Zoology" has so far only been published in German, but it is to be hoped that an English translation will follow in due course. It will be a matter for regret if the efforts of the Cambridge University Press to provide English-speaking biologists with standard editions of works which are otherwise accessible only in a foreign language do not receive sufficient support to justify their continuance. The present volume, which is very considerably larger than the first (reviewed in NATURE, March 4, p. 2), deals with the secondary aftergrowth of lost parts, embracing the phenomena of morphallaxis and deformation. The allied subject of grafting, which finds a place in Prof. Morgan's work on "Regeneration," published eight years ago, is not systematically dealt with, but it may well be that this is reserved for special treatment in the final volume on function. The subject-matter of the part now under notice is divided into eight chapters, dealing successively with the different groups of the animal kingdom, from the Protozoa to the Vertebrata. To these is added a general summary, containing an account of the general laws which govern the regenerative processes and their development in phylogeny. There are sixteen coloured plates, which are bound at the end of the volume, but these are so overcrowded with figures as to tend towards confusion, and the execution is not good. The work is adapted for purposes of reference rather than for continuous reading, and is furnished with an extensive bibliography, in which few omissions are to be detected.

In dealing with the power of compensatory hypertrophy possessed by the generative glands, the author alludes to the fact that although unilateral castration is said to promote an increased growth on the part of the remaining testis, the number of spermatozoa found in the semen is very appreciably diminished, at least according to Lohde's observations. These statements, however, are not necessarily conflicting, since Ancel and Bouin and others have shown that in all probability the interstitial cells of the organs, and not the spermatogenetic tissue, are responsible for the normal testicular influence which is exerted upon the secondary sexual characters and the organism as a whole; and so it may perhaps be, in general, that it is the interstitial rather than the seminiferous portion of the testis which undergoes hypertrophy after one-sided castration. Moreover, the time which Lohde allowed to elapse after extirpating the single testis was probably too short to admit of definite conclusions being drawn regarding the power of compensation possessed by the remaining testis. Dr. Przibram notes the occurrence of thyroid regeneration following the partial removal of that organ, but he omits to state that in certain cases the parathyroids are capable of regenerating tissue containing colloid substance, and so resembling, if not identical with, normal thyroid tissue. Neither does he mention that in rabbits and other animals which can survive thyroidectomy the function of the thyroid appears to be taken over by the pituitary, in which the cells of the *pars intermedia* show an increased activity, as manifested especially by a greater secretion of colloid. Both these processes are probably to be regarded as instances of functional restitution in allied organs of the body.

The regeneration of the uterine mucosa after parturition and menstruation is alluded to, but there is no reference to Heape's papers, which deal more fully than any others with the nature of the post-menstrual recuperative processes. Futhermore, there are certain omissions in the literature dealing with teratological science. Nevertheless, the work, as it stands, contains by far the most comprehensive account of the subject of regeneration that has as yet been written, and, as such, it constitutes an important addition to the literature of experimental zoology.

FRANCIS H. A. MARSHALL.

A NATURALIST IN TASMANIA.

A Naturalist in Tasmania. By G. Smith. Pp. 151. (Oxford: Clarendon Press, 1909.) Price 7*s.* 6*d.* net.

TASMANIA is the smallest of the Australian States, and its scientific interest is out of all proportion to its size, while its magnificent scenery, picturesque lakes, rugged mountains, noble forests, and its combination of vegetation of tropical luxuriance with a temperate summer climate will always make it one of the most attractive of Australian tourist resorts. The State has still a small and scattered population; internal communication and railway construction are exceptionally difficult, so, though it was the second in date of Australian colonies, much of the island is still very imperfectly known.

Mr. Geoffrey Smith, of New College, Oxford, made an expedition to Tasmania in 1907–8, aided by a British Association grant, in order to investigate the primitive shrimps inhabiting its lakes. The short volume gives a charmingly written narrative of his journey, and it is illustrated by some of Beattie's beautiful photographs and excellent drawings of some Tasmanian animals, such as that of the Tasmanian Devil (Sarcophilus), by Mr. Goodchild. It is accompanied by a geological sketch-map based on Johnston's.

Mr. Geoffrey Smith is enthusiastic over the beauty of Tasmanian scenery. He deals especially with the districts near Hobart and around the Great Lake on the Central Plateau. He gives a short note on the aborigines, with illustrations both of their heads and skulls. On the vexed question as to the relation of the Tasmanians, he is emphatic (p. 28) that—

"Whether the Tasmanian race ever inhabited the mainland of Australia or not, it is certain that neither in their physical characters nor in their culture have they anything to do with the Australian blacks, whose

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relationship lies rather with the Veddahs of Ceylon and the other straight-haired Proto-Dravidian races that still exist sparsely in India and the Malay Islands."

He says we have a good deal of information as to their burial customs, which differ totally from those of the Australians, and their language "seems to have differed entirely from the Australian and to show remote connection with the Andamanese" (p. 31).

His last chapter discusses the biological relations of Australia and Tasmania, and the evidence for the connection of Australasia with Antarctica. He is convinced that the fauna and flora of Australia entered it from the south and not from Asia. As he truly remarks, the marsupials are most numerous and of the most primitive types in southern Australia, while they are comparatively rare and most specialised in northern Australia. If they had migrated from Asia the opposite arrangement would have been expected.

The author still accepts Galaxias as evidence of the recent connection of Australasia and South America; he admits that it visits estuaries, but considers that it can only have spread across the southern Pacific along the shelf around the Antarctic land. After Mr. Boulenger's letter (NATURE, 1902, vol. lxvii., p. 84), with its convincing evidence that Galaxias breeds in the sea, the distribution of that fish is no indication of a former land connection. One slip, in fact, is the statement that the tree Senecios are unknown in the tropics (p. 133). They are the largest trees in the alpine zone of Kenya and other east African mountains. The author represents Tasmania as not a biological appanage of Australia, as he holds that it acquired its present distinctive characters before its separation from the mainland. Although this view is probable, the striking differences which the author well describes between the faunas of the two areas indicate that the separation happened long enough ago for many of the Tasmanian mammals to have developed into new species. The most striking part of the book is Mr. Smith's valuable contributions to knowledge of the primitive Tasmanian fresh-water shrimps, of which he discovered a new genus. They are allied to those of the European Carboniferous Crustacea, and are one of the groups of archaic animals still living in Australasia.

PROPERTIES OF BUILDING MATERIALS.

Introduction to the Chemistry and Physics of Building Materials. By Alan E. Munby. Pp. xx+345. (London: A. Constable and Co., Ltd., 1908.) Price 6s. net.

UNLIKE many books intended chiefly as short cuts to success in examination, this work seeks to impart in a clear, concise, and accurate manner the scientific principles underlying the proper use of material in construction.

Part i. contains chapters devoted to natural laws, measurement, the air, heat, chemical principles, water, acids and bases, coal, and a useful outline of geology. In part ii. all the chief building materials are dealt with in detail. The origin and occurrence of each material are described, also the preparation for use, varieties met with, impurities and adulterants, defects, and tests for quality, including both laboratory tests and simple practical tests such as may be applied by the workman. In every case the author is careful to point out the application of correct scientific principles, and from his practical knowledge is able to suggest many useful tests not generally known.

The work is thoroughly up to date, from both a scientific and a practical point of view, and the latest results of investigation into such matters as the setting action of cement, the rusting of iron, and the micrography of metals are clearly and broadly stated in their bearings upon the practical use of material.

This book will prove of great value to students intending to take up architecture as a profession. The builder, also, and the practical man will be glad to take advantage of much of the information given. In fact, many teachers in the architectural and building departments of technical colleges will be glad to know of the book with the view of recommending it to their students.

This being the first edition, it is hardly to be expected that the book is entirely free from defects. The diagrammatic illustrations given seem to be the least satisfactory part of the work. While the work has been written so lucidly as to render numerous figures unnecessary, it would seem that more than nine illustrations might be legitimately employed to assist the reader in grasping the subject. There is room for some improvement, too, in the chapter on timber, several inaccuracies having escaped correction, *e.g.* on p. 295, what is described as decay due to worms should rather be ascribed to the larvæ of certain beetles, &c. Also, on p. 296, the Teredo, although popularly regarded as a worm, should really be classed with the mollusca. In dealing with dry rot on p. 294, the temperature conditions are not referred to, although these play an important part in the development of the fungus.

A few statements in other parts of the book seem to call for reconsideration or correction, *e.g.* p. 20, § 3:—"If two vessels containing the same liquid be connected, the level in each will become the same *whatever*[1] the form or distance of the connecting pipe." Again, the statement, p. 277, "Shearing and torsional stresses are identical, apart from the method of applying the force producing them," although true, needs explanation to the mind not trained in mechanics.

The explanation given on p. 323 as to the optical theory of the production of a green pigment from yellow and blue powders, will hardly explain fully how it happens that the same blue powder, mixed with a red one, will produce purple. Turning to the useful table on p. 63, the tyro may be puzzled again to know why, if the substance denoted by CaO_2H_2 is termed calcium *hydroxide*, the substance PbO_2H_2 is termed lead *hydrate*; or, if CO_2 is called carbon *dioxide*, why SiO_2 is called silicon *oxide*. On p. 18 the author correctly says, "To move a heliostat reflecting a beam of light requires no more effort than would be necessary in the dark," but the heliostat being

[1] Italics not author's.

unknown to most students of building materials, it might be advisable to substitute the more familiar "mirror."

However, in spite of a few minor points like these, the book as a whole is well written, and admirably adapted to the class for whom it is intended. It deserves to take a permanent place among the text-books upon the subject, and in future editions the points referred to will no doubt receive attention.

H. B.

ECONOMIC BACTERIOLOGY.

Bacteria in Relation to Country Life. By Dr. Jacob G. Lipmann. Pp. xx+486. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 6s. 6d. net.

WRITTEN in non-technical language, this book gives a good account of the activities of micro-organisms. It may therefore be recommended to all those who desire to obtain a general knowledge of the functions of bacteria and the important *rôle* they play in relation to daily life, while the intelligent agriculturist will find a large amount of information which should aid him in his work. After a brief survey of the form, structure, food requirements, and conditions of growth of bacteria, successive chapters deal with these organisms as met with in air, water, and sewage. The relation of water to health and disease is discussed, and the chief factors in connection with the contamination and purification of water are detailed. A readable account is given of the disposal of sewage and of bacterial systems of sewage disposal. Next follow the most important sections of the book, viz. the relation of bacteria to soil fertility and the influence of manures. We here find accounts of the sources of nitrogen in the soil, of nitrification and denitrification, of the action of leguminous crops in fixing nitrogen, and of soil inoculation with pure cultures of nitrogen-fixing organisms. The proper methods of storing farmyard manure are dealt with at some length, and it is shown that under different conditions of storage the losses of organic matter from the manure stack in three or four months may range from 15 to 20 per cent. to 40 to 50 per cent. of the initial quantity, and valuable suggestions are made on the best means of conservation of manurial constituents, both by proper methods of storage and by the use of chemical fixatives.

The chapters which follow on milk, its production and preservation, are also excellent. Details are given which show that *careful* hand-milking yields a better milk as regards bacterial contamination than any milking machine, unless *extreme* precautions are taken in the sterilisation of the latter. The subject of pasteurisation of milk is also critically discussed, and the following extract sums up the author's views on the advantages and disadvantages of the process, views with which we fully agree and which should be widely known:—

"Pasteurisation is effective for the destruction of disease bacteria in milk and for the improvement of its keeping quality. It is agreed that city children fed on pasteurised milk, properly heated and properly cooled, are less subject to intestinal disturbances than children fed on raw milk. At the same time, it must be admitted that the pasteurisation of milk already filled with bacteria, and the products of their aictivities, will not remedy its defects. The undesirable substances formed by the bacteria are not entirely destroyed by the heating, and may still cause injury to the person consuming the milk.

"By resorting to pasteurisation, a dealer may be able to dispose of milk that would otherwise quickly become unsaleable. Similarly, the failure to cool the pasteurised milk quickly and to keep it at a temperature of 50°, or below that, may lead to the rapid multiplication in the milk of germs producing injurious or poisonous substances. Hence, pasteurised milk should be consumed within twelve hours, or should be immediately cooled down to between 45° and 50°."

The subject of tuberculosis in relation to milk is fully discussed. It is pointed out that large numbers of tubercle bacilli may pass into the excreta of tuberculous cows, a fact which was fully confirmed by the experiments of our Royal Commission on Tuberculosis as contained in the last report, and it is concluded that

"Whatever difference of opinion there may prevail as to the extent of human tuberculosis caused by the consumption of milk and milk products, it is conceded by sanitarians that persistent efforts should be made to eradicate bovine tuberculosis."

Subsequent chapters deal with milk beverages, butter and cheese, canning, ensilage and fermented liquors.

The book is adequately illustrated and clearly printed.

R. T. HEWLETT.

FORESTRY.

(1) *Our Forests and Woodlands.* By Dr. J. Nisbet. New and revised edition. Pp. xxiii+348. (London: J. M. Dent and Co., 1909.) Price 3s. 6d. net.

(2) *Trees: A Handbook of Forest-Botany for the Woodlands and the Laboratory.* By the late H. Marshall Ward. Vol. v., Form and Habit. Pp. xi+308. (Cambridge: University Press, 1909.) Price 4s. 6d. net.

(1) THE first edition of Dr. Nisbet's well-known book, "Our Forests and Woodlands," appeared in 1902. The second edition has now been issued, and will doubtless be welcomed by a large circle of readers, not only on account of the interesting and important information it contains, but the price is such as to bring it within the reach of many who cannot afford the more expensive, though excellent, works on forestry at present available to the English reader. A very important, and probably the most outstanding feature of the new edition is the preface, in which the author has given a *résumé* of the progress which has been made in forestry since the appearance of the first edition. The doings of the various Governmental committees and commissions which have sat of late years are clearly set forth. There is also given a very striking table in the form of an abstract from the "Annual Statement of the Timber Trade of the United Kingdom" for 1906 and 1907. Here it is shown that the gross total imports of wood and timber, wood-pulp, and manufactured wood-pulp come to about 37,500,000*l*. To supply these

present demands, leaving out of consideration the increasing consumption, which will no doubt continue, the author points out that it would require 3,000,000 acres of conifer and other woodlands, or an annual cut of 50,000 acres of timber worked on a sixty years' rotation. Contrary to opinions held in other quarters, Dr. Nisbet anticipates the decrease in the supply, to this country at least, of pitwood. At present large supplies come from Bordeaux, but signs are not lacking that the quantity of suitable timber is decreasing, while the French collieries themselves show increasing demands. It would be a serious blow to all our industries dependent on coal should the supply of pitwood fail, and in any case the price is likely to increase, which will, other things remaining the same, raise the price of coal.

Another very important question to which the author directs attention is the wood-pulp industry. At the present time the United States dominate the paper market of the world, but there is an increasing shortage of suitable timber for the making of paper-pulp, which is, therefore, naturally increasing in price, and the recent large rise in the price of paper is due to the growing shortage in the supply of spruce. Since 1904, the cost of mechanical wood-pulp in this country has increased from 85*s.* a ton to 120*s.*, while in America during the past ten years the price has increased threefold. The demand for pitwood and wood-pulp is bound to continue; in other words, there is a sure market for such produce, and the author, who is a widely recognised authority on such matters, points out that our waste lands and poor pastures are to a very large extent capable of producing conifers and soft-wood crops which could be established at comparatively little cost, and would yield good returns to the owner, and at the same time supply pit-wood for our mining industries and therefore indirectly benefit all industries dependent upon coal; and, lastly, with a sufficient supply of raw material for the making of paper-pulp a new industry would be created in this country.

There are altogether eleven chapters in the book, with an index at the end. Some very fine illustrations are also included. The first two chapters are mainly taken up with historical matters, which provide extremely interesting reading. The next two chapters deal with the sylvicultural characteristics of the oak and beech. In chapter v. the remaining hardwoods are considered, while the soft woods, such as alder, birch, lime, and poplars, are dealt with in chapter vi. Coniferous plantations of pines, firs, and larch are treated in chapter vii. Chapter viii. is more arboricultural, as it deals with hedges and hedgerow trees. Chapter ix. is occupied with the consideration of high-woods, copses, and coppicewoods, while the last two chapters, viz. x. and xi., are devoted to woodlands, game and sport, and the improvement of British forestry respectively.

The book is full of sound and trustworthy information. Its price is moderate, and it deserves a hearty reception from all those interested, directly or indirectly, in our forests and woodlands.

(2) This volume dealing with the form of trees is the final one of its series. The volume, like the previous one, has been seen through the press by Dr. Groom, who informs us in the preface that he has reduced changes from the original to a minimum. The few alterations and additions which were found necessary have been indicated by enclosure within square brackets. Part i. deals in a general way with the habit or form of trees, and, in addition to the text, the form or habit of the tree is indicated in many instances by illustrations, while the form of the branch-system is also indicated diagrammatically. A series of Mr. Henry Irving's well-known photographs illustrating the outward appearance of the bark has been included.

In part ii. the trees are detailed according to their form and other external appearances. The system of tabulation adopted is similar to that employed in the previous volumes. At the end we have an appendix which contains a classification of trees and shrubs according to their seedlings, and here we have many excellent drawings by Miss E. Dale from actual seedlings, the scale of magnification or reduction being indicated in each case. No doubt this appendix, as Dr. Groom points out, is not so complete as the author evidently intended to make it, yet it is, including the drawings, valuable so far as it goes, and is well worthy of careful study.

Taking the whole work as it now stands, we have five volumes which deal respectively with buds, leaves, flowers, fruits, and form, and it will be admitted on all hands that the late Prof. Marshall Ward has left behind a monumental work which will long be considered a standard on trees.

NEW BOOKS ON ORGANIC CHEMISTRY.

(1) *Modern Organic Chemistry.* By Dr. C. A. Keane. Pp. xiv+503. (London: The Walter Scott Publishing Co., Ltd., 1909.) Price 6*s.*

(2) *Practical Organic Chemistry.* By Dr. J. J. Sudborough and T. C. James. Pp. xviii+378. (London: Blackie and Son, Ltd., 1909.) Price 5*s.* net.

(3) *The Elements of Organic Chemistry.* By E. I. Lewis. Pp. viii+224. (Cambridge: University Tutorial Press, Ltd., 1909.) Price 2*s.* 6*d.*

(4) *Abhandlung über die Glycole oder Zwei atomige Alkohole.* By Adolf Wurtz. Pp. 96. Ostwald's *Klassiker,* No. 170. (Leipzig: W. Engelmann, 1909.)

(1) To anyone possessing a sound elementary knowledge of organic chemistry we can strongly recommend Dr. Keane's book. It is not a text-book, for there is no systematic arrangement of the materials, and the properties of individual substances and the relations of different groups are not brought into relief. If, for example, the student wishes to learn something about ordinary phenol, he will find bits of scattered information in four different places. Systematic instruction is obviously not the object of the book. But although the treatment is unconventional, and frequent digressions are made into regions not usually embraced by organic text-books, this very fact rather enhances than detracts from the interest of the

volume. The subject is brought into touch with other branches of the science. Thus, under hydrocarbons, we read a little about thermochemistry; under aldehydes there is a reference to autoxidation; under acids there are a few words about steric hindrance; under ethereal salts (a rather antiquated term) a short account is given of mass action, and so forth. In addition to this there are separate chapters on laboratory methods, stereochemistry, the sugars, dynamic isomerism, heterocyclic compounds, and the physiological properties of organic compounds.

That the subjects are treated rather broadly than deeply seems no serious defect. They are sufficient for the general reader, who is provided with elaborate references if he desires to extend his knowledge. In conclusion, we would direct the author's attention to a few inaccuracies which have been noticed, and which might be modified or corrected in a future reprint. The two isomeric dimethylethylenes, which are stated to be known in only one form, have been prepared by J. Wislicenus (p. 310); the molecular weight of triphenylmethyl has been determined, and corresponds to the double formula (p. 423); Fischer and Slimmer were unsuccessful in effecting an asymmetric synthesis (p. 301); it is incorrect to state that propylene and hydrobromic acid give exclusively isopropyl bromide (p. 45).

We would also suggest the following:—Thiele's hypothesis requires amplification to be understood (p. 46); it is very questionable if the explosiveness of a compound depends upon its breaking up into stable molecules, for many silver salts share with silver oxalate this property, whereas a substance like platinic chloride does not explode; the statement that *ethyl* and *methyl* "cannot exist in the free state because they contain one of the carbon affinities unsaturated" (p. 27) is inconclusive, especially as triphenylmethyl is referred to later as possibly existing (pp. 36, 423); without some qualification it is misleading to say that Dumas's theory of types "was especially developed by Gerhardt," and "received the support of Williamson and Wurtz" (p. 17). In the first place, Williamson originated the idea of Gerhardt's types, which were simple inorganic compounds in which hydrogen could be replaced by radicals. They were intended to denote chemical behaviour and not relationships. Ether had no generic relationship to acetic anhydride, though they belonged to the same type. Dumas's types, on the other hand, were organic substances which were intended to show relationships produced by substitution rather than chemical behaviour.

(2) The "Practical Organic Chemistry" of Sudborough and James is rather a laboratory handbook or book of reference than a course of practical instruction. As stated in the preface, examples are given of different types of operations. These types are grouped together. Thus, there is a chapter on the preparation of hydrocarbons, one on alcohols, another on halogen compounds, acids, esters, nitro-compounds, sulphonic acids, and so forth. In addition, there is a preliminary chapter on organic analysis and molecular-weight determinations, and, at the end of the volume, a number of useful examples of analyses and the determination of physical constants such as are playing an increasingly important *rôle* in the study of structure. The descriptions are clear and full, and the photographic illustrations are masterpieces of their kind. Altogether the book is probably the most complete among those of home manufacture on the subject of practical organic chemistry that has yet appeared.

(3) This modest little volume, which is one of the University Tutorial Series, should form an excellent introduction to the study of organic chemistry, and if the process of practical instruction can be carried on concurrently with theoretical teaching, as the author does with his own class, nothing better could be desired. He takes a few of the commonest organic substances and uses them, as they can easily be used, to illustrate quite a large variety of chemical operations and products. If the substance of the book can be assimilated in the course of four school terms, as the author states, we think that both teacher and student should be satisfied with the result. May we suggest that the name of Würtz should be spelt without the diæresis and Senderens without an *a*?

(4) One turns from the intricacies of a modern treatise on organic chemistry to Wurtz's classical memoir on the glycols with the same sense of relief that one listens to the simple melody of an early composer after the confused sounds of a modern orchestral symphony. Short and simple though it is, it is difficult to overrate the far-reaching results of Wurtz's research. It was not merely the discovery of a new class of alcohols and organic oxides, or an extension of Williamson's water type. It afforded for the first time clear experimental evidence of the existence of what were then termed "polyatomic" radicals. To quote Wurtz's own words:—

"The main result, which, in my opinion, is derived from these synthetic experiments, is not the discovery of the new compound, glycol—there are enough new compounds in organic chemistry—it is not even the synthesis of glycerine nor the difficulties connected with its preparation which have been successfully overcome; but it is the manner of the formation of glycol and the antecedent reactions which made it possible; it is the conversion of the allyl compound by which the iodide passed into glycerine. All these experiments, which were directed to the same end, have shown that an organic group united to 2 atoms of chlorine or bromine can replace two atoms of silver, and are therefore equivalent to two atoms of hydrogen, and that an organic group united to three atoms of chlorine or bromine can replace three atoms of silver and is equivalent to three atoms of hydrogen."

The theory of polyatomic radicals, like ethylene and glyceryl, soon developed into that of the polyatomic elements or the theory of valency, upon which the whole fabric of modern organic chemistry rests. Wurtz himself held perfectly clear views on the different valency of the elements. In his address to the Chemical Society in London in 1862 on ethylene oxide, he points out that as ethylene oxide represents a diatomic radical united to oxygen, so many of the metals may be regarded as diatomic elements. The paper is well worth re-reading, and is not by any means the least interesting addition to the *Klassiker*.

J. B. C.

PHYSICS FOR THE LECTURE ROOM AND LABORATORY.

(1) *The Elements of Electricity and Magnetism. A Text-book for Colleges and Technical Schools.* By Prof. W. S. Franklin and Barry Macnutt. Pp. viii + 351. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 7*s*. net.

(2) *A Short University Course in Electricity, Sound and Light.* By Dr. Robert A. Millikan and J. Mills. Pp. v + 389. (Boston and London: Ginn and Co., n.d.) Price 8*s*. 6*d*.

(3) *Naturlehre für höhere Lehranstalten auf Schulerübungen gegrundet.* By Dr. Friedrich Danneman. Teil ii. Physik. Pp. vii + 204. (Hanover and Leipzig: Hahnsche Buchhandlung, 1908.) Price 3.50 marks.

(4) *The Elementary Theory of Direct Current Dynamo Electric Machinery.* By C. E. Ashford and E. W. E. Kempson. Pp. vii + 120. (Cambridge: University Press, 1908.) Price 3*s*. net.

(5) *Electrical Laboratory Course for Junior Students.* By R. D. Archibald and R. Rankin. Pp. vi + 95. (London: Blackie and Son, Ltd., 1908.) Price 1*s*. 6*d*. net.

(1) THE order in which the elements of electricity and magnetism are presented in the first volume under notice is:—(*a*) Electric current; (*b*) magnetism; (*c*) electrostatics; (*d*) electric waves. This order is one which does not make the exposition perfectly happy. Thus it does not seem natural when it is found necessary to refer provisionally to the measurement of currents by their magnetic effect (p. 7) prior to any statement as to how magnetic effects themselves are measured. Surely the natural order is to take magnetism before considering the electric current, even though it may be preferred to deal with both before considering the phenomena of electrostatics. The author passes naturally and easily to the exposition of the last-named phenomena, and as many prefer this order this portion may certainly be commended to them.

The author is convinced that "elementary science instruction must be made to touch upon the things of everyday life if it is to be effective." This sentence may be taken as the keynote to the entire book. Thus electric resistances are usually represented as electric lamps. Those who are accustomed to abstract thinking may smile at these concrete representations; but it must be remembered that this is only an elementary book, and it must be admitted that much of the difficulty which many junior students feel is connected with the unreality of the subject as it appears to them. We commend the book for endeavouring, in this and other ways, to make the subject more real than it usually is.

More attention is given than is customary in an elementary course to phenomena connected with recent discoveries, such as kathode rays, radio-activity, electric waves, &c. We conclude that in America a junior course is in some respects more advanced than with us. This remark applies most to the chapter on electric waves, and to the appendix on ship's magnetism. Both these portions are very well done, though we would have thought them fairly strong meat for those who are making a "first systematic study of the subject." However, whether a student takes them in completely in his first study or not, he will be very glad to find them here ready to hand when required.

(2) The second of the volumes under review "represents primarily an attempt to secure a satisfactory articulation of the laboratory and class-room phases of instruction in physics." Expressed otherwise, it consists of a description of laboratory work, each experiment being preceded by as much theory as is necessary to make a complete logical exposition of the subject under study. We think that this plan is an excellent one; and it has been very satisfactorily carried out. Of course, it will be understood that the theoretical part is not sufficient to replace a text-book dealing specially with the theory.

Although electrostatics is introduced in the first chapter, electric capacity is not defined until later, when it can be measured by means of a ballistic galvanometer. There may be something to be said for this, but we think that the course of experiments would be considerably improved and the student would get a more vivid idea of what capacity is if experiments were added on parallel plate condensers used along with a gold-leaf electroscope or an electrostatic voltmeter.

In sound, a series of experiments on diffraction is included. The experiments on light *begin* with diffraction, a fact which prepares us for the exclusive use of the wave-method in proving the general phenomena of reflection and refraction. The final chapter is on radio-activity, and contains some simple experiments on uranium and thorium salts. The book is altogether a most excellent manual.

(3) We find in our third volume a well-selected series of very elementary experiments in the whole round of physics suitable particularly for school use. Though the subject is dealt with satisfactorily as a rule, it is not beyond criticism. The diagram of the paths of rays in a microscope would be improved if the rays represented as passing through the eyepiece were the same as those transmitted through the objective. The experiment on the "velocity of electricity" would be best left out of such an elementary book; the statement that electricity travels with the velocity of light is, of course, absurd.

(4) We are in entire agreement with the authors of this book, that in the training of an electrical engineer there should be included a knowledge of the theory of the subject built up logically from first principles, each step being illustrated with the help of some piece of machinery or practical appliance of a general and simple rather than an elaborate or necessarily up-to-date type. The present volume is intended to be used only as a note-book accompanying a course of experimental lectures. The authors are to be congratulated on the excellence of their little manual. The diagrams in particular are very carefully designed.

(5) The last of this group of text-books covers an elementary first year's evening course and part of a

second year's course. The first method of proving the inverse square law for magnetic poles will not convince. However, putting aside an occasional criticism of this kind, we think that the book will well serve its purpose of replacing manuscript instruction sheets in a junior laboratory.

OUR BOOK SHELF.

Théorie des Corps déformables. By E. et F. Cosserat. Pp. vi+226. (Paris: A. Hermann et Fils, 1909.) Price 6 francs.

THE authors, who are well known by their writings on general elastic theory, here reprint in separate form an appendix contributed by them to M. Chwolson's "Traité de Physique." The kinematical and dynamical theories of the flexible line, the flexible surface, and the deformable three-dimensional medium are discussed in turn in great detail. The dynamical standpoint adopted is that of the principle of action, which forms, in the authors' opinion, the only satisfactory basis for the "deductive" exposition of the subject. In each case the most general form of the function representing the "action" is sought which is consistent with the necessary invariantive relations. This procedure is, of course, not altogether new, and an expert, turning over the pages, will recognise much that in one form or another is familiar to him. The treatment is necessarily somewhat abstract, and is mathematically very elaborate, Cartesian methods being followed throughout. To many readers the long train of general investigations, unrelieved by a single application, may prove deterrent; but the authors at all events claim that their procedure has never before been carried out so resolutely and completely, and may justly pride themselves on the mathematical elegance of their work. Apart from its other qualities, the treatise has a distinct value as a book of reference, and furnishes a whole arsenal of formulæ which may save trouble to future writers.

The book begins with a kind of philosophical introduction to which the authors attach great importance. This requires to be read in conjunction with a previous treatise, which has also appeared in the French edition of M. Chwolson's work. Those who adopt in its fullest extent the empirical view of mechanics will perhaps consider that too much weight is attached to discussions of this kind. The historical references are, however, interesting, and fairly complete. The authors are indeed exceptionally well read in the history of their subject, and admirably conscientious in their citation of authorities. In their preface they promise a subsequent treatment of the theories of heat and electricity from a similar standpoint.

Practical Physiological Chemistry. A Book designed for Use in Courses in Practical Physiological Chemistry in Schools of Medicine and of Science. By Prof. Philip B. Hawk. Second edition, revised and enlarged. Pp. xvi+447. (London J. and A. Churchill, 1909.) Price 16*s*. net.

PROF. HAWK'S text-book falls into the front rank with the numerous additions and improvements which have been introduced into the new edition. It is not only a practical guide, and, as such, should be found in all physiological laboratories, but forms a very complete, readable, and up-to-date account of our present knowledge of the chemical side of physiology.

A special feature has been made of the illustrations, which are beautifully executed, and most of which will be new to workers in physiological chemistry. The crystalline forms of the many protein derivatives which the work of Emil Fischer and his colleagues has been instrumental in rendering familiar to the students of this branch of science will be found among them.

One small slip we notice in connection with the matter of protein nomenclature. The initiation of the new system of terminology which is now being adopted for the albuminous substances is wrongly attributed to the British Medical Association. It was really a committee of the Physiological and Chemical Societies of this country which set the ball rolling.

The mistake is, however, a pardonable one, seeing that it was at the meeting of the British Medical Association held at Toronto in 1906 that the opportunity of presenting the subject to our American colleagues was taken advantage of. The success that has attended this effort to secure uniformity of nomenclature amongst English-speaking people has been very gratifying; the American system, adopted under the auspices of the American Physiological Society and the American Society of Biological Chemists, differs in only small and unimportant details from our own. W. D. H.

Behind the Veil in Bird-land. Some Nature Secrets revealed by Pen and Camera. By Oliver G. Pike, with a number of pen sketches by E. R. Paton. Pp. 106. (London: The Religious Tract Society, 1908.) Price 10*s*. 6*d*. net.

SINCE the Keartons, some years ago, showed what splendid results could be achieved by an intelligent use of the camera as an aid to the study of natural history, a host of nature-photographers has arisen, but only a very few have attained the high standard of merit set by the founders of this branch of photography. Mr. R. B. Lodge and Miss E. L. Turner in this country, Schillings in Germany, and H. K. Job in America have in some respects even surpassed the Keartons; while in this display of resource and dogged persistence in the most trying circumstances they stand unrivalled.

Mr. Pike in this rather pretentious volume has given some very excellent photographs, but the "Nature Secrets revealed by Pen and Camera" which he promises in his title-page are conspicuous by their absence. His pages contain hardly one single new fact, but a great deal that is banal. He solemnly assures us, in writing of the kestrel, that "The first summer rose, a delicate pink amidst the surrounding green, is a greater picture of spring than ever the sunlit sea could be"—which statement contains a great deal of truth!—"and," he continues, "a kestrel hovering over a meadow, yellow with summer's flowers, tells us a deeper story than the eagle soaring over a wind-swept moor." We fail to grasp why this should be so.

"Bird-land's veil" is constantly being "lifted up" for him, like the drop-scene at the theatre, and on the stage appear blackbirds, which tell him "the story of the leaves and flowers," and wrens, which reveal "the secrets of the hedgerows," while skylarks, to complete the illusion, like the celebrated Grigolati troupe in the pantomime, fly to and fro across the stage, and sing "happy songs"! Perfectly charming! W. P. P.

An Account of the Deep-sea Asteroidea collected by the R.I.M.S.S. "Investigator." By Prof. René Koehler. Pp. 143; 13 plates. (Calcutta: Indian Museum, 1909.) Price 12 rupees.

THIS substantial contribution to the material of the echinoderm "system" consists of 126 pages of minute description, and nine pages of general remarks. It is a continuation of certain reports of a preliminary and incentive character published many years ago by the naturalists and pioneers of the Indian Marine Survey, but, except that some doubtful identifications are disposed of and some errors criticised, it does not incorporate that earlier work.

In the descriptive part of the memoir thirty-nine species are enumerated, of which thirty are regarded as new, and are exhaustively described. The general remarks refer to eighty-eight species—the thirty-nine species treated by the author, and forty-nine species dealt with in the earlier reports—and furnish the evidence of the author's main conclusions. These conclusions are that the deep-sea starfish of the Bay of Bengal and Arabian Sea are much more Phanerozonia than Cryptozonia, and that their geographical affinities, so far as they can be discerned at all, are exclusively Indo-Pacific, with a slight Hawaiian touch.

Of the new species described by Prof. Koehler, five are separated as types of new genera. These are Johannaster, which is placed with very justifiable hesitation among the Plutonasteridæ, for some of its characters suggest a pentagonasterid connection; Phidiaster, which seems scarcely distinct from Psilaster; Sidonaster, which agrees in all points with Porcellanaster, except that, as in other porcellanasterid genera, the elements of the cribriform organs are papillar instead of lamellar; and Circeaster and Lydiaster, both of which are Antheneids having the abactinal plates of the disk much smaller than those of the rays.

It may be thought that the limits of some at least of these genera are cut too fine to last; and of the descriptions of species it may almost be said that they are accurate expositions of specimens rather than impressive definitions of nature's products; but such is the way of systematic zoology nowadays.

The memoir is most bountifully and most beautifully illustrated by the author's own hand; the plates, which are thirteen in number, are quite above criticism.

Antimony: its History, Chemistry, Mineralogy, Geology, Metallurgy, Uses, Preparations, Analysis, Production, and Valuation; with complete Bibliographies for Students, Manufacturers, and Users of Antimony. By Chung Yu Wang. Pp. x+217; illustrated. (London: C. Griffin and Co., Ltd., 1909.) Price 12*s*. 6*d*. net.

Mr. Wang observes in his preface that a metallurgical work in English by a Chinese author is unusual. After reading the book, the conclusion is irresistible that English metallurgists would gain if Chinese authors were more numerous. Mr. Wang has treated his subject with the greatest respect, and has drawn up with methodical care a complete treatise which will be very useful to all students of the subject. The long and apparently exhaustive bibliography at the end of each chapter would alone give the book a right to a place on metallurgists' shelves, but in many cases the facts are sufficiently set forth in the present work.

The author carried out some practical tests of the latest volatilisation process of extracting antimony from its ores, which was patented last year by M. Herrenschmidt, and seems to have been much impressed by its merits. The account of these tests is, however, almost the only original matter in the book, which is mainly a compilation of previously published material, printed without comment. Its merits lie chiefly in the logical sequence and the accuracy of the extracts.

Étirage, Tréfilage, Dressage des Produits métallurgiques. By M. Georges Soliman. Pp. 164. (Paris: Gauthier-Villars and Masson et Cie., n.d.) Price 3 francs.

This interesting little work, one of the well-known "Aide-Mémoire" series, deals with its subject from a practical point of view. It is divided into five chapters, the first considering shortly the general mechanical properties of metals and alloys such as tensile, shock, bending, hardness, and torsion tests. Chapter ii. shows the influence of annealing and of cold work. Chapter iii. is devoted to "étirage," or drawing, defined as "an operation which has for its object the completing of work done by rolling and giving to the metal a cross-section which cannot be obtained by rolling," after the manner of wire-drawing ("tréfilage," chapter iv.), which is a special case of drawing where the cross-section is circular. Chapter v. gives a short account of methods of straightening ("dressage"). A. McW.

Nutrition and Evolution. By Hermann Reinheimer. Pp. xii+284. (London: John M. Watkins, 1909.) Price 6*s*. net.

This is an essay on the importance of nutrition as a factor in evolution, and the author is in good company. For was it not Claude Bernard who said, "l'évolution, c'est l'ensemble constant de ces alternatives de la nutrition; c'est la nutrition considerée dans sa réalité, embrassée d'un coup d'œil à travers le temps"? To have had this thesis worked out in a methodical manner would have been great gain, but the author is not strong in scientific method. He has gleaned far and wide to illustrate "the evolutionary aspects of nutrition," and while he has a crow to pick with most of his authorities, who have not the "central key of a uniform analysis," he uses them when they suit him to back up his conclusion "that in its silent effects nutrition is one of the most formidable factors in the shaping of individual and racial destinies." The conclusion is sound, but we cannot say this of many of the arguments.

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.]*

Bessel's Functions.

I once stated that a good style of writing English is not a strong point amongst British mathematicians, and the justice of this remark is exemplified by Prof. Hill's letter on this subject (Nature, July 8), since it contains the phrases Meissel's tables, Smith's tables, Aldis' tables, Isherwood's tables, which are correct; and Bessel functions, British Association tables, which are wrong. It is not in general permissible in English to employ a proper noun as an adjective, for the rules of grammar require either the use of the genitive case, or the conversion of the noun into an adjective, as in the words Newtonian, Lagrangean.

The British Association is one of the most important societies in the British Empire; it long ago discarded the insularity of our ancestors, and has become cosmopolitan in its operations. It is therefore not too much to expect that it will conform to the rules of grammar in its publications, and employ its influence in encouraging a good literary style.

I do not understand what Prof. Hill means by Neumann's functions. I believe that Neumann was the first mathematician who studied the properties of zonal harmonics and allied functions of degree $n+\frac{1}{2}$, where n is zero or a positive integer; but the subject was afterwards taken up and greatly extended by Prof. W. M. Hicks in connection with circular vortex motion. Hicks calls these harmonics *toroidal functions*, which is a much better phrase, since it puts in evidence the fact that these functions are connected with the potentials of *anchor rings* or *tores*.

There is also another class of functions which are zonal harmonics of complex degree $m-\frac{1}{2}$. These have been studied by Hobson (*Trans. Camb. Phil. Soc.*, vol. xiv., p. 211), who calls them *conal harmonics*.

A. B. Basset.

Fledborough Hall, Holyport, Berks, July 9.

Musical Sands.

May I record the existence of musical sands along the shore at the Sandbanks, Poole Harbour?

Some years ago the Poole authorities erected a series of box groynes along this coast between Poole Head and the Haven, and these have considerably increased the natural accumulations of sand, so that it is "making" everywhere, and the growth of the marram grass on the dunes is in many places (independently of that recently planted) rapidly extending seawards.

The beach now, between each groyne, consists of wide and flat deposits of sand, shells, and flint pebbles, but about midway between the dunes and the sea, where the sand is comparatively free from these, musical zones are of frequent occurrence.

In walking along the shore in a westerly direction, starting from the first groyne, the sounding qualities of the sand notably increase. Thus between the first and second groynes there are no musical patches, between the second and third the sounds are very faint, and between each of the other groynes, until one reaches the last at the Haven Point, the intensity of the sound increases. In a small cove at the Point, formed by the last groyne (constructed of barrels of concrete and an old ship), the sand is remarkably musical.

The increase of sound observed when walking in a westerly direction is due, I think, to the fact that the prevailing westerly winds, and the littoral drift, separate the finer particles from the sand and carry them eastwards, and a microscopic examination of samples obtained from distances about a mile apart on this shore confirms this.

This musical sand is of the Studland Bay type, and near the Haven gives even better results than any I have found there. The occurrence of musical sands along this particular shore through the conserving influence of the groynes is an interesting fact, for their existence there previously was very unusual, being only once noted in very small quantity during the last twenty years.

Parkstone-on-Sea, July 4. CECIL CARUS-WILSON.

The Commutative Law of Addition, and Infinity.

Referring to the review of Hilbert's "Grundlagen der Geometrie," on p. 394 of No. 2066 of Nature (June 3), may I point out that the commutative law of addition can be proved without the help of any axioms at all, other than those of general logic? The method, indeed, used by Peano in 1889 ("Arithmetices Principia . . .," Turin, 1889, p. 4), which is only based on axioms of a general nature (such as the principle of mathematical induction), and not on such special laws as the distributive ones, appears in so far superior to Hilbert's; and, since all Peano's axioms were proved in Mr. Russell's "Principles of Mathematics" of 1903, Hilbert's proof seems quite superseded. Further, the difficulties arising out of Dedekind's proof of the existence of infinite systems can be avoided without the introduction of "metaphysical" arguments about time and consciousness (see Russell, *Hibbert Journal*, July, 1904, pp. 809–12), as, indeed, your reviewer seems to think possible. But the connection of the fact that the existence of an infinity of thoughts (which must be in time) with Hamilton's idea that algebra was interpretable especially in the time-manifold, just as geometry is in the space-manifold, is not obvious. PHILIP E. B. JOURDAIN.

The Manor House, Broadwindsor, Beaminster, Dorset, July 2.

Neither Dr. Hilbert nor the reviewer make any suggestion that the commutative law of addition is best proved as a deduction from the laws of multiplication. But the laws of multiplication are so often treated as deductions from those of addition that it is interesting to have a case of the converse procedure. The fact that both these operations and their laws have been treated independently and in a strictly logical manner by Dedekind, Peano, and others is, of course, perfectly well known to all who have paid any attention to this part of mathematics. Whether Dedekind's critics have really avoided metaphysical arguments without at the same time making metaphysical assumptions is a question on which a difference of opinion is permissible.

G. B. M.

THE THEORY OF CROOKES'S RADIOMETER.

I HAVE noticed that the theory of this instrument is usually shirked in elementary books, even the best of them confining themselves to an account, and not attempting an explanation.[1] Indeed, if it were necessary to follow Maxwell's and O. Reynolds's calculations, such restraint could easily be understood. In their mathematical work the authors named start from the case of ordinary gas in complete temperature equilibrium, and endeavour to determine the first effects of a small departure from that condition. So far as regards the internal condition of the gas, their efforts may be considered to be, in the main, successful, although (I believe) discrepancies are still outstanding. When they come to include the influence of solid bodies which communicate heat to the gas and the reaction of the gas upon the solids, the difficulties thicken. A critical examination of these memoirs, and a re-discussion of the whole question, would be a useful piece of work, and one that may be commended to our younger mathematical physicists.

Another way of approaching the problem is to select the case at the opposite extreme, regarding the gas as so attenuated as to lie entirely outside the field of the ordinary gaseous laws. Some suggestions tending in this direction are to be found in O. Reynolds's memoir, but the idea does not appear to have been consistently followed out. It is true that in making this supposition we may be transcending the conditions of experiment, but the object is to propose the problem in its simplest form, and thus to obtain an easy and unambiguous solution—such as may suffice for the purposes of elementary exposition, although the physicist will naturally wish to go further. We suppose, then, that the gas is so rare that the mutual encounters of the molecules in their passage from the vanes to the envelope, or from one part of the envelope to another part, may be neglected, and, further, that the vanes are so small that a molecule, after impact with a vane, will strike the envelope a large number of times before hitting the vane again.

Under ordinary conditions, if the vanes and the envelope be all at one temperature, the included gas will tend to assume the same temperature, and when equilibrium is attained the forces of bombardment on the front and back faces of a vane balance one another. If, as we suppose, the gas is very rare, the idea of temperature does not fully apply, but at any rate the gas tends to a definite condition which includes the balance of the forces of bombardment. If the temperature be raised throughout, the velocities of the molecules are increased, but the balance, of course, persists. The question we have to consider is what happens when one vane only, or, rather, one face of one vane, acquires a raised temperature.

The molecules arriving at the heated face have, at any rate in the first instance, the frequencies and the velocities appropriate to the original temperature. As the result of the collision, the velocities are increased. We cannot say that they are increased to the values appropriate to the raised temperature of the surface from which they rebound. To effect this fully would probably require numerous collisions. Any general increase in the velocity of rebound is sufficient to cause an unbalanced force tending to drive the heated surface back, as O. Reynolds first indicated. If we follow the course of the molecules after collision with the heated surface, we see that, in accordance with our suppositions, they will return by repeated collisions with the envelope to the original lower scale of velocities before there is any question of another collision with the heated face. On the whole, then,

[1] See for example Poynting and Thomson's "Heat," p. 150.

the heated face tends to retreat with a force proportional both to the density of the gas and to the area of the surface.

A calculation of the absolute value of the excess of pressure cannot be made without further hypothesis. If we were to suppose that the molecules, after collision with the heated face, rebound with the same velocities $(v+dv)$ as they would have were the temperature raised throughout, the pressure would be increased in the ratio $v+(v+dv):2v$ or $1+dv/2v:1$. On the other hand, if the temperature were actually raised throughout, the pressure, according to the usual gaseous laws, would be increased in the ratio $(v+dv)^2:v^2$ or $1+2dv/v:1$. On this hypothesis, therefore, the unbalanced increment of pressure on the heated face is one-quarter of the increment that would be caused by a general rise of temperature to the same amount. This estimate is necessarily in excess of the truth, but it is probably of the right order of magnitude.

The supposition upon which our reasoning has been based, viz. that the mean free path of a molecule is large in comparison with the linear dimension of the vessel, has been made for the sake of simplicity, and is certainly a very extreme one. It is not difficult to recognise that in the extreme form it may be dispensed with. All that is really necessary to justify our conclusions is that the mean free path should be very large in comparison with the *vane*. The magnitude and distribution of the velocities with which the molecules impinge will then be independent of the fact that the face of the vane is heated, and this is all that the argument requires. The repulsion by heat of a silk fibre suspended in a moderately rare gas was, it will be remembered, verified by O. Reynolds.

RAYLEIGH.

LIFE IN AN OASIS.[1]

ALTHOUGH the oases of the Libyan Desert have been frequently visited by travellers—Poncet in the seventeenth century, Browne in the eighteenth century, and Cailliaud, Drovetti, Edmonstone, Hoskins, Rohlfs, Zittel, Schweinfurth, Brugsch, and others in the nineteenth century—yet none of these authors enjoyed anything like the opportunities for the study of these remarkable districts which have fallen to the lot of the writer of the work before us. For nine years Mr. Beadnell, as a member of that active body the Egyptian Geological Survey, was engaged in the study of the Libyan Desert—including the four oases of Baharia, Farafra, Dakhla, and Kharga—while during the last three years, as director of the operations of a development company, he has resided in the last mentioned, and has carried out important observations and experiments in connection with the questions of water supply, the effects of moving masses of sand in increasing the fertility of some areas, while overwhelming and destroying others, as well as of many other problems of great historical and antiquarian interest.

Now that the opening of a railway from Qena, a little north of Luxor, to the village of Kharga has been completed, the long and tedious camel-journey of four or five days along very rough caravan routes is avoided, and excursions from the Nile valley to this typical oasis will doubtless become much more frequent. The appearance of the present work is, therefore, very opportune. The detailed topographical and geological survey of the Libyan Desert with its oases was undertaken in 1897–8. Mr. Beadnell carried out the mapping of the Farafra and Dakhla oases, while Dr. Ball was engaged in surveying that of Kharga, the work in the Baharia Oasis being shared between the two investigators. Dr. Ball's map of the Kharga Oasis, with the accompanying official report, is a work of great geological value and interest, and Mr. Beadnell's residence in the district has enabled him to add not a few important scientific details to the admirable sketch given by his colleague.

The whole Libyan Desert forms a plateau, having an elevation which, at its maximum, is but little less than 2000 feet above sea-level, yet with a fairly general slope towards the north. In this great expanse of rough limestone and flint-covered flats, with hillocks and troughs of drifting sand, the oases are deep depressions, the bottoms of which vary from 100 to 300 feet above sea-level, surrounded, for the most part, by steep escarpments, through which only a few passes can be found which are capable of being used as camel-tracks. The whole of the deserts are underlain by great beds of sandstone (the Nubian series), forming two divisions, the "surface-water sandstones," never more than 160 feet thick, separated by 250 feet of impervious grey shales, from a much thicker series of sandstones below, the "artesian-water sandstone," which has been penetrated by borings to the depth of 400 feet.

It is by the removal, through denudation, of great masses of Eocene and Upper Cretaceous limestones and shales that the "surface-water sandstones" have been exposed on the floors of the oases. These beds are the source of springs, and, since the districts have been occupied by human beings, a great part of the area of the Kharga Oasis was covered by shallow lakes, probably formed by the outflow from these springs. But these great lakes have been gradually dried up, and the constant drain on the limited supplies of water afforded by the "surface-water sandstones" has greatly reduced its importance as a means of irrigation. The accounts of the various deposits laid down in these old lakes, with their interesting contents of worked flint-flakes and pottery, are among the most novel and interesting portions of Mr. Beadnell's book.

Far more important, however, than the surface-water sandstones, as a source of irrigation water, are the "artesian-water sandstones," which, by means of borings, have been drawn upon from the earliest times, and constitute even now a practically inexhaustible means for promoting the cultivation of the oases. On all questions connected with the nature and amount of the yield of the different kinds of wells, the author of this book writes as an authority, and he is able to give the results of numerous ingenious experiments, carried on, in some instances, for many months. That the enormous quantities of water contained in the thick sandstones of the Nubian system have their source, in part in the highlands of Abyssinia, in part in the Sudan, and to some extent in the upper waters of the Nile, where it flows over these pervious sandstones, there can be little doubt, though as to the proportional parts played by these several factors of the supply there is still much room for doubt—a doubt which can only be removed by prolonged observations.

The manner in which the ancient wells have been made, kept open, and from time to time repaired, has engaged the author's attentive study. It is surprising to learn how much has been accomplished with the aid of very simple appliances; and the long subterranean aqueducts—tunnels driven for miles into the sandstones for the purpose of increasing the flow of water—with numerous manholes up to the surface,

[1] "An Egyptian Oasis: an Account of the Oasis of Kharga in the Libyan Desert, with special reference to its History, Physical Geography, and Water Supply." By H. J. Llewellyn Beadnell. Pp. x+248; with 28 plates and 4 maps and sections. (London: John Murray, 1909.) Price 10*s*. 6*d*. net.

are wonderful monuments of persevering toil. The introduction of modern boring machines and other labour-saving contrivances may probably do much towards increasing the productiveness of the land of these oases in the future. Very interesting information is given concerning the cultivation carried on in the Kharga Oasis, and its possible extension in the future. The chief crops at present are rice, date and doum palms, and lucerne, though grapes, oranges, and other fruits are produced to a small extent. Many of these fruits, with cotton and other useful vegetable products, may be largely supplied from these districts, now that communication has been improved by the construction of the railway. In spite of the traditions concerning the existence of deposits of gold, silver, and other metals in the oases, it is probable, considering the geological structure of the district, that it is never likely to yield mineral products of greater value than the ochre, alum, and epsom salts, which the ancients obtained in small quantities as the result of an altogether disproportionate expenditure of labour and pains.

The author, being evidently a keen sportsman, is able to give many interesting details concerning the feral life in these singular depressions of the desert. The wild mammals consist of the Dorcas gazelle, with three species of fox, and occasional striped hyænas and jackals; the birds, of sand-grouse, rock-pigeons, turtle-doves, and quail. But British sportsmen must be prepared to find, among the primitive inhabitants of these lands, competing sportsmen, as enthusiastic and probably more experienced and persevering than themselves.

Although it is to the questions of water supply, and the dependent problem of agricultural development, that we look mainly for information to this work, yet its author has not been unmindful of many other points of general interest concerning the population of 8000 to 9000 souls and its distribution. They belong to Berber tribes, quite distinct from the fellahin of the Nile Valley, but with admixture from various other sources, and the author has been able, during his sojourn among them, to learn much that is of interest about their habits and customs. Their personal characteristics, peculiarities of land- and water-tenure, their taxation and commercial methods are well described, and the features of their villages and farms are admirably illustrated. Their modes of combating their great enemy the drifting sands from the north, which tend to form ever-advancing sand-dunes, receive especial attention. Some of the results attending this constant sand-drift are illustrated in the figures taken from the work.

The Egyptian kings, certainly from as far back as the eighteenth dynasty (1545–1350 B.C.), have claimed dominion over these oases. When Egypt fell under Persian rule, Cambyses sent an ill-equipped expedition to conquer the oases, but the whole army of 50,000 men, probably through the treachery of guides, perished miserably in the desert. The Romans long held sway in the oases, and many of the most remarkable of the monuments of the district must be referred to the period of their rule. The work before us indicates the great numbers of objects of archæological interest which are found in the district, including many Græco-Roman temples and a wonderful early-Christian necropolis, as well as very early flint implements and pottery. We learn that Mr. Pierpont Morgan has already had explorations commenced for the enrichment of American museums, and the completion of the railway may not improbably lead to excursions to Kharga and its temples becoming as popular as the trips to the cataracts and temples of the Nile are now. The book before us, which is dedicated to the memory of an old colleague of the author, Mr. Thomas Barrow, who fell a victim to the climate during explorations in the Sudan, ought to help to make known the points of interest attaching to these wonderful depressions in the great Sahara.

JOHN W. JUDD.

Encroachment of Sand-dunes at Meheriq. From "An Egyptian Oasis."

THE ISLE OF WIGHT.[1]

NOWHERE else in this country can the geologist find, along a coast line of only sixty miles, so many varied and magnificent cliff sections of the Cretaceous and Tertiary formations, and in no British area of equal size—a hundred and sixty square miles—can the botanist collect so many species of flowering plants, as in the "Garden Isle," which has long been a happy hunting-ground for field naturalists. Its rich flora and fauna, conditioned largely by its diversified soil, has already been dealt with in various works, notably in Venables' "Guide to the Isle of Wight" (1860), and in the Hampshire section of the "Victoria County History" series.

This new "Guide" contains a large number of new records, and will at least form a good basis upon which resident and visiting naturalists may build a complete natural history of the district. There can be no question as to Mr. Morey's qualifications for the editorship of this volume, since he has worked at the fauna and flora of the island for forty years, and in producing the "Guide" has obtained the services of a capable band of systematists in the various branches dealt with. One cannot but admire his industry, versatility, and enthusiasm. He tells us, "when, nearly three years ago, I decided to bring out a work which should fairly illustrate the fauna and flora and the natural history generally of the Isle of Wight, I did so, almost literally, with fear and trembling, fully realising the difficult task that I was undertaking"; and he expresses himself content to have served as a "horrible example" if by doing so those who come after him are enabled to profit by his mistakes of omission and commission. Such modesty disarms criticism, and Mr. Morey's energy and enterprise deserve the warm thanks and congratulations of all who are interested in the natural history of the Isle of Wight.

As is the case with all compilations, the book is unequal in quality, but we feel bound to point out two defects which, though common enough in works of this kind, detract considerably from its value and interest.

A book which attempts to compress into a comparatively small space an enumeration of the entire fauna and flora of a rich district, with an account of its geology, to say nothing of articles on palæolithic implements, meteorology, and even earthquakes, must necessarily consist largely of a census catalogue of species. Lists of species are undeniably useful, and not to be despised when compiled carefully, but the ideal to be aimed at in a real natural history is surely something that shall go beyond, and in some respects be the antithesis of, a mere list. Beyond a few vague references to the bare fact that the distribution of species of flowering plants, mosses, &c., is affected by the characters of rocks and soils, we look in vain for any evidence of the scientific ecological spirit which animates such works as Baker's "North Yorkshire," Lees' "West Yorkshire," and Wheldon and Wilson's "West Lancashire," and has made them valuable contributions to the growing literature of plant ecology. The three books cited are, of course, limited

Photo.] [*H. F. Poole.*

FIG. 1.—The Culver Cliffs: Inset showing Herring Gulls at their Nests. From "A Guide to the Natural History of the Isle of Wight."

[1] "A Guide to the Natural History of the Isle of Wight." A Series of Contributions by Specialists, relating to the various branches of Natural History and kindred subjects. Edited by Frank Morey. Pp. xx+560. (Newport, I.W.: County Press; London: W. Wesley and Son, 1909.) Price 8s. 6*d*. net.

to the botany of each district, but a general sketch of the distribution of the flowering plants, at any rate, should have been given in this "Guide." The island would afford excellent scope for a botanical survey, on the lines of the well-known work done by Dr. Smith, Dr. Moss, and other ecologists, in various parts of Britain. It is greatly to be hoped that in a future edition of, or supplement to, this "Guide" it will be found possible to include a chapter on plant distribution, with a vegetation map of the island, and, for comparison and correlation, a geological map. This would, if carefully done, preferably by an ecologically-minded botanist residing in the district, undoubtedly enhance the value of the book and secure for it more than the local interest that attaches to a merely floristic work.

Photo.] [*H. F. Poole.*

FIG. 2.—White Stork—a rare visitor—captured at Shorwell in 1902. From "A Guide to the Natural History of the Isle of Wight."

The second suggestion we venture to make, with reference generally to books similar in scope to this "Guide," is that most of the systematists responsible for the various lists of plants and animals given in local naturalistic compilations would do well to obtain the cooperation of a biological botanist or zoologist when writing their prefatory remarks on the group of plants or animals they are dealing with. So far as this "Guide" is concerned, we refer chiefly, as examples, to the sections dealing with some of the cryptogamic plants. It would be far better for the average cryptogamic systematist to pass straight on to his list and say nothing whatever about the life-history and development of his group than to write a string of incoherent and inaccurate sentences, repeating and perpetuating long since exploded errors and mare's-nests. Lichenologists, we know, are a stiff-necked generation, but surely it is time they hesitated to record in print their refusal to recognise the dual nature of the lichen thallus, which has been fully and finally established. There can be no excuse, either, for the hepaticologist who tells us that the liverworts are "linked to the lichens" by means of their thalloid forms! The account of the relationship between the liverwort Frullania and the rotifer which sometimes occupies its pitchers is entirely imaginative. The list of hepatics (liverworts) is conspicuous by the omission of several species which are certainly found in the island, and often abundantly in places, such as *Anthoceros laevis*, *Scapania nemorosa*, and *Lepidozia reptans*.

The articles by Mr. G. W. Colenutt (geology), Mr. P. Wadham (fishes, mammals, &c.), and Mr. R. H. Fox (birds) stand out as refreshing oases in the arid desert of species lists, being written in a "nature-study" spirit which can hardly be said to characterise the work of the other contributors. The "Guide" is illustrated by twenty-six excellent plates, chiefly from photographs by Mr. H. F. Poole, two of which we are permitted to reproduce here. F. C.

SLEEPING SICKNESS.[1]

IT may be taken as definitely established that sleeping sickness is due to infection with a trypanosome (*Trypanosoma gambiense*), and that this trypanosome is conveyed by a tsetse-fly (*Glossina palpalis*). But if we proceed to analyse and extend this proposition we soon get into difficulties. We do not know for certain whether man is the only "reservoir" of this trypanosome, or whether monkeys and other mammals, especially native dogs, can also harbour it. Should this prove to be so—though the balance of evidence is against the supposition—it must materially affect prophylactic measures. If we consider next the mode by which the trypanosome is conveyed we find ourselves in the midst of the most conflicting evidence. It is still uncertain whether the transmission is mechanical or whether there is a cycle of development[2] of the trypanosome in the fly; facts appear to be all in favour of the first view, analogy all in favour of the latter. Nor is the question a purely academical one, for if the transmission is mechanical, then the flies are no longer infective after the infecting reservoir (man) is removed; if, however, there is a cycle of development, then it remains to be determined how long an infected fly can remain infective after the infecting source is removed.

If, again, we consider the question, Can sleeping sickness be conveyed by any other species of tsetse-fly than *Gl. palpalis?* we must confess our ignorance. The balance of evidence certainly seems to be against the possibility, but should it be shown that other species can convey the disease, then the question of prophylaxis would be even more difficult than it now is. These reports show that these are some of the questions that urgently need solution, but there are others of equal importance which arise in the immediate carrying out of prophylactic measures. They concern the fly itself, its habits, duration of its life, its breeding grounds, its food, its powers of flight, its likes and dislikes in regard to foliage, trees, shrubs, grass, &c. These questions are all important, and

[1] "Reports of the Sleeping Sickness Commission of the Royal Society." No. ix.

[2] The existence of such a cycle is now practically established by the recent work of Kleine confirmed by Bruce.

in our opinion it is imperative to appoint one or more officers with special entomological knowledge to study these points minutely. It is true that these reports afford evidence that the officers concerned in these investigations have made additions to our knowledge on these points, but the other duties of these officers are so multifarious that valuable time is being lost through this defect. It is true also that in the epidemic in Uganda the condition of things is so terrible that it is impossible to wait for the solution of all these questions, however important, before any action is taken, and we may now consider what, with the present available knowledge, is being done to check the epidemic. The means of prophylaxis may be considered under three aspects:—(1) Those directed against the fly; (2) those directed against the carrier of the trypanosome, *i.e.* man; (3) those directed against the trypanosome itself.

(1) With regard to measures directed against the fly. It has been found, and it is a matter of the highest importance, that the "natural range" of the fly, *i.e.* the distance to which flies follow from water in search of blood, is, as a rule, under 50 yards. The still more important fact has been determined that clearing and burning or removing the undergrowth for a distance of 100 yards in either direction, *e.g.* from a ferry for a strip 50–100 yards broad, has the effect of banishing the fly. It is this method, then, *i.e.* banishing the fly by clearing from its "normal fly range," that is the basis of the methods now being carried out in Uganda. It is not necessary to clear extensively around a village, but simply to clear comparatively small strips of the "fly range" frequented by man. Although flies may occur in the village itself, unless there is a "fly area" present these flies are those which have followed their victims beyond the "fly range" to the village. If the flies of the "fly range" are banished, then, *ipso facto*, the "following" flies also disappear. A typical fly area, though there are exceptions, consists of more or less open water with contiguous and especially overhanging shade and generally a fairly well-defined bank or shore. If, then, clearing can permanently banish the fly, and we believe that this will be found to be the case, because the fly still has plenty of uncleared area to frequent—though the fact that its human blood supply is at the same time removed may modify the result—it is an important measure of prophylaxis, though its value is perhaps restricted to somewhat small areas and special conditions.

If the fly cannot be removed by clearing, then the population must be deported from the vicinity of the fly. This measure has been extensively carried out in Uganda by the removal of populations from the lake to inland fly-free areas two miles away, to prevent traffic from the lake, which is responsible for the great bulk of the infection; but in many cases there are serious difficulties in the way. Further, the removal of populations still non-infected from a potentially dangerous fly area to a safe fly-free area would be of the greatest importance, and would form a more striking object-lesson to the native of the value of these measures than the removal of an infected population, because a certain, probably high, percentage of these latter will eventually die of sleeping sickness, although in a safe area; whereas this would not be the case if the population removed was non-infected.

(2) As the two measures, clearing and deportation, of the healthy, are undertaken with the object in view of preventing access of the fly to man, so segregation of the sick prevents fresh infection of the fly, and diminution of the infectivity of the fly in a fly area. This implies the removal of the sick of a village to another village or camp in a fly-free area, and it is important to note that such areas are numerous, and may often be only a few hundred yards away. Fresh infection of the fly is also avoided by preventing the removal of infected natives to uninfected fly areas. The applicability of this measure depends mainly upon the "attitude" of the native.

(3) Measures directed against the trypanosome itself, *i.e.* the treatment of infected persons, are bound up closely with the segregation of the sick. The treatment of the segregated in fly-free areas by atoxyl or other arsenic preparations is the only one that is at all effective, but it must be admitted that the results are disappointing, and that the good results of the drug are in many cases only temporary. The patient's blood becomes free from trypanosomes (and presumably non-infective, though this is not proved), and so the chance of infection of the fly, if patients come in contact with fly areas, becomes less.

Time will show how far these measures, the numerous important details of which we have to leave unconsidered, will be successful. Those engaged in carrying out these arduous and dangerous measures have hope that although sleeping sickness may not be eradicated or the fly totally annihilated, yet that the epidemic will soon be under control. It must be the sincere wish of everyone that this hope may be justified.

J. W. W. S.

THE CONTAMINATION OF MILK.

THE contamination of milk has been the subject of a detailed research by Dr. Orr, carried out on behalf of the councils of the county boroughs of Bradford, Hull, Leeds, Rotherham and Sheffield, and the administrative counties of the East and West Ridings of Yorkshire. Of previous investigations, Delépine concluded that though his results did not exclude the possibility of infection at the home of the consumer, or during transit from the farm, they did indicate that infection at the farm, or through vessels infected at the farm and used by the farmer for the storage and carriage of milk, was of paramount importance. On the other hand, Newsholme attaches little importance to infection at the cowshed. Dr. Orr's investigation was carried out in a systematic manner, and not only were the bacteriological examinations carefully performed, but, in addition, the condition of the cows and cowsheds and the effects of season and atmospheric temperature were noted. First, the bacterial content of the milk in the udder was estimated, and it was found that the fore-milk (that first milked) contained from 18,000 to 48,000 microorganisms per cubic centimetre, and the milk after the removal of the fore-milk 890 to 4800 per cubic centimetre.

It is generally agreed that the milk as secreted is sterile, the microorganisms in the milk as drawn being derived from lodgment and multiplication in the teats and cistern.

Dirt on the udder is a fruitful source of contamination, and, during milking, dust, &c., from the udder adds much to the bacterial content of the milk. Dust in the cowsheds, and the entrance of dirt during transit and delivery, further add to the contamination, so that the milk, when it reaches the consumer, may contain an appalling number of microbes. The chief conclusions derived from Dr. Orr's work are:—

(1) Of the total organisms in the milk used by the consumer, the greatest number are contributed by the farmer. During railway transit, at the retailer's premises, and in the consumer's house, smaller amounts are added, the amount in each instance being apparently about the same.

(2) Of the glucose-fermenting or intestinal organisms and the streptococci, by far the greatest number are added

at the farm. The retailer adds a certain number, the consumer none.

(3) The sediment or "dirt" gains entrance to the milk chiefly at the cowshed. In 86·8 per cent. of the samples examined there was no increase in the sediment when sold by the retailer, but a decrease in 68·8 per cent.

(4) The farmer was responsible for the *Bacillus enteritidis sporogenes* (Klein) in the milk consumed in 66·6 per cent. of the samples. In 11·1 per cent. of the samples these bacilli were added by the retailer or the consumer, while in 22·2 per cent. the source was doubtful.

Various suggestions are made for improving the milk supply, and the imposition of the following standards is advocated:—

(1) A bacterial standard of not more than 50,000 organisms per c.c.

(2) Milk not to contain glucose-fermenting bacteria in less than 1/10 c.c.

(3) A sediment standard (at first) not exceeding 40 volumes per million.

Altogether, this report on the milk supply is one of the most important that has appeared in this country, and should be brought to the notice of all producers and retailers of this important article of diet.

THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION.

WE are now in a position to give some further details about the local arrangements for the British Association meeting in Winnipeg during the last week in August next, and also the provisional programmes of the sections.

The Drill Hall will be used as the reception room. The main floor is 147 feet by 87 feet, so that there is no fear of undue crowding. Arrangements will be made for free access to the Parliament building grounds adjoining.

On the opposite side of Broadway are the University building and grounds. The University is a small and by no means beautiful structure. It resembles, in fact, in size and general style the public elementary schools of the city. But it must be explained that the University at present only teaches scientific subjects. Arts, medicine, and agriculture are taught in "affiliated" colleges which are scattered in various parts of the city. Thus, the classics and modern languages are taught in the four "affiliated" denominational colleges, St. Boniface (Roman Catholic), St. John's (Church of England), Manitoba College (Presbyterian), and Wesley College (Methodist); medicine is taught in the Manitoba Medical College, and agriculture in the Manitoba Agricultural College (Provincial Government) at Tuxedo Park. The University of Manitoba (also a Government institution) has been a teaching institution for five or six years. Founded in 1871 as an examining board, the University itself at present undertakes instruction in mathematics, chemistry, physics, botany, physiology, pathology and bacteriology, and civil and electrical engineering. But chairs in English history and political economy have been recently established, and these new departments will commence work next October. The government and organisation of the University is undoubtedly in an unsatisfactory state, and is, in fact, the subject of a Government Commission at the present time. There is a widespread feeling that the province ought to have a provincial university of the type provided in many States of the Republic to the south, and entirely free from any denominational influences.

Five of the sections (B, D, G, I, K) will meet in the University building. Section A will find its temporary home in Wesley College, where three rooms will be set aside for the meetings. Section E will be placed in the Convocation Hall at Manitoba College, and Section F in a class-room of the same institution. Section L will have the honour of sitting in the Legislative Chamber of the Provincial Government, while agriculture (subsection of K), and Sections H and C, will meet in the Alexandra, Carlton, and Isbister Schools respectively.

All these meeting places are conveniently near the reception room.

The local sectional secretaries are as follows:—A, Prof. F. Allen, professor of physics, University of Manitoba; B, J. W. Shipley, assistant to the professor of chemistry, University of Manitoba; C, R. T. Hodgson, Brandon Collegiate Institute, Brandon; D, C. A. Baragar, University of Manitoba; E, Alex. McIntyre, Normal School, Winnipeg; F, W. Manahan, Winnipeg; G, Prof. E. Brydone-Jack, professor of civil engineering, University of Manitoba; H, not yet appointed; I, Dr. Wm. Webster, demonstrator of physiology, University of Manitoba; K, Prof. A. H. Reginald Buller, professor of physiology, University of Manitoba; Principal W. J. Black, Manitoba Agricultural College; L, D. M. Duncan, registrar of the University of Manitoba.

University of Manitoba. (For Sections B, D, G, I, and K.)

A few hints to travellers may not be out of place. For the ocean voyage, heavy coats and wraps and a travelling rug would be great comforts, if not absolute necessities, as it is never very warm on the North Atlantic route. These, however, should be packed away for the overland journey, otherwise they will give rise to considerable inconvenience.

Travellers from Europe are specially warned not to carry with them in the train more baggage than is absolutely necessary for the journey. Each person ought, indeed, to be content with a suit-case and perhaps a small handbag. All kit-bags, gladstone bags, and such like are quite out of place, as there is no space provided for these, and they may be a great nuisance to everybody. An elaborate toilet, at any rate, is not possible during the railway journey, but the railway companies' sleeping cars are provided with sufficient lavatory accommodation. Everything except the suit-case and hand baggage should be *checked through* to destination.

To any American, or indeed to anyone who has ever travelled on the North American continent, such advice may seem quite superfluous, but it is rare that one travels across the country or witnesses the departure of trains without noticing some Englishman struggling to convey huge piles of luggage into a railway car; he is usually prevented from so doing by the porter, but if he succeeds his belongings soon become a trouble to himself and a nuisance to his fellow-travellers.

In regard to clothing, for Winnipeg during the week of the visit travellers should be provided with the same sort of selection as would be desirable at a meeting in Great Britain. The days in the latter part of August are usually hot, and the nights pleasantly cool. Those undertaking the excursion to the Pacific coast should be provided with some warm clothing for the mountains.

Manitoba College. (For Sections E and F.)

Those intending to visit Winnipeg for the meeting have been provided with postcard forms to fill in, giving various particulars of use to the local committee. These may be obtained from the assistant secretary in London, and should, with any other communications with regard to the meeting, be addressed to the local secretaries, University of Manitoba, Winnipeg.

In connection with the meeting, arrangements have been made by Mr. M. B. Cotsworth, of the Natural History Society of British Columbia, Victoria, B.C., on behalf of some of the members of the Association, to make a trip northward along the Pacific coast from Victoria or Vancouver to Alaska. The journey to Prince Rupert, Skagway, and back occupies ten days, costs about 14*l*., and may be made either before the meeting at Winnipeg or from September 10 to 19. An extension to Dawson (Klondike) and back brings the total time up to three weeks, and the cost to about 32*l*., while the round trip from Vancouver to Dawson, thence down the Yukon river to Nome and back by the Bering Sea and Aleutian Islands, occupies about a month, and costs 40*l*. Climatic considerations, however, make it desirable to carry out such extended trips before the meeting, and it is understood that some members have already arranged to do this. The excursions are not among the official arrangements of the Association, but further particulars may be obtained from the London office, Burlington House, W.

We are informed that Sir Joseph Thomson, in his presidential address to the Association, will touch on the following subjects:—The importance of original research as a means of education; the advantages and disadvantages as a training for work in science of the systems of education now in force in our schools and universities; the light thrown by recent investigation on the nature of electricity; on the relation between matter and æther, and the part played by the æther in modern physics; and a discussion of some problems raised by the discovery of radium.

SECTIONAL PROGRAMMES.

SECTION A (MATHEMATICAL AND PHYSICAL SCIENCE). President, Prof. E. Rutherford, F.R.S.—The arrangements for the meetings of this section are at present very provisional. After the address of the president of the section, the most important items in the provisional programme are two discussions, one on positive electricity, to be opened by Sir J. J. Thomson, F.R.S., and the second on earth tides, to be opened by Prof. A. E. H. Love, F.R.S. The papers promised include the following:—photographs of recent comets, Prof. E. Barnard; new photographs of Jupiter taken at Flagstaff Observatory, Percival Lowell; on sun-spots and magnetic effects, Dr. L. A. Bauer; the structure of the stellar system, G. C. Comstock; the asymptotic expansions of Legendre functions, Dr. J. W. Nicholson; on a continuant expressed as the product of linear factors, W. H. Metzler; luminosity and persistence-of-vision curves, Prof. Frank Allen; variation of the specific heat of mercury at high temperatures, Prof. H. T. Barnes; the effect of temperature-variations on the luminous discharge in gases for low pressures, R. F. Earhart. This list includes only those papers for which definite titles have been received; many others are promised. Friday morning, August 27, will be set aside for papers of interest to chemists, and the section will meet in joint session with Section B (Chemistry).

SECTION B (CHEMISTRY). President, Prof. H. E. Armstrong, F.R.S.—The provisional programme is as follows:—Joint sitting with the Section of Botany and Subsection of Agriculture to discuss "wheat" from several points of view, including requirements of the wheat crop, influence of external conditions, review of the chemical work on strength, the miller's requirements, wheat breeding, the history of the wheat plant, and the economics of the subject. (See programme of the Subsection of Agriculture.) Joint sitting with the Physiology Section to discuss food. Combustion, Prof. W. A. Bone, F.R.S.; chlorophyll, Prof. Willstätter; papers dealing with the physical chemistry of sulphur, Prof. Alex. Smith; (1) rotatory dispersion, (2) the cadmium arc, Dr. T. M. Lowry; (1) mercurous sulphate for standard cells, (2) on the constancy of the hydrogen gas electrode, Dr. C. J. J. Fox. Reports of committees:—(*a*) hydroaromatic substances; (*b*) aromatic nitroamines; (*c*) electroanalysis; (*d*) dynamic isomerism. This report will be presented in such form as to initiate discussion.

SECTION C (GEOLOGY). President, Dr. A. Smith Woodward, F.R.S.—Dr. Woodward's presidential address will be on the evolution of the vertebrates. There will be reports of research committees on:—the erratic blocks of the British Isles, Dr. A. R. Dwerryhouse; the fauna and flora of the Trias of the British Isles, which will be supplemented by an account of the progress of this investigation, illustrated by lantern slides, H. C. Beasley; and the fossiliferous drift deposits of Kirmington, Lincolnshire, and the East Riding of Yorkshire. This is the final report of the Committee. The papers will include:—the composition and origin of the crystalline rocks of Anglesea, E. Greenly; the faunal succession in the Carboniferous Limestone of the British Isles, Dr. A. Vaughan, which will be supplemented by an account of the progress of these researches, illustrated by lantern slides, by Prof. Sidney H. Reynolds, of Bristol; critical sections in the Palæozoic rocks of Wales and the west of England, W. G. Fearnsides; the microscopical and chemical composition of Charnwood Rocks, Prof. T. T. Groom; the igneous and associated rocks of Glensaul and Lough Nafovey areas, co. Galway, Prof. S. H. Reynolds; geological photographs, with illustrations of British scenery in relation to geology, Prof. S. H. Reynolds; the Glacial Lake Agassiz, Prof. Warren Upham; the advances in the knowledge of the glacial geology of South Wales, Dr. Aubrey Strahan; unconformities in limestone and their contemporaneous pipes and swallow-holes, E. E. L. Dixon; on new faunal horizons in the Bristol coalfield, Herbert Bolton; on the Permian succession in the north of England, Dr. D. Woollacot; a mineralogical paper, A. Hutchinson. Prof. J. W. Gregory, F.R.S., and Dr. Tempest Anderson are now making extended tours in Australia and the South Seas, and it is expected that they will have valuable and interesting communications to make to the section. An extended tour for four days has been arranged to the mining districts of Corall and Sudbury, under the direction of Prof. W. G. Miller, and Dr. J. W. Spencer will lead a party to Niagara and the glacial outlet of Lake Erie.

SECTION E (GEOGRAPHY). President, Sir Duncan Johnston, K.C.M.G.—The following are among the papers to be brought before the section:—some characteristics of the Canadian Rockies, A. O. Wheeler; the evolution of wheat culture in North America, Prof. A. P. Brigham; water routes from Lake Superior to the west, Lawrence J. Burpee; Yellowhead Pass and Mt. Robson, the highest point in the Canadian Rockies, Prof. A. P. Coleman; the influence of traffic or transportation upon the framework of cities, with an introductory reference to the influence of geography in the same direction, G. E. Hooker; the cycle of Alpine glaciation, Prof. W. H. Hobbs; the teaching of geography in secondary schools in America, Prof. R. E. Dodge (to be read at a joint meeting with Section L); the formation of arroyos in the south-west of the United States, Prof. Dodge; the development of Nantasket Beach, near Boston, Mass., Prof. D. W. Johnson; floods in the great interior valley of America, Miss Luella A. Owen; the precious metals as a geographical factor in the settlement and development of towns in the United States, Prof. Hubbard. Mr. J. Stanley Gardiner, F.R.S., will give a lecture, illustrated by lantern slides, on his work in the Seychelles, and there will probably be papers also by Prof. Goode, Dr. C. H. Leete, and Prof. Hoke.

SECTION G (ENGINEERING). President, Sir W. H. White, K.C.B., F.R.S.—In addition to Sir W. H. White's presidential address, a report will be presented by the committee on gas explosions, and a paper on the some subject will be contributed by Mr. Dugald Clerk. Other papers are as follows:—Skimming boats, Sir John Thornycroft; the Isthmian Canal, Col. Goethals; the work of the International Electrotechnical Commission, Ormond Higman; torsion tests on materials, C. E. Larrard; dielectric stress in three-phase cables, Prof. W. M. Thornton. Papers on grain handling and transportation in Western Canada, on the navigation of the St. Lawrence, and on high-tension overhead lines are in preparation.

SECTION K (BOTANY). President, Lieut.-Colonel D. Prain, F.R.S.—The following are some of the communications to be brought before the section:—*On Thallophyta:* On the production, liberation, and dispersion of the spores of Hymenomycetes, Prof. Buller; numerical determinations of the bacteria in the air of Winnipeg, Prof. Buller and Mr. Lowe; the nuclear phenomena of Ascomycetes in relation to heredity, Miss H. C. I. Fraser; the nucleus of the yeast plant, H. Wager, F.R.S., and Miss Peniston; some problems connected with the life-history of *Trichodiscus elegans*, Miss E. J. Welsford. *Ecological papers:* The fundamental causes of succession among plant associations, Prof. H. C. Cowles; some observations on *Spiraea Ulmaria*, Prof. Yapp. *Other papers:* A paper on the anatomy of the Osmundaceæ, Prof. Gwynne-Vaughan; (1) the evolution of the inflorescence, (2) the rubber industry, J. Parkin. The annual semi-popular lecture will be given by Mr. Harold Wager, F.R.S., on the perception of light in plants. In addition to the above, there will be a joint sitting with Section B and the Agricultural Subsection of K for a discussion on "wheat." Dr. O. Stapf, F.R.S., will contribute a paper towards this discussion, on the systematic history of wheat. Several other papers have been promised by prominent American botanists, but the titles are not yet to hand.

SUBSECTION K (AGRICULTURE). President, Major P. G. Craigie, C.B.—*Joint meetings:* (1) With the Economic Section, Thursday afternoon, August 26. The future possibilities of extending the food production of Canada, Prof. Mavor. (2) With the Chemical and Botanical Sections, Monday morning, August 30. Subject, wheat problems. Papers:—the miller's requirements; a review of recent chemical work on the strength of wheat, Dr. E. F. Armstrong; factors determining the yield of wheat, A. D. Hall, F.R.S., and Dr. E. J. Russell; milling properties of certain Canadian wheats, Prof. R. Harcourt; Canadian wheats, F. T. Shutt; wheat breeding in Canada, C. E. Saunders. Papers also by Dr. W. Saunders and by C. A. Zavitz. *Ordinary meetings:* Presidential address, Major Craigie; methods of crop reporting in different countries, E. W. Godfrey; the experimental farm system in Canada, Dr. W. Saunders; the fruit industry of British Columbia, R. W. Palmer. *Prairie soil problems:* Geography of the prairie soils, R. W. Brock; chemical characteristics of the prairie soils, F. T. Shutt; soil moisture and crop production, Prof. F. H. King; soil moisture as related to dry farming, Prof. F. J. Alway. Papers by A. D. Hall, F.R.S., and Dr. E. J. Russell. *Live-stock problems:* Paper by Prof. W. Somerville; the evolution of a breed of cattle, Prof. J. Wilson; some special features of the Danish system of cattle breeding, P. A. Morkeberg; paper by J. G. Rutherford. *Forestry problems:* Paper by Prof. W. Somerville; Canadian forest resources, R. H. Campbell; the insect pest problem, Prof. Lochhead; some forestry problems of the great plains of North America, C. E. Bessey.

SECTION L (EDUCATIONAL SCIENCE). President, Dr. H. B. Gray.—After the president's address on August 26 a discussion on moral instruction in schools will be opened by Prof. L. P. Jacks, editor of the *Hibbert Journal*. He will be followed by Mr. Hugh Richardson, and it is hoped that American and Canadian educationists will also take part. On Friday, August 27, there will be a discussion on practical work in schools, which will be opened on behalf of the subcommittee of the association which is now considering the question by Mr. W. M. Heller. Dr. C. W. Kimmins will contribute some account of the London trades schools, Miss Lilian J. Clarke will speak on practical work in girls' secondary schools, and Mr. W. Hewitt on practical work in evening and continuation schools. On Monday, August 30, there will be a joint meeting with the Geographical Section of the association for the discussion of geography teaching. Prof. R. E. Dodge, of Columbia, and Mr. G. G. Chisholm, of Edinburgh, are expected to open the discussion. There will also be a discussion on the relations of universities and secondary schools, with special reference to the accrediting and examining systems. On August 31 the president of the section will open a discussion on education as a preparation for agricultural life, with special reference to Canadian conditions. Should time permit, it is also intended to discuss the subject of consolidation schools. The organising committee of the section is in correspondence with educationists in Canada and America, and it is hoped to arrange that each subject shall be opened by representatives of American, Canadian, and British education.

NOTES.

We announce with deep regret the death of Prof. Simon Newcomb, Foreign Member of the Royal Society, on July 11, at seventy-four years of age.

The next international congress of mining and metallurgy is to be held in June, 1910, at Dusseldorf. The last congress was in 1905, and the place of meeting Liége.

At an audience on July 10, the King conferred upon Mr. E. H. Shackleton the Insignia of a Commander of the Royal Victorian Order in recognition of his work in the Antarctic.

It is stated by the St. Petersburg correspondent of the *Globe* that a Bill for the substitution of the new style for the old style of date reckoning in Russia will be brought before the Council of the Empire and the Duma in the autumn. There is at present a difference of thirteen days between the Russian calendar (old style) and the reformed Gregorian calendar introduced in 1582 and used in our country since 1752.

Another exhibition, arranged in connection with the *Model Engineer*, on similar lines to that which proved successful in 1907, will be held at the Royal Horticultural Hall, Westminster, S.W., in October next. The exhibits will include engineering models, electrical and scientific apparatus, lathes and light workshop appliances, model aëroplanes, and technical education equipment. An attractive feature will be the exhibits in the competitions for model and scientific apparatus making, several classes for both amateur and professional workers having been arranged, for which valuable prizes are being offered. Full particulars may be obtained from the organisers, Messrs. Percival Marshall and Co., 26–29 Poppins Court, Fleet Street, London, E.C.

The first Gustave Canet lecture was delivered by Lieut. Trevor Dawson at the twenty-fifth anniversary meeting of the Junior Institution of Engineers on June 30. The lecturer is the recipient of the first gold medal, which is to be awarded every fourth year by Madame Canet in memory of her husband, the award being made through the council of the institution. In his lecture, Lieut. Dawson gave many instances of the increased power and accuracy of guns. One photograph showed six 100-lb. shots striking the water, having been fired as a volley from 6-inch guns on a British cruiser at a range of 7300 yards. The total space embraced by the six shots was only 88 yards. Towards the end of the lecture the question of airship attack was dealt with, and the special ordnance to be used against these vessels described.

The British and Irish Millers' Convention was held at Chester on July 7, when a paper was read by Mr. A. E. Humphries, of Weybridge, on "Ideal British Wheats." Mr. Humphries pointed out that the British farmer no longer grows what the miller wants; instead of producing a strong wheat, capable of making large, shapely loaves, he produces a weak wheat, the flour from which is usually a drug in the market. The home-grown wheat committee of the British Millers' Association has been investigating the question of improvement, and is very hopeful about the future; it is believed that wheats will be produced of better quality, with better straw, less susceptibility to disease, and greater cropping power than those now available. The committee asks for a national cereal-breeding station, and commends this to the Board of Agriculture and the Chancellor of the Exchequer as one important means of agricultural development.

At the end of last year we observed with regret the report that Mr. James Parsons, principal mineral surveyor of Ceylon, had disappeared in the jungle, and his death was presumed. It seems that on the morning of December 29 last Mr. Parsons left his hotel at Nuwara Eliya for a walk in the open country, intending to return in time for lunch. About noon he was seen traversing a certain tea-estate, but from that date he was never seen alive. We now learn that, after three months' search, his remains were found in the jungle on April 11. Death was probably due to exposure. Mr. Parsons went to Ceylon in 1902 as assistant to Dr. A. K. Coomaraswamy to undertake a mineralogical survey of Ceylon. On Dr. Coomaraswamy's retirement he took his place in 1906. His last writings were two papers in *Spolia Zeylanica* on fluor-spar in Ceylon and votive offerings of weapons.

The recently issued account of the income and expenditure of the British Museum for the year ended March 31 last, and the return of the number of persons admitted to visit the Museum and the Natural History Museum, South Kensington, in each year 1903 to 1908, both years inclusive, provides much information of interest. The number of visits made by the public to the Natural History Museum during 1908 was 517,043, as compared with 497,437 in 1907, showing an increase of 19,606. The attendance on Sunday afternoons showed a slight falling off, the figures being 65,986, as against 66,367 in the previous year. The average daily attendance for all open days was 1420·4. The total number of gifts received during the year by the several departments was 2259, as compared with 2105 in 1907. Among other donors may be mentioned Mr. F. D. Godman, valuable collections of insects from Central America and other localities, and a series of water-colour drawings of butterflies of the family Hesperiidæ; the Hon. Walter Rothschild, mounted specimens of a male and female Californian sea-elephant, from the island of Guadeloupe, and a male sea-lion from California; the trustees of the Percy Sladen Fund, a large collection of reptiles, batrachians, and fishes from the Seychelles, Chagos Islands, and the Indian Ocean; Mr. C. D. Sherborn, a valuable collection of specimens of the handwritings of naturalists, consisting of some 8000 letters and other documents; and Mrs. R. P. Murray, the extensive herbarium made by the late Rev. R. P. Murray, comprising about 15,000 sheets.

According to the curator's report for 1908–9, the Otago University Museum at Dunedin has been augmented by a new wing—the Hocken wing—which will shortly be opened to the public, and is mainly devoted to art and literature. A living tuatara lizard has been kept alive for some time on the museum premises.

The report of the Rhodesia Museum at Bulawayo for 1908 shows continued progress on the part of that comparatively juvenile institution, despite the fact that one source of revenue has been cut off, while the Government has declined to be responsible for an annual subsidy to the funds. The largest increase to the collection has taken place in the entomological section.

The most important additions to the Giza Zoological Gardens, as we learn from Captain Flower's report for 1908, were the hippopotamus and the Nubian bustard. The curator finds it necessary to take special precautions to protect the smaller mammals and birds from nocturnal four-footed marauders, of which the worst is the jungle-cat, although jackals, dogs, and foxes also do much harm. During the year a jungle-cat killed a pelican. The pro tective measures rendered necessary by these raids have given rise to protests from European visitors ignorant of the true facts of the case.

Naturwissenschaftliche Wochenschrift for June 27 includes an illustrated article, by the Rev. E. Wasmann, on the origin of slavery and social parasitism among ants, in which it is urged that, before these can be properly understood, it is essential that we should acquire a knowledge of a series of independent developmental histories of different species, genera, and subfamilies, which commenced in past geological times. Only with such histories before us will it be possible to construct anything like a true working hypothesis of the origin of the phenomena in question.

To Mr. G. Gilson, director of the Royal Museum of Natural History of Belgium, we are indebted for a copy of an address read before a conference held in the apartments of the Royal Zoological and Malacological Society of Belgium on June 12, on the subject of the proposed establishment of an educational museum in Brussels. The address is chiefly concerned with the aims and objects of such a museum and the manner in which the scheme should be carried out. A teaching museum, it is urged, should be kept entirely apart from museums of the ordinary type, and run on totally different lines. As regards the selection and installation of the objects to be shown in the museum, it is pointed out that this task should be entrusted, in the first instance, to scientific experts, but that after this the collections should be handed over to the actual teaching staff.

To the July number of the *Century Magazine* Mr. R. W. Yerkes contributes an article on "imitation in animals," a considerable portion of which is devoted to an account of the behaviour of three Manx kittens, which had never previously seen mice, when confronted with one of these rodents. When the first introduction was made the kittens were five months' old, and the mouse was uninjured. Six weeks later the experiment was repeated, when the kittens were hungry, but still no attempt was made to devour the mouse. Later on the parent cat was introduced into the cage, when the mouse was killed by her, and, little by little, the kittens eventually learnt to follow their mother's example. The experiments, in the author's opinion, serve to show that these particular kittens had no instinctive propensity to kill and eat mice, and that they only learnt to do so by the force of example. Whether this holds good for kittens generally remains to be proved.

UNDER the title of *Technitella thompsoni* (after Prof. D'Arcy Thompson) Messrs. E. Heron Allen and A. Earland describe in the Journal of the Quekett Microscopical Club a new species of arenaceous foraminifera which constructs its enveloping test entirely out of regularly arranged calcareous plates of echinoderms. Of this foraminifer two specimens only have been found from dredgings in the North Sea. It possesses no oral aperture, the perforations in the echinoderm plates furnishing a sufficient outlet for the pseudopodia. Other species of the genus make their tests out of sponge spicules, but it is believed that the present species stands preeminent in its selective power of building material.

THE annual address to the Armstrong College Agricultural Students' Association, by Mr. A. Tindall, has been printed in the Proceedings of that body, and will be interesting to students of agricultural economics. It deals with the history and development of the Newcastle cattle market, and includes a number of valuable statistics, such as prices of cattle, &c., as well as accounts of sale customs. In the same publication will be found a short article on milk production and milk products by Mr. John Anderson.

THE United States Department of Agriculture Bureau of Entomology has issued a circular (No. 42) on the control of the San José scale. This pest has, in the past, proved a serious menace to the fruit-growing industry, but experience both in California and in the eastern States shows that it can be controlled. Seven methods have proved successful when properly carried out, viz. :—(1) the lime-sulphur wash; (2) soap wash; (3) pure kerosene; (4) crude petroleum; (5) mechanical mixtures of either of these two oils with water; (6) petroleum emulsion and soap; (7) miscible oils. Instructions are given for carrying out each of these methods.

BULLETIN No. 166 of the Maine Agricultural Experiment Station contains a discussion, by Messrs. Raymond Pearl and Frank M. Surface, of the inheritance of fecundity in poultry. The daughters of "200-egg" hens (*i.e.* hens laying 200 or more eggs in twelve months) were kept under observation. It is, as yet, too soon to draw general conclusions, but no evidence was obtained to show that a good winter layer necessarily produces another good winter layer, as is said to be assumed by practical poultry-breeders. On the contrary, the exact opposite happened here: the mothers, on the whole, were exceptionally good, and the daughters unusually poor, as winter layers.

RECENT bulletins from the Colorado Agricultural College include three on strawberry growing, dewberry growing, and the pruning of fruit trees, one on animal diseases, and one on bacterial diseases of plants. A disease of lucerne, first described by Paddock in 1906, and shown to be bacterial, is dealt with at some length. The bacteria seem to come from the soil and work up the stem, giving rise to a "watery, semi-transparent brownish appearance of the tissue, which turns black with age." Blisters are present, containing a sticky, yellow liquid swarming with bacteria. Other diseases dealt with are pear blight, soft rot of sugar beet, black rot of cabbage, bacterial blights of the potato family, of beans, and of cucumbers; specific organisms have in several of these cases been isolated.

THE endoparasites of Australian stock and native fauna form the subject of two papers by Dr. Georgina Sweet, of the Melbourne University. The work, which is still going on, aims at making a systematic and thorough inquiry into the nature of the internal parasites infesting Australian animals, both native and domesticated, and then into the life-history and conditions of increase and spread of these injurious forms. The work is both of scientific and practical importance; species exist in Australia that have not been recorded elsewhere, and it is desirable that their life-histories should be worked out; methods of control are also necessary, since Australia is largely dependent on its livestock, and suffers great losses of revenue as a result of parasitic diseases. In part i. the author gives a census of forms recorded up to date, in which the work of Dr. N. A. Cobb in New South Wales and others has been drawn upon; part ii. contains the new and hitherto unrecorded species.

WE are in receipt of the *Journal of Agriculture of South Australia*, a publication which is devoted almost exclusively to practical matters of local interest. The statistics for 1907 are discussed in one of the articles. The area under crop was 2,265,017 acres, nearly one-fourth of the whole area of the State, and 100,000 acres more than in the previous year. South Australia was at one time the granary of Australia, but here, as elsewhere, there is a strong tendency for other branches of husbandry to be taken up, and for wheat to lose in relative importance. The exports of wool were nearly 51 million pounds, again a considerable increase on the previous year. The acreage under barley and oats is the highest on record, while the fruit industry has made very rapid progress. Perhaps the best indication of improvement in method is found in the increasing use of artificial manures. Not many years ago the use of artificial manures was practically unknown. In 1897 it is estimated that 3000 tons were used for cereal crops; the consumption then steadily increased, and has been uniformly greater every year; in 1906 no fewer than 59,000 tons were used. In another article there is an account of the Roseworthy Agricultural College, an institution which not only provides instruction for those intending to be farmers, but also conducts investigations in the area it serves.

A friendly, and for the most part favourable, criticism of forest practice is provided by an American forester, Mr. B. Moore, in an article on the forests of northern India and Burma, published in the April and May numbers of the *Indian Forester*. He expresses a very decided opinion in favour of a regulated fire policy for forests of young teak and sal where the forests are situated in a moist climate, as in Assam. He also agrees with those who consider that Indian foresters in training should gain their practical experience in India.

A series of papers by Dr. B. L. Robinson, Miss A. Eastwood, and Mr. H. H. Bartlett, describing chiefly new or little-known Mexican and Central American plants, are collected in vol. xliv., No. 21, of the Proceedings of the American Academy of Arts and Sciences. The most important is the synopsis of Mexican species of Castilleja, with diagnoses and clavis compiled by Miss Eastwood; seventeen new species contribute to a total of fifty-four species for the genus. Dr. Robinson furnishes a revision of the genus Rumfordia with six species, and diagnoses of various tropical American phanerogams. New identifications are presented by Mr. Bartlett in a synopsis of American species of Litsæa and other articles.

Mr. G. Massee is responsible for two articles in the *Kew Bulletin* (No. 5), the one being a list of exotic fungi, the other a note on witches' broom of cacao. The latter is produced by a Colletotrichum receiving the specific name *luxificum*. Both vegetative and flowering branches are attacked, with the consequent production of hypertrophied shoots and flowers and diseased pods. The fungi are all new species of Boletus—except one Strobilomyces—collected by Mr. Ridley in Singapore. Another article in the bulletin is devoted to notes, by Richard Spruce, on the vegetation of the Pastasa and Bombonasa rivers, providing a description supplementary to chapter xvii. of the second volume of "Notes of a Botanist on the Amazon and Andes."

We have been favoured with a copy of the address delivered by Prof. J. W. Moll before the members of the Koninklijke Akademie van Wetenschappen te Amsterdam when presenting the dissertation of Dr. K. Zijlstra on the transport of carbon dioxide in leaves. Prof. Moll presents an excellent summary of the investigations, which prove that, to a limited extent, the transport of carbon dioxide is possible through the intercellular spaces; but it is obvious that such transport, if it takes place under natural conditions, is of no appreciable advantage to the plant, and could not enable the plant to absorb carbon dioxide from the soil. Thus the primary conclusion of Prof. Moll's original investigations is confirmed.

The prosperity of Egypt depends largely on the successful cultivation of the particular types of cotton known as "Egyptian." During the last twelve years, however, the yield of cotton has steadily and appreciably diminished, the loss amounting at current rates to about 5*l.* per feddan (1·109 acres). Many causes have been suggested as contributing to this result, and in "Cotton Investigations in 1908" (*Cairo Scientific Journal*, February, 1909) Mr. W. Lawrence Balls puts forward the view, for which there is some direct evidence, that a rise in the water-table in Egypt has been an important factor. Owing to improvements in irrigation, the supply of water in Egypt is greater than formerly, whilst the natural loss remains more or less constant. Artificial drainage is lacking, and in his view Egypt is in danger of becoming water-logged, in which condition the soil is rendered impervious to the roots of most plants. The remedy advocated is extension of the drainage system, an expensive proceeding, but justifiable if the reduced yield is due to the rise in level of stagnant water. Another important matter dwelt on in Mr. Balls's paper is the depreciation of cottons grown in Egypt owing to the hybridising of the Egyptian varieties by the less valuable "American Upland" races, cultivated because of their heavy yield. To combat this he proposes the breeding of a cotton bearing flowers in which the stigma is buried deeply amongst the stamens, thus reducing to a minimum the risk of natural crossing. The report is accompanied by a photograph of a section of such a synthesised flower. Egypt is leading the way in the practical application of Mendel's discoveries, for 1909 has seen the establishment by the Khedivial Agricultural Society of a Mendelian experiment station.

In the June number of *Folk-lore* Mr. T. C. Hodson, author of a valuable monograph on the Meithei tribe in Manipur, describes the custom of head-hunting among the hill tribes of Assam. The custom is, in the first place, ancillary to and a part of the funeral rite, which is affected by the social status of the deceased and the manner of his death. The funeral of a Kuki chief is incomplete without the head of a victim. The corpse is placed within the trunk of a tree, where it remains until it is sufficiently desiccated to allow of the preservation of the bones. The heads, again, are presented before piles of stones, the abode of the Lai, a powerful, mysterious entity, not always or necessarily anthropomorphised. The rite of deposition of the head of the victim is thus partly piacular, intended to propitiate the spirit of the deceased; partly religious, inasmuch as it is devoted to the vaguely conceived tribal spirit. The custom has also its social side, as success in a raid is held to be a proof of manliness, marking the transition from adolescence to maturity. It is also protective, because the spirit of the owner of the head becomes guardian of the village; and hence, as a necessary corollary, the head of a stranger is most highly valued, because, being ignorant of its surroundings, it is less likely to escape from the village of which, perforce, it has become protector.

An account of the life and philosophical doctrines of Henri Poincaré is given in the *Revue des Idées* for June 15 by M. Jules Sagret.

Prof. Garbasso, writing in the *Atti della Società italiana per il progresso della Scienza* (Rome: G. Bertero, 1909), discusses the structure of the atom, and gives a brief account of the theories of Briot, Kirchhoff, Bunsen, Helmholtz, Hertz, Lockyer, Kayser and Runge, Rydberg, Puccianti, Stoney, and J. J. Thomson.

IN the *Sitzungsberichte* of the Vienna Academy, cxvii., 8, 9, Dr. Philipp Forchheimer discusses certain mathematical solutions of the problem of underground flow of water in a homogeneous stratum bounded by a plane impervious floor, the equation of continuity in this case being the ordinary two-dimensional form of Laplace's equation, with the square of the depth as the dependent variable.

THE theory of the polar planimeter is treated in a novel way by Dr. Gabriele Torelli in the *Rendiconto* of the Naples Academy, xiv., 8–12 (1908). The author finds that the treatment of the subject given in text-books is far from convincing, and he proposes an alternative treatment based on the use of Jacobians. Those who have worked with planimeters in this country will fully agree with the author as to the need of a more satisfactory investigation of their principle, and if such a need exists in the case of the polar planimeter it is still more necessary for the so-called "hatchet planimeter," which is usually worked by rule, with little attempt, if any, to explain its principle.

AN important contribution to our theories of wave-propagation in wireless telegraphy is given by Prof. A. Sommerfeld in the *Annalen der Physik*, xxviii., pp. 665–736 (1909). The investigation, while taking account both of surface waves and of waves distributed in space, tends to support the view that we have to deal with waves propagated along the surface of the earth in accounting for the transmission of Marconi signals. Prof. Sommerfeld, further, in his analytical results obtains analogues of properties associated with electrodynamic waves in wires and certain optical phenomena (Brewster's law).

IN the *Rassegna contemporanea* for May, 1908, Mr. Gino Cuchetti discusses the project for anti-seismic houses, due to Prof. Giuseppe Torres, of Venice. This project is based on the view that circular structures are the best calculated to withstand earthquake shocks, and in the designs shown in the illustrations each building consists of several circular turrets of different diameter communicating with each other, an arrangement having considerable artistic merits, though wasteful of space. In the succeeding number of the *Rassegna* Dr. Enrico Pantano discusses the problem of "internal colonisation" as applied to Italy, and we note with considerable interest the important bearing on this problem of the campaign against malaria.

A REPORT on the resistance of rivets is presented by M. Ch. Fremont to the *Bulletin de la Société d'Encouragement* for April. It is pointed out that the resistance of riveted plates to statical forces or shocks should be borne as much as possible by the adhesion of the plates and as little as possible by shearing of the rivets themselves, and the author emphasises the necessity of standardising the heads of rivets and of regulating the maximum temperature during the process of heating, so as not to destroy the elastic qualities of the rivet. The increased efficiency obtained by the application of continued pressure during the riveting is also mentioned.

IN a paper on the most general problem of optics, published in the Proceedings of the Turin Academy of Sciences, Prof. Antonio Garbasso and Guido Fubini point out that little has been done in solving problems of propagation of light waves in a medium which is neither homogeneous nor isotropic. The authors propose a theory for the special case of a medium in which the ellipsoids of elasticity are of revolution having their axes parallel, and the lengths of these axes are the same at all points in a plane perpendicular to the axis of revolution. An illustration of such a medium is afforded by a stratum of gelatin placed in contact with a solution of zinc chloride and subjected to pressure; the colours seen in such a medium under polarised light are shown in a plate accompanying the paper.

WE have received part iii. of "Klimatographie von Oesterreich," issued by the Meteorological Office of Vienna, in which the climatology of Styria is fully and ably discussed by Dr. Robert Klein. The treatment of the subject follows closely along the lines laid down by Hann in his "Handbuch der Klimatologie," and is, indeed, similar to that adopted by that author in the earlier parts of the work which deal with Austria proper. The book is a model of what the treatment of the special climatology of a restricted area should be. It gives for each region the probabilities of the occurrence of phenomena such as frosts of different degrees of intensity, heavy rainfall, and others. At the same time, the underlying principles are not lost sight of. Styria presents many features of special interest, as the altitudes included in its boundaries vary from about 200 metres to 4000 metres above sea-level. The cultivated region extends up to about 1500 metres. We have thus a great variety of meteorological conditions brought before us in the records from the stations of the second order which are discussed in the volume.

IN the April number of *Meteorologische Zeitschrift* Mr. E. Alt gives an interesting account of the double daily oscillation of the barometer over the globe, especially with reference to the Arctic regions. He preludes his paper by a *résumé* of the efforts hitherto made to elucidate this intricate problem by harmonic analysis, by Lamont, Angot, Hann, and others, and gives useful explanations of the several terms of the series. The theory now generally accepted is that referred to by Lord Kelvin (Proc. Roy. Soc. Edin., 1882) and developed by Prof. Margules (*Sitzungsber.* Vienna Acad., 1890). Mr. Alt has discussed a large number of observations both on land and at sea, and has exhibited the synchronous distribution of the double wave of air pressure by a series of charts. With reference to the Arctic regions, observations taken mostly from the *Challenger* report show that the maxima of the oscillations occur, on an average, about 11h. 20m. a.m. and p.m., and of the minima, on an average, about 5h. 20m. a.m. and p.m. (G.M.T.). The amplitude is small, amounting, on the average, to about 1/10 mm. The investigations of several physicists, including Prof. Margules, point to the view that the synchronism of the oscillation in the polar region is due to the existence of a second half-daily oscillation of the atmosphere which occurs in the direction of the meridians.

WE direct attention to a very laborious and important work by Dr. H. Fritsche entitled "The Mean Temperature of the Air at Sea-level exhibited as a Function of Longitude, Latitude, and Period of the Year" (Meteorologische Publication I.). The author has, *inter alia*, calculated from the constants of the harmonic formula the resulting values of mean temperature for the whole surface of the earth, for each 10° of longitude and 5° of latitude, for twenty-four equidistant epochs of the year, and for the whole year, with maxima, minima, and phase times. But this general description in no wise gives an idea of the immense work covered by some 184 closely printed tables; these are rather difficult to follow, being, with the explanations in German, printed in facsimile lithography. The calculations are based mostly on Buchan's monthly and yearly isothermal charts ("Atlas of Meteorology," by Bartholomew and Herbertson). The mean yearly temperature of the globe is given as 14·6° C., and the amplitude as 4·2°; the coldest period is at the end of January, 12·5°, and the warmest in the middle of July, 16·7°. The mean temperature of the northern hemisphere, 15·3° C., is nearly $1\frac{1}{2}$° higher than that of the southern. The work includes seven isothermal charts between 30° and 90° S. latitude for the year, for mid-January, and each alternate month.

The *Halbmonatliches Literaturverzeichnis* of the *Fortschritte der Physik*, issued under the auspices of the German Physical Society, still continues to furnish more promptly than any other periodical a list of the papers dealing with topics of interest to physicists which appear in the various journals and proceedings of societies. As instances of the promptness with which titles of papers are published, we may mention that the number for June 15 contains the titles of several papers read at the meetings of the Royal Society and of the Physical Society of London in April and May.

The prestige of the "principle of relativity" as a basis for our treatment of electrodynamics in moving media has been increased by a preliminary communication made to the German Physical Society by Dr. E. Hupka, an account of which is given in the *Verhandlungen* of the society for June 15. Three or four months ago Dr. A. H. Bucherer announced that the results of his experiments on the inertia of the negatively charged particles of the β rays from radium were distinctly in favour of the principle as against its most formidable rival the "sphere theory." Now Dr. Hupka, working with the electrons produced when light falls on negatively charged bodies, has shown that when these electrons are accelerated by the action of an electric field, and then deflected by passing through a magnetic field, the deflections observed are again in favour of the principle, which may be stated as follows:—The electrodynamic phenomena exhibited within two systems moving with respect to each other in a straight line will follow the same laws, provided that in each system the unit of time be so chosen that the velocity of light is expressed by the same number.

"Supplementary Investigations of Infra-red Spectra," by Prof. Wm. W. Coblentz (parts v., vi., vii.), has been received from the Carnegie Institution of Washington. This publication contains supplementary data on the doubtful points which arose in the author's preceding work, and also some additional observations on the emission spectra of metal filaments and insulators, thus rounding up the subject as completely as possible at the moment. Although, as Prof. Coblentz goes on to say, the programme of investigation is completed, the subject is not exhausted—not even thoroughly initiated. The value and importance of the author's work in the infra-red region of the spectrum are too well known to need any further diploma of merit at this time; moreover, it is impossible to deal in detail with the account of the many new observations described in the present monograph. There are three separate lines of work, namely, infra-red reflection spectra, transmission spectra, and emission spectra. To these is added a valuable chapter on the instruments and methods used in the work. Two points of special interest may be noted, one of which is the relation between the maxima in the reflection spectra of the carbonates and the atomic weight of the metal, where the maxima steadily shift towards the red with increase in molecular weight. The second point of interest is the infra-red spectra of the colloidal metals in relation to the coloured glasses. There is no doubt that, quite apart from its general importance, Prof. Coblentz's work, owing to the range of spectrum dealt with, will have considerable bearing upon the relation between absorption and chemical constitution.

A new form of gearing, which has been invented by Mr. Jules Lecoche, and is being introduced by the Anglo-Foreign Inventions Syndicate, Ltd., of 10 Camomile Street, E.C., is illustrated in *Engineering* for July 2. The gearing essentially consists of two wheels having spiral or helical teeth which run out of contact, a mechanical clearance of about 1/32-inch separating the tops of the teeth on the two wheels. One of the wheels is provided with field magnets in such a way that a magnetic flux is generated between its teeth and the corresponding teeth on the other wheel. The mechanical drive is obtained entirely by means of the magnetic flux, the form of the teeth being such that, when the wheels are running together, the tops of any two teeth in magnetic mesh lie immediately one over the other, and follow each the same path. As two teeth leave each other, the magnetic flux will be transferred from the leaving teeth to the approaching teeth, thus ensuring continuity of drive. As there is no contact there can be no friction; and as the power consumed in the field coils is only about 3 per cent. of the power transmitted, a gearing efficiency of about 97 per cent. is attainable. Another advantage lies in the high speed of transmission possible. Ball bearings are used for the spindles, an example at present being shown in London by the Albany Engineering Company, of Ossory Road, S.E., having a gearing loss of 1·79 per cent. and an over-all efficiency of more than 90 per cent. The advantages of this gear should open a wide field for its applications.

We have received a copy of the report of the Indian Association for the Cultivation of Science for the year 1907. The association arranges courses of lectures upon scientific subjects, maintains a laboratory and library, and conducts an annual examination of candidates for prizes and medals. Interesting speeches were given at the annual meeting held last November, and altogether the association appears to be doing useful work in spreading a knowledge of and interest in science.

The July number of the *Fortnightly Review* contains an article by Dr. Marie C. Stopes entitled "An Expedition to the Southern Coal Mines." Dr. Stopes was sent by the Royal Society for special palæobotanical work to Japan, where she spent a year and a half in close touch with the Japanese. In addition to devoting a large part of her stay to research work in the Imperial University, Dr. Stopes travelled widely on tours of inspection and investigation. She entered a great many of the coal mines in Japan, and penetrated to the heart of the country searching for interesting specimens. Her article is in the form of a diary, not written for scientific workers, but intended to supply a series of pictures of life in many parts of Japan.

OUR ASTRONOMICAL COLUMN.

Radial Motion in Sun-spot Vapours.—Referring to some comments and queries, by Mr. Buss, in the May number, Mr. Evershed gives further details of the radial motion discovered in sun-spot vapours, in No. 411 of the *Observatory*. He has found that when the slit of the spectroscope does not bisect the spot symmetrically, but crosses the penumbra on the side of the spot nearer to the centre of the sun's disc, the lines are always convex towards the violet; whereas if the slit crosses the opposite side of the penumbra they are convex towards the red. That the line displacements are due solely to motion is shown by the change in position angle of the maximum shift as the spot traverses the disc. The maximum displacement is always such as to indicate that the maximum motion is along the radius, but the observations are not yet sufficiently delicate to disprove the existence of a superimposed, relatively slow spiral motion; on the other hand, there is no direct evidence that such an outward spiral motion exists.

Recent work shows that the radial motion is confined to the lower chromosphere—the "reversing layer." In the higher chromosphere the absorption lines H_3, K_3, and probably $H\alpha$, are usually twisted in the opposite direction to the other lines, thus indicating an inward movement of the vapours. This apparently agrees with Prof. Hale's observation of a dark flocculus moving towards the centre of the spot. There is still an apparent discrepancy between this radial movement and the vortex motions invoked by Prof. Hale to explain the Zeeman effect in sun-spot lines, and, according to Mr. Evershed's results, the vortex, if it exists, either above or below a sun-spot, does not affect the absorbing gases of the "reversing layer" in the penumbræ of spots.

BINARY STAR ORBITS.—In No. 4, vol. xxix., of the *Astrophysical Journal*, Father Stein discusses the photometric observations of the binary star *RZ* Cassiopeiæ on the assumption that it is an Algol variable. Assuming that the orbit is circular, and that the mean densities of the two components are equal, he finds that the mass of the system is 1·002 the sun's mass, the mass of the bright body, the primary, being 0·040 sun's mass; the radius of the bright body is 1·43, and that of the satellite 1·17 the sun's radius, the mean density of each body being 0·222 that of the sun's density. The centres of the two bodies are separated by 0·022 astronomical unit.

No. 13, vol. i., of the publications of the Allegheny Observatory, contains a discussion of the orbits of the spectroscopic components of 2 Lacertæ, by Mr. R. H. Baker. In spectrograms of this star taken on fine-grained plates, the lines of the components are, at certain epochs, separated, and it is interesting to note that the "blend" curve differs considerably from various parts of the primary curve, thus suggesting that for all spectroscopic binaries having a large range of velocities it is desirable that spectrograms should be taken on the finest-grained plates obtainable at the epochs of maximum velocity. The measurement of such plates might, supposing the lines to be separated, considerably modify the results obtained from coarser-grained plates on which the component spectra are inseparable. Mr. Baker finds the period of this star to be 2·6164 days.

MICROMETRIC MEASURES OF DOUBLE STARS.—In No. 4336 of the *Astronomische Nachrichten*, Mr. Phillip Fox publishes the measures of a number of miscellaneous double stars made with the 12-inch and 40-inch refractors of the Yerkes Observatory. The 40-inch is not used regularly for this work, but is employed when conditions are not suitable for securing parallax plates. Mr. Fox's observing-list is mainly made up of Holden double-stars, about half of which have now been observed, but these measures are reserved until the complete list is ready. The present publication includes the measures, made during 1907–8, of about 130 multiple systems.

THE IDENTITY OF COMETS 1908*a* AND 1908*b* (ENCKE).—In No. 4332 of the *Astronomische Nachrichten*, Dr. Ebell discusses the question of the identity of comet 1908*a* with Encke's comet. It will be remembered that when 1908*a* was first discovered by Prof. Wolf, it was announced as being Encke's comet, but the latter was not discovered until May, 1908, when it was found by Mr. Woodgate at the Cape Observatory. Dr. Ebell finds that both the motion and the brightness of comet 1908*a* are against the theory of identity with Encke's, for the latter was, theoretically, much fainter, about 3·5 magnitudes, than the observed object. There still remains the question as to whether 1908*a* was a fragment of Encke's, split off by some accidental encounter or explosion, and this question is being investigated at Pulkowa.

COMET 1909*a*.—Photographs of comet 1909*a* (Borrelly-Daniel) were obtained at the Greenwich Observatory, with the 30-inch reflector, on June 22 and 30, and the resulting positions are published in No. 4337 of the *Astronomische Nachrichten*. The same journal also contains a set of elements computed by Prof. R. T. Crawford, and elements and ephemeris calculated by Prof. Kobold.

THE KING ON INCREASED PROVISION FOR ADVANCED SCIENTIFIC INSTRUCTION AND RESEARCH.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY.

THE King laid the first stone of the new buildings of the Imperial College of Science and Technology on Thursday, July 8. The plans exhibited were those of the Royal School of Mines and an extension of the City and Guilds of London Institute, which will occupy the block of ground at the corner of Exhibition and Prince Consort Roads, South Kensington, and extend as far west as the Royal College of Music. The Imperial College of Science and Technology consists at present of the Royal School of Mines, the Royal College of Science, and the City and Guilds of London Institute, and is administered by a Board of governors appointed by Royal charter, and under the presidency of Lord Crewe.

It is interesting to note that the first building to be erected by the governors of the Imperial College is the much-needed one for the Royal School of Mines, and that the funds for the purpose have been provided chiefly by the late Mr. Alfred Beit and Sir Julius Wernher, of the mining house of Messrs. Wernher, Beit and Co.

The life of the Royal School of Mines has been one of many vicissitudes. Even from the time of its foundation in 1851, difficulty has been experienced in providing adequate accommodation. The move from Jermyn Street to South Kensington, which began in 1872, and, as was stated by Lord Crewe in his address to his Majesty, was not completed until 1880, furnished better accommodation for subjects such as chemistry, physics and mechanics; geology was probably in but little worse position than in Jermyn Street, and metallurgy had better laboratories than before, but mining, which was the last to move, has had but poor quarters. The demand for scientific education, however, has grown so rapidly that even the laboratories for chemistry and physics soon became too small, and the fine buildings in Imperial Institute Road, in which the Royal College of Science has its chemical and physical laboratories, have for the past two years received the students. The buildings now to be erected will comprise well equipped laboratories, museums, lecture- and classrooms, and drawing offices for the mining, metallurgical, and geological sections, and, in a one-storied building, 250 feet by 120 feet, under a separate roof, ore-dressing testing works and an experimental metallurgical laboratory are to be erected, the equipment being provided by the Bessemer Memorial Committee.

The extension of the City and Guilds of London Institute will include a laboratory for the study of hydraulics, equipped by Mr. G. Hawksley, but the extension is chiefly necessary on account of the number of students having already outgrown the space available, and the introduction of advanced courses on special subjects requiring more room. Here, again, top-lighted courts will allow the extension of the mechanical laboratories of the institute. The Goldsmiths' Company has provided a large sum towards this work.

In the course of his reply to the address delivered by Lord Crewe on behalf of the governors, professors, students, and staff of the Imperial College, the King said:—

"The concentration of various associated colleges into one institution, which was effected by our Order in Council of July, 1907, has always seemed to me to be an admirable scheme for the furtherance of scientific instruction, which my dear father had so much at heart; and the names which appeared in the first list of the members of the governing body were sufficient in themselves to give the college a very high status in the educational world.

"The purposes of the college, as stated in the charter, are to give the highest specialised instruction and to provide the fullest equipment for advanced teaching and research in various branches of science, especially in its application to industry. In recent years the supreme importance of higher scientific education has, I am happy to say, been fully recognised in England; and as time goes on I feel more and more convinced that the prosperity, even the very safety and existence, of our country depend on the quality of the scientific and technical training of those who are to guide and control our industries. The rapid growth of knowledge makes it necessary for the teacher of any branch of applied science to be a specialist of a high order, and the most accomplished specialist cannot impart the full advantage of his knowledge without that complete provision of apparatus for research and instruction which this college will supply.

"The college has already given admirable results, and we may well look for a steady increase in the number of students and in the efficiency of the instruction provided.

"The thanks of the country are due to those public-spirited donors through whose generosity a large portion of the funds have been provided for this great work, and I join in your appreciation of their munificence. I think it is especially fitting that the great discoveries of the late Sir Henry Bessemer, to which the remarkable development of the engineering industries in the last half-century is largely due, should be commemorated by the equipment of the new laboratories of this institution."

University of Birmingham.

On July 7 the King and Queen, accompanied by the Princess Victoria, performed the opening ceremony of the new buildings of the Birmingham University. Inasmuch as the founding of the University on the initiative of Mr. Chamberlain has been effected almost entirely by means of money subscribed by the inhabitants of the Birmingham district, the occasion was appropriately made to partake largely of the nature of a civic function.

The characteristic note of the proceedings may perhaps best be given by some quotations from the King's speeches. In replying to the address from the Corporation, after warmly commending the public spirit of the citizens, His Majesty said:—"Great schemes such as that for providing your city with pure water have been undertaken in the past, and have been brought to a successful issue; but none is worthier of support or more far-reaching in its scope than the establishment and extension of the great University in which you have taken so important a part." Later, in reply to an address from the Chamber of Commerce expressing the recognition by the commercial and mercantile classes of the value of the advancement of higher education, his Majesty said:—"I am glad to learn that the commercial community have been faithful and generous supporters of the University. I feel assured that your expectations of advantages to be derived from the Faculty of Commerce in training the future captains of industry will be realised."

After a luncheon at the Council House, their Majesties drove, through roads lined with enthusiastic spectators, to the new buildings at Bournbrook, a distance of about three miles. The opening ceremony took place in the great hall of the University, which was occupied largely by members of the University and representatives of other educational bodies.

The University address was read by Sir Oliver Lodge, and the following characteristic passage may be quoted:—"Guided by our Chancellor, whose inability to be present on this memorable occasion we deeply regret, we have made no attempt to give an appearance of finality to our present undertaking. Rather do we regard it as capable of indefinite expansion. Whilst the field of scientific research is ever widening, and its discoveries demand yearly a fresh application to the facts of life, the claims of the humaner studies become none the less imperative; and in both these branches of human activity, which can only flourish side by side, we realise the need of continual development. But we believe that the work which we have begun, upon which this day your Majesties set the seal of your Royal approbation, can confidently be entrusted to the generosity and to the devoted service of the generations that are to come."

His Majesty, in replying, after paying a tribute to the Chancellor, proceeded:—"For the wonderful progress of higher education in the country we have largely to thank the great universities established in our principal cities. No nobler object for munificence can be found than the provision for the necessary equipment for such education; an equipment which, in view of the diverse and elaborate requirements of the modern schools of instruction, must be costly; but without which these schemes, however carefully designed, will prove fruitless. Such institutions as this are of paramount importance in enabling students to obtain in their native city instruction in science and technology, in art and mathematics, which in former days they were compelled to seek in places far distant from their homes, at an expense which in some instances they could ill afford. The universities also foster a wholesome rivalry, and encourage the growth of the highest form of public spirit. A man educated at this University will be a better citizen of Birmingham, and a better subject of the Empire."

At the close of the opening ceremony, their Majesties inspected a part of the departments of civil and electrical engineering.

THE SCIENCE COLLECTIONS AT SOUTH KENSINGTON.

THE question of the worthy housing of the science collections at South Kensington has been brought before the Government on several occasions during the last thirty years or so. The object of a deputation which waited upon Mr. Runciman at the Board of Education on Tuesday was again to endeavour to obtain an assurance that the Government will provide the money for the building of a museum in which the science collections can be exhibited as satisfactorily as are those of art. The deputation included distinguished representatives of the leading scientific societies and institutions, and the memorial which was presented was signed by the president and officers of the Royal Society, all its living past-presidents, and 128 of its Fellows distinguished in physical science; the Chancellors of the Universities of Cambridge, London, Glasgow, and St. Andrews; the Vice-Chancellors of the British universities; the presidents of scientific societies and institutions; professors of chemistry, physics, mathematics, astronomy, and engineering in all the British universities, university colleges, and principal technical schools and polytechnics; the directors of the chief polytechnics in London and in the provinces; and a very large and distinguished body of persons eminent in and interested in British science and desirous of its promotion.

There can be no doubt, therefore, as to the opinion of representatives of physical science upon the urgent need of satisfactory provision for the housing of the science collections. As Sir William Anson said in introducing the deputation, "the museum, which represents the application of science to material, should be placed in the same position as art and natural history by the Government of the country."

The collections should be in a suitable building, with room for rearrangement and expansion. A site is available at South Kensington if the Government will come forward with the offer of funds for the actual building; but in spite of the memorial and the deputation, Mr. Runciman did not give an assurance that the money will be forthcoming. He was sympathetic, and promised to place the matter before the Prime Minister and the Chancellor of the Exchequer, and with this result we must be satisfied for a while. A useful purpose has certainly been served by bringing the subject into public view. We can now only hope that the Government will rise to the opportunity and offer to the physical sciences, which are closely connected with the industries of this country, the same advantages for its collections as are already possessed by natural history and by art.

From a full report of the deputation in Wednesday's *Times* we make the subjoined extracts.

The memorial presented by Sir Henry Roscoe was as follows:—

"We, the undersigned, being deeply interested in the practice and progress of British science, desire to bring before you the importance of the proper housing of the Science Collections at South Kensington. The permanent buildings now erected provide accommodation for art collections only; to complete the scheme a suitable building for the science collections is a necessity. The formation of a science museum representative of all branches of physical science, both pure and applied, has long engaged the attention both of the Government and of British scientific men. So long ago as 1874 the Duke of Devonshire's Commission on Science strongly recommended the establishment of such a museum, and in their fourth report the Commissioners state:—'While it is a matter of congratulation that the British Museum contains one of the finest and largest collections in existence illustrative of biological science, it is to be regretted that there is at present no national collection of the instruments used in the investigation of mechanical, chemical, or physical laws, although such collections are of great importance to persons interested in the experimental sciences. We consider that the recent progress in these sciences and the daily increasing demand for knowledge concerning them make it desirable that the national collections should be extended in this direction, so as to meet a great scientific requirement which cannot be provided for in any other way.' Since these words were written a National Science Museum has been established, and the collections in it have been steadily enriched by many important acquisitions. These collections are at present housed in the old buildings at South Kensington known as the Southern Galleries and the Western Galleries. They now include models and copies of historical and modern philosophical apparatus of the greatest value to all interested in the progress of British science, and a large number of machines, instruments, and models of great interest as illustrating the origin and development of our most pregnant British inventions, together with such special collections as the unique series of models illustrating the history of shipbuilding.

"In 1876 the Royal Commissioners of the Exhibition of 1851 offered to the Government of the day a sum of 100,000*l.*, together with a site on the Commissioners' ground, for the proper housing of this collection, under the condition that the Government should undertake its maintenance. In 1878 the Commissioners repeated their offer, and in 1879 this was declined by the Government. In 1888 the land to the south of Imperial Institute Road, reaching to that conveyed to the Government in 1864 for the erection of the Natural History Museum, and containing 4½ acres, was sold to the Government for 70,000*l.* This land has now been in part permanently allocated to the main section of the new buildings of the Imperial College of Science and Technology and to the building in course of erection for the Meteorological Office and a post office. The remainder of the site is at present occupied partly by temporary buildings and partly by the old buildings—the "Southern Galleries"—which now afford accommodation for the machinery and naval architecture collections of the Science Museum. This portion of the site, adjoining as it does on the north the Imperial College and on the south the Natural History Museum, is well regarded as an ideal position for the long projected Science Museum, which would complete the magnificent group of museum buildings already erected at South Kensington.

"The cost of acquisitions for the current growth of such a science museum, it may be noted, is far less than that of a corresponding art museum. The value of art products increases rapidly with age, whereas the scientific implements, machinery, and apparatus, interesting from an historical point of view, have rarely any great commercial value. The art collections of the Victoria and Albert Museum are now in possession of splendid buildings. If the buildings provided for the science collections were equally worthy of the interests which they should serve, the objects now in the museum could be exhibited to much greater advantage. Moreover, those *lacunae* which mark sections of recent activity in discovery and invention would be more readily filled than they can be while the obviously temporary character of the accommodation suggests to those who hold objects of interest in the history and advance of science that the authorities have but little appreciation for such things.

"Other countries, notably France and Germany, have recognised the importance of preparing suitable buildings for their National Science Museums. In Paris the Museum of the École des Arts et Métiers has a world-wide renown; and a National German Science Museum is now being built in Munich at the cost of 300,000*l.* England, the mother of so many great inventions that have proved to be pioneers in industrial arts, stands alone in having made no adequate provision for exhibiting and arranging in proper order her unique collections. The undersigned venture to urge upon you that the time has now arrived for action. Land sufficient for the purpose is in the Government's hands, and the Royal Commissioners of '51 if approached by the Government with a definite building scheme would doubtless give it due consideration. The need is great, and the mass of British science workers will hail your favourable decision with gratitude."

In his remarks, Sir Henry Roscoe said that what is needed is a building adequate to the proper exhibition of the present collection, and one worthy of British science. The grant for science purposes is 1800*l.*; that for art 11,260*l.* The fact that with so small a grant the national science collections have reached so important and in many respects so unique a position has been partly due to the fact that the cost of acquisitions for the current growth of such a science museum is far less than that of the corresponding growth of an art museum. Land sufficient for the required purpose is in the hands of the Government, and the Royal Commissioners of 1851, so long ago as 1878, offered to contribute 100,000*l.* towards a building for the Science Museum. Sir Archibald Geikie said that the council of the Royal Society desired him to express its keen sense of the importance of the collections and the need for better housing for re-arrangement and expansion. Sir David Gill said that, confining his remarks principally to the astronomical collection, he was much impressed with its extreme value, as it included apparatus of all periods, from the earliest days down to the present time. Mr. Alexander Siemens, expressing the view of the Institution of Civil Engineers, said that in the interest of students of engineering it is of the utmost importance that the collections should be housed with plenty of space, and should be as complete as possible. Sir Hugh Bell, as president of the Iron and Steel Institute, said his national pride was hurt when he went through the building at South Kensington and saw the collections housed in a place erected about fifty years ago as refreshment-rooms or something of that sort. Paris, Munich, and Berlin are very much in advance of London in that matter. Dr. R. T. Glazebrook, director of the National Physical Laboratory, said that the physical collection at South Kensington is very inadequately housed and quite fails to represent the growth of that science in England. Mr. W. M. Mordey, president of the Institution of Electrical Engineers, said there is at present no adequate representation of their work in this country. Sir William Ramsay said it is practically impossible to gain any notion of the progress of chemistry from a visit to the collection. Sir George Darwin said that in going over the museum he was struck by two or three things—first, the great interest of the collection; secondly, the overcrowding of it; and, thirdly, the extreme deficiency of the buildings in which it is housed.

Mr. Runciman, in the course of his reply, said:—The memorial which has been presented to the Board of Education and to me on the subject of this museum is one of the most weighty memorials that I think has ever been received by any Minister. We not only provide, or intend to provide, an exhibition for the exposition and demonstration of the principles of science, but we provide illustrations of the applications of science and arts to industry, including models and actual examples of outstanding inventions which are of historical importance, and, as Sir Henry Roscoe has said, are absolutely irreplaceable. We have the greatest desire to maintain historical industrial processes, and we have special collections, such as those in which I myself am enormously interested—namely, naval architecture, models of machines, and astronomical instruments. The whole of these are of priceless value. But I quite recognise that they are in many respects incomplete; and I am also impressed with the fact, as indeed everybody is who knows the building in which that collection is housed, that the housing has a great deal to do with the collection in the buildings in their present state. I recognise that the collection, even at the present day, is dreadfully overcrowded. The best illustration of that lies in the fact that in the cases now erected in the museum we have found it necessary to provide for what may be called a basement exhibition. When one passes through the exhibition one sees a considerable number of persons kneeling down on the floor in order to see what is in the basement of these cases. Anyone who is responsible for the museum can hardly avoid being ashamed of that condition of things. It is true that some parts of the galleries were put up as temporary buildings. They were part of the exhibition, I think, of 1862, and it is remarkable that they have lasted so long. The whole difficulty is the very prosaic difficulty, I fear, of money and land. The South Kensington area, which now contains some of the most remarkable collections and some of the most valuable buildings in the world, has been very rapidly occupied. We cannot go south because of the Natural History Museum, and we are blocked on the north by the Imperial Institute, the Royal College of Science, and some of the other buildings, and I cannot at the moment see in what direction it will be possible for us to expand. The magnificent work which has been done in the direction of art on the other side of the road certainly sets the pace, and I recognise with you that it is pressingly necessary that we should have a new building for our great science collection at the earliest possible date. The question of funds is affected to some extent by the hint thrown out by Sir Henry Roscoe of assistance from the 1851 Commissioners. I cannot imagine any better work to which the Commissioners could devote their funds than in giving assistance in the construction of new buildings. For the moment I will say no more than that I will transmit to my colleagues and lay before the Cabinet, the Prime Minister, and the Chancellor of the Exchequer the very valuable statement which you made, and I will use my own personal influence, for whatever it may be worth, to impress on them the necessities of the case.

ESKDALEMUIR OBSERVATORY.[1]

WE have received the annual report of the observatory department of the National Physical Laboratory for the year 1908, which is noteworthy as being the first report issued since the establishment of the new magnetic and meteorological observatory at Eskdalemuir. Readers of NATURE will be aware that the advent of electric tramways to the neighbourhood of the observatory at Kew has greatly interfered with magnetic work there. The new establishment in Dumfriesshire is far removed from all industrial undertakings, and will thus be free from disturbing effects due to artificial causes.

So far as Eskdalemuir is concerned, the past year has been one of installation and experiment, and the report contains no results of observations. The superintendent, Mr. G. W. Walker, went into residence on May 11, 1908, and was followed shortly after by his staff, comprising observer, computer, mechanic, and mechanic's assistant. The first instruments to be set up were the Elliot unifilar magnetometer and the Dover dip circle, which were given to the laboratory by Sir Arthur Rücker. They are the instruments which were used by the donor and Prof. Thorpe in their magnetic survey of the British Isles in 1890. The first absolute measurements of horizontal force, declination, and inclination were made on May 29, and were continued for eight weeks, when some changes became necessary. Observations, made three times a week, were resumed in October, and have since formed part of the routine work of the observatory. The final determination of the azimuth of the fixed mark awaits the completion of the arrangements for the time signal.

The recording apparatus consists of a set of Eschenhagen magnetographs and a set of Kew pattern magnetographs made for the observatory by Mr. P. Adie. The former belong to the Admiralty, and are those used at the *Discovery's* winter quarters in 1902–4. Owing to damp, the magnetic house could not be used immediately, and the instruments had to be accommodated elsewhere. The Eschenhagen recorders were set up temporarily in the seismograph room. The Adie instruments were accommodated in the general laboratory, but the warping of the wooden supports has made satisfactory compensation for temperature changes impossible, and the point will have to be taken up again when the instruments are removed to their permanent positions.

For seismological work a twin-boom Milne seismograph is in use. Regular records have been obtained since September 24. Provision has also been made for carrying on the work of a meteorological observatory or station of the first order. The photographic barograph and wet- and dry-bulb thermograph have been lent by the Meteorological Office. They are the identical instruments which were formerly in use at Fort William Observatory, the base station of Ben Nevis. A Dines pressure-tube anemometer, a Beckley autographic rain-gauge, a Campbell-Stokes sunshine recorder, and barograph and thermograph of Richard pattern complete the outfit of ordinary meteorological instruments. Provision has, of course, been made for the usual control readings and for eye observations of weather phenomena. An Ångström compensation pyrheliometer has also been set up, and preparation has been made for recording the atmospheric electrical potential.

At Kew the usual observing and testing work has been continued. Summaries of the magnetic and meteorological work are given in the appendix. The results of measurements of solar radiation with an Ångström pyrheliometer, and of the temperature of the soil at depths of 1 foot and 4 feet, are given for the first time. The examination of the apparatus to be used at Eskdalemuir has formed an important part of the year's work, and we note also that Mr. W. Dubinsky, of the Pavlovsk Observatory, spent some time at Kew for the purpose of making comparisons between the Kew standard magnetometers and barometer and the standards in use in Russia. These comparisons were carried out in accordance with a general scheme for the international comparison of standards approved by the last International Meteorological Conference. The report concludes with the usual summaries of the magnetic results obtained at the observatories at Falmouth and Valencia.

[1] The National Physical Laboratory. Report of the Observatory Department Richmond, Surrey, and of the Observatory, Eskdalemuir, Langholm, Dumfriesshire, for the Year 1908, with Appendices. Pp. 53. (Teddington, 1909.)

THE IMPERIAL CANCER RESEARCH FUND.

THE annual meeting of the general committee of the Imperial Cancer Research Fund was held on July 9 at Marlborough House, when the Prince of Wales, the president of the organisation, took the chair.

The following are extracts from the report, which was adopted at the meeting:—

During the past year further correspondence took place with the authorities of the International Society for Cancer Research in Berlin, in which it has been suggested that the executive committee should re-consider the attitude hitherto adopted and join the International Society; and offering that the first International Congress should be held in London. The executive committee is of opinion that the decision arrived at is in the best interests of the scientific investigation of cancer, and accordingly it adhered to its position. At a subsequent date a petition was presented by the International Society for Cancer Research in Germany to the King, as patron of the Imperial Cancer Research Fund, asking that the decision might be reviewed, but His Majesty, after considering the facts submitted to him through the Foreign Office, expressed the view that the Imperial Cancer Research Fund has cooperated freely in the past, both with German and other foreign workers, and will continue to do so in the future.

It may be well to recall in this connection the extent to which the Imperial Cancer Research Fund has encouraged the investigations of independent workers both at home and abroad. As is well known, the material for experimental research is difficult and costly to obtain, and is beyond the reach of many who, but for the help given from this fund, would be debarred from participation in this branch of the research. Recognising that such help must be of the first importance, it has been the aim of the general superintendent, Dr. E. F. Bashford, with the entire concurrence of the executive committee, to distribute to all applicants who possess the necessary credentials the material accumulated with much labour and expense.

A satisfactory feature of the past year has been the recognition of the work of the fund by foreign investigators, as is shown by the number of applicants for permission to work under the general superintendent. It has been found impossible to concede all the requests, but gentlemen from Italy, Bukarest, New York, and Munich have been accorded full liberty to pursue their researches in the laboratories supported from the fund, and every facility has been given them. Special arrangements have also been granted to other workers to pursue certain specific investigations, and to certain foreign medical men to study the methods during a short visit to this country.

Reviewing the results of seven years' work on the comparative and experimental investigation of cancer, says the general superintendent in his report, one is struck by the difference between the nature of the problems before us seven years ago and of those now being considered, as well as by the freedom one feels in investigating the problems presented to-day, without the incubus of having to consider them from the standpoints of the many hypotheses now proved to be untenable. I do not think that too much is claimed by asserting that the arduous labour of the past seven years is gradually effecting, and in several respects has actually effected, a complete revolution in many aspects of the cancer problem. But it has done still more in opening up new vistas in biology. Seven years ago no one conceived it possible that portions of the mammalian organism could be kept growing for a period four times the length of life of the whole animal. But to-day the number of different kinds of tissues now being propagated separately make it theoretically possible that the majority of the tissues may be so grown and segregated. In other words, a living animal can be analysed into many of its living component tissues. The finer relations of various kinds of tissues to one another have been revealed by the application of the new methods. The biological alterations which living mammalian cells may undergo suddenly, as well as gradually, under the influence of experimental conditions, can now be studied. These and many other achievements in the field of general biology are the most important practical fruits which have accrued from the experimental study of cancer, upon which they have only indirect bearings. Ultimately they are bound to be of far-reaching general biological importance, although to-day they are merely the weapons that have been forged to attack cancer. Their further development and their utilisation for the solution of purely biological problems will probably precede the solution of many of the problems surrounding the nature and causes of cancer.

While some chance opportunity may yield results of immediate practical moment, the outlook on therapeutics in the meantime is in the direction of preventing dissemination or metastasis. The means of explaining why inoculated cancer can undergo spontaneous cure have been greatly enriched by the acquisition of fresh strains of propagable tumours behaving in a variety of ways in this respect, and presenting all gradations from some growing progressively in every animal inoculated, to others which, while developing for a time in every animal, are ultimately got rid of in all cases by the active resistance which the tumours induce against themselves.

In acknowledging a vote of thanks, the Prince of Wales said, during the course of his remarks:—"When presiding over this committee on previous occasions I have expressed the view that immediate results in regard to the cure of cancer must not be counted upon, but that rather we must look forward to steady and consistent progress in accordance with the experience of all scientific investigation. There can be no doubt, however, that the seven years' work already accomplished by the fund has brought about a complete change in the standpoints from which cancer should be studied. The many and varied lines of research are being pursued with the utmost perseverance, and every development, as it occurs, is followed up with the minutest care. During the past year an important work—the third scientific report—has been issued from our laboratories, and has been received with appreciation by all those at home and abroad who are competent to express opinions on these highly technical researches. This of itself marks a steady and valuable advance, and one of which we have every reason to be satisfied.

SCOTTISH EXPEDITION TO SPITSBERGEN.

Dr. William S. Bruce, of the Scottish Oceanographical Laboratory, is conducting another expedition to Prince Charles Foreland and other parts of Spitsbergen. One of the chief objects of the expedition is to complete the survey of Prince Charles Foreland which he began in association with H.S.H. the Prince of Monaco in 1906 and continued in 1907. He will also connect this survey with the mainland of Spitsbergen across Foul Sound, thus joining up the work of H.S.H. the Prince of Monaco, the late Captain Guissez, Captain Bourée, and Captain Isachsen in the north-west of Spitsbergen.

In 1907, Dr. Bruce brought back geological collections which have been described by Dr. G. W. Lee, of H.M. Geological Survey of Scotland, in a paper read to the Royal Physical Society, Edinburgh. These rocks and fossils entirely change previous opinions of the geology of Prince Charles Foreland, which was thought to be Silurian, whereas the rocks of Prince Charles Foreland consist, first, of a series of metamorphic crystalline schists, quartzites, and non-fossiliferous shales and hard grey limestones; secondly, of the fossiliferous limestone, probably permo-Carboniferous; and, thirdly, of grey shales containing the remains of dicotyledonous plants of Tertiary age. This time Dr. Bruce will carry with him a specially strong geological staff, and he hopes to clear up definitely the whole geology of Prince Charles Foreland and the neighbouring coasts of the mainland.

A special study of the botany of the Foreland will be made, Dr. Rudmose Brown carrying on that special part of the work. Dr. Bruce's staff consists of Mr. J. V. Burn Murdoch, who accompanied him to Prince Charles Foreland in 1907; Mr. John Mathieson, of H.M. Ordnance Survey of Scotland, who will take entire charge of the survey work; Dr. R. N. Rudmose Brown, late botanist of the *Scotia*, at present lecturer on geography, Sheffield University; Mr. Ernest A. Miller, who accompanied Dr. Bruce in 1906, and has since been attached to the meteorological and magnetical service of the Argentine Republic, having wintered at Scotia Bay, South Orkneys, during the last year. Mr. H. Hannay and Mr. A. M. Peach are the geologists, and Mr. Alastair Geddes will also accompany the expedition.

Dr. Bruce has chartered the steamer *Conqueror*, which is being specially re-fitted for the purpose, and has selected as master of the ship Captain Francis Napier, who has been kindly lent by Messrs. James Currie and Co., Leith. The expedition will leave Leith on Monday next, July 19, and is expected to be absent about two months.

We understand that this expedition, which will be Dr. Bruce's ninth visit to the polar regions, in no way interferes with his future Antarctic plans.

BIRD NOTES.

To the May number of *Naturen* Mr. O. J. Lie-Pettersen contributes an account of the life-history of the icterine tree-warbler (*Hypolais icterina* or *H. hypolais*) in Norway, where it is known as the "bastard nattergale." The dates of arrival in the neighbourhood of Bergen during a period of eleven years range from May 16–20 inclusive; birds of the year take their departure about the middle of July, and old birds some weeks later. By the middle of August nearly all have vanished, although an occasional straggler may be seen up to the end of that month, and one specimen was so late as September. Among the trees haunted by this species the hazel is the favourite; nesting takes place at the end of May or early part of June, and the period of incubation is thirteen days.

The April number of the *Emu* contains the minutes of a conference on Government bird-protection in Australia, held at Melbourne in November, 1908. A large number of species and subspecies were recommended for total protection, among these being lyre-birds, coachwhip-birds, emeus, and cassowaries. Owing, however, to the conference being unable to prepare a protection Bill, on account of the relations existing between the Commonwealth and its constituent States, it was eventually decided that the list of species and groups recommended for protection should be submitted to each State for favourable consideration. The urgent need for efficient legislation in this direction is made evident by a statement on another page of the same issue with regard to a recent wholesale slaughter of emeus.

To Mr. L. J. Cole we are indebted for a copy of a paper from the April number of the *Auk* on the importance of "tagging," or marking, birds as a means of studying their movements. It is pointed out by the author that we are still nearly as much in the dark as regards the true "inwardness" of migration as was the case a century ago, and that practically all our information on this subject is connected with mass-movements, so that we are ignorant of the wanderings of individual birds. The acquisition of a knowledge of such individual movements will, it is urged, aid, not only in the study of the general migration of species, but will assist in analysing the factors connected with migration as a whole. Active measures are being taken to inaugurate a system of bird-marking in the United States.

A similar movement has been started in this country by Mr. H. F. Witherby, the editor of *British Birds*, the details of which will be found in the June issue of that serial. The rings used for marking are extremely light, and do not in any way interfere with the bird's power of flight; each is stamped "Witherby, High Holborn, London," and bears a distinctive number, which in the smaller sizes is stamped inside the ring, and it is hoped that anyone into whose hands should fall a bird so marked will send the bird and the ring, or, if this is not possible, then the particulars of the number on the ring, the species of bird, and the locality and date of capture, to the address given.

Yet another centre for bird-marking is to be established at Aberdeen, as announced in the June number of *British Birds*.

The history of the rise and progress of ornithology in South Africa is presented in concise and popular form by Mr. A. Haagner in Popular Bulletin No. 2 of the South African Ornithologists' Union, recently published at Pretoria.

To No. 1670 of the Proceedings of the U.S. National Museum Mr. E. A. Mearns contributes a paper on new and rare birds from the Philippines, while in No. 1683 of this serial the same author gives a list of birds recently collected in the Philippines, Borneo, and certain other Malay islands.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Dr. E. Knecht has been appointed professor of technological chemistry in the University of Manchester.

From the *Observatory* we learn that Mr. J. Lunt, astrophysical assistant at the Cape Observatory, has been given the honorary degree of D.Sc. by the University of Manchester.

The annual meeting of the Midland Agricultural and Dairy College will be held on Monday, July 26, when the report on the year's work will be presented. The Duke of Rutland will address the meeting, and present the diplomas and certificates gained during last session.

Merely to mention the titles of four of the six articles contained in the February–March issue of the *Southern Educational Review* is to demonstrate the importance its editor attaches to the education of the negro. These articles are those on "Results of Attempts at the Higher Education of the Negro of the South," "The Essential Requirements of Negro Education," "Negro Rural Schools," and "Relation of the State to the Education of the Negro." The review is published at Chattanooga, Tenn., U.S.A., by the editor, Mr. H. Elmer Bierly.

It is proposed to establish in connection with the Paris University a system of exchange between French and foreign professors on similar lines to that which has for some time been in vogue between Berlin and America. M. Liard, rector of the university, has made an appeal to the friends of the university to create a fund for the purpose. M. Albert Kahn has placed at the disposal of the rector an annual grant of 30,000 francs for five years. The *Revue scientifique* states that two million francs are necessary for the success of the scheme.

It is announced by the New York correspondent of the *Times* that Mr. John D. Rockefeller has celebrated his seventieth birthday by giving 2,000,000*l.* to the General Education Board, which he founded in 1907 for the purpose of endowing American colleges and universities. The Board had already received 8,600,000*l.* from him. Some forty institutions of higher education have benefited by this trust, including Harvard and Yale Universities. The correspondent states that the Board's policy is governed by the belief that every city of more than 100,000 inhabitants should possess a college. The annual income of the Board is said to be 200,000*l.*

The accounts of the London Polytechnics for the year ended July 31, 1908, have been printed by the London County Council. The council's comptroller points out that the total ordinary receipts of these eleven institutions amounted to 212,495*l.*, an increase of 8,543*l.* over the previous year. The council's grants amounted to 80,503*l.*, or 37·88 per cent. of the total receipts. Grants from the Board of Education amounted to 38,229*l.*, or 17·99 per cent.; the sums received from the City Parochial Foundation were 27,704*l.*, or 13·04 per cent., and from City companies, &c., 6,929*l.*, or 3·26 per cent. The total ordinary expenditure on revenue account of all the polytechnics amounted to 211,950*l.*, an increase of 4,431*l.* over the previous year. Taking the results as a whole, so far as ordinary income and expenditure are concerned, there was a surplus of 545*l.* on the institutions, as compared with a deficit of 3,567*l.* in 1906–7. The amount expended on teachers' salaries reached 99,286*l.*, or 47·84 of the total expenditure; other salaries accounted for 25,509*l.*, or 12·30 per cent.; rent, rates, and taxes absorbed 11,586*l.*, or 5·58 per cent.; and apparatus and other educational appliances and furniture cost 18,327*l.*, or 8·83 per cent. of the total expenditure.

Teachers at agricultural schools and colleges in this country will be interested in the full and detailed syllabus issued by the Colorado State Agricultural College. The requirements for admission strike an English teacher as severe, and we can only congratulate the Colorado College if it is in a position to insist on the high standard they imply. The student is expected to have a certain acquaintance with English literature, gained by reading specified classics, and to be "familiar with the essential principles of rhetoric," including the following:—"choice of words, structure of sentences and paragraphs, the principles of narration, description, exposition, and argument." History is another essential subject, and the teacher who is preparing pupils for the college is informed that "the mere learning of a text will not give the preparation that the colleges desire. Effort should be made to cultivate the power of handling facts and of drawing proper deductions from data, to develop the faculty of discrimination, to teach the pupils the use of books, and how to extract substance from the printed page." The other subjects—mathematics, chemistry, physics, "other languages"—are to be taught in a similar spirit. Students so trained would form admirable raw material, and could have no great difficulty in taking the fullest advantage of the college course.

The Board of Education has issued [Cd. 4736] its regulations for technical schools, schools of art, and other forms of provision of further education in England and Wales which will come into force on August 1 next. No changes of special importance have been made as compared with those of last year. It is satisfactory to note that the amount of each of the royal exhibitions, &c., tenable at the Royal College of Art and the Imperial College of Science and Technology, South Kensington, has been raised from 50*l.* to 60*l.* per session. The old royal exhibitions and national scholarships tenable at the Imperial College of Science and Technology, have been combined as royal scholarships, the competition for which is to be conducted on the lines hitherto adopted for the award of national scholarships. In place of the former studentships-in-training in science, the Board of Education has established special studentships for teachers of science and technology who are qualified to enter on the third or fourth year of the course provided at the Imperial College. We notice that in future such teachers-in-training are not to be permitted to continue for more than two years in all at the Imperial College, a change which, in view of the need for highly qualified teachers in our provincial schools of science and technology, seems of doubtful wisdom.

THE new laboratories of St. Paul's School, built to celebrate the quatercentenary of the foundation, were opened on Wednesday, July 8, by Lord Curzon. In his address, Lord Curzon said he noticed how the school had kept pace with the spirit and reforms of the day, how during the last hundred years its numbers had increased from 153 to 600; how the modern side had grown to equal the older side in numbers and importance; and he told how great had been the achievement of the school under the late high master, Dr. Walker, one of the great school-masters of the nineteenth century. Lord Curzon went on to say that we lived in an age of self-depreciation, of a too great self-depreciation. Foreign critics were always coming to our public schools to learn how, having their superior equipment and their excellent organisation, they might obtain also "that training in character, that sense of moral responsibility, that spirit of civic patriotism, that ordered sense of personal liberty which were among the chief and most honourable characteristics of our public school system." So while content to learn from others we were not to forfeit that in our educational system which had done so much in the civic government of the country and the empire. The Bishop of Manchester referred to the conditions, so different from those obtaining now, under which he had learnt at St. Paul's School; yet he had learnt there that most valuable of lessons, to think. The high master, Dr. Hillard, said that St. Paul's had taken its full share in all those changes in educational method which began with Arnold's life at Rugby.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, June 16.—Prof. W. J. Sollas, F.R.S., president, in the chair.—The Carboniferous Limestone of County Clare: James A. **Douglas**. The district forms the westernmost limit of the central Carboniferous Limestone plain of Ireland. The area, for the purposes of description, is divided into two main districts. The northern region is formed by an elevated plateau of Viséan Limestone, which rises on the north and east in terraced cliffs, but to the south-west dips below the "Coal-measure" series. The surface is of bare rock, devoid of vegetation. The southern district is not formed of limestone; the high ground on the east is of Old Red Sandstone and Silurian rocks, that on the west of Coal-measures. The older formations appear as two anticlinal flexures, forming the mountains of Slieve Aughty and Slieve Bernagh. The margin of the syncline is formed by Tournaisian shales and limestone, while the Viséan limestones occupy the core. The limestone fauna show that the Geological Survey boundary between the Upper and Lower Limestones corresponds with the transition from a Tournaisian to a Viséan fauna, and the Middle Limestone contains a fauna distinct from that of the Upper, although they are not separable on lithological grounds. The Old Red Sandstone is succeeded by a series of sandy shales containing brachiopods characteristic of the Cleistopora zone; at the base are found modioliform lamellibranchs. The Zaphrentis zone is well developed. The most remarkable portion of the whole sequence is included in the Syringothyris zone. These beds show evidence of deposition in shallow water. The fauna is compared with that of the Waulsortian phase of Belgium. The incoming of a Viséan fauna is well marked at the base of the Seminula zone; in the middle of this zone occurs an important bed of oolitic limestone, with abundant gasteropods. The Dibunophyllum zone attains a thickness equal to that of the Midland area.—The Howgill Fells and their topography: J. E. **Marr**, F.R.S., and W. G. **Fearnsides**. The Howgill Fells form a monoclinal block, from which the Carboniferous rocks have been denuded. The northern slope probably corresponds with the sloping plane of unconformity between the Carboniferous rocks and Lower Palæozoic strata. On the south the slope to the Rawthey is along a block-fault. The chief drainage was originally north and south from the watershed at the summit of the block. The tract was glaciated by its own ice, but "foreign" ice was conterminous with the local ice on all sides. The rocks are, from the point of view of erosive effects, nearly homogeneous. The chief erosive effects of glaciation were the truncation of spurs, the formation of conchoidal scoops in the concavities of the valleys, a general widening of the valleys, and but slight deepening. A feature of interest is the contrast in this small area between these glaciated valleys and others of V-shaped cross-section, which are typical water-carved valleys unaffected by glacial erosion.—A new species of Sthenurus: L. **Glauert**.—Some reptilian remains from the Trias of Lossiemouth: D. M. S. **Watson**. The fore-limb of *Ornithosuchus woodwardi* is shown in a specimen in the Manchester Museum. Ornithosuchus is restored as an animal walking on all fours, with the head carried rather low. The proportions are identical with those of Ætosaurus. A description is given of the skeleton of a very small reptile, interesting as recalling Ætosaurus in its armour.—Some reptilian tracks from the Trias of Runcorn (Cheshire): D. M. S. **Watson**. Four types of tracks which occur on the slab of sandstone from Weston Point, described in 1840 by Dr. Black, are discussed in this paper. It is suggested that some of these prints may quite well belong to such thecodonts as Ornithosuchus.—The anatomy of *Lepidophloios laricinus*, Sternb.: D. M. S. **Watson**.

Linnean Society, June 17.—Sir Frank Crisp, vice-president, in the chair.—The growth of a species of Battarea: J. G. Otto **Tepper**.—The deposits in the Indian Ocean: Sir John **Murray**.—The *Sealark* Penaeidea, Stenopidea, and Reptantia: L. A. **Borradaile**.—The *Sealark* Lepidoptera: T. B. **Fletcher**.—Report on the Porifera collected by Mr. C. Crossland in the Red Sea, part i., Calcarea: R. W. H. **Row**.—The African species of Triumfetta, Linn.: T. A. **Sprague** and J. **Hutchinson**.—New species of Malesian and Philippine ferns: Dr. H. **Christ**.—The acaulescent species of Malvastrum, A. Gray: A. W. **Hill**.

DUBLIN.

Royal Dublin Society, June 22.—Dr. J. M. Purser in the chair.—The fossil hare of the ossiferous fissures of Ightham, Kent, and on the recent hares of the *Lepus variabilis* group: M. A. C. **Hinton**. The paper describes the fossil remains of *Lepus variabilis*, Pall., obtained from the rock fissures at Ightham, and deals with the osteology of the recent and fossil hares of the *L. variabilis* group. The Pleistocene hare of England is referred to a new subspecies, *L. variabilis anglicus*, which is to be regarded as the immediate ancestor of *L. variabilis hibernicus*, its relationship with the existing Scotch form not being so close. The subspecies *anglicus* and *hibernicus* are shown to be the most primitive members of the *variabilis* group. The most important conclusion reached is that, contrary to the prevalent view, the *variabilis* group of hares has originated in temperate latitudes, and not in the high north.—The value of benzidine for the detection of minute traces of blood: Prof. E. J. **McWeeney**. The author began by explaining the chemical nature of benzidine, which is a di-*p*-diamino diphenyl. This substance, when dissolved in acetic acid and brought into contact with blood in presence of H_2O_2, at once undergoes oxidation with formation of a brilliant blue colour. The reaction is in principle the same as that with guaiacol, the old-fashioned Van Deen's or Schönbein's guaiacum test. The colour base from guaiacol differs from the benzidine colour-base in the same way as an amine (aniline) differs from a phenol, or an aurine from a rosaniline dye. The test is ten-fold more delicate than that with guaiacum, and detects blood in solution as weak as 1/500,000; but for medico-legal purposes it is preferable to bring particles of the suspected matter into contact with the reagent, when each granule, if blood, at once strikes a most brilliant blue. The reaction can be observed under the microscope. The test worked well with blood-stains many years' old, and seemed to be independent of the nature of the substratum. Controls, and a time limit of about a minute, were essential, and the sensitiveness of each batch of benzidine had to be worked out beforehand. Of all the substances tested, none gave the typical blue colour so speedily as blood, save fresh vegetables and fruit, which at once struck an intense blue, at first limited to the fibro-vascular bundles. Boiling deprived them of this power, owing to the destruction of the oxydase, whereas blood solutions gave the blue reaction at once after five minutes' boiling. The author recommended this test to the attention of medical jurists.

Paris.

Academy of Sciences, July 5.—M. Émile Picard in the chair.—Some new trialkylacetophenones and the trialkylacetic acids derived from them: A. **Haller** and Édouard **Bauer**. It has been shown in a preceding communication that dialkylacetophenones can be converted into trialkylacetophenones by treatment with an alkyl iodide in benzene solution in presence of sodium amide. These trisubstituted ketones, when further heated with sodium amide in toluene give a nearly quantitative yield of the amide of the trialkylacetic acid, together with benzene. In the present paper alkyl groups of high molecular weight are introduced. It has been found that on treatment with sodium amide these trialkyl ketones always give the fatty amide, the expected change into benzamide and the trialkylmethane not being effected. The preparation and properties of several new ketones are described.—The tectonic relations of the island of Elba with Corsica, and the situation of the latter in the Alpine chain: Pierre **Termier**.—The new *Recueil* of levellings of Russian railways as a basis for the hypsometry of the country: J. de **Schokalsky**.—Central Asiatic Russia and the level of the lake basins: J. de **Schokalsky**. There is evidence that the levels of the Siberian lakes are slowly rising. This is connected with the fact that the annual rainfall for the last twenty years has been slowly increasing. It is possible that there are alternate dry and wet periods in Siberia, and that at the present time the wet period has passed its maximum.—M. J. C. **Kapteyn** was elected a correspondant in the section of astronomy.—Occultations of stars observed at the Observatory of Lyons with the Brunner 16-cm. equatorial during the eclipse of the moon of June 3: J. **Guillaume**.—The summation of Dirichlet's series: Marcel **Riesz**.—The singular integrals of certain algebraical differential equations: B. **Gambier**.—Linear differential equations and uniform transcendentals of the second order: René **Garnier**.—Some inequalities having a bearing on the theory of elastic vibrations and electrical vibrations: A. **Korn**.—The conductivity of a gas at atmospheric pressure under the influence of a high alternating voltage: A. **Chassy**. The conductivity of a gas increases continuously with the voltage, and it is only for the highest voltages well above the critical voltage that the capacity of the gas condenser is the same as that which would be obtained if the gas were replaced by a liquid conductor. It is possible that under these conditions the gas is a true conductor and follows Ohm's law.—The radio-activity of potassium salts: Émile **Henriot** and G. **Vavon**. The minute radio-activity shown by potassium salts would appear to be a property of the potassium atom, since all attempts to concentrate the radio-activity by a series of fractionations failed. This confirms the results of Campbell and MacLellan. The rays have been identified with the β rays.—Tautomeric changes elucidated by means of the magnetic rotatory power: P. Th. **Muller** and M. **Thouvenot**. A differential method was employed to increase the sensitiveness of the measurements. Experiments were made with methyl cyanacetate and its sodium salt and with acetoacetic ester and its sodium derivative. The results indicate a change in the internal structure when the molecule passes into the sodium derivative.—The chlorides of silicon: A. **Besson** and L. **Fournier**. The evolution of hydrogen from silicochloroform under the action of the silent discharge has been confirmed by working in a current of hydrogen chloride gas.—A new method for the isolation of terbine: G. **Urbain**.—The oxidation of aldehydes by silver oxide: Marcel **Delépine** and Pierre **Bonnet**. The aldehyde in aqueous solution is mixed directly with silver nitrate, and baryta solution added in a proportion sufficient to set free the silver oxide and neutralise the organic acid formed. Various applications of the method are given, the yields being very high, usually more than 90 per cent. of the theoretical.—The hydrolysis of proteid materials by means of hydrofluoric acid; some new results: L. **Hugounenq** and A. **Morel**. By varying the strength of the hydrofluoric acid used for the hydrolysis the reaction can be stopped at definite stages. The process is especially advantageous for the isolation of the simple peptides.—Study of the principal layers of the alkaline rocks of the French Soudan: G. **Garde**.—The elaboration of the materials containing phosphorus and saline substances in the leaves of living plants: G. **André**.—Two new carbohydrates extracted from asparagus: Georges **Tanret**. These have the composition $(C_6H_{10}O_5)_n$, where n is about 15. Details of the method of isolation and properties of these carbohydrates are given.—The *rôle* of the fluorescent bacilli of Flügge in plant pathology: Ed. **Griffon**.—The biometrical study of the seeds of *Vitis vinifera*: P. **Seyot**.—The supposed utilisation of atmospheric nitrogen by certain special hairs of plants: François **Kövessi**. The development of plant hairs is independent of the presence of atmospheric nitrogen, and there is no evidence that these organs have specialised absorptive powers for nitrogen.—Seeds killed by anæsthetics retain their diastatic properties: Jean **Apsit** and Edmond **Gain**. Grains of wheat, the germinating power of which had been destroyed by treatment with ether, retained both their diastatic and peroxydiastatic properties.—The sensation of relief: A. **Quidor**.—The presence of attractive spheres and of centrosomes in the cells resulting from the parthenogenetic segmentation of the fowl's egg, and on the characters of these formations: A. **Lécaillon**.—The caves of Lacave (Lot): Armand **Viré**.—The morphological zones of western Switzerland: E. **Romer**.—The earthquakes of June 11 and 23: Alfred **Angot**.—An attempt to guard against hail: M. de **Beauchamp**.—New observations on earth currents between stations differing greatly in height: B. **Brunhes** and P. **David**.

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THURSDAY, JULY 22, 1909.

THE DRESSING OF MINERALS.

The Dressing of Minerals. By Prof. Henry Louis. Pp. x+544. (London: Edward Arnold, 1909.) Price 30*s*. net.

THE author says, in his preface:—

"The object of the present work is to give an account of the theory and practice of the dressing of minerals, which will, I hope, prove useful to the miner or metallurgist who desires to understand the principles upon which this art is based, as also to the manufacturer who supplies the necessary appliances, and above all to the student who is preparing for either of the above professions." . . . "I have disregarded the time-honoured division which would make separate branches of the dressing of ores, and the cleaning of coals."

The first impression produced on reading this statement is that the new departure is warranted; that there are many points in common in the two branches, and that the comparison of practice under the different conditions would be of an illuminating character. The further perusal of the book, however, seems hardly to bear out this promise, and the joint treatment of the two branches rather tends to confusion, for the cleaning of coal involves the use of so many methods that are inapplicable to ores and *vice versa* that, if the two branches are to be treated in the same book, they should at least be dealt with under different sections.

Difficulties, inherent to the method adopted of dealing with the subject, are found throughout the book, and it is practically only in the chapter on general construction of dressing works that any clear differentiation between coal and ore dressing appears. It may be that the manufacturer should be acquainted with the machines used in both classes of work, and even that the student should acquire a knowledge of, and be able to draw comparisons between them, but that coal-miners should be called upon to study the various forms of rock-breakers, stamps, and other crushing mills and fine grinders seems unnecessary.

The book is well written and interesting, more especially, perhaps, in those parts that deal with theoretical considerations which relate to the construction of the machines. The designs of various machines are illustrated by excellent plates, and leading dimensions are often given, as well as the cost of the machines and manufacturers' figures regarding capacity. The latter are sometimes apt to be high; for instance, it is stated on p. 140 that a pair of Krom rolls 26 inches diameter by 15 inches face will crush about two tons of average ore per hour to about 30 mesh.

Relatively little information, however, is given as to setting up machines, their adjustments or running, the general conditions that have to be fulfilled or the general care of a dressing plant. Early forms of machines and historical references have received a good deal of attention, possibly more than they deserve, while in many cases modern forms have been passed over with brief mention, and a statement that they have not been long enough in use to enable an opinion to be formed regarding their value.

The treatment of the subject is divided into general considerations; volumetric sizing; sorting and washing; comminution; separation by specific gravity; appliances depending essentially on vertical fall; jigs; horizontal current separators; shaking tables; pneumatic, magnetic, and electrostatic separation; separation by surface tension; accessory appliances and general construction of dressing works.

It is, perhaps, in the chapter on volumetric sizing that the treatment of coal and ores together is most objectionable. It is sometimes difficult to gather whether the machine spoken of is used for coal or ores, and although, of course, many of them could be used for both, there is a more or less clear line of distinction between the two. To find a Wilfley impact screen described between the Klein screen and Zimmer conveyor screen seems curious. Trommels are said to be satisfactory to $\frac{1}{16}$-inch mesh. In the chapter on comminution such varying machines as rock breakers, rolls, Huntingdon mills, ball mills, tube mills, and disintegrators have been dealt with all too shortly. The Griffin mill is passed over in one paragraph, in which it is described as "like the Huntingdon mill with a single large roller which is caused to revolve on its spindle by means of gearing," but the construction, mode of action, and causes of crushing are so different in the two machines that the Griffin certainly merits a fuller description.

It seems questionable whether vanners should be included under the title of shaking tables, and no distinction is made between the condition of a pulp adapted for a vanner and that for a shaking table. The number of discussions that have taken place, and tests that have been made to prove whether it is better to classify the pulp or not before treatment on vanners, do not appear to be mentioned, while an authoritative pronouncement on the subject would have been of interest.

The subject of pneumatic separation has been treated more fully than it appears to deserve, and machines described which have certainly not warranted their existence. Magnetic separation has also received a good deal of attention, and many machines are figured which are used both for strongly and feebly magnetic substances.

In dealing with separation by surface tension, the author says it is impossible to offer correct or satisfactory explanations of the observed phenomena. He, however, presents an historical account of the development of the processes which depend upon this property, and briefly refers to several of the flotation processes. He has, however, only described the Elmore oil process and the Elmore vacuum process in any detail, from which it would seem that, in his opinion, they only are worthy of consideration. The chapter on accessory appliances passes from tipplers to various ore bin gates, then comes back to creepers, and returns to various conveyors of the belt, bucket, scraper, and screw types. Car and bucket elevators and tailings-wheels are dealt with, as well as ore feeders, and the chapter is finished with a few words on weighing and sampling.

There is a great deal of varied information contained in the book, but it would have been better to confine the subject to one or other of the branches referred to in the opening paragraph.

DUSTLESS ROADS.

Dustless Roads. Tar Macadam: A Practical Treatise for Engineers, Surveyors, and Others. By T. Walker Smith. Pp. xi+225. (London: Charles Griffin and Co., Ltd., 1909.) Price 10*s.* 6*d.* net.

THE growing use of motor-cars, and the destructive action due to the rapid speed at which they are driven, and the sucking action of the indiarubber tyres on the surface of the roads, has rendered a change in their management necessary.

It is the almost unanimous opinion of road experts that, in order to preserve the surface of the roads in good condition, it is necessary that some kind of bituminous material must be used for binding the stones of the macadamising, which, while cementing them together, will also give a waterproof and comparatively dustless surface.

The book under notice has, therefore, been published at an opportune time, as the method of repairing roads described in it, which has been more or less successful, has been so far only of a tentative character, the work not being carried out on any scientific basis, but very much by the rule of thumb.

The author, who was borough engineer at Barrow-in-Furness for several years, had under his charge many miles of macadamised roads subject to motor traffic, and devoted his attention to experimenting and trying to find out the best means of solving the difficult problem of keeping these roads in good order, and preventing the creation and spreading of dust, at a reasonable outlay. The results of his experience are given in the book under notice. The author, however, not content with his own experience, has also collected the opinions of a large number of road surveyors throughout the country as to the advantages and disadvantages, and cost of tar macadam, the answers to the queries submitted being given in the tables contained in the book.

The subjects dealt with are divided into fifteen chapters relating to tar macadam as a remedy for dust nuisance; the necessity for standardisation in construction; tar; aggregates for tar macadam; preparation and laying; mechanical mixing; effect of wear and tear; scavenging, watering, and maintenance; camber, gradient, noiselessness, and hygienic advantages; tractive effort; statistics of road mileage; cost of maintenance; and tar spraying. There are twenty-four illustrations and a tabulated analysis of the replies to queries.

The author shows that the binding material used in the making or repair of macadamised roads is the crux of efficient road maintenance and the prevention of dust. His opinion is that it is absolutely necessary, if macadamised roads are to meet the needs of present-day traffic with the searching demands that motor traffic makes on the surface of the road, that a bituminous binding or matrix should be employed. He points out that so far, although this fact is fully recognised, no scientific study has been made to standardise the materials used, and the proportion and quality of this material:—

> "Thus the matrix is usually prepared as it seems best to the individual in charge of the tar boiler who uses anything that comes from the local gas works; who boils it as long as he thinks necessary, and adds to it whatever he thinks may improve it in the way of pitch or creosote. It is a subject in which the personal factor has entered to an exceedingly great extent, and each man acts more or less as it seems best to him in his own mind."

The aggregates for tar macadam are also fully dealt with. The author points out that as the tar binding cements the stones together, the abrasion caused by friction in water-bound macadam is thus absent, the properties of noiselessness, elasticity, and resilience being secured. The only portion of the road material which is subject to any considerable wear is the surface, which has to bear the friction due to the rolling of the wheels, and also the impact of the horses' feet. It is, therefore, contended that the use of granite or other similar expensive material is not necessary for the lower coat, which consists of from 80 to 85 per cent. of the whole; but that where the road is only subject to moderate traffic the lower layer may consist of hard limestone or slag, either of which material holds the tar better than granite; the upper layer, which has to bear the surface wear and tear, being composed of granite. The author's experience leads him to the conclusion—

> "that it is an absolute waste of money to put such good material as granite in the bottom when a less costly material will do perfectly well when armoured with a good coating of tarred granite."

The patent processes known as "Tarmac" is described. The makers of this road material have expended upwards of 20,000*l.* in the construction of works and plants at Wolverhampton. The aggregate used is slag, the tar is distilled before using, and the mixing is done by machinery. The author, however, does not seem to think that it has any special advantage over ordinary tar macadam mixed locally when this is done in a proper manner. In the tables the cost of the materials and of mixing and laying is given for a great number of localities. As an average this may be taken as from two shillings to half a crown per square yard for a coating of 3½ inches of slag and hard limestone for the bottom layer, and half an inch of tarred granite for the surface coat. The general opinion appears to be that there is a saving in the cost of maintenance of roads where tar macadam is used in place of water-bound macadam, in some cases amounting to as much as 75 per cent., the average, however, being put at 37½ per cent.

With occasional tarring and sanding of the surface, a tar-macadam road, so far as the lower layer is concerned, is practically everlasting. The surface where there is much traffic requires re-covering about once in four years. Instances are given from the author's own experience where roads having a fair amount of traffic "have been as good at the end of six years as when first covered, and so far as can be seen will need very little for another six years."

This book ought to be carefully studied by all surveyors having charge of roads subject to motor traffic.

VECTORIAL GRAPHICS.

Vectors and Vector Diagrams applied to the Alternating Current Circuit. By W. Cramp and C. F. Smith. Pp. xvi+252. (London: Longmans, Green and Co., 1909.) Price 7*s*. 6*d*. net.

NOT many years ago a certain type of journalist used to compare and contrast the theorist and the practical man, to the demolition of the former and the apotheosis of the latter. Fortunately, such an attitude of mind is no longer possible. The merely practical man could never have constructed the Forth Bridge, nor launched the *Mauritania* on her record-making career. Innumerable examples might be given of the necessity of true theory in the economical designing of all kinds of machinery; but probably there is nothing that better proves how much mathematical science lies at the foundation of modern methods than electrical applications, especially those that have to do with the alternating current. The whole history of the development of the transformer and the alternating-current motor is simply the realisation of the solution of a differential equation given long ago by Maxwell. In this realisation the first great steps were taken by Heaviside, who introduced the terms impedance, admittance, reluctance, &c., giving a new precision to the ideas involved. By a mathematical extension of meaning the symbols which entered into the electrical equations of steady currents became applicable to the corresponding cases of sinusoidal currents. Stated in purely mathematical language, this transition depended on the properties of the complex variable.

Thus, to take the simplest case, Ohm's law $RC=E$ for steady electromotive force becomes Maxwell's expression $(R+L d/dt)C=E$ when E is variable. Representing a sinusoidal electromotive by the exponential of the imaginary ipt, we get the solution in the form $(R+iLp)C=E$, where C and E now stand for the amplitudes of the varying quantities. This complex quantity which operates on C may be treated analytically like the real quantity R in Ohm's law. Multiplication by the conjugate gives

$$(R^2+L^2p^2)C=(R-iLp)E.$$

In the end, after all analytical transformations have been effected, the real part of the expression must be picked out. A little experience will make the average student quite efficient in this kind of algebra, especially if it is combined with numerical and practical work.

But the value of the method does not stop here. Following familiar paths, we may give a geometrical form to the expressions, and obtain graphical representations of important relations. Thus the complex quantity $RC+iLpC$ may be laid down as a vector in a plane, RC being the component along a chosen direction and LpC the component at right angles to this direction, while the ratio Lp/R measures the tangent of the angle between the vector and the chosen direction of reference. Again, if we regard C as a complete vector, the complex operator may be considered to be a versor rotating C through the angle just named. Can we utilise these fundamental vectorial and versorial conceptions to construct a graphical representation of real value to the electrical engineer? The answer has been given in the affirmative; and among those who have worked up the method along these lines, no one holds a higher place than C. P. Steinmetz. The method has been presented in more or less detail in most of the recent books on the alternating current, and now we have an extremely valuable addition to the literature of the subject in "Vectors and Vector Diagrams applied to the Alternating Current Circuit," the joint work of William Cramp and Charles F. Smith, both lecturers in the electrical engineering school of Manchester University. The authors, for reasons given, depart somewhat from Steinmetz in their development of the method, but the foundation is essentially the same. Once the fundamental propositions are admitted and grasped, the whole treatment is a model of lucidity and self-consistency. One unusual feature of the book is that it assumes a certain fairly advanced knowledge at the start. This is a good feature, which might well characterise more of our text-books. The authors are careful at the same time to indicate exactly what knowledge the student must possess before he is in a position to make effective use of their methods—he must know the fundamental laws of the alternating-current circuit very thoroughly. Nevertheless, it would have been of advantage to have indicated in a few preliminary sections the manner in which the method originally took shape as a synthesis of the symbolic solutions of Maxwell's differential equations. There also seems to be a certain looseness of argument in the way in which the properties of vectors are stated. For example, having defined in the usual geometrical way the meaning of the "vector product" of two vectors, and having so named it, they remark, "This product must itself be a vector product, since it has already been shown to possess a definite sense." This is no proof, but mere statement. The defined product must be shown to obey the vector law of addition before it can be called a vector product.

These imperfections do not, however, affect the purpose of the authors, who are to be congratulated on having enriched our technical literature with a clear and systematic exposition of the vectorial graphics of alternating-current phenomena. After a discussion of the more purely geometrical character of the method, illustrated throughout by reference to familiar electrical phenomena, a succession of chapters follows on self and mutual induction, the transformer, motors of the induction type, and alternating-current commutator motors. A chapter is then thrown in on the product of two vectors, and the two concluding and longest chapters deal respectively with locus diagrams and examples of the application of locus diagrams. The book is amply illustrated by more than a hundred diagrams. Everything is concise and to the point, and the student who *works* through its pages will find himself equipped with a valuable weapon of research.

THE RECONSTRUCTIONAL ANATOMY OF THE KIDNEY.

Untersuchungen über Bau und Entwickelung der Niere. Edited by Prof. Karl Peter. Erstes Heft. Inhalt I., Karl Peter, Die Nierenkanälchen des Menschen und einiger Säugetiere. II., Michio Inouye, Die Nierenkänalchen des Rindes und des Tümmlers. Pp. viii+447. (Jena: Gustav Fischer, 1909.) Price 30 marks.

THE editor of this monograph holds with Koelliker that a knowledge of the morphological characteristics of the renal tubules is an important groundwork for the study of the physiology and diseases of the kidney. This ground plan he has laid down in a bulky volume, profusely illustrated by numerous and well-executed drawings. By means of maceration with concentrated hydrochloric acid and subsequent isolation of the urinary tubules, as well as by reconstruction models and serial microscopic sections, he has studied, along with his pupil, Michio Inouye, the structure of the kidney in various mammalian families in great detail. For the benefit of those who desire to ascertain his results without reading the whole of the text, he condenses a summary of his work into seventy-five pages of this volume.

Prof. Peter has worked out the structure of the kidney of the mouse, rabbit, sheep, cat, man, and pig, while Inouye has studied the organ in the seal and ox. They have given a minute description, perhaps too minute, of the organ in the various animals without adding, to any great extent, to our knowledge of the subject.

As a result of his study, Prof. Peter divides the medulla of the kidney into an inner and an outer zone, and the latter into an inner and an outer area. The cortex he divides into a *pars convoluta* and a *pars radiata*. These, to some extent, can be recognised with the unaided eye or by means of a lens, and each is composed of certain definite parts of the tubules, each zone or area being composed of the same parts in the same species. In fact, with some slight exceptions they are composed of the same parts throughout the whole of the mammalia. A summary of the zones and their contents is given.

These researches of Prof. Peter—minute and accurate as they are—have particularly little in them that will interest those who seek to elucidate the functions and diseases of the kidneys. The author himself states that as regards the significance of the Malpighian bodies his investigations have produced nothing new. Concerning the first convoluted and zigzag tubules which he includes under the name of the "Hauptstück," certain observations have been recorded with regard to variations in the amount of fat contained in the cells, and from the fact that these vary in their affinity for eosin in different parts of the convoluted tubule, the deduction is made that the functions of the latter are not the same throughout its length. The facts adduced by these investigations have very little bearing on the two rival theories of the manner in which the kidney removes the urine from the blood—whether by a process of secretion or one of filtration.

The function of the narrow, clear part of the loop of Henle is concluded to be the resorption of the water which has been thrown out of the glomerulus. This is deduced from a ratio which Prof. Peter has found to exist between the relative length of this part of the tubule and the specific gravity of the urine in various mammalia with the exception of some of the smaller ruminants. In this matter his observations support the experiments of Ribbert and H. Marger, and of Hausmann. These experimenters removed the whole of one kidney and the medulla of the second in a rabbit, with the result that the urine was doubled or trebled in amount. As the narrow, clear part of the loop of Henle is contained in the medulla, it is inferred that the increase in the amount of urine is due to the removal of the resorbing part of the tubule. So many factors have to be considered in a case like this that the author's deductions must be regarded with a certain amount of reserve. While one must admire the industry and accuracy manifested by this work, it must also be admitted that even those specially interested will find it very tedious reading, and it is to be hoped that it may be possible to confine the other promised volumes within a more modest compass.

R. D. K.

GREEKS AND HITTITES.

Ionia and the East. Six Lectures delivered before the University of London by D. G. Hogarth. Pp. 117. (Oxford: Clarendon Press, 1909.) Price 3*s*. 6*d*. net.

THE author of this book aims at solving the interesting problem of the origin of Hellenic civilisation in the Grecian colony of Ionia, in western Asia Minor. He utilises, in a masterly manner, the results of the extensive archæological researches that have been carried out within the last thirty years in south-eastern Europe. The excavations of Schliemann, Evans, and numerous other workers in this field have completely revolutionised our ideas about the origin of that early Grecian culture to which modern European civilisation owes so much.

Mr. Hogarth's conclusions are, that in Attica the home country of the Ionians, the population, before the migration to Asia Minor, was mainly Ægean, but mixed with a northern element of invaders from the Danubian area. At this date there survived in Attica a vigorous bloom of Ægean culture affected to an unusual degree by some eastern influence, so that the colonists who settled on the west coast of Asia Minor in the early centuries of the first millennium B.C. were by no means barbarians. In Ionia the Greek settlers came in contact with a highly developed Asiatic civilisation—namely, that of the Hittites—and one of the most original features of Mr. Hogarth's book is the demonstration which he gives of the powerful influence of the Hittite civilisation in the development of the Hellenic culture in Ionia. The Hittites were predominant in Asia Minor from 2000 B.C. to 800 B.C., and, besides being possessed of a highly developed culture of their own, acted as intermediaries for the transmission of Mesopotamian culture to the Greeks. Of both these influences there is distinct evidence in the few excavations that have been carried out in Asiatic Greece.

There appears to be a rich field awaiting the archæological excavator both in Ionia and in other parts of Asia Minor. In Lydia, which was apparently a Hittite satrapy, very little excavation has been done, and in the Hittite country on the upper Euphrates hundreds of buried cities are known to exist, in some of which, it is almost certain, as Mr. Hogarth points out, bilingual inscriptions connecting the Hittite script with the Assyrian will be found. We may, then, expect discoveries equalling, if not excelling, in importance those that have recently been made in Mesopotamia, in Egypt, and in Crete.

Another iconoclastic view of Mr. Hogarth's is that the Phœnicians played an insignificant part in the development of Greek civilisation. He reduces "the part played by the Phœnicians among the Greek Isles and coasts to that of mere huckstering traders who followed seaways long ago opened by others."

Mr. Hogarth considers that the Hittites were not a maritime people, but were confined strictly to their continent by the Ægean command of the sea. In view of the migration from Lydia to Umbria related by Herodotus, and of the existing population of broad-headed races in the Balkans, which, judging from its present distribution, must apparently have landed on the eastern shores of the Adriatic, Mr. Hogarth's views on the non-maritime character of the Hittites will, we venture to think, be considerably modified by future discoveries. The one weak point in Mr. Hogarth's admirable little book is his disregard of the evidence of physical anthropology. No explanation of the ethnological evolution of the East will be satisfactory which fails to account for the transition of the primitive dolichocephalic peoples of the Balkan peninsula into the strongly brachycephalic population of the present day, and in this respect Mr. Hogarth's otherwise admirable work completely fails. J. G.

SOME NEW CHEMICAL BOOKS.

(1) *Naturgeschichte einer Kerze von Michael Faraday.* Herausgegeben von Dr. R. Meyer. Pp. viii+172. (Leipzig: Quelle und Meyer, 1909.) Price 2.50 marks.

(2) *Junior Chemistry.* By R. H. Adie. Pp. viii+266. (Cambridge: University Tutorial Press, 1909.) Price 2s. 6d.

(3) *Chemistry.* By Prof. W. A. Tilden, F.R.S. Dent's Scientific Primers. Pp. ix+108. (London: J. M. Dent and Co., n.d.) Price 1s. net.

(1) FARADAY'S six lectures on the chemical history of a candle were, it may be remembered, delivered to a juvenile audience at the Royal Institution during the Christmas holidays of 1860–1, nearly half a century ago.

In reading them we are impressed not merely by the delightful simplicity and freshness of their style, and by the variety and ingenuity of the experimental illustrations, but more especially with the completeness of the story he had to tell. There is little that has been modified or extended in this branch of knowledge during these fifty years; there is scarcely a single sentence which might not be uttered without comment or correction to a similar audience to-day.

It is not surprising, therefore, that a fresh edition of Dr. Meyer's excellent German translation should be in demand among young people in Germany, and it speaks well for their appreciation of Faraday and his charming "chemical history" that the translation has reached its fifth edition.

The book is attractively bound, and contains a very pleasing portrait of the author, together with a short biography.

(2) Mr. Adie justifies the production of another elementary chemistry on the ground that the average first-year student shows a lack of intelligent understanding of chemical aims and methods, for which, we infer, the other books are mainly responsible. We are inclined to think that this want of intelligent understanding is due neither to the character of a particular book, nor altogether to the teacher, but to the kind of chemistry done in schools and fostered by the scholarship system of the older universities.

If the systematic study of chemistry at the university or college were founded on a good general knowledge of mechanics and physics, and an elementary notion of those chemical processes applicable to everyday phenomena, the path of the college professor or lecturer would be made much smoother. But schools are not content with this modest programme, and insist upon a standard of knowledge beyond the grasp of the average schoolboy. The result is that the college teacher has to build upon a muddy foundation of confused ideas, which are so familiar to examiners and so difficult to eradicate later. What commends Mr. Adie's new book is not so much the disastrous effects of its predecessors as the long teaching experience of the author. The results of fifteen years' experience of a thoughtful teacher are always valuable, and, as one might have anticipated, the book offers a thoroughly sound course of practical instruction.

The arrangement of the exercises is clear and logical, the examples are thoroughly typical, well selected, well illustrated, and carefully described. Many of the experiments, without being exactly new, are modified and arranged in a convenient form, and the quantitative examples, which are numerous and varied, furnish a sound basis for that most difficult part of chemistry, the understanding of quantitative laws and the theories drawn from them. In reference to the quantitative part, it would be interesting to know what sort of errors the author obtained in determining such things as the gravimetric composition of water, the weight of steam, and the analysis of the oxides of nitrogen, of which no actual examples are given. If the two oxides of nitrogen give anything like correct results by the method described, that much-quoted example of multiple proportion would lose something of its elusive character.

(3) In the editor's preface to Dent's Scientific Primers, in which the one under review is included, we are told that the great advances in knowledge during the last thirty years necessitate a re-statement of the theories of the different sciences.

This may be true of chemistry if it were a question of publishing a new treatise or even a students' text-book; but when we consider that this miniature volume of a hundred pages is intended for a student possessing no previous acquaintance with the subject and without the leisure to study it systematically, we cannot be surprised that the advances in knowledge are not very apparent. We might even go further and state that, except for a passing reference to radium and the noble gases, and the use of the words "stereochemistry" and "polypeptides," the book might just as well have appeared thirty years ago.

With the very limited space at his disposal, Prof. Tilden has made good use of his materials, and has compressed into a small compass a very readable and suggestive account of the elementary facts and theories of chemistry.

J. B. C.

OUR BOOK SHELF.

Histoire du Développement de la Chimie depuis Lavoisier jusqu'a nos Jours. By Prof. A. Ladenburg. Traduit sur la 4e édition allemande. By Prof. A. Corvisy. Pp. v+388. (Paris: A. Hermann et Fils, 1909.) Price 15 francs.

Forty years ago, the first German edition of Ladenburg's "Lectures on the History of the Development of Chemistry during the past 100 Years" was published. This was a relatively small book of 320 pages, which presented, in the course of fourteen lectures, a carefully drawn and evenly balanced sketch of the progress of chemistry subsequent to the time of Lavoisier. At the date of its publication it was unique in dealing, in a logical and consistent manner, with the progress of the atomic theory in its application both to inorganic and to organic chemistry, and in serving at least as an introduction to the particularly difficult and complicated period in the history of organic chemistry which began in the 'thirties and extended to the late 'fifties or early 'sixties of last century. It was not until about four years later that this period was dealt with, a good deal more elaborately, by Kopp in his "Development of Chemistry in Recent Times" (1873). A specially valuable feature of Ladenburg's lectures was the abundance of references to the literature, which tended to encourage the reader to extend his knowledge of particular branches of the subject by consulting the original papers of the various authors. A second German edition was called for in 1887, when the original book was revised, and was extended by the addition of a fifteenth lecture.

In 1900 an English version of Ladenburg's "History" was published, which was translated from the second German edition, but included various corrections and minor additions by the author, and also a sixteenth lecture, specially written for this translation. A revised English edition appeared in 1905. The third German edition (1902) was merely a reprint of the second edition with the sixteenth lecture added to it, but in 1907 a thoroughly revised and very considerably enlarged German edition appeared, which extended to more than 400 pages, and contained seventeen lectures, the subject-matter being brought up to date as fully as possible, and including accounts of the progress of discovery in connection with such recent subjects of extended investigation as radium, asymmetric nitrogen, the proteins, and the colloid substances. It is from this fourth German edition that the French translation which is before us was prepared, and the fact that a French version is now published may be taken as in itself a tolerably satisfactory indication, not only that Ladenburg's book has established itself as a work of permanent value in the estimation of chemists irrespective of nationality, but also that it is free from national bias, such as is frequently met with in historical works. The translation bears every evidence of having had much careful attention bestowed upon it, and it gives a faithful representation of the original. The book is produced in a creditable style typographically.

(1) *Biologisches Praktikum für höhere Schulen.* By Dr. Bastian Schmid. Pp. vi+71. (Leipzig and Berlin: B. G. Teubner, 1909.) Price 2 marks.

(2) *Biologische Experimente nebst einem Anhang mikroskopische Technik.* By Walther Schurig. Pp. xi+180. (Leipzig: Quelle und Meyer, 1909.) Price 2.40 marks.

(1) This is an attempt to compress into seventy-one octavo pages a practical introduction to the study of the comparative anatomy of plants and animals, together with a certain amount of experimental physiology. There are seventy-five text-figures and nine plates. A considerable number of types, ranging from bacteria to mammals, are dealt with in a very scrappy and superficial manner in the text. A large proportion of the illustrations are borrowed from the works of well-known authors. They are well reproduced, but the text and explanations of the figures are very inadequate. A plate containing figures of the skeletons of a frog, a dog, and part of the skeleton of a bird (apparently there was no room for the skull, which is omitted), without a single bone labelled, is not likely to be of very much service even to the most elementary scholar. Doubtless, however, there are people who are gratified by observing a resemblance between an actual specimen and a book illustration, and they may even think that they have learnt something by comparing the two. It is only fair to the author to mention that the book is intended to be used in conjunction with the instruction of a teacher, who, no doubt, would be able to supply many of the deficiencies.

(2) This little book is addressed to school teachers and students of nature, and is intended to serve as a guide to a large number of simple experiments in animal and vegetable biology. It is very suggestive, but the style is rather too much that of a cookery book, and the work suffers greatly from over-condensation. A good practical course on general physiology, in itself a very desirable thing, might be founded upon it by an experienced and well-read teacher of biology, but it would take a very long time to carry out all the experiments in a satisfactory manner.

Inborn Errors of Metabolism. The Croonian Lectures delivered before the Royal College of Physicians of London in June, 1908. By Dr. A. E. Garrod. Pp. vi+168. (London: Henry Frowde, and Hodder and Stoughton, 1909.) Price 3*s.* 6*d.* net.

Dr. Garrod delivered before the Royal College of Physicians in June, 1908, his Croonian lectures under the above title, and the present little book is a welcome re-publication of these lectures in a rather more extended form than those actually delivered. The author is well known for his researches on nutrition, metabolism, and the urine, and has always had a special bent in the unravelling of those rarer anomalies which in so many cases are transmitted from generation to generation. It would lead one too far into strictly medical matters to attempt anything in the shape of even a condensed account of the matters specially selected by Dr. Garrod, and so one need only mention that the anomalies treated at length are albinism, cystmaria, alkaptonuria, and pentosuria.

It must not be supposed that the examination of these comparatively rare conditions is devoid of general interest, for it is often just these curious accidents of perverted tissue change which form the opportunity of the keen observer in unravelling the perplexities of the normal state. The natural sequence of study is physiology first, pathology next. But very often an inversion of this order leads to important accessions to knowledge. Dr. Garrod is to be congratulated on having been successful in such an experiment, and those interested in metabolism cannot do better than study his lucid and bright exposition of the subject. W. D. H.

Practical Testing of Gas and Gas-meters. By C. H. Stone. Pp. x+337. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 15*s.* net.

THIS is a laboriously complete compilation of the various methods of testing gas for illuminating power, purity, chemical composition, and calorific value, and of proving the accuracy of the indications of gas-meters. The subject is one mainly of technical interest only, and very specially so even for that, and hardly suitable, therefore, for detailed consideration in these columns. An examination of the book shows how great a diversity of apparatus has been devised and thrust upon the innocent gas-producing world, and how gratuitous some of the diversity is. Where apparatus has been designed for official testings, the objection to protecting the manufacture by patents has given the constructor liberty to alter and "improve" or spoil an instrument, as the case may be.

The American has a great opinion of the English official ten-candle lamp designed by Mr. Harcourt, but he will not take it as he finds it, and so he makes an American pattern. The English official calorimeter, too, judging by the observations made, has also gone through a metamorphosis in crossing the Atlantic. As is to be expected, the book is well got up and illustrated, and its value is increased by the inclusion of a number of tables of value to those whose business is to test and examine gas.

A Compendium of Food-microscopy. By E. G. Clayton. With sections on Drugs, Water, and Tobacco. Compiled, with additions and revision, from the late Dr. A. H. Hassall's works on Food. Pp. xxxix+431. (London: Baillière, Tindall and Cox, 1909.) Price 10*s.* 6*d.* net.

THIS book, written by an ardent disciple of the late Dr. Hassall, is largely based on Dr. Hassall's works on food and its adulteration. An account is given of the microscopical characters of all the principal vegetable food-stuffs, beverages such as tea and coffee, fruit preserves and condiments, and of tobacco, opium, and a few other drugs, together with those of the chief adulterants of these substances. In addition, chapters are devoted to foods of animal origin and the parasites which may infect them, milk, cream, butter, and cheese, and to the microscopical flora and fauna of water. The book is profusely illustrated with line drawings to scale, which usually reproduce very clearly the characteristics of the substances they are intended to depict, though occasionally there is an irritating want of systematic arrangement of the figures, Fig. A, for instance, sometimes being on the right, sometimes on the left, of the page. Though the botanical terminology is not always that used nowadays, on the whole the book should form a useful addition to the library of the analyst and microscopist.

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.]*

Molecular Scattering and Atmospheric Absorption.

SINCE Lord Rayleigh discussed the question of molecular scattering, and its bearing on the explanation of the blue colour of the sky, our experimental and observational data have become much more trustworthy. While our knowledge of the number of molecules in a gas allows us now to calculate with sufficient accuracy the amount of direct sunlight which is diverted by scattering, Mr. Abbot's series of measurements at Washington and on Mount Wilson gives us the actual observed opacity of the air for different wave-lengths.

Lord Rayleigh showed that, on the hypothesis of the elastic solid theory of light, small particles of matter, which act simply by adding inertia to the æther, scatter light and retard the passage of a wave passing over them in such a way that the relation

$$k = \frac{32\pi^3(\mu - 1)^2}{3N}$$

holds, where k is the coefficient of extinction of energy, μ the refractive index, and N the number of molecules per cubic centimetre. He showed, further, that the same equation may be deduced from the electromagnetic theory if the particles locally affect the inductive capacity of the medium. In the forthcoming new edition of my "Optics" it will be proved that the equation is independent of theory, provided μ is nearly equal to unity; the limit of its applicability is only reached when there is a retardation of phase at the origin of the scattered light the square of which is appreciable, and it can be shown that this is actually the case except within the region of anomalous dispersion. The range of the formula may be further increased if $\frac{1}{4}(\mu^2 - 1)^2$ is written for $(\mu - 1)^2$.

For N I have used Rutherford and Geiger's value $2{\cdot}72 \times 10^{19}$, and with the known value of the refractive index of air, k may be calculated. If h is the height of the homogeneous atmosphere above the point of observation, e^{-kh} is the fraction of light which would reach the observer if no light were lost in any other way than by molecular scattering. In the following table the transmitted light calculated in this manner is compared with Abbot's observed figures. The first column gives the wave-length, the second column contains the observed values of the transmitted energy for Washington, taking all observations into account, while the third column gives the number calculated from the observations on February 15, 1907, when the air was exceptionally clear. The calculated values are entered into the fourth column. The last three columns give the corresponding numbers for Mount Wilson. The selected clear day in this case was October 11, 1906.

	Washington			Mount Wilson		
Wave-length	Observed mean	Observed clear day	Calculated	Observed mean	Observed clear day	Calculated
4×10^{-5}	0·55	0·72	0·71	0·73	0·76	0·76
5	0·70	0·84	0·87	0·85	0·89	0·89
6	0·76	0·87	0·94	0·89	0·92	0·95
7	0·84	0·90	0·96	0·94	0·96	0·97
8	0·87	0·94	0·98	0·96	0·99	0·98
10	0·90	0·96	0·99	0·97	0 99	0·99

The close agreement between the two last columns shows that on a clear day on Mount Wilson atmospheric absorption is practically accounted for by molecular scattering. There is a slight indication of selective absorption in the red, but otherwise the columns are in complete agreement. On the average day there seems an additional absorption of about 2 per cent. It is remarkable that, even at Washington, the calculated absorption for blue light should so nearly agree with the calculated value; this means that even at the sea-level the greater part of the absorption on a clear day is due to scattering by the molecules of air. The large diminution in the intensity of blue light at Washington on the average day seems to indicate that there is a substantial amount of scattering by small solid or liquid particles.

The figures for Mount Wilson give us confidence in the trustworthiness of Mr. Abbot's determination of the solar constant, because it is clear that the total effect of the atmosphere can be eliminated with greater certainty if it is mainly due to the permanent constituents of the atmosphere, and not to matter which is variable in amount. As the top of Mount Wilson is less than 1800 metres above sea-level, we may conclude that at high elevation the blue colour of the sky is completely accounted for by molecular scattering.

That the scattering sets a limit to the transparency of gases must be kept in mind in discussing problems of solar and stellar physics. We may feel confident, for example, that what is called the reversing layer can only have a small thickness, for otherwise we should not be able to observe so far into the ultra-violet as we do.

The scattering may profoundly modify the character of the spectrum, as I have explained in a paper on "Radiation through a Foggy Atmosphere" (*Astrophysical Journal*, vol. xxi., p. 1), in which it is shown how increased thickness, without change of temperature, may convert an absorption line into a bright line. It seems to me probable that the bright and dark flocculi shown in spectroheliograph pictures may find their explanation chiefly in variation of thickness in the absorbing layer, the bright patches being due to increased thickness.

The transparency of interstellar space has recently received a much needed critical discussion at the hands of astronomers, and Prof. Turner has applied the law of scattering to explain certain discrepancies between visual and photographic magnitudes. The value he gives for the opacity allows us to calculate the average density of the matter which is diffused through space on the supposition that it is gaseous. If the value of $(\mu-1)/D$ (where μ is the refractive index and D the density) be taken to be approximately equal to that of air, I find that the number of molecules per cubic centimetre in space would have to be of the order of a million, and the mean free path of the order of 3000 kilometres.

Although not directly connected with the subject which forms the main part of this communication, I would like to point out that the same analysis which gives the coefficient of extinction in terms of the retardation of phase at the source of the scattering also gives a resultant force acting on the molecule in the direction in which the light is passing. When summed up for all the molecules this force is found to be identical with what is generally called the "pressure of light," for if E represents the energy density, the force acting per unit volume on the scattering molecules is found to be kE, where k is the coefficient of extinction.

There is a widespread impression that light pressure only acts on particles the linear dimensions of which include several wave-lengths of light, but this is not correct. The determining factor is the extinction of light, whether by scattering or by absorption, as indeed appears if we take the view adopted in Prof. Poynting's work on the subject that a propagation of momentum accompanies the transmission of light. The momentum is destroyed equally whether the molecules act as scattering or as absorbing centres. The extinction by scattering near the surface of stellar bodies does not, however, appear to be sufficient to cause any measurable effects comparable with their gravitation.

ARTHUR SCHUSTER.

The Fixation of Nitrogen by Soil Bacteria.

MAY I be allowed through the columns of NATURE to ask Prof. W. B. Bottomley a few questions with regard to his paper on "Some Effects of Nitrogen-fixing Bacteria on the Growth of Non-leguminous Plants" (Proc. Roy. Soc., B, lxxxi., 1909, 287), abstracted in NATURE of May 13 (vol. lxxx., p. 327), as I had not the opportunity of being present when the paper was read?

Prof. Bottomley bases his conclusions on experiments to show that Pseudomonas, the bacterium associated with the leguminous plants, will fix more nitrogen in an artificial culture, when Azotobacter is also present, than when alone. He quotes the following results:—

Control	0·48	mgm. N. per 100 c.c. culture solution
Pseudomonas alone	0·91	,, ,, ,,
Pseudomonas and Azotobacter ...	1·24	,, ,, ,,

These differences would almost seem to be within the range of experimental error, but in any case, does not the demonstration require a further statement of how much nitrogen Azotobacter alone would fix? Other observers are accustomed to get fixations by Azotobacter alone of from 5 to 20 mgm. of nitrogen per 100 c.c. of such a culture solution, the maximum being about 10 mgm. of nitrogen fixed per gram of mannite. The only conclusion that could be drawn from Prof. Bottomley's figures would be that Pseudomonas injuriously affects the power of Azotobacter to fix nitrogen, supposing that a reasonably active culture of the latter had been used.

Turning to the field experiments, in which Prof. Bottomley claims to get an increase of crop by adding cultures of Pseudomonas and Azotobacter to soil which presumably already contains both organisms, data for estimating the probable experimental error are again lacking. From the Rothamsted experiments, where we may assume the conditions are more than usually favourable to exactitude, the mean error of a pair of similarly treated plots in a single year is about ± 10 per cent., which would more than cover the differences observed by Prof. Bottomley's experiment with oats.

In another experiment with barley, Prof. Bottomley obtained a higher percentage of nitrogen in the corn from the treated strip than in the corn from the rest of the field, 1·76 against 1·55 per cent. (I presume that "milligrammes of nitrogen per cent." is a clerical error). In view of the comparatively small changes in the composition of the grain of a cereal which are usually effected by large variations in the supply of nutrient, I should like to know from Prof. Bottomley if duplicate samples were taken from different parts of the untreated section of the field, and what range of variation they showed in their nitrogen content.

Coming to the next experiment, it is difficult to judge how far a bulbous plant like *Galtonia candicans* is suitable for experiments on nutrition, but it is rather necessary to know what relation the weight of the bulbs planted bore to those harvested. Prof. Bottomley only says that 250 bulbs "of equal size" were planted in each bed. Can he let us have the weights in each case? Moreover, he tells us that the treated bed was twice watered with the culture solution, the control bed being given pure water at the same time; was the same amount of water given to each, and how much of the culture solution was applied, for it contained monopotassium phosphate, sodium chloride, &c., which may well have been a considerable factor in any beneficial effect experienced?

Prof. Bottomley will perhaps forgive me if these questions may seem somewhat critical of his conclusions, but any communication appearing in the Proceedings of the Royal Society must be taken into account, and one therefore wishes to have the data necessary for determining the weight to be attached to the results.

A. D. HALL.

The Rothamsted Experimental Station, July 12, 1909.

Occasional Unexplained Ringing of House-bells.

AN observation sent me by Mr. Alexander Sinclair, of Swansea, to the effect that during a thunderstorm drops of water leaking through the ceiling "assumed a pear shape and jumped 9 inches almost horizontally to the curtain rings above the window," suggests that house-bells of the ordinary non-electric type may occasionally be rung by this means. I picture the process as follows:—The bell wires collect atmospheric electricity, by induction or otherwise, which the walls are insufficiently conducting to carry off freely; consequently the bells get charged, are attracted to a neighbouring wall or pipe, and released suddenly by a spark. This little lateral jerk rings the bell.

I put the simple suggestion on record because I sometimes hear of an inclination to attribute the phenomenon to less familiar causes.

OLIVER LODGE.

Musical Sands.

IN an interesting letter Mr. Carus-Wilson gives us the results (NATURE, July 15) of further observations made by him on a phenomenon on which he has written from time to time. I believe I have suggested to him in years gone by—if not, perhaps you will allow me to suggest now—the possibility of the musical ring of certain sands in motion being due to their consisting largely of grains of *hyaline* quartz. That fact, if ascertained, would account for the ring of the grains in motion, while the smoothness of their glassy surfaces would facilitate their motion, and so increase the force of their mutual impact, tending to raise the pitch of the note produced. I have never had an opportunity myself of making a microscopic examination of such sands, but I venture to commend such an examination to Mr. Carus-Wilson's consideration. The assortment of the sands by the wind into possibly more rounded and more angular grains may also throw some light upon the matter.

A. IRVING.

Bishop's Stortford, July 19.

Wych Elm Seedlings.

THE prolific flowering of the Wych elm, *Ulmus montana*, this year must have been followed by the formation of unusual numbers of fertile seeds. At present the ground beneath these elms in my garden is covered with hundreds of their seedlings, many of which have already developed a second pair of serrated leaves.

The elms themselves seem to have suffered from the strain of producing so large a crop of fruits, for their leaves, though now of the usual size, were very late in appearing, and are sparsely distributed on the branches.

ROSAMOND F. SHOVE.

26 Blessington Road, Lee, Kent, July 13.

POPULAR NATURAL HISTORY.

MR. LEA'S "Romance of Bird-life,"[1] a handy and fully illustrated volume published at a marvellously low price, covers the whole life-history of the bird, from the egg upwards, the twenty-one chapters containing a summary of the observations of a great many writers on ornithology arranged in a masterly and most attractive form. One of the concluding chapters deals with the birds of the past and vanishing species, and is illustrated with a reproduction of a curious old wood-cut published in 1601, representing early voyagers knocking down dodos and other birds with sticks on the island of Mauritius. In that upon "Wisdom and Folly" we have anecdotes bearing on the intellectual capacity of birds. There are many instructive passages in the book, which is quite a mine of information. It is stated that in more than one instance, if when a chick was cheeping while still in the shell the mother uttered a note of warning, the cheeping stopped instantly; and it is pointed out that this teaches us that the simple language of call-notes is instinctive, for the chick cannot possibly have learnt their meaning by experience. Nestlings the food of which is placed in their mouths by their parents cannot be taught to pick it up from the ground like chicks until they are much older. Young moorhens, however, which are fed from their mother's beak at first, will peck upwards at anything that is offered to them, but not downwards. So far as the author is aware the frigate bird is the only species which ever carries on fishing in mid-air, waiting until the flying-fish are startled from the sea by some large fish which preys on them below the surface; other fishing birds follow them into the water. The romantic story of the ospreys at loch-en-eilein (which should be written eilean) is told and illustrated.

Possibly the "romance" is a little overstrained in places, and ordinary incidents in a bird's general life habits sometimes magnified or transfigured into something more wonderful. For instance, it is a common custom with snow buntings (and with some other quick-footed birds which feed in flocks) for the rear ranks to fly to the front over the backs of the others, a manœuvre repeated by the others in turn. This simple desire (and its expression) to have first turn at whatever food is going is here advanced as "a boisterous little game of their own" in the section on sport and play. The combats of ruffs are much milder and much less important affairs than is here represented; and it seems really unlikely that nuthatches could drive out squirrels from their nest, or would want to take possession of it. Unlike most of the popular bird books published in recent years this one fills a vacant place.

Almost anyone seems to feel capable nowadays of writing a book on British birds, and, in good truth, there is material enough to compile from. Time was when to write an account of British birds was an undertaking attempted by few, and those only who had made the subject their main study for many years, and were on all hands accounted authorities. Now almost anyone does it, and there is a perfect stream of books on this subject. They come out so frequently that, although the title has been turned and twisted in a great variety of ways, it has even been found impossible to discover fresh and original names to distinguish them by. Most of them put forward some special claim upon the public. Many of them purport to cater for the ignorant and the beginner; one, indeed, made a point of picking brains without acknowledgment. Here is one[1] "with a new method of identification." This book has been written with the exclusively practical object of enabling persons unacquainted with British birds to identify them by their most obvious characteristics. By the grouping of birds, as here carried out, under such headings as "Black-and-White Birds," "Ruddy-breasted Birds," "Trunk-climbing Birds," it is claimed that the birds are presented to the beginner as he himself sees them. Where necessary, notes are appended to the descriptions indicating those birds with which the one described is most likely to be confounded, and the chief characteristics by which it is to be distinguished from them. Before proceeding to observe birds, however, the user of this book need do no more than read through the list of group-headings. The book is, in fact, another attempt at a royal road to a knowledge of our birds. The idea has been tried over and over again in some shape or form, both here and in America, but we do not think it will ever be successful. In the present case the difficulties of grouping begin to be apparent very shortly. "Skuas" as a group heading will convey nothing to the beginner without good pictures. In the end the author is left with three birds, the jay, the goldfinch, and the white wagtail, which do not fall into any groups. The two first are so conspicuous that perhaps they do not want grouping; but, really, after some of the grouping, *e.g.* putting the hedge sparrow and some others among those which are "brown above and white below," it seems rather like straining at a gnat not to have dropped the third in among the black-and-white birds. We are glad to read that there are a few breeding pairs of kites in the Midlands of England, and hope

[1] "The Romance of Bird Life." Being an Account of the Education, Courtship, Sport and Play, Journeys, Fishing, Fighting, Piracy, Domestic and Social Habits, Instinct, Strange Friendships and other interesting Aspects of the Life of Birds." By John Lea. Pp. 376; illustrated. (London: Seeley and Co., Ltd., 1909.) Price 5*s*.

[1] "British Birds and their Eggs, with a New Method of Identification." By J. Maclair Boraston. Pp. x+301; 136 coloured illustrations. (London and Edinburgh: W. and R. Chambers, 1909.) Price 6*s*. net.

it is the case. There is a classified list of the birds contained in the book, and an index, so that every facility is given to those who try to learn birds' names in this way. Illustrations of the eggs of *all* British-breeding birds appear in the sixteen plates devoted to that part of the subject. Some of the plates of birds are pleasing. But in the great majority of cases the three-colour process has probably played sad tricks with the colours, and some of the pictures are misleading. Others make the bird-lover shudder; for horrible and appalling crudeness of colour their equal would be hard to find.

Young egg-collectors are also provided with a simple guide to identify their finds.[1] A part of a larger work, "The Young People's Nature-study Book," it is in the form of a pocket-book, with blank leaves at the end for making notes on the spot. The system of this key is as follows. The nests are grouped under the headings according to their locality and position. Turning to the particular section to which a nest belongs we find additional characteristics of the nests and eggs described, which it is hoped should lead by process of elimination to a correct result. The eggs figured on the four coloured plates are those most generally confused. They can hardly be expected to be very good, but will be useful. The introductory remarks are instructive, and there are some photographs of nests.

Mr. Vos has issued[2] the second and third parts of a description (illustrated) of the rambles of two friends in search of birds' nests near London, comprising the results of two seasons. They seem to have been exceptionally fortunate in finding many interesting birds and nests, and some which would not have been expected. For instance, a snipe's nest almost within earshot of Bow Bells seems wonderful. But even more so in some respects, perhaps, is "a little colony of three pairs" of carrion crows on a small island; for in our experience, even where crows are common, it is most unusual for these unsociable birds to nest in close proximity to one another. The situation of one nest, in the top of an elder-tree, about twenty-five feet from the ground, seems unusual in a country where big trees are to be found, and the egg described as about an inch long was very small, an average crow's egg measuring an inch and three-quarters. The third part concludes with a grouping of the birds mentioned to aid in their recognition; a description with figures of the eggs; a synopsis, an alphabetical index of some of the birds mentioned, and a general index. A number of nests have been nicely photographed for the book, but the photographs of *stuffed* birds are open to criticism, as is usual.

Some of our best and really competent ornithologists have from time to time considered the possibility or advisability of editing Johns's classic,[3] but they have feared to tread. With regard to the present edition we can only regret that a good old book has been spoilt to some extent. Fortunately, not much has been done to it, for although the editor claims to have rectified statements as to the local distribution of various species which, with the progress of time and local changes, no longer apply, and to have added facts here and there which he considered of some value, this has been done so inadequately that it might as well have been omitted altogether. There are some birds, the Lapland bunting and shore lark, for instance, the status of which on the British list has entirely altered since Johns wrote; yet the articles on these species are left just as he wrote them. The editor has also brought the scientific arrangement of the species up to date. If this was to be done, more care should have been taken, when the order and sequence of the species was altered, to avoid absurdities consequent upon careless revision of the articles. As it is, we are told that the black tern is scarcely less aquatic than the whimbrel; that the name laughing gull is often given to the common gull; that the snow-bunting does not confine itself so closely to the Arctic regions as our homely reed-bunting, and various other absurdities, all of which are due to the fact that the use of the expression "the preceding species" has not been revised. Harmless as are these misstatements to the seasoned ornithologist, they might easily confuse the beginner. A large number of species included in the older editions of Johns's work have been omitted from this edition, presumably because of their rarity. But this weeding out, if done at all, should have been done consistently, and on some definite plan. Here we find that while the whole of the rarer herons, including the little bittern (which is believed to have bred with us), have been left out, the black stork, a very rare casual visitor, has been retained. The spotted eagle, which has only occurred on a very few occasions, is included, while the blue-throated warbler, an annual visitor, sometimes in some numbers, has been cut out. Then why include the little crake and not Baillon's crake? Why the Pomatorhine skua and not Buffon's skua? The black-necked grebe (which has bred in this country) is not included in the text, though it is figured. But it is needless to go further through the list, except to say that one very rare bird, the lesser grey shrike, has been inserted. The statement that the green sandpiper breeds probably in wild parts of Surrey, Sussex, and Hampshire has been added to Johns's account of this bird because "the Son of the Marshes considers that it does so." More definite information would have been very desirable. There is a glossary of provincial names and of technical terms, and an index. The old (and often unsurpassed) wood-cuts with which we have been so long familiar no longer appear, and we cannot but regret them. Instead we have sixty-four original coloured plates, comprising 256 figures. Many of these are absolutely charming and excellent portraits of birds, and altogether they are by far the best coloured pictures of our birds we have seen in a book published at anything like so low a price as this. The colour reproduction has been much more successful than usual, for which the artist may well be pleased and the publishers congratulated.

The account of the principles and measures which Baron von Berlepsch advocates[1] for the exercise of a rational protection of birds as carried out at Seebach will be read with interest and profit by the many people who like to feed the birds in winter and get them to breed in boxes. The main features of the protection here treated of are the provision of shelter woods and plantations, pruning bushes and trees in such a way as to provide nesting situations, winter feeding, and making up for the loss of natural nesting-places of the breeders in holes consequent upon the removal of old and decayed trees. With planting for birds we are not so much concerned in England as

[1] "The Young People's Bird's-nest Chart. A Simple Guide to Identify the Nests of Common British Birds." By the Rev. S. N. Sedgwick. Pp. 61; illustrated. (London: Robert Culley, n.d.) Price 1*s*. net.

[2] "Birds and their Nests and Eggs, found in and near Great Towns." By George H. Vos. Second Series, pp. viii+223 Third series, pp. xii+240. (London: George Routledge and Sons, n.d.) Price 1*s*. each.

[3] "British Birds in their Haunts." By the late Rev. C. A. Johns. Edited, revised and annotated by J. A. Owen. Illustrated with 64 coloured plates by William Forster with a Glossary of Common and Provincial Names and of Technical Terms. Pp. xxvi+326. (London: George Routledge and Sons, 1909.) Price 7*s*. 6*d*. net.

[1] "How to Attract and Protect Wild Birds." By Martin Hiesemann, translated by Emma S. Buchheim, with an introduction by Her Grace the Duchess of Bedford. Pp. 86; illustrated. (London: Witherby and Co., 1908.) Price 1*s*. 6*d*. net.

they are on the more open plains of the Continent; nor is feeding so necessary in our usually more open winters; but the chapter on bird-boxes will be sure to interest those who have been in the habit of hanging up boxes in their gardens and woods. Baron Berlepsch came to the conclusion that the nesting-boxes in use in his boyhood served no purpose, and that the only chance of success lay in the boxes being made to imitate nature. He has now succeeded in getting proper boxes made, most of which are exact imitations of woodpeckers' holes. They are here figured and fully described, and the manner of fixing and hanging them. They are now to be bought in England. Other illustrations show sections of woodpeckers' holes, correct and worthless boxes, plans of shelter woods for birds, the woods before and after cutting, pruned bushes, &c. A useful calendar of operations concludes this very practical little volume.

The first volume of the "Book of Nature-study"[1] covers animal life from mammals to insects, spiders and worms, &c., and is educational in character, written chiefly for the education of those who have to teach natural history to the young. The editor points out that one of the causes of teachers failing with their students of natural history is their ignorance of the subject; and one of the main objects of this book has been to place the necessary information in such a form as to be accessible to the teacher. It is also most truly pointed out that in teaching natural history a principal object which should never be lost sight of is the stimulation of the powers of independent inquiry and observation on the part of the children themselves. The introductory chapter expounds certain general themes which must form part of the intellectual background of successful nature-study in the field of animal life, and the subsequent sections contain an excellent and clearly written introduction to the various forms thereof, their structure and life-history. A useful bibliography of works dealing with the subject, and in which it can be followed up, is appended to each section. The matter dealt with is so extensive that space cannot here be found to indicate more than the general character of the work, and it must suffice to say that it serves its purpose admirably. The illustrations are exceedingly fit and suitable for the purpose in view. The book is well printed on good paper, and the six coloured plates are simply delightful, as well as most instructive, and are some of the best and most successful efforts at colour printing we have seen.

Ringed Plover going to nest; the breast feathers are being drawn over the eggs. From "The Book of Nature-study."

[1] "The Book of Nature-study." Edited by Prof. J. Bretland Farmer, F.R.S., assisted by a staff of specialists. Vol. i. Pp. xii+212; illustrated. (London: Caxton Publishing Company, n.d.) Price 7s. 6d. net.

THE ADAMELLO GROUP.[1]

THE Adamello group is a conspicuous though distant feature in the panoramic view of snow-clad giants which greets us on reaching some lofty peak of the Pennine Alps in the neighbourhood of Zermatt. It rises like an island above a sea of lower mountains, almost untouched by snow—a vast tabular mass covered with glaciers, "a huge block," to quote Mr. Douglas Freshfield's graphic description, "large enough to supply materials for half-a-dozen fine mountains. But it is, in fact, only one. For a length and breadth of many miles, the ground never falls below 9500 feet. The highest peaks (about 11,600 feet) . . . are merely slight elevations of the rim of this unlifted plain. . . . Imagine an enormous white cloth unevenly laid upon a table and its shining skirts hanging over here and there between the dark massive supports" ("The Italian Alps," p. 202).

One huge mass of intrusive igneous rock, now laid bare by denudation, practically forms the Adamello. On the east it is defined by the great Judicaria fault; on the west by the Val Camonica; on the north the narrow neck crossed by the Tonale Pass alone separates the waters running to the Lagò d'Iseo from those which flow either to the Lago di Garda or to the Adige. Thus it seems indicated by nature as a subject for a monograph, and Dr. W. Salomon accepted her challenge nearly twenty years ago. From time to time he has published papers on important details, and now gives us the fruits of his studies in one of those massive memoirs which only a national institution can afford to publish. We have but to glance at his route-map, in parts of which the red lines showing his track cross and recross like a mass of wriggling worms, to see that he has done his work with Teutonic thoroughness, leaving hardly any accessible place unvisited, while in order to ascertain how the rocks are related to those of neighbouring regions he has extended his investigations to the Val Tellina and to the lakes of Iseo and Idro.

Selection from so great a mass of details is impossible, and criticism of them demands a knowledge of the district comparable with that of the author, so that we can only indicate his main conclusions and comment on one or two which have a more general character. The igneous holocrystalline rock, to which Von Rath, about half-a-century ago, gave the name tonalite (from the Tonale Pass) consists of quartz, plagioclase felspar (probably andesine), biotite, and hornblende. It varies a little in coarseness and in composition, especially in the relative abundance of

[1] "Die Adamellogruppe, ein alpines Zentralmassiv, und seine Bedeutung für die Gebirgsbildung und unsere Kenntniss von dem Mechanismus der Intrusionen." Von Wilhelm Salomon. i. Teil: Lokale Beschreibung, kristalline Schiefer, Perm, Trias. Pp. xiii+433. (Wien: Abhandlungen der k.k. Geologischen Reichsanstalt, 1908.) Price 30 kr.

the last two minerals, the second of which is often fairly idiomorphic. It is, in fact, a variety of quartz-diorite, for which some petrographers use the name. Enclosures of a darker, more basic rock are not unfrequent, which in some cases much resemble included fragments, but in others may have a concretionary origin. The tonalite is cut by dykes of a more aplitic character, and apophyses from it penetrate the neighbouring sedimentary rocks. The percentage of silica is rather lower than in an average granite, that of ferro-magnesian constituents is higher, while in the alkalies the soda much exceeds the potash. The monzonite of the Fassathal differs from it in being poorer in silica and richer in alkalies; the granite of that valley and of the Cima d'Asta exceeds it in both respects; but, as we see from the neighbourhood of Predazzo, these early Mesozoic ejections indicate much differentiation of any original magma. But for these interesting questions it is enough to refer to Prof. Brögger's classic memoir [1] on that district.

If this tonalite *massif* represents the supply basin to one or more volcanic orifices, all traces of the latter have completely disappeared. The blood-red "porphyries," so characteristic of a broad region east of the Adige, above and below Bozen, can also be seen west of that river, at no great distance from the Adamello, and can be traced south of it to beyond the Sesia. These were erupted in Permian times, but the tonalite, like those other holocrystalline masses already mentioned, is later than most of the Trias. On that point evidence has been accumulating since 1846, but it is made more than ever certain by Dr. Salomon's exhaustive examination of the relations of the tonalite and the various stages of that system from the Werfener Schichten (Bunter) to the Haupt Dolomit (lower part of the Rhætic). The usual proofs of intrusion can be seen in many places, and a zone of contact metamorphism traced for a considerable distance outwards from the margin of the invading rock. It can also be seen breaking into Permian sediments and into the older crystalline schists.

These schists Dr. Salomon divides into three groups: the Edolo Schiefer, the Rendena Schiefer, and the Tonale Schiefer. The first, which occur on the north and in the northern part of the west of the Adamello *massif*, are said to be phyllites, sometimes anthracitic, with quartzose-banded phyllites and quartzites; the second, consisting of phyllitic gneisses and mica schists, occur occasionally on the west, but are more developed on the east; and the third, specially characterised by bands of saccharoidal marble, often rich in silicates, and associated in one part with a zone of augen gneisses, occur on the north, on the other side of the Edolo Schiefer. Dr. Salomon regards the Rendena Schiefer as early Cambrian or late Archæan, but refers some of the Tonale Schiefer to the Mesozoic, considering the marbles to be infolded Triassic limestones, metamorphosed by intense pressure. It may seem presumptuous for one who has merely traversed this district, and that not at all recently, to express any difference of opinion, but, as Dr. Salomon supports his views by references to other parts of the Alps which the present writer has carefully and continuously studied, he has no hesitation in saying that the identification of those Alpine marbles with the acknowledged Triassic limestones is very like that of Monmouth and Macedon, and that the asserted Mesozoic age of the crystalline schists, to which most of the so-called phyllites belong, and with which these marbles are associated, is supported by no better evidence than mistakes in elementary mineralogy and the neglect of important facts, such as the presence of fragments of those crystalline schists in indubitable Triassic rock. So we venture to think that the last word has not yet been said on the subdivisions and the ages of these crystalline schists.

[1] "Die Eruptionsfolge der triadischen Eruptivgesteine bei Predazzo," 1895.

As dolomitic limestone occurs in the neighbourhood of the Adamello, the author discusses the relation of these rocks to coral reefs. Here we are surprised at not finding any direct reference to the Royal Society's memoir on the borings at Funafuti, and the author is apparently satisfied with the following quotation (p. 417):—"Die Bohrung auf Funafuti erscheint in demselten Licht; die dort erreichte grosse Dicke wurde wahrscheinlich in der Grunlage einer alten Kalksteines erreicht, so dass die erlangten Resultate keinesweg die Annahme der Senkungstheorie nötig machen." We can only suppose that Dr. Salomon has never seen the conclusion of Dr. C. J. Hinde's study of the cores (Memoir, p. 334):—"The evidence appears to me to indicate a continuous formation of reef rock, without any abrupt break, from the depth of 1114 feet to the present time"; while Prof. J. W. Judd (p. 175), after stating that specimens of Tertiary limestones from reefs in Indian and Pacific seas had been carefully studied for purposes of comparison, expressly states:—"The same recent forms of foraminifera, corals and other organisms occur from the top to the bottom of the series of cores. On this point the evidence appears to be conclusive, and we are justified in stating that no basis of old Tertiary limestone was reached in the deep boring at Funafuti."

But these two defects, for such we deem them, do not blind us to the many merits and great value of this memoir. The facts will remain, even if, in a few cases, Dr. Salomon's interpretation of them be ultimately set aside. The book is the outcome of years of patient toil, and, when completed by the petrographical and palæontological studies of his collections, will be a permanent monument to his scientific energy, zeal, and acumen.

T. G. B.

TIDAL PROBLEMS.[1]

THE authors of the planetesimal theory have in this volume made a further important contribution to the discussion of the problems of cosmogony. In their endeavours to establish their own theory on a sound footing, much work has necessarily to be done in the way of criticising earlier theories. The classical nebular hypothesis of Laplace has already been discussed in a series of papers by Profs. Chamberlin and Moulton, and found wanting in many respects. To them in part is due the general abandonment of this hypothesis in anything like its original form by most astronomers of the present day. The present volume of papers is directed mainly against the tidal theories developed by Sir George Darwin, and more particularly against the view that at some far-distant epoch the moon separated from the earth.

Prof. Chamberlin's paper on "The Former Rates of the Earth's Rotation" opens with an attack on the theory of centrifugal separation of the heavenly bodies. We are compelled to admit the force of many of his criticisms with regard to the separation of the planets from a parent sun, but the similar criticisms levelled against the formation of the planetary sub-systems are lacking in weight. In particular, the argument from a comparison of the present orbit of Phobos with the ring system of Saturn fails if a change in the dimensions of the orbit of Phobos, assumed negligible, is allowed for. Also the mere statement

[1] "The Tidal and other Problems." By Profs. T. C. Chamberlin, F. R. Moulton, and others. Pp. iv+264. (Washington: Carnegie Institution, 1909.)

that the recently discovered retrograde satellites complicate the centrifugal hypothesis is no serious argument against this hypothesis. They can be made to fit into a general modified scheme. With regard to the earth-moon system, the criticism based upon the irregularity of present-day ocean tides seems irrelevant to the main issue. In the past, at any rate, we must look to regular body tides in the earth as the main factor in tidal evolution; of these tides, as mathematical analysis shows us, a natural result is a retardation of rotation. There are several further criticisms of interest in the paper, notably the reminder that the moon, if brought down to the surface of the earth (assumed to be of its present size), would be inside the limit given by Roche's criterion of stability, and would split into fragments. This point has already been considered by Sir G. Darwin (NATURE, 1886). In his discussion of it he abandons any idea that his theory explains the actual method of genesis of the moon, while he claims that it is of importance in dealing with the moon's later history.

The dynamical arguments of the paper are reinforced by geological arguments. It is shown that there is no geological evidence supporting the view that in earlier times the earth's rotation was much more rapid, and consequently the earth itself much more oblate than at present. The greater part of the changes must have taken place before the earth had solidified and its surface had become a book for the geologist to read. Only on such terms will the geologist accept the tidal theory, and on this particular point he has the support of Kelvin. In view of recent discoveries of unsuspected sources of heat and energy, it seems that the necessary extension of time involved in this requirement of the geologist may be granted by the physicist, and that the theory need not be abandoned by the mathematician at the bidding of the geologist.

Prof. Moulton's line of attack is quite distinct from that of his colleague. By considerations of energy and momenta alone he traces back the earth-moon system under various simplifying assumptions to the time when day and month were equal. He obtains in all cases a distance between the centres of the two bodies of more than 9000 miles. This result is very much the same as that originally found by Sir G. Darwin, but the latter suggested, without examining the point very closely, that a consideration of the sun's tidal effect would greatly diminish this distance. Prof. Moulton proves that the actual difference due to this cause is very slight, and his conclusion strongly reinforces the view that fission must have taken place, if at all, at a time when the earth was much less dense than at present. The further contention that the fission could not have been the result of increased rotation alone has already been recognised as valid by Sir G. Darwin. The latter's suggestion that the coincidence of a solar tide with a free period of oscillation of the earth might have led to a condition of instability has been examined by Prof. Love (Phil. Mag., March, 1889), who showed the idea to be quite feasible.

Of the remaining papers in the volume, which deal mainly with special points discussed by Chamberlin or Moulton in relation to the wider problem, the most interesting is an examination by Dr. Lunn of the heat which would be developed in the building up of a planet according to the planetesimal theory. A general qualitative agreement with the known requirements of facts is reached. More could, perhaps, hardly be looked for. Perhaps the following general criticism of the planetesimal theory may be made at its present stage of development. In many respects it gives a general *qualitative* agreement with observed facts, while its supporters are criticising older theories on the ground that they lack at times a close *quantitative* agreement with observed facts. It remains to be seen whether the newer theory will come up to the standard by which the older theories are being judged.

F. STRATTON.

PROF. SIMON NEWCOMB.

BY the death of Prof. Simon Newcomb science has sustained one of the most severe blows of recent years. America has lost her most eminent man of science, and not since the death of Adams has the world been deprived of so illustrious an investigator in theoretical astronomy. Newcomb's career up to 1899 was described by Loewy in the article on "Scientific Worthies" in NATURE, vol. lx., p. 1, and his activity and marvellous powers of work continued up to the date of the illness that has just terminated fatally. Since 1899 he has given us his interesting book entitled "The Reminiscences of an Astronomer" (1903), in which he described the early incidents of his life and related the extraordinary circumstances by which his steps were guided into the career which led him to such eminence.

Newcomb commenced his reminiscences with the words:—"I date my birth into the world of sweetness and light on one frosty morning in January, 1857, when I took my seat between two well-known mathematicians (Winlock and Runkle) before a blazing fire in the office of the 'Nautical Almanac' at Cambridge, Mass."

Though born at Wallace, in Nova Scotia, March 12, 1835, Simon Newcomb was of almost pure New England descent. His father was, he tells us, the most rational and the most dispassionate of men, who, when he had reached the age of twenty-five, set forth to search for a wife who possessed the qualities most suitable in a helpmeet. His search had extended nearly a hundred miles before, in the village of Moncton, he found in Emily Prince what he desired, and his son says the marriage was "in all respects a happy one, so far as congeniality of nature and mutual regard could go." . . . "My mother was the most profoundly and sincerely religious woman with whom I was ever intimately acquainted, and my father always entertained and expressed the highest admiration for her mental gifts, to which he attributed whatever talents his children might have possessed. The unfitness of her environment to her constitution is the saddest memory of my childhood. More I do not trust myself to say to the public, nor will the reader expect more of me."

How Newcomb's early years were passed may perhaps be conjectured from the fact that the autobiographical chapter in which he records them bears the title of "The World of Cold and Darkness." He had, however, from his earliest years a keen desire for knowledge, and read whatever books were available. His first introduction to the intellectual career he desired was not promising. In those days there was a so-called physician, Dr. Foshay, living near Moncton, who was reputed to have effected cures of sick persons given up by other doctors. As Newcomb says, "Diomeds of the medical profession before whose shafts all forms of disease had to fall were then very generally supposed to be realities." By the intervention of an aunt, young Newcomb agreed to live with the doctor, rendering him all assistance in preparing medicines, while the doctor, on his part, undertook to supply Newcomb's bodily needs and teach him "the botanic system of medicine." After a little experience it began to dawn upon Newcomb that Dr. Foshay, notwithstanding his boasted medical skill, was no more than an ignorant pretender, and that the time of his assistant would be utterly wasted instead of being, as he expected, expended on studying botany and scientific medicine. So on September 13, 1853, Newcomb determined to run away after leaving a letter for the doctor, in which he explained that, as the doctor had shown no indication of fulfilling his promises, his assistant felt that the arrangement was annulled. Newcomb was on the road before daybreak, and walked until late at night, ever fearing pursuit from the doctor. It appears that the doctor did actually attempt a pursuit, but, by good fortune, Newcomb eluded recapture, and at last reached a house where he was hospitably entertained. "Thus ended," he says, "a day which I have always looked back to as the most memorable in my life."

After a week of hardship, which Newcomb says he will not harrow the feelings of the reader by describing, he arrived at Calais, where he found a boat bound for Salem. The little money that he had in his pocket was less than the price of the passage, but he undertook to supplement the deficiency by working his way. A few months later we find him engaged as a teacher in a school at a place called Massey's Cross Roads, in Kent County, and devoting every spare hour to reading whatever mathematical books he could obtain. His first appearance as an author was in refutation of a Mr. Eveleth, who doubted the Copernican system, and Newcomb published in the *National Intelligencer* an exposition of the fallacies in the paradoxer's essay. In 1856 he was teaching in the family of a planter, near Washington, and on a visit to the library of the Smithsonian Institution he was delighted to see among the mathematical books the greatest treasure that his imagination had ever pictured, a work that he had thought of almost as belonging to fairyland—Laplace's "Mécanique Céleste." Shortly afterwards he summoned up enough courage to seek for an interview with Prof. Henry, who suggested that he should look for some position in the Coast Survey, and his reception by Mr. Hilgard was such that Newcomb writes:—"I found from my first interview with him that the denizens of the world of light were up to the most sanguine conceptions I ever could have formed." Mr. Hilgard introduced him to Prof. Winlock, of Cambridge, Mass., and thus in 1857 he entered "the world of sweetness and light" by becoming one of the computers in "The American Ephemeris and Nautical Almanac."

From this time the progress of Newcomb to the height of astronomical fame was unchecked. Dr. Gould, the well-known astronomer, wrote to tell him that there was a vacancy in the Corps of Professors of Mathematics attached to the Naval Observatory at Washington, and suggested that he might like the post. Newcomb at first was disinclined to consider the proposition. Cambridge seemed to him the focus of the science and learning of his country. He also rather shrank from what he called the drudgery of night work in the observatory, for he considered that it would interfere with the mathematical investigations in which he was specially interested; but he finally decided to apply, and a month later, September, 1861, was much gratified in receiving the appointment duly signed by Abraham Lincoln. Newcomb accordingly settled in Washington, where he married, in 1863, Mary Caroline, daughter of Dr. C. A. Hassler, U.S. Navy, and three daughters were the issue of the marriage.

In the winter of 1870 Mr. Cyrus Field, of Atlantic cable fame, had a small dinner-party at the Arlington Hotel, Washington. A young son of Mr. Field's was present, who had spent the day in seeing the sights of Washington. The youth described his visit to the observatory, and expressed his surprise in not finding any large telescope. The guests were at first incredulous, but, finding that the statement was true, a senator who was present declared that this must be rectified, and in due course Alvan Clark and Sons were entrusted with the manufacture of a great objective of 26-inches aperture.

Newcomb was specially interested in this enterprise, because, as he says, "the work of reconstructing the tables of the planets, which I had long before mapped out as the greatest one in which I should engage, required as exact a knowledge as could be obtained of the masses of all the planets. In the case of Uranus and Neptune, the two other planets, this knowledge could best be obtained by observations on their satellites. To the latter my attention was therefore directed." In 1875 the instrument was given over to Prof. Asaph Hall, and of course it has become for ever famous as the means by which Hall made his beautiful discovery of the two satellites of Mars.

In Newcomb's "Reminiscences" we find, in a chapter on "The Author's Scientific Work," a most interesting sketch of the great problems to the solution of which his life's work was devoted. It appears that the first important investigation on which he entered in his early years at Cambridge, Mass., related to the orbits of the asteroids. This particular investigation discussed the theory that these bodies originated as fragments of a large planet broken up by some cataclysm. It involved an extended examination of the secular perturbations of the orbits of the asteroids to determine whether at any epoch even hundreds of thousands of years ago all the orbits passed through one point, though by the influence of perturbations they have now ceased to do so. The investigation seems to show that no such cataclysm as that looked for ever occurred, and that each of the asteroids has been a separate body since the solar system came into existence.

Another problem which shows the lines of thought habitually present to Newcomb may be thus stated. Do the mutual attractions of the sun, planets, and satellites completely explain all the motions in the solar system? or, as he expressed it, "Does any world move otherwise than as it is attracted by other worlds?" This opens up two great researches: first, in bringing the labours of astronomers together so as to determine with the utmost accuracy the actual movements of the heavenly bodies, and, second, in securing all attainable perfection in the mathematical methods employed in their examination. A very important branch of this inquiry is presented by the movements of the moon. Such an investigation as Newcomb sketched out had a stimulating effect on the discussion of old and valuable observations of the positions of the moon deduced from ancient eclipses, and much of Newcomb's best work was done in connection with the lunar theory.

In 1875 Newcomb was offered the position in Harvard University which is now filled with such distinction by Prof. Pickering, but he declined this offer after careful consideration. On September 15, 1877, he was appointed editor of "The American Ephemeris and Nautical Almanac." He tells us that "the change was one of the happiest of my life. I was now in a position of recognised responsibility where my recommendations met with the respect due to that responsibility, where I could make plans with the assurance of being able to carry them out." He approached the duties of this office in the loftiest spirit, and devoted his energies to the task of improving the fundamental constants employed. With this object in view, extensive investigations in various parts of dynamical astronomy had to be undertaken. His efforts were unremitting to improve at every point the processes of calculation, as well as the materials on which the calculations were based. Among the greatest of Newcomb's labours, measured by their value to science, are, undoubtedly, those done in connection with this office. Astronomers all over the world recognise "The Astronomical Papers of the American Ephemeris" brought out under Newcomb's guidance as works of classical value. In this great task he had the good fortune to obtain the assistance of many eminent men, among whom was Mr. George W. Hill, who, in Newcomb's generous words, "will easily rank as the greatest master of mathematical astronomy during the last quarter of the nineteenth century." Newcomb's important "Compendium of Spherical Astronomy," published in 1906, should also be mentioned in connection with the "Astronomical Papers." After his term of service in the office of the American Ephemeris had expired in 1883 by the age-limit, Newcomb became professor of mathematics and astronomy in Johns Hopkins University in Baltimore, and this post he held until 1893.

As in the case of other men who have risen to a foremost position in science, Newcomb was wonderfully versatile. He was, as we have seen, a leader among mathematical astronomers, he did good work on various occasions in practical observation, and that he was a skilful experimenter when occasion required is shown by his beautiful investigations of the velocity of light; but Newcomb also wrote a number of books intended more for the general public than for technical astronomers. His "Popular Astronomy" is universally recognised as an admirable work full of lofty thought and luminous suggestion. It is remarkable for its literary grace no less than for its scientific accuracy, and those who had the privilege of enjoying Prof. Newcomb's friendship will recognise throughout "Popular Astronomy" indications of that quaint humour which was so characteristic of the author. He wrote many other books; he was recognised as an authority on economics and life assurance, and he even wrote a novel, though I do not know whether this particular venture was sufficiently successful to encourage a repetition of the experiment. All the honours which his own country or other countries could bestow on a man of science were liberally showered on him with universal approval.

It need hardly be said that for a self-taught man to become one of the most consummate mathematicians of his day, and one of the great leaders of science, not only great abilities, but indomitable industry were necessary. Newcomb was an indefatigable worker. From morning until night he was at his desk, and yet such was the kindliness of the man that when a demand on his time and friendship was made by a brother astronomer or mathematician, his books were laid aside, and he would devote himself assiduously to a day of gracious offices for his visitor. Newcomb had a serious illness about fifteen years ago, but he made a remarkable recovery, and until the last few months he was still hard at work. He died after a long illness on July 11, 1909.

Thus passes from the world the most conspicuous figure among the brilliant band of contemporary American astronomers. His inspiring example will long be treasured by those who were acquainted with his work. His habitual loftiness of thought, nobility of character, dignified courtesy, and ever-ready helpfulness endeared him to his many friends on both sides of the Atlantic. His private acts of quiet kindness and goodness of heart will be affectionately cherished by those fortunate persons to whom they are known.

ROBERT S. BALL.

NOTES.

THE first attempt to cross the Channel by aëroplane was made by M. Latham on Monday, July 19. The machine, which is a monoplane, started from Sangatte, and was about 600 feet above sea-level when it left the land. This altitude was increased to about 1000 feet, and a speed of between forty and forty-five miles an hour was attained. After travelling about eight miles from the shore in the direction toward Dover the engine stopped, and the monoplane glided steadily down in a straight line to the water, where it floated until the destroyer *Harpon* came up about five minutes later. M. Latham was then taken on board, and his monoplane towed into Calais harbour.

THE death is announced of M. Henri de Parville, who was for several years editor of *La Nature*, and more recently a contributor to *Cosmos*. M. de Parville did much useful work in the direction of instructing and interesting the French public in the achievements of science. Primarily an engineer, he was well versed in other branches of pure and applied science, and for many years devoted the greater part of his energies to work for the scientific Press.

THE Institute of Metals has just completed the first year of its existence, during which period the membership has increased from barely two hundred to well over five hundred. The autumn meeting of the association will be held at Manchester on Thursday and Friday, October 14 and 15. A series of about half a dozen papers will be read and discussed at the two morning sessions of the institute. The afternoon of the first day will be devoted to a visit to the University of Manchester, where members will be received officially, on behalf of the University, by Vice-Chancellor Alfred Hopkinson, K.C. The new engineering laboratories will be open for inspection, and facilities will also be given for inspecting the Municipal School of Technology. In the evening a reception will be held by the Lord Mayor at the Town Hall. During the afternoon of Friday, October 15, members will have the opportunity of visiting works of metallurgical interest in the neighbourhood of Manchester.

THE committee nominated by the Paris Academy of Sciences for the distribution of the Bonaparte fund (25,000 francs) for 1909 has received thirty-five applications, only nine of which are considered to conform with the regulations laid down by the committee of 1908. It is proposed to allocate the fund as follows:—4000 francs to M. Cayeux, to enable him to pursue his researches on the fossils of the Oolitic iron deposits in the United States; 4000 francs to M. Chevalier, to assist him in carrying on his geographical and ethnographical researches in the French colonies in tropical Africa; 4000 francs to M. Pérez, to assist in the publication of his memoir entitled "Recherches histologiques sur les Métamorphoses des Muscides"; 3000 francs to M. Houard, to enable him to proceed to Corsica, Algeria, and Tunis to collect material for his anatomical and physiological studies; 2000 francs to M. Berget, for the construction of an apparatus for the study of the distribution and intensity of gravity; 2000 francs to M. Bernard, to continue his studies of the variation of the solar radiation and the illumination of the sky in the immediate neighbourhood of the sun; 2000 francs to M. Blaringhem, for the continuation of his experimental researches on the variation of species; 2000 francs to M. Estanave, for the continuation of his researches on stereoscopic projection by direct vision, stereoradiography, and autostereoscopy; 2000 francs to M. Mathias, to enable him to continue in the cryogenic laboratory of Leyden his researches on liquids and on the law of corresponding states at low temperatures.

THE seventh annual meeting of the South African Association for the Advancement of Science will be held at Bloemfontein during the week ending on Saturday, October 2, under the presidency of Sir H. Goold Adams, K.C.M.G. The work of the association will be divided into three sections, as follows:—section i. will include mathematics, physics, astronomy, meteorology, geodesy, geography, engineering, mining, and architecture; section ii. will include chemistry, metallurgy, mineralogy, geology, botany, zoology, agriculture, forestry, bacteriology, physiology, and hygiene; section iii. will include education, philology, psychology, history, archæology, economics, statistics, sociology, anthropology, and ethnology. Papers on any of the subjects enumerated will be welcomed, and should be submitted to either of the secretaries. A strong reception committee has been formed under the chairmanship of the Mayor of Bloemfontein (Mr. C. L. Botha), who is taking active steps towards making the visit to Bloemfontein a success. The joint honorary secretaries at Bloemfontein are Dr. Geo. Potts, of the Grey University College, and Mr. Arthur Stead, 40 Victoria Road, Bloemfontein. Further details regarding this meeting of the association may be obtained from the assistant general secretary, P.O. Box 1497, Cape Town.

THE provisional programme of Section H (Anthropology) of the British Association, for the Winnipeg meeting, has now reached us. In arranging the proceedings of the section an attempt has been made, so far as possible, to cover the latest developments in anthropological science. Dr. T. Ashby, director of the British School at Rome, will deal with archæology in the western Mediterranean; Mr. R. M. Dawkins, director of the British School at Athens, with archæology in the eastern Mediterranean; and Mr. D. G. Hogarth with the archæology of Asia Minor, with special reference to the Hittites. Miss Breton will review the present state of our knowledge of the arms and armour and of the physical type of the ancient inhabitants of Central America. It is hoped that the first results of an expedition which Dr. Haddon is now conducting among the natives of the western coast of North America may be available for the meeting. A number of prominent anthropologists of the United States have promised to contribute to the proceedings of the section. Among these may be mentioned Dr. F. Boas, who will deal with anthropological problems in Canada; Miss Fletcher, who will read a paper on her work among the Omaha people; papers will also be contributed by Dr. Gordon, of Pennsylvania, and Dr. Clarence Moore. Dr. Harry Piers, of Halifax, Nova Scotia, will deal with our present knowledge of the natives of Nova Scotia, and Mr. C. Hill-Tout will present his final report on the natives of British Columbia. The valuable reports which have been presented to the association from year to year by Mr. Hill-Tout are the results of work undertaken under the auspices of the Canadian Ethnographic Survey Committee of the British Association, now defunct. In this connection it may be mentioned that papers dealing with the urgent necessity for an ethnographic survey of Canada will be contributed by Mr. E. S. Hartland and Dr. F. C. Shrubsall.

IN the *Revue scientifique* for July 3 is published the discourse delivered by Dr. Edmond Perrier, Director of the Paris National Museum of Natural History, on the occasion of the inauguration, on June 13, of the statue of Jean de Lamarck. In this oration, which is characterised by eloquence and insight, M. Perrier does full justice to the extraordinary industry of Lamarck, and to the merits of his work on the systematics of invertebrates and plants In dealing with his speculative treatises on meteorology and kindred subjects, while allowing that his imagination was apt to get the better of his judgment, M. Perrier pertinently asks what would become of science if its professors never permitted themselves to attack questions which current opinion pronounces insoluble. On the subject of organic evolution, the author brings out in an interesting way the contrast between the influence of Lamarck and that of Darwin upon scientific opinion. M. Perrier does not concern himself to defend Lamarck's view of the method of evolution against objections, but points out that while Lamarck was himself thoroughly convinced of the truth of the general principle which is everywhere accepted to-day, his work met at the time with almost universal neglect. On the other hand, it fell to Darwin's lot to secure the general assent of his scientific contemporaries. After discussing the opposition to Lamarck offered by Cuvier, M. Perrier concludes with the observation that the great anatomist, in the pride of his assurance, was alter all mistaken, and once more it is the *pêcheur de Lune* who was right.

THE Torquay Natural History Society has started a journal of its own, of the first number of which we have received a copy. This opens with an account of the history of the society, which is followed by a series of short papers, several of them dealing with local subjects.

WE are indebted to the Conchological Society for a copy of the July number of the *Journal of Conchology*, in which special reference is made to the need of further workers in Scotland to assist the "census" of British land and fresh-water molluscs now being taken.

THE July number of the *Popular Science Monthly* contains two articles on Darwinian subjects, one, by Prof. F. H. Giddings, dealing with Darwinism in the theory of social evolution, while in the second Prof. Dewey discusses Darwin's influence on philosophy.

THE July number of the *Museums Journal* deals largely with American topics, one article being devoted to the tariff on certain objects of art, a second to exhibits in the Brooklyn Institute illustrative of evolution and the preservation of animals, and a third to the history and collections of the Chicago Academy of Sciences.

To vol. xxvi. (pp. 283–331) of the *Bulletin of the American Museum of Natural History*, Mr. A. Hermann, the chief preparator to the museum, contributes an interesting account of the methods now in use in preparing vertebrate fossils. The plates accompanying this paper illustrate the newest American systems of mounting fossil skeletons for the combined purposes of exhibition and study.

DR. G. STEINMANN has sent us a copy of a paper entitled "Zur Abstammung der Säuger," published in vol. ii. of the *Zeitschrift für induktive Abstammungs- und Vererbungslehre*, in which he further elaborates his remarkable views as to the polyphyletic origin of mammals. The extent to which he carries his views will be apparent when we state that while he derives Glyptodon from the dinosaurs of the Ancylosaurus group, its relative Panochthus is considered to be descended from Polacanthus.

ACCORDING to the July number of the *Selborne Magazine*, the Brent Valley Bird-sanctuary is yearly proving more and more successful, nightingales being numerous, while nuthatches and nightjars have made their appearance in the preserve. At least one pair of nuthatches is known to have nested, and it is not improbable that the nightjars may have laid in a recently made clearing. The Selborne Society desires to make it known that its work is by no means limited to birds, but that antiquities, as well as many other subjects, come within its purview.

THE New York Zoological Society has recently issued a special "Wild-Life Preservation Number," dealing with the efforts that have been recently made, alike in the States and in British Columbia, to preserve a remnant of the big-game fauna of the country. The year under review is a notable one, on account of marking the establishment of no fewer than five new game-reserves on the North American continent. By special enactment, the prongbuck, of which it is estimated that above 5000 head still remain, has been placed on the totally protected list; but it is a question whether the law will be obeyed in remote districts. If not, the only course is to form a reserve in the special habitat of this remarkable and interesting species.

IT is surprising how long it takes to acquire a complete knowledge of the structure even of an animal so thoroughly investigated as the frog. It is not many months since the existence of Reissner's fibre in the *canalis centralis* of the central nervous system of this animal was first announced by Nicholls, and now we learn that the frog also possesses a *nervus terminalis*, morphologically similar to that of fishes. For this information we are indebted to Herrick, who contributes a short paper on the subject to the May number of the *Journal of Comparative Neurology and Psychology*. The nerves in question, for they are, of course, paired, are extremely short and slender, and may be observed in transverse sections lying beneath the olfactory bulbs, but they appear to be quite distinct from the olfactory nerves. They are composed of non-medullated fibres. In the next paper in the same journal, R. E. Sheldon records the occurrence of the same pair of nerves in the carp.

STUDENTS of embryology will find much to interest them in two recent numbers of the *Zeitschrift für wissenschaftliche Zoologie* (vol. xcii., parts iii. and iv.). A memoir by Erwin Taube on the development of the Euphausidæ deals with the segmentation of the egg up to the time of gastrulation, and constitutes an important contribution to our knowledge of cell-lineage in the earlier stages of ontogeny. A kindred topic is ably handled by E. Martini in a study on the constancy of the histological elements in *Oikopleura longicauda*. The author maintains that in many species certain cell-individuals in every specimen come to occupy exactly the same position in the body, always show the same relations to their surroundings, and can also be recognised as homologous by their histological characters. He refers to Goldschmidt's recent work on the central nervous system of Ascaris as one of the best examples of such constancy, and finds a similar condition of things in the nervous system, notochord, and certain other organs of Oikopleura, while the endostyle does not conform to the general rule.

IN the May number of the *Journal of Experimental Zoology*, Raymond Pearl sketches out a comprehensive scheme for the study of the physiology of reproduction in the domestic fowl, and makes a commencement with a biometrical investigation of the shape of the eggs laid by a particular pullet. The first egg was very abnormal in shape, but the normal form was ultimately attained by a progressive regulatory change which is shown to follow a logarithmic curve. The author concludes that the shape of the egg is determined by the muscular activity of the walls of the uterus. The physiology of nematocysts is dealt with in the same journal by O. C. Glaser and C. M. Sparrow, whose investigations support Grosvenor's view that the discharge of the thread-cells is brought about by osmotic pressure. They also afford further proof of the fact, recently demonstrated by Toppe, that the threads are capable of penetrating the tissues of other animals; but it appears that in order to do this they must make their punctures before eversion is complete.

WE learn from the *Transvaal Agricultural Journal* (No. 27) that *Phylloxera vastatrix* has appeared in the Transvaal vineyards, and may be expected to spread and do a considerable amount of damage. Fortunately the Transvaal possesses an excellent Agricultural Department, and all proper steps to cope with the pest will be taken. In an article in the journal Mr. Davis, the Government horticulturist, describes phylloxera-resistant vines that would be suitable for the country and should in future be planted.

THE *Agricultural Journal* of the Cape of Good Hope recently directed attention to the ravages caused by the *Antheraea tyrrhea* caterpillar in certain districts, and published an appeal from the Government entomologist, Mr. Lounsbury, for material. The caterpillar comes as a plague, but between its intervals of abundance it appears to be held in check by some parasitic enemy. Two parasites are known, and others are being looked for as the simplest and most effective way of getting rid of the caterpillar.

THE necessity for looking after fruit trees properly is well brought out in a Bulletin (No. 253) recently issued by the Michigan State Agricultural College. Upon many Michigan farms there are said to be mature apple orchards that have been neglected for many years, and have produced no income beyond an occasional small crop of apples of uncertain quality. A detailed account is given of the methods, chiefly involving pruning and spraying, by which three such orchards were improved and made to yield an average net profit of 104 dollars per acre per annum for a period of five years.

THE results of field experiments in Shropshire and Staffordshire, and at the Harper Adams Agricultural College, have just been issued by the Staffordshire Education Committee. They include manurial trials on grass land, potatoes, mangolds, and swedes, and are on the lines generally adopted in such cases. Unfortunately, no analyses of the soils are given, nor any descriptions sufficient to enable anyone to apply the results to any other case. However, if the intention was simply to show that artificial manures increase crops the experiments have been a success. The experiments carried out at the college are fuller, and some interesting notes are added from the various departments on black scab of potatoes, by Mr. Malthouse; black leg in cattle, by Mr. Wilson; and agricultural chemical analyses, by Mr. B. F. Davies.

IT has always been recognised in England that an agricultural college should have its own farm, but in Scotland the conditions have hitherto been rather different, and it has been held that the college could do without one. We now learn, however, from the *North British Agriculturalist*, that the Glasgow College of Agriculture has decided to acquire a farm at Kilmarnock, to be used both for teaching and experimental purposes. The sum of 3000*l*. will be needed for equipment, but the Scotch Education Department has promised to contribute one half, on condition that the other half can be raised locally. The experiment is attracting a good deal of attention among agriculturists in Scotland.

EXPERIMENTS made in Cape Colony, and reported in the *Agricultural Journal* of the Cape of Good Hope, show that Turkish tobacco of good quality can be grown in certain districts. Irrigation was not found necessary, excepting when planting was to give the crop a good start; indeed, the crop will stand drought quite as well as vines when once it is established. The price realised in 1907 was 1s. 11*d.* per lb., being 5*d.* in excess of the previous year's price; nearly three times as much was grown in 1908 as in 1907, and there has also been a great improvement made in the method of curing. Although the labour required is somewhat special, it has not been found impracticable to train women, girls, and boys to do the finer work.

THE removal of charlock from corn crops was formerly a costly matter when it had to be effected by hoeing, but has become much more simple since chemical methods were devised. Experiments carried on at various centres are reported by Mr. G. F. Strawson, and confirm the results obtained by other investigators. They show that young charlock can be destroyed in growing corn crops without injury to the latter by spraying with fifty gallons of a 3 per cent. solution of copper sulphate per acre. If the charlock is older a stronger solution must be used; early spraying is therefore economical. The crop—whether corn, tares, beans, or peas—increases considerably when the competing weeds are killed, and young grass seeds and clover sown in with the corn are not injured by the copper sulphate because their leaves are too smooth for the solution to remain on.

A WELL-ILLUSTRATED description of the Polish Miocene species of Turritella is given by M. W. Friedberg in the *Bulletin international* of the Cracow Academy, 1909, 2. The author finds that the genus is well represented, and contains a number of varietal forms differing from those ordinarily described. This applies specially to *T. Turris* and *T. pythagoria*, of each of which M. Friedberg describes five varieties.

THE probable origin of the white Florentine iris forms the subject of a note by Drs. R. Pirotta and M. Puglisi in the *Atti dei Lincei*, xviii., 10. Forms have been observed with blue spots variously arranged, and it is found that these are not peculiar to individual plants, but may occur on different plants in different years. From this, as well as from geographical considerations, the authors propound the view that *Iris florentina* is a variety of *I. pallida* which has become permanent.

BY the publication of a well-arranged catalogue, the authorities of the Bradford Public Libraries have shown in the most practical way their appreciation of a large collection of scientific books and pamphlets acquired from the library of the late Dr. F. A. Lees, the author of the "Flora of West Yorkshire." The collection is especially rich in local floras of the British Isles. The herbarium of 25,000 specimens collected by Dr. Lees was acquired at the same time, and is arranged in the Cartwright Memorial Hall.

AN account of the black wax of Burma known in the vernacular as "pwê-nyet" is provided by Mr. D. Hooper in the *Agricultural Ledger* (No. iii., 1908). The wax is stored by a small bee, *Melipona laeviceps*, which forms its hive generally in a hollow tree, and constructs a peculiar trumpet-shaped entrance. The bees commonly swarm in the kanyin-tree, *Dipterocarpus turbinatus*, because in tapping for resin large holes are made in the trees which furnish suitable cavities for the construction of the hives. Incidentally, Mr. Hooper publishes analyses of resins from various species of Hopea, Shorea, Dipterocarpus, and Canarium for comparison with the wax. The chemical tests point to the wax being similar to the resins of Dipterocarpus and Hopea, while the substance forming the vestibule is almost certainly the resin of Dipterocarpus.

A FOURTH article on the sylva of Colorado dealing with forest formations and forest trees is contributed by Prof. F. Ramaley to vol. vi., No. 3, of the University of Colorado studies. There is a well-differentiated forest region in the river valleys, where cotton woods and willows predominate; two mesophytic formations are the canyon and aspen forests of the foothills; the higher montane and sub-alpine formations are composed of pines, firs, and Douglas spruce. The flora contains a number of interesting trees. The pinyon, *Pinus edulis*, yields large edible seeds; the rock pine, *P. scopulorum*, is recommended for planting in semi-arid districts; the Colorado blue spruce, *Picea parryana*, is a fine ornamental tree. The genus Populus includes the aspen, the balsam poplar, broad-leaf cotton-wood, *P. Sargentii*, narrow-leaf cotton-wood, *P. angustifolia*, and lance-leaf cotton-wood, *P. acuminata*. *Rhamnus purshiana* furnishes the drug "cascara sagrada."

THERE are differences of opinion as to the best method of improving the Indian cottons, but there can be no doubt as to the advisability of testing the possibilities of improvement by the hybridisation of native varieties. The problem, which furnishes a capital opportunity for disciples of the Mendelian school, has been broached by Mr. P. F. Fyson, who records his experiments in the Memoirs of the Department of Agriculture in India (vol. ii. No. 6). His object was to test the stability of certain characters as a preliminary to more definite investigations. Colour of flower, shape of leaf, and fuzziness of seed were selected as likely characters. With regard to colour, yellow appeared to be dominant over white, and since the colour in Gossypium is a sap colour, this conforms to general experience. The pointed leaf characteristic of *Gossypium neglectum* (*arboreum*) was dominant over rounded *herbaceum*, but the segregation of "fuzzy" and "naked" seeds was not distinct.

IN the July number of the *Reliquary*, Mr. E. H. Goddard continues the useful series of articles dealing with local collections of antiquities, his subject being Roman objects discovered in Wiltshire. Though the county possesses no Roman sites ranking in interest and importance with those of Dorchester, Silchester, Bath, or even Lydney or Woodchester, it contains Cunetio near Marlborough, villas at Box, Colerne, and Wraxall, and, in particular, Old Sarum, which will remain a sealed book until the excavations now projected are taken in hand. But besides these there are numerous smaller sites, of which only one, Rotherley, has been properly investigated. The best collection of late-Celtic pottery is that gained from the Westbury Ironworks. Mr. Goddard figures and describes a number of interesting objects—pottery, bronze rings and fibulæ, kitchen utensils, the sole of a Roman lady's shoe, and a curious bronze plaque with a figure of Minerva, the last from the downs above Lavington. On October 21, 1638, the Devil visited Widdecombe Church, a fine building on the river Webburn, in Dartmoor, a full account of which remarkable event is recorded on a tablet in curious versification, the work of the village schoolmaster, which is preserved in the church. As a matter of fact, the place was the scene of a terrible thunderstorm, which caused the loss of several lives, damaged the tower, and caused such consternation that it was attributed to demoniacal agency. The original tablet, a curious instance of the popular beliefs current at the time, is reproduced by Mr. Le Blanc Smith in the July number of the *Reliquary*.

THE seventh annual report of the director of the Bureau of Science, Manila, shows what the Americans are accomplishing in the Philippines. One of the most pressing needs has been to obtain a sufficient medical staff to cope with the infectious and epidemic diseases and the pernicious superstitions of the natives relating thereto. At present there is but one doctor to every 430 square miles of territory in the Philippines, and many towns even of some importance have no resident medical man. In these circumstances the medical school is training intelligent natives, and is making efforts to secure sufficient numbers of students to remedy the deficiency. Anthropomorphic measurements of Filipinos and of Igorots are made, and other studies have been undertaken to throw light on the histories of the natives. In addition, a large amount of work is recorded on the natural resources of the island—sugar, fibres, essential oils, &c. It is stated that the fruit of *Pittosporum resiniferum*, Hemsl., commonly known as the petroleum nut, yielded on distillation 7 per cent. of heptane.

"A SHORT Guide to the Museum of Practical Geology, Jermyn Street, London, S.W.," has been issued anonymously at the price of one penny. It seems strange that the names of the curator and director are not attached, but we may take it for granted that they are responsible, as the guide is "sold only at the museum." It will undoubtedly prove of great service to visitors in directing attention to the many objects of scientific interest and practical importance that are exhibited, and in giving so far as possible within the compass of forty-eight pages a good deal of explanatory information. The last handbook to the museum, prepared by Mr. Rudler, the former curator, was issued in 1896, and since that date many alterations and improvements have been made. The removal of the fine collection of British pottery and porcelain, though lamented by many students, was necessary for the proper display of further raw materials in place of manufactured articles. Thus the exhibition of British minerals has been considerably extended, and the practical applications of geology have been more fully illustrated by examples of brick clays, road stones, &c. The map department has received special attention, and illustrations are displayed of the mode of preparation of the Geological Survey sheets on the scales of six inches and one inch to a mile. Instructive models of the Isle of Purbeck and of the complicated district of Assynt, in Sutherlandshire, have also been introduced. Plans showing the arrangement of the specimens on the several floors of the museum form an exceedingly useful feature in this new guide.

WE have received from the Philippine Weather Bureau reports by the Rev. J. Coronas of two severe typhoons experienced in 1908. The first, called the Hong Kong typhoon of July 27 and 28, resembled in its leading characteristics the destructive storm of September 18, 1906. The Manila Observatory was able to announce its appearance to the north of Luzon on the morning of July 26; it increased in speed in the China Sea, where its velocity of translation was about $8\frac{1}{2}$ miles an hour, and about $14\frac{1}{2}$ miles when it struck Hong Kong, but once in China it began to fill up, as is generally the case. The Hong Kong Observatory carefully watched the progress of the storm, and gave timely warning of its approach. The second storm, called the *Tarlac* typhoon of September 18 to 27, from the wreck of the ship of that name, was first announced on the morning of September 20, being then near the Western Carolines. When it reached the Philippines its velocity was about fifteen miles an hour. The storm was most violent at Borongan (Samar), and reduced that town to a heap of ruins; it reached the northern part of Indo-China on September 27. An eye-witness at Borongan states that the roof of the town church was "blown up like a huge kite," while the convent was "simply crushed down" soon afterwards, showing that there were ascending and descending currents on the same side of the centre, the winds being in both cases from the same direction. The area of destructive winds had an average radius of about fifty miles. The full reports, with diagrams, are published in the bulletins of the Weather Bureau.

WE have received a reprint of the article "London by Night," by Mr. H. Wild, which appeared in *Photography and Focus* in March last. It contains four very realistic reproductions of photographs of London streets taken at night by means of the illumination provided by the ordinary artificial lights. The photographs were taken on rapid quarter plates of several makes by means of a portrait lens (Dallmeyer's 2B) with an exposure of about half a second, and they will bear enlargement up to 15×12 inches. They open up a field in photography which was undreamt of a few years ago.

THE June number of *Le Radium* contains an article by M. Moulin on the most probable value of the atomic charge e of electricity according to the most trustworthy of the observations made up to the present time. The three methods which M. Moulin discusses are:—First, the condensation method adopted by Sir J. Thomson and his pupils, and by Profs. Millikan and Begeman in America; second, the direct measurement of the charge on the particle, by Prof. Rutherford and Dr. Geiger; and third, the calculation of the number N of molecules in a gram molecule, based on the measurements of the Brownian movements by Prof. Perrin. The first and third of these methods agree in giving for e the value $4 \cdot 1 \times 10^{-10}$ electrostatic units, while the second gives 4·6, a high result which M. Moulin attributes to the want of uniformity in the layer of radium C with which Messrs. Rutherford and Geiger worked. His final conclusion is that the most probable value of e is $4 \cdot 1 \times 10^{-10}$ electrostatic units, and of N 7×10^{23}.

IT is well known that reaction steam turbines have a lower efficiency at the high-pressure end than at the low-pressure end. This is caused by the relatively small area of blades at the high-pressure end and the proportionally high percentage of clearance which permits of excessive leakage of steam round the blades. Published tests of a large marine turbine show an efficiency ratio of the high-pressure turbine of 55 per cent. at full power, as against 63 per cent. for the low-pressure turbine, in spite of the adoption of lower steam and blade speeds in the high-pressure turbine, thus securing a higher ratio of blade area to clearance area for the purpose of reducing leakage. In the Melms-Pfenninger turbine, illustrated in *Engineering* for July 9, a successful attempt is made to combine the advantages of the impulse type for the high-pressure end with the reaction type for the intermediate and low-pressure sections. An important feature of this turbine is the adoption of a drum construction for the impulse section, in which it differs from the wheel construction usual in turbines of the Curtis type. The remainder of the turbine is of the well-known Parsons type. The makers say that they have found it practicable to work with a clearance of but 10 mils. between the nearest points of the opposed fixed and moving surfaces.

THE steamer *Tortuguero*, which was launched from the shipbuilding yard of Messrs. Alexander Stephen and Sons, Ltd., at Linthouse, on the Clyde, on March 24, and sailed on April 22, represents the latest practice in the transport of bananas from the West Indies. A full description of the vessel appears in the *Engineer* for July 9, from which we note that she is of 5000 tons gross, having insulated space of 220,000 cubic feet, the capacity of the fruit bins being 175,000 cubic feet. Granulated cork is used for the insulating material, the average thickness of the cork being from 7 inches to 8 inches, and the bins are so constructed that the bunches of fruit do not come into contact with metal surfaces during transit, all such being protected by wood gratings and battens, or by hemp-rope coverings. An elaborate arrangement of air passages enables cooled air to be supplied throughout the cargo, the cooling of the air being effected by a Hall's CO_2 refrigerating plant. An even temperature of 55° F. is maintained, and the fruit is inspected frequently so as to ensure its arrival at Manchester in proper condition for the market. In loading, the fruit is stored without covering of any kind, the lowest bunches are arranged with stems vertical, and the final layer placed horizontally, an arrangement which economises space and ensures freedom from damage.

A SECOND edition of Mr. Arturo Massenz's "Lavorazione e Tempera degli Acciai" has been published by Mr. Ulrico Hoepli, of Milan. The price of the volume is 2 lire.

SOLUTIONS of the exercises in their "Modern Geometry" have been prepared by Messrs. C. Godfrey and A. W. Siddons, and are published in volume form by the Cambridge University Press at 4s. net.

MESSRS. DAWBARN AND WARD, LTD., have published a fifth edition of the 1909 "Photographic Annual, incorporating the Figures, Facts, and Formulæ of Photography." This year-book is edited by Mr. H. Snowden Ward, and the present issue has been extended, largely re-written, and revised to June, 1909.

MR. BERNARD QUARITCH has just issued a catalogue of books on natural history which he is offering for sale. Particulars are given of works on zoology, geology, palæontology, mineralogy, and botany. Among other interesting items we notice the original drawings of Hubner's European butterflies, an example of Jacquin's Selectarum Stirpium Americanarum Historia, and a few important herbals.

WE have received in two volumes parts A, B, C, and D of the quarterly bulletin of the results for the year 1907–8 secured during the periodical cruises and in intermediate periods in connection with the Permanent International Council for the Exploration of the Sea. The parts in order deal with the temperature and salinity of the surface water; the temperature, salinity, density, &c., of sea water at different depths; the oxygen, nitrogen, and carbon dioxide dissolved in sea water; and plankton tables for August and November, 1907, and February and May, 1908. The first three parts have been prepared with the assistance of Mr. Martin Knudsen, and the last with the help of Mr. Harry M. Kyle. The volumes are published by Andr. Fred. Høst et Fils, of Copenhagen.

OUR ASTRONOMICAL COLUMN.

STATIONARY METEOR RADIANTS.—Since Mr. Denning announced the existence of stationary meteoric radiants in 1878, many observers have endeavoured to explain, and account for, them, hitherto without much success. The apparent radiant of a meteor depends almost as much on the true direction of the earth's motion as it does on the true motion of the meteor itself, therefore it seems almost impossible that these bodies should appear to stream from the same point of the heavens for months at a time. In an article appearing in No. 5, vol. xxix., of the *Astrophysical Journal* (June, p. 365), Prof. W. H. Pickering shows, however, that this apparently puzzling phenomenon is only what is to be expected, arguing from our present knowledge of meteor-orbits. Briefly, he shows by diagrams and tables that the attracting force of the earth's mass is, at different times, capable of deflecting or accelerating the smaller bodies, so that the apparent change of the longitude of the radiant counterbalances the variation produced by the earth's motion; thus the radiant appears to be stationary, or nearly so. Prof. Pickering also produces arguments against the prevalent idea that meteors are generally of infinitesimal mass.

COMPARISON OF THE SPECTRA OF THE CENTRE AND EDGE OF THE SUN'S DISC.—Previous observations having indicated that in passing from the centre to the edge of the sun's disc the spectrum suffers modification, MM. Buisson and Fabry recently repeated the observation, using their interferometer method, in which each wave-length is examined independently of those of the other lines. Their observations, which are published in No. 26 of the *Comptes rendus*, confirm the earlier ones of Hale and Adams, and Halm.

The latter showed that the wave-length of a line in the spectrum at the limb was a little greater than when the centre of the disc was observed. From the study of fourteen lines in the region of λ 4400 MM. Buisson and Fabry find that the increase of wave-length varies from 0·004 to 0·006 Ångström; to this rule the two vanadium lines, λ 4379·4 and λ 4406·8, are exceptions. The observations also show that in the spectrum at the limb the same lines are a little broader than in the spectrum at the centre, the increase of breadth amounting, in the mean, to 0·010 Ångström.

MM. Buisson and Fabry suggest that these two phenomena, displacement and broadening, are due to the same cause. The only modification a line really undergoes is a displacement, amounting to 0·010 Ångström, of its red edge, the more refrangible edge remaining invariable. In the exceptional case of vanadium the broadening is apparently symmetrical. They suggest, further, that the asymmetrical broadening may be caused by pressure—an increase of seven atmospheres would be sufficient to produce the observed effect—but only becomes apparent at the limb where a greater thickness of the denser layers is traversed by the radiations.

CHANGES OF FORM IN SUN-SPOTS.—Some interesting results of detailed observations of sun-spot forms are discussed, and illustrated by drawings, by M. A. Amaftounsky in No. 4332 of the *Astronomische Nachrichten*.

He shows that whilst, in general, the outline of the penumbra roughly follows the form of the nucleus, tremendous changes may take place in the former, whilst the latter is apparently undisturbed. This is what would be expected on the hypothesis that the nucleus of the spot is a depression, a hole, and the penumbra is produced by the ascending and descending of incandescent vapours. The appearance of bright spots in the nucleus, sometimes followed by the bridging and disintegration of the latter, is explained by the supposition that the nucleus is at a higher temperature than the photosphere, and constantly re-vaporises the filaments and tongues of the penumbra by the expulsion of hotter vapours.

MUTUAL OCCULTATION OF JUPITER'S SECOND AND FOURTH SATELLITES.—In No. 4338 of the *Astronomische Nachrichten* M. Pidoux describes the conjunction and mutual occultation of J ii. and J iv. observed by him at the Geneva Observatory on June 17, 1908. Plotting the various measures, he finds that the conjunction took place at 8h. 33·4m. (G.M.T.), the shortest distance between the centres of the satellites being 1·9″. Whilst the latter quantity agrees exactly with that calculated and published by Oudemans, the time is 4·6 minutes in advance of the ephemeris.

According to calculation, satellites iii. and iv. should have been in conjunction at 7h. 58·5m. on July 3, 1908, but when first observed by M. Pidoux, at 7h. 52m., the conjunction was already complete and the satellites appeared as one. At 7h. 59m. the system was elongated, and at 8h. 2m. the two images were distinctly separated. It therefore appears that the observations prove the calculated times to be several minutes too late.

THE YERKES OBSERVATORY.—From the University of Chicago we have received a brochure in which Prof. E. B. Frost gives a brief, detailed account of the establishment, equipment, and work of the Yerkes Observatory. Fourteen excellent reproductions of photographs of instruments, spectroheliograms, nebulæ, &c., illustrate the twenty-four pages of the booklet, and give the reader a very fair idea of the enormous activities and possibilities of the institution. One point which attracts our attention is Prof. Frost's emphasis of the necessity for having, in a modern astronomical observatory, well-equipped workshops wherein repairs and modifications of existing instruments may be executed, and new instruments constructed.

PROMINENCE OBSERVATIONS.—No. 6, vol. xxxviii., of the *Memorie della Società degli Spettroscopisti Italiani* contains Prof. Riccò's periodical summary of the Catania prominence observations, dealing with the first six months of 1908. Prominences were observed on ninety-three days during the six months, and 170 in the northern, and 247 in the southern, hemisphere were measured. The mean latitude for the two hemispheres was 27·5°, but, dividing the latitude, N. and S., into 10° steps, there were two maxima (lat. 10°–20° and 50°–60°) in the northern hemisphere and only one (20°–30°) in the southern.

SCIENTIFIC WORK IN INDIA.

THE annual report of the Board of Scientific Advice for India for the year 1907–8 has lately been issued by the Superintendent of Government Printing, Calcutta. The Board was constituted in 1902, and consisted originally of the heads of the meteorological, geological, botanical, forest, survey, agricultural, and veterinary departments, but the Government of India invites from time to time to serve upon it other men of science in the service of the imperial and provincial Governments. The Board is a central authority for the coordination of official scientific inquiry, intended to ensure that the work of research is distributed to the best advantage and the prevention of useless duplication of inquiries and lack of inter-departmental cooperation. The advice of the Board is given with the view of aiding the Government of India in prosecuting practical research into questions of economic and applied science on the solution of which the progressive prosperity of the country depends. The Board discusses annually the proposals of the head of each of the great departments in regard to the programme of investigation in his department, and submits each year a general programme of research to the Government. Its reports and programmes are communicated through the Secretary of State for India to the Royal Society, which has appointed an advisory committee to consider them.

The present report opens with a summary of the proceedings at the three meetings held during 1908, two at Calcutta and one at Simla. As indicative of the scope of the labours of the Board, some of the subjects discussed at the first meeting may be mentioned. The Board had under consideration the remarks of the Royal Society committee on the Board's report for 1905–6 and its programme for 1907–8. The subjects discussed included, among many others, the preparation of a hand-list of the species of the flora of India, economic and industrial chemistry, and the limits of the imperial mycologist's research work, the relations of the zoological section of the Indian Museum to other departments engaged in zoological research, and proposals for a special report on the progress of the Geological Survey.

The conclusions arrived at by the Board in these matters were as follows:—that, as regards the preparation of a hand-list of the flora of India, although its importance was recognised, lack of staff and the existence of more immediately necessary work precluded its preparation forthwith; that the consideration of economic and industrial chemistry and the work of the imperial mycologist should await the results of the discussion of the subjects by the Board of Agriculture for India; that reference should be made, so far as possible, to the zoological section of the Indian Museum by other departments engaged in zoological research; and that no officer was available for the increase of work that the preparation of a special report on the progress of the Geological Survey of India would necessitate.

Very full reports upon the work of the various scientific departments during the year 1907–8 then follow. Dr. J. W. Leather and Mr. D. Hooper deal with the work on industrial and agricultural chemistry, and Mr. Puran Singh with forest chemistry; Dr. G. T. Walker, F.R.S., with solar physics, meteorology, and terrestrial magnetism; Sir Thomas H. Holland, F.R.S., with geology; Colonel S. G. Burrard, F.R.S., with geodosy and geography; Messrs. W. W. Smith, A. Howard, E. J. Butler, and R. S. Hole with various branches of botany; Mr. A. M. F. Caccia and A. J. Gibson with forestry; Dr. N. Annandale and Messrs. H. Maxwell-Lefroy and E. P. Stebbing with zoological subjects; and Colonel H. T. Pease with veterinary science.

The programmes of work of the various scientific departments for the year 1908–9, as approved by the Board, constitute the next section of the volume, which concludes with an appendix by Dr. W. R. Dunstan, F.R.S., director of the Imperial Institute, describing the economic investigations conducted for India at the Imperial Institute during the year ended September 30, 1908.

The detailed programmes of work teem with particulars of investigations of great interest, but since the bare enumeration of the researches to be undertaken runs to twenty-seven large pages, it is possible here only to give an example or two. In meteorological work, a special endeavour is being made this year to secure meteorograph records of temperature and humidity up to great heights by means of small balloons. At four nearly equidistant periods between April and December batches of registering balloons have been, and are to be, liberated at some place in the west of the Punjab, and organised efforts made to recover as many as possible on descent. Each batch was to comprise, perhaps, ten complete units, the adjustment and liberation of which takes between a week and ten days. It was hoped to reach heights of 25,000 feet in the earlier experiments, and later in the year it is hoped to increase the heights at which the balloons are caused to descend until 50,000 feet has been reached. It is important to reach this height in order to see whether the isothermal zone, which has been almost invariably found at or near that level by sounding balloons in Europe, is to be encountered over India.

The new work to be undertaken by the Geological Survey provides another typical instance of the activity of scientific workers in India. The mapping of previously unsurveyed areas in the Amherst district of Lower Burma is being proceeded with, the geological map of the Raniganj coalfield is being revised in conjunction with a committee appointed by the Mining and Geological Institute of India, and the following pieces of work are in hand:—a survey of the ossiferous deposits of the Siwaliks and the Salt Range; an examination of copper-ore and associated sulphide-ore deposits in Sikkim; a survey of certain glaciers in Sikkim; and a study of the palæontology of (*a*) the Cretaceous rocks of Tibet, (*b*) the fossil fishes of the East Coast Gondwanas.

POSITION FINDING WITHOUT AN HORIZON.

WHEN about three years ago the first Gordon-Bennett balloon race was held, and several of the aëronauts descended precipitately on the north coast of France, believing they were approaching the Bay of Biscay, it seemed to me worth while to consider the possibility of designing an instrument by the aid of which observations could be taken so as to obtain even a rough idea of position. For this purpose the observation of the altitude and azimuth at any moment of a single star or of the sun will be sufficient to establish the locality, or the altitudes of two stars not in the same vertical plane with the observer will do as well.

If the observation is such that the error is as great as the diameter of the sun or moon, the resulting uncertainty of position will be a little more than thirty miles, and so in proportion. The observer will be, of course, on a circle on the earth described round the point where the star is in the zenith, the radius of which in nautical miles is equal to the zenith distance of the star expressed in minutes.

A search at the Patent Office library showed that a large number of inventors had for nautical purposes, rather than for use in balloons, imagined instruments which, for various reasons, would be impracticable. In some an attempt has been made to combine a sextant and a pendulum, but even if the observer were not expected to watch the star and the pendulum at the same time, the pendulum was made so short and of such quick period that the inevitable trembling of the hand would give rise to angular relative movement of the pendulum represented by several diameters of the sun. The beauty of the sextant is the property it possesses of gluing the two objects, *e.g.* the sun and horizon or moon and star, which are being observed together, so that with all the spasmodic movements which the magnification of the telescope and the unsteadiness of the hand make inevitable, the eye, nevertheless, can follow them and see if there is continuous close contact or not, whereas if the apparent position of one of the objects only depended upon the steadiness of the hand, no observation worthy of the name would be possible. It is therefore essential, if any approach to accuracy is required, that the star or sun should be seen in the same field with, and glued to, the mark, whatever form that may take, which determines the altitude, and also that the angular variation in the position of this mark should hardly be affected by the trembling of the hand. I tried at the time to interest one or two instrument makers, but unsuccessfully; now, however, that the subject is attracting attention in Germany, as shown by Dr. Lockyer's (vol. lxxx., p. 29) article in a recent number of NATURE, perhaps my design may be worth bringing forward. I would only remark that an instrument of the kind would be useful on board ship when the sun or stars may be visible while the sea horizon is obscured, provided only that, as is usual in fog, the ship is not rolling seriously. These worse conditions can only be met by the more complicated gyroscopic horizon perfected by Admiral Fleuriais.

The instrument depends essentially upon the use of a vertical collimator suspended on gimbals, and top-weighted like a metronome, so as to have a period of swing either way of as much as one second. The collimator has at its focus a scale of, say, tenths of a degree in transparent divisions upon an opaque ground, and above its lens a clear or half-silvered glass mirror set at 45° with the axis of the collimator. The collimator is suspended in a tube, which is the handle of the instrument, and which carries also the parts of a small sextant.

Figs. 1 and 2 are vertical sections through the axis of the instrument, the latter partly in elevation. *a* is a box frame to which are attached the tubular handle *b*, the telescope *c*, and other sextant parts. The telescope is carried by means of a slide *d* and pin *e*, so that it may be moved sideways or be hinged downwards when not in use. Inside the handle is mounted a gimbal ring *f*, on which the collimator *g* is supported on knife-edges *h*; *i* is the scale already described; *k* is the unsilvered mirror attached to the collimator, by means of which the scale *i*, illuminated by the mirror 7, may be seen in the telescope; *l* and *n* are the horizon and index glasses respectively of the sextant, but made as prisms for convenience, though, of course, the usual mirrors might be used; *r* is the top weight of the collimator; and *t* a correcting weight running on a screw to bring the zero of the scale *i* apparently on to the true horizon. A conical damper *u*, lined with velvet, is made to slide within the handle, being pressed upwards by a spring *v* so as to steady or even to lift the collimator off its *v*'s and against the pins 1, and capable of being moved downwards by the thumb-lever *x* and fork *y*. An exterior sleeve 5 carries a cap 8, which serves as a protector to the translucent window at the base of the handle, and as a holder also for the illuminating mirror 7; 3 is a quadrant carrying three dark or tinted glasses.

When the telescope is directly opposite the mirror *k* and the reflectors *l*, *m* of the sextant, the star will be seen by double reflection projected upon the scale, of which one half is marked + and the other −. The arm of the sextant being therefore set to any position to bring the star on to the scale, a series of scale readings may then be made, which, added to or subtracted from the vernier reading, give the series of altitudes. If the telescope is slid sideways so that half its field is to the right of the mirror *k*, it may be made to look into the object-glass end of a surveyor's level or even at the sea horizon with a known dip, and the zero of the scale tested and so adjusted by means of the moving weight *z*. At any time when a sea or artificial horizon is available, observations may be made as with an ordinary sextant with the telescope laterally displaced, and by this means also the index-glass may be adjusted.

I have experimented with a collimator and telescope mounted as described, and found that, without the top

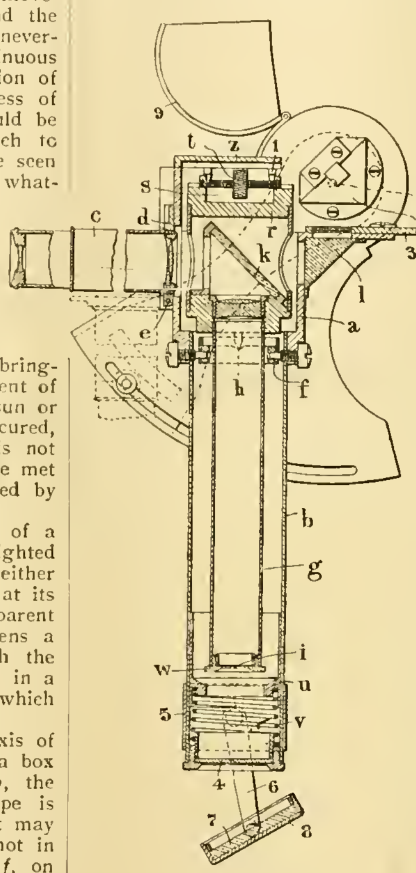

FIG. 1.

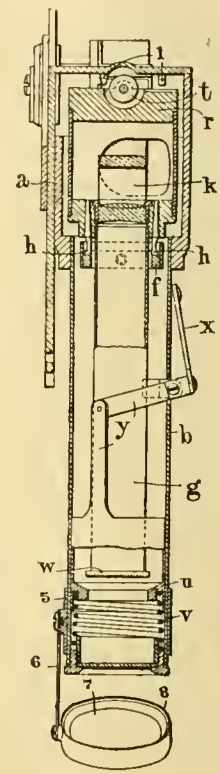

FIG. 2.

weight, the angular movement due to unsteadiness of the hand is far too great for accurate observation, but that when the period is increased to about one second by top-weighting, the angular movement is so far reduced that, when sitting at a table and holding the instrument in the hand, an accuracy of 1′ is possible. Of course, with the trembling of the hand the collimator turns about its centre of oscillation, and so with the period named a sudden movement of 1/100 inch will correspond to 1′ about, while if the period is two seconds the angular accuracy will be four times as great.

If used on a ship with any appreciable rolling it would be best to get down to the neutral axis, and observe zenith stars through a hatchway, so as to avoid the horizontal acceleration which is so pronounced on the bridge, for, of course, the collimator will hang, not in the true vertical, but at an angle equal to $\tan^{-1}\frac{\text{horizontal acceleration}}{g}$. If this is small the star may be observed to move a corresponding degree upon the scale in time with the rolling of the ship, and the successive elongations may be read off.

In a balloon, owing to the extreme quiet, I believe useful observations could be taken, more especially at those times at which it is not turning. I do not think it would be of any use on a flying machine in motion.

C. V. BOYS.

THE POSITION OF HIGHER EDUCATION.

THE higher education subcommittee of the education committee of the London County Council has had under consideration the relations which it is desirable should subsist between the University of London and other institutions of university rank in the metropolitan area and the London County Council. The subcommittee's report was presented to the education committee towards the end of May, and contains, not only a valuable *résumé* of the various steps taken by the late London Technical Education Board and by the Council itself to improve the supply of higher education in London, but also an important collection of statistics concerning the financial aid given by municipal and other authorities in the great provincial centres of population.

The subcommittee's report includes tables of grants made by other local education authorities to university education, the grants made by the Treasury in London and the provinces, and those provided by the London County Council. In London the grant from the Council is 48·6 per cent. of the Treasury grant, and in other towns the grant from the local authorities is 75 per cent. of the Treasury grant.

Grants mode by Provincial Local Authorities to Universities and University Colleges.

	Treasury grant	Grants from Local Authority
Universities:	£	£
Birmingham	11,000	7,010
Leeds	11,000	14,456
Liverpool	13,050	14,650
Manchester	15,200	5,950
Sheffield	5,700	11,744
University Colleges:		
Bristol	4,750	532
Newcastle-upon-Tyne	6,750	2,890
Nottingham	5,800	4,340
Reading	3,950	1,800
Southampton	3,250	2,113
Aberystwyth	4,000	—
Bangor	4,000	—
Cardiff	4,000	4,712
Dundee	1,000	80
Total	£93,450	£70,277

London County Council Grants to University Education.

	Treasury grant	Council grant
	£	£
Bedford College	4,000	800
King's College	8,700	2,000
University College	10,000	1,500
London School of Economics	1,150	1,200
East London College	—	1,000
Imperial College of Science and Technology	20,000	5,000
University of London	8,000	10,000
Extra Grants	—	3,720
Total	£51,850	£25,220

It is pointed out in the report that the various universities and university colleges have been successful in obtaining great assistance from generous donors, and that in such cases the receipt of State aid and financial help from the local authority does not seem to affect the flow of private benevolence. Thus Birmingham has received more than 256,000*l.* in this way; Leeds 380,000*l.*; Liverpool more than 188,000*l.*; Manchester more than 192,000*l.*; and Sheffield more than 229,000*l.*; while, in London, University College had received up to the date of the latest Government report 453,000*l.*; King's College 206,000*l.*; and Bedford College more than 29,000*l.* from private benefactions.

The subcommittee has given careful and sympathetic consideration to the applications received from certain London institutions of university rank for grants during the present year, and has come to the conclusion that more might be done in London for university education in consideration of the amount of the grant received from the Treasury, and having regard to the rateable value of the county of London. In this connection the following table, abbreviated from one included in the report, is instructive:—

Town	Rate in £ necessary to raise grant to local University or University College	Amount obtainable from a similar rate in London
		£
Birmingham	0·498	92,672
Leeds	0·638	118,724
Liverpool	0·6027	112,162
Manchester	0·227	42,203
Sheffield	0·646	120,228
Bristol [1]	0·070	12,946
Newcastle-upon-Tyne	0·173	32,129
Nottingham	0·851	158,360
Reading	0·6033	112,288
Southampton	1·00	186,111
Aberystwyth	—	—
Bangor	—	—
Cardiff	0·977	181,840
Dundee	0·019	3,604
London	0·135	25,220

The table shows very clearly that if London made the same proportional provision for higher education that Cardiff does, the annual grant would be 181,840*l.* instead of 25,220*l.*; or 158,360*l.* if it applied the same fraction of the rate as Nottingham does for higher education.

It is of interest to pass from the comparison of rate-aid and State-aid for higher education in England and Wales made in this and the preceding tables to some facts relating to the position of the subject in other countries. By a fortunate circumstance, an exhaustive article by Prof. Guido H. Marx in the issue of *Science* for May 14 shows remarkable growth and spread of interest in higher education, and the consequent great increase in the number of young men and women pursuing advanced studies, and receiving higher scientific and other training, in various countries.

It is natural to look to Germany for significant educational movements, and Prof. Marx, dealing with the combined attendance at the twenty-two German universities, shows that prior to 1870 this attendance was fairly uniform, keeping regular pace with the population. Immediately after 1870 the increase of attendance grew much more rapidly than the population, and there is not the slightest tendency for the increase to fall off. At the beginning of the period of rapid development in 1870 there was in Germany one student in the institutions of higher education for every two thousand inhabitants, while in 1907 there was one such student to every thousand inhabitants.

In the case of the United States of America, the combined attendance at all the colleges, universities, scientific, technical, and professional schools—omitting preparatory departments—up to the year 1885 showed a condition of practical stability, but beginning with that year the ratio of these students to the population increased year by year, and at present indicates no signs of falling off. In 1885 there was one such student for every seven hundred inhabitants, and twenty years later one for every four hundred of population.

Several important deductions can be made from the following table, drawn up by Prof. Marx:—

[1] The Bristol Town Council has decided to devote the produce of 1*d.* rate (about 7 000*l.* a year) to university education.

Number of Students in Higher Educational Institutions in different Countries.

Country	Population	Total number of students	Population per student
United States	84,000,000	210,333	400
Switzerland	3,500,000	6,500	530
Germany	61,000,000	61,267	1,000
Sweden	5,300,000	5,000	1,060
France	39,000,000	32,000	1,200
Roumania	6,000,000	5,000	1,200
Italy	33,000,000	24,000	1,400
Belgium	7,100,000	5,000	1,400
Holland	5,600,000	4,000	1,400
Austria-Hungary	47,000,000	30,000	1,570
Spain	19,000,000	12,000	1,600
Great Britain	44,000,000	25,000	1,750
Russia	147,000,000	23,000	6,400

Russia, it is seen, is the only western country of prominence which has not passed Germany's figure of the year 1870, namely, one student for two thousand inhabitants. "Perhaps," says Prof. Marx, "the most striking fact displayed by this table is the way Great Britain has lagged in this vast movement of the democratisation of the advantages of higher education—and, scarcely less significant, the strong leading position of the United States."

Too much importance must not, however, be attached to the table here reprinted with slight modifications, or to Prof. Marx's conclusions. The total number of students of higher education in the case of the United States includes students of both sexes in colleges, universities, technical and professional schools (exclusive of preparatory departments), in the session 1905–6, and in the case of Germany, too, the students of technical and professional schools above gymnasial rank are included in the total. But Great Britain's 25,000, and the totals assigned to all the remaining countries except Russia, deal only with their universities; their technical colleges and professional schools being ignored, apparently. It is not by any means contended that higher instruction in science and letters receives anything like the consideration it should in this country, but it is desirable, in making a comparison such as that Prof. Marx has instituted, to eliminate as many sources of error as possible, and to confine attention rigidly to matters which are really comparable. The article upon "The Supply of Secondary Education in England and Elsewhere," which appeared in NATURE of June 17, supplements to some extent the information brought together by Prof. Marx and summarised in the foregoing tables.

ASSOCIATION OF ECONOMIC BIOLOGISTS.

THE eighth annual meeting of this steadily growing association was held in the new School of Forestry at Oxford on July 13–15. The outstanding features of the meetings were the extremely interesting, and in many cases important, papers that were read and the discussions which followed, signs alike of the increasing importance of the application of biological science.

The president, Dr. A. E. Shipley, F.R.S., opened the meeting with a paper on the relations of certain cestodes and nematode parasites to bacterial disease. He argued that the piercing of the wall of the alimentary canal by parasites carries with it bacterial infection. In the case of the "disease" of the grouse, the piercing of the wall of the cæcum by the tapeworm *Trichostrongylus pergracilis* was followed by an intrusion of bacteria into the submucous layers. It is found that there is a definite relation between the number of worms in the alimentary canal and the number of bacteria in the body of the host. This perforation of the intestinal wall and subsequent invasion of the lesions by bacilli is of importance in such diseases as peritonitis and appendicitis. Such worms as Oxyuris, &c., are frequently associated with peritonitis, and other entozoa with appendicitis. He strongly advocated the greater use of vermifuges, which are used less than heretofore, and in this he was supported by Prof. Osler in the discussion that followed.

One of the most important papers was that of Prof. G. H. F. Nuttall and Dr. S. Hadwen, who gave an account of their successful curative treatment of piroplasmosis. This "tick-fever" is very fatal. In severe cases 80 per cent. to 85 per cent. of the red blood-corpuscles are infected, and the escape of the parasites into the blood gives rise to the characteristic hæmoglobinurea. The life-cycle, which was described, bears a definite relation to the treatment, and the double pyriform and large rounded forms of the parasite are dominant in the blood. It was found that if trypanblau was injected subcutaneously or intravenously all the pyriform parasites disappeared, and the remaining parasites degenerated two hours later. The animals (dogs) showed no symptoms. The parasites returned in very small numbers after about ten to twelve days, but the animals appear to be quite well, and the parasites disappear. One injection was sufficient, and nearly all the animals injected were cured, while the uninjected controls all died; a 100 per cent. mortality which occurred in this disease in dogs was converted into an 85 per cent. recovery. The drug has the same effect on the Piroplasma causing "red-water disease" in cattle. Further investigations of a thorough character are necessary before the drug can be put to practical use, but its discovery is of the greatest importance.

Mr. C. Warburton gave a very interesting account of his experiments on the life-histories of the human Pediculi, the clothes and head lice. Great difficulties were encountered at first, but finally, by allowing them to feed on the back of his hand two or three times a day, the author was able to fill a very important blank in the knowledge of these insects. He found that the female of *P. vestimenti* laid 124 eggs in twenty-five days. The eggs began to hatch in eight days, and continued to do so for about a month. The larvæ feed as soon as they are hatched, and after moulting three times became imagines in eleven days. Great trouble was experienced in breeding *P. cervicalis* (*P. capitis*), but patience and discomfort were rewarded with success, and it was found that a single female deposited forty-eight eggs, which hatched in seventeen to eighteen days, and the later stages were correspondingly lengthened compared with those of *P. vestimenti*.

The actual and possible applications of recent discoveries in heredity to biological problems of an economic character were discussed by Mr. A. D. Darbishire. He showed how important were such Mendelian principles as segregation and the breeding true of organisms bearing the recessive character. The recessive character may be a resistance to the rust fungus, as Prof. Biffen discovered in wheat. He was inclined to believe that resistance to the attacks of the beetle Bruchus might be dealt with according to Mendelian principles, and also the increase of the saccharine contents of peas by the selection of the absorptive character, which is different in round and wrinkled peas.

Mr. S. A. Neave gave an interesting account of his observations on the distribution and habits of the tsetse-fly *Glossina palpalis*, which were made in the Congo Free State and North-east Rhodesia in the years 1907–8. It would appear that the high plateau country forming the watershed between the basins of the Congo and Zambezi rivers forms a barrier against the southward extension of the distribution of the fly. He was of the opinion that, on the whole, *G. palpalis* will not be found to occur in the Zambezi basin, an important fact in view of the possibility of the spread of sleeping sickness into South Africa entertained by some authorities.

The results of observations and investigations on other insects of economic importance were communicated to the association. Dr. C. Gordon Hewitt has continued his investigations on the large larch saw-fly *Nematus erichsoni*, and finds that the natural enemies are increasing in number. The percentage of parasitic ichneumons has increased, as also the attacks of the small vole *Microtus agrestis*. A parasitic fungus (Cordyceps) has been found attacking the pupal stage, and the insectivorous birds are being encouraged. In spite of all these he was of the opinion that the results of the attack would be of a grave character, an opinion which was shared by Prof. Somerville in the subsequent discussion. A number of successful experiments on the breeding of the house-fly during the winter months (February) under favourable conditions of temperature, &c., were described by Mr. F. P. Jepson, who has thus been able successfully to confirm the observations of previous investigators. Mr. Walter E. Collinge described the part played by the Collembola, or "springtails," in the destruction of such plant life as developing seeds, bulbs, orchids, and hops. The structure of the rose-aphid *Siphonophora rosarum* was described by Mr. A. J. Grove, and Prof. E. B. Poulton exhibited a collection of predaceous insects and their prey.

The disappearance of the fresh-water crayfish from the Thames valley and other localities in this and European countries owing to the so-called "plague" is a problem of great interest to biologists. Mr. Geoffrey Smith's paper on some of the work that he has been carrying on in cooperation with Prof. Dreyer on the pathogenic bacteria of *Carcinus moenas* was of especial interest to economic biologists, as this work is connected with the question of the relation of the so-called plague bacillus to other pathogenic bacteria living on the outside of crabs, lobsters, and crayfishes.

Prof. William Somerville exhibited an interesting collection of injurious fungi and the injuries caused by the same, and a paper on the blossoming and pollen of our hardy cultivated plants, by Mr. C. H. Hooper, was communicated to the association.

On July 14 a very enjoyable excursion to the School of Forestry's arboretum at Tubney and to Bagley Woods was made. It was also resolved to accept the invitation to hold the meeting next year at the University of Manchester.

THE MUSEUMS ASSOCIATION.

THE twentieth annual conference of the Museums Association, which opened at Maidstone on July 13, attracted a fair number of members from the more southern towns, though the northern districts were not very generally represented.

Preceding the conference there was a council meeting on the evening of Monday, July 12, when the secretary and editor, Mr. E. Howarth, resigned those offices, after being editor of the *Museums Journal* since its first issue in 1901, and secretary for many years prior to that date. The formation of the association was first advocated in an article written by Mr. Howarth and published in NATURE in 1877. From that time the idea gradually extended, and in 1889 the association was duly organised at York, where it will very fitly hold its twenty-first anniversary next year.

The president, Mr. Henry Balfour, curator of the Pitt-Rivers Museum at Oxford, opened the proceedings with an extremely interesting address, which dealt cogently with the question of a national folk-museum, one of the phases of museum work that has been strangely neglected in these islands. While the ethnology of most regions of the world is illustrated in museums with profusion, the mediæval and post-mediæval life of our own country has received quite inadequate attention. Even the British Museum is everything except British so far as ethnology is concerned. The president instanced two museums, however, where praiseworthy efforts were made to illustrate local folk-culture, viz. the Museum of the Society of Antiquaries in Edinburgh and the Guildhall Museum, London. "What is required is a national folk-museum dealing exclusively and exhaustively with the history of culture of the British nation within the historic period, and illustrating the growth of ideas and indigenous characteristics. Others have, indeed, a perfect right to criticise us, for in most European countries a folk-museum is a prominent and patriotic feature of very many of their cities and towns," Berlin, Budapest, Sarajevo, Moscow, Paris, Helsingfors, Copenhagen, Bergen, Christiania, and Stockholm being cited as a few examples.

Mr. Balfour then described with some detail the Nordiska museum in Stockholm as a model upon which to base a national folk-museum of our own, and said, "I feel sure that a well-organised and carefully arranged folk-museum standing in grounds which could be adapted for an open-air exhibition would be as much appreciated by students and as popular with the masses as any institution in the country." If a strictly national collection develops as it should, and is treated upon broad scientific lines, there will be no lack of lessons that may be learnt from it. The development of culture within the geographical region would be illustrated by chronological series depicting the general life and habits of the people at successive periods. An open-air exhibition in connection with the main museum would enable obsolete types of habitations and other large structures to be erected, and admit of the exhibition of many features of the older domestic and social economy; and, further, it would supply a permanent centre for the performance of the folk-dances, songs, and old-time ceremonies of the British people.

It was rather singular that the special subject of the "arrangement of mammalia in museums," which had been selected by the council, was completely ignored, not a single paper with any reference to it being submitted, while ethnology received a large amount of attention. Mr. H. L. Braekstad supported the president's plea with a bright, descriptive paper on open-air museums in Norway, Mr. F. W. Knocker discoursed on the practical improvement of ethnographical collections in provincial museums, and Mr. W. Ruskin Butterfield offered some suggestions for loan exhibitions of local antiquities. Art museums were dealt with in thoughtful papers by Benj. I. Gilman, of the Museum of Fine Arts, Boston, and Dr. A. H. Millar, of the Albert Institute, Dundee. Other papers comprised the Maidstone Museum, by J. H. Allchin; the relation between libraries and museums, by F. Woolnough; mounting and displaying coins, by R. Quick; life-history groups of injurious insects, by H. Bolton; and a very serviceable description by Sir Martin Conway of his ingenious and convenient method of dealing with photographs.

The annual report, read at the business meeting on July 15, recorded the uninterrupted growth of the association, which now possesses a cash balance of 250*l.*, as well as a stock of publications that are constantly in demand. The ballot papers showed that Dr. Tempest Anderson had been elected president, Mr. E. E. Lowe secretary, and Mr. F. R. Rowley editor. It was decided to publish a directory of all the museums in Great Britain and the colonies, the work to be proceeded with at once by Mr. H. M. Platnauer and Mr. E. Howarth.

ADAPTATION IN FOSSIL PLANTS.[1]

THE Darwinian theory of the origin of species by variation and natural selection only fulfils its *rôle* in so far as the distinctive characters of organisms are, or have been, adaptive, *i.e.* beneficial to the species. Purely "morphological" characters (if any such exist) and non-adaptive characters in general are not explained by the Darwinian theory (or only indirectly with the help of correlation). I therefore make no apology for having a good deal to say about adaptations in what follows.

That the great bulk, if not the whole, of organic structure is of the nature of an adaptive mechanism or device cannot be seriously doubted.

The origin of species by means of natural selection does not, as has sometimes been imagined, involve a constantly increasing perfection of adaptation throughout the whole course of evolution. Darwin expressed his belief "that the period during which each species underwent modification, though long as measured by years, was probably short in comparison with that during which it remained without undergoing any change."[2]

During the long periods of rest, adaptation to the then existing condition of life must have been relatively perfect, for otherwise new variations would have had the advantage and change would have ensued. It thus appears that, as a rule, a state of equilibrium has existed in the relation of organisms to their environment, only disturbed when the conditions were changing. That such long periods of evolutionary stability have actually occurred is shown, for example, not only by the familiar case of the flora of Egypt, unaltered during a long historic period, but still more strikingly by the absence of any noticeable change

[1] Abridged from the presidential address delivered before the Linnean Society on May 24. By Dr. D. H. Scott, F.R.S.

[2] "Origin of Species," sixth edition, p. 279.

in the plants of our own part of Europe since Glacial or pre-Glacial times.

The conclusion follows that at any given time, apart from the relatively short critical periods when changed conditions had to be met, we must expect to find organisms in a state of complete adaptation to their surroundings. When physical, and especially mechanical, conditions are in question, such as have practically remained constant through all geological time, we may reckon on finding the corresponding adaptive structures essentially the same at the earliest periods as they are now.

Hence the attempt to support the Darwinian theory by the detection of imperfect mechanical adaptations in Palæozoic plants is wholly futile, as was well shown by the late Prof. Westermaier. This author's own point of view was not that of a Darwinian, but, nevertheless, his conviction that efficient adaptation has always been characteristic of living organisms is a perfectly sound one, thoroughly in harmony both with the principles of Darwin and Wallace, and with the observed facts, as far back, at any rate, as the palæontological record extends. In particular, Westermaier's contention that the construction of the Carboniferous plants followed the laws of mechanical stability and economy of material, just as is the case in plants of our own day, is completely confirmed by accurate observations on their structure, while an opponent's supposed detection of Palæozoic constructions "in direct contradiction to the principles of the engineer" merely showed that the critic had failed to distinguish between the supporting and conducting tissues of the plant. It appears to have been characteristic of Palæozoic plants that their mechanical tissues were, to a great extent, independent of the wood and concentrated in the outer cortex—the most advantageous position on engineering principles. For example, the extremely prevalent "Dictyoxylon" type of cortex, in which bands of strong, fibrous tissue, united to form a network, alternate with the living parenchyma enclosed in their meshes, was an admirable mechanical construction for stems which did not attain any great thickness by secondary growth.

In the Calamites we find, in young stems, the same alternation of fibrous and parenchymatous bands in the cortex, which is so familiar to physiological anatomists in the stems of our living horsetails.

The great tree-ferns of the later Carboniferous (if ferns they were) evidently depended for their mechanical strength on a stereome or supporting tissue quite distinct from the vascular system, and for the most part peripherally disposed, as it should be. Their power of resistance to bending strains was no doubt greatly increased by the dense external envelope of strongly constructed adventitious roots, imbedded in the cortex, a mode of support which we meet with in some monocotyledons such as Kingia (Liliaceæ) and species of Puya (Bromeliaceæ) at the present day.

When we come to the most highly organised of the Palæozoic plants, the Cordaitales, constituting the characteristic gymnosperms of that epoch, we find that the young stems had the same "Dictyoxylon" construction of the cortex as was so common among the contemporary fern-like seed-plants. The cordaitean wood, however, often assumed a dense structure, and in many cases (as also sometimes occurred among the pteridosperms) there were tangential bands of narrow fibre-like wood-elements, suggesting, though not identical with, the autumn wood of recent coniferous trees, and no doubt subserving a special mechanical function.

The exigencies of secondary growth, when occurring on a great scale, ultimately demand that the mechanical tissues should be seated in the wood, on the inner side of the growing zone, though this is not the best position on engineering principles. The old plants were, on the whole, more correct in their methods; their successors have more often had to adopt a compromise, which sacrifices a certain degree of mechanical efficiency in order to facilitate construction.

In the leaves of the Cordaiteæ we meet with remarkably perfect types of mechanical construction showing various applications of the I-girdle principle, with utilisation of the "web" for the protection of the conducting vascular strands. The construction is on the same lines as that of many of the monocotyledonous leaves investigated by Schwendener in his classical work. It will be remembered that the cordaitean leaves were originally classed as those of monocotyledons, which they closely resemble in form and mechanical requirements. Here there is no secondary growth to disturb the lines of a rational construction; the leaves were of great length and borne on lofty stems, requiring a strong mechanical system for their support, and hence we find that they present admirable illustrations of engineering principles.

Without pursuing the subject further, it may be added that other Palæozoic leaves show essentially the same types of mechanical construction as are found in leaves of corresponding shape and dimensions in the living flora.

These few illustrations may suffice to show that, from an engineering point of view, the plants of the Palæozoic were just as well constructed to resist the strains to which their organs were exposed as are their recent successors.

I have elsewhere dwelt on the gradual change in the construction of the wood, correlated with the on-coming of secondary growth, and have traced the slow extinction of the old, "cryptogamic," centripetally developed wood, as the newer, centrifugal wood, derived from a cambium, more and more effectually took its place.[1] In the former we have to do with a structure becoming vestigial, but it is interesting to note how the doomed tissue was not always left in its old age to be a mere pensioner on its more active neighbours, but was often employed, while it survived, on such work as it was still able to do. We find, in quite a number of cases,[2] that the central wood had changed its character, and shows by its structure that it had become adapted to the storage rather than to the transmission of the water-supply, its earlier function now being more conveniently left to the external parts of the wood. Such utilisation of vestigial structure appears to be a good mark of a high standard of adaptation.

Another interesting case of adaptive specialisation in an organ which may be regarded as of an old-fashioned type is to be found in the rootlets of Stigmaria. The nature of these appendages has been much disputed; last year we had an interesting discussion on the subject, opened by Prof. Weiss. I have used the word "old-fashioned" because there is some reason to suppose that these organs were not yet quite sharply differentiated as roots; at any rate, there are certain points in which they rather resemble modified leaves, though in my opinion the root-characters predominate. Though they may thus be "primitive," from the point of view of our current morphological categories, these organs, as Prof. Weiss has discovered, show a remarkable adaptive mechanism in the presence of strands of water-conducting elements running out from the central vascular bundle, and terminating in plates of tracheæ placed in the outer cortex. The whole constitutes an absorptive apparatus more elaborate than anything found in recent roots, if we except a few highly specialised haustorial roots of parasites. This example seems to me instructive, for it shows how a very high degree of adaptation may co-exist with characters which suggest a somewhat archaic type of organ.

As an example of adaptation to more special conditions, I may instance the xerophytic characters shown by various Carboniferous plants, especially in the structure of their leaves.

Though there is no question of absolute perfection in nature, it appears that, under given conditions, adaptation is and was sufficiently perfect to make it very difficult to put one's finger on any defect. When we think we can do so, it generally turns out that the defect is in the mind of the critic rather than in the organism criticised. We will take a particular case, where the history seems to give some justification for our fault-finding.

The late Palæozoic family Medulloseæ were in some respects the most remarkable plants, from an anatomical point of view, that we know of. Most of them were plants of great size, with rather sturdy stems bearing immense fern-like fronds; the habit altogether must have been something like that of a tree-fern, but their reproduction was by large seeds, borne on the fronds. To

[1] Scott, "The Old Wood and the New" (*New Phytologist*, vol. i., 1902).
[2] Megaloxylon, Zalesskya, *Lepidodendron selaginoides*.

adapt the vascular system of the stem to the supply of the large and compound leaves, the polystelic type of structure was assumed, *i.e.* the single vascular cylinder (still to be recognised in some of the earlier members of the group) became broken up, in various ways, into a number of distinct cylinders, only connected at intervals. So far the change was in the same general direction as in the evolution of the higher ferns; the fossil family, however, was not content with a complex primary vascular system, but must have secondary growth as well. Now if you have a number of vascular columns in the same stem, each growing continuously in thickness on its own account, it is evident that very special arrangements will be necessary to avoid overcrowding. The difficulty was overcome, and the Medulloseæ for some time flourished among the dominant families—the Permian formation represents their Golden age. But one is tempted to think that the system was too complicated to last; at any rate, it seems not to have lasted, for these elaborate stems have not been found in any later rocks. Either, as Mr. Worsdell supposes, the medullosean stem became reduced and simplified to form the cycadean type of stem of later days, or, as I am more inclined to believe, the family died out altogether. Even here, though we seem to have an instance of a cumbrous mechanism, over-reaching itself in elaboration, yet it worked well enough for a time, and it would be difficult to say exactly what the conditions were that led to its being superseded.

The hypothesis of "a gradual development from the simpler to the more complex" is not borne out by the facts of palæobotany—the real course of events was infinitely more involved. On a general view, as Darwin himself recognised, "the geological record does not extend far enough back to show with unmistakable clearness that within the known history of the world organisation has largely advanced."[1] This wise saying has been too often overlooked by those who have tried to popularise evolution—it is eminently true of the geological history of plants. Though there is no doubt a balance on the side of advance, due chiefly to the increasing complexity of the inter-relations among the organisms themselves, the general progress since Palæozoic days is by no means so great as has often been assumed, and we may be sure that as our knowledge of the older plants increases we shall come to form a still higher estimate than we do now of their adaptive organisation.

It has been alleged that it is the fact of the gradual appearance of higher forms which enables us to determine the relative age of strata by their fossils. So far as plants are concerned, this statement is only true to a very limited extent. A fossil angiosperm, no doubt, would be evidence of an age not earlier than the Cretaceous, but, on the other hand, a lycopod of much higher organisation than at present would establish a strong presumption of Palæozoic age; so would the higher forms of the equisetales; a cycadophyte with a fructification far more elaborate than that of recent Cycadaceæ would afford sure proof that the bed containing it belonged to the Lower Mesozoic.

Of course, much depends on the meaning we give to the words "higher" and "lower." If by "higher" we mean nearer to the recent types, then it is merely a truism to say that the higher forms are characteristic of the later rocks; but if by "higher" we mean more elaborately differentiated, then the statement quoted is, in any general sense, untrue. If, again, we imply by the word "higher" more perfectly adapted to the existing conditions, then it would be very difficult to prove any advance, for, as I have endeavoured to show, adaptation has in every age been fully adequate in relation to the then conditions. If organisms have grown in complexity, it is only where the conditions of their life have become more complex. The most striking examples of high organisation in relation to organic environment are presented by the characteristic modern subkingdom, the angiosperms, in the evolution of which, as Saporta pointed out, insect fertilisation has been the chief determining factor, leading to an infinite variety in the special adaptations of the flower, and no doubt indirectly affecting the mode of life of the whole plant. The advent of the angiosperms seems to have been almost simultaneous with that of the higher families of insects, which now, at all events, are chiefly concerned in pollination. It would be difficult to overestimate the importance of these relations in their effect on the flora of the world. If the vegetation of our own epoch appears, on the whole, definitely more advanced than that of earlier geological periods, this is probably due in a greater degree to the contemporary insect life than to any other cause.

[1] "Origin of Species," sixth edition, p. 308.

I have discussed the subject of reduction in evolution elsewhere,[1] and will only briefly allude to it here. In many groups (lycopods, equisetales, cycadophytes) there has been a lowering of the standard of organisation, partly due to direct reduction, partly to the extinction of the higher forms in each group. There are, however, many other cases in which the simplification of particular organs means a real advance.

Taking into account all the causes which make for simplification, the question suggests itself whether, when we find a simple type of structure existing at the present day, there is any presumption in favour of its primitive nature. It has sometimes been urged that such a presumption exists (except when direct evidence of reduction can be adduced) on the ground that the general course of evolution must have been from the simpler to the more complex, a rule, as we have seen, subject to so many exceptions that, within the limited period to which the palæontological record extends, it has practically no validity. My own conviction is that in such cases there is no *presumption* of primitiveness at all, and that we should demand very strong evidence before admitting that a given simple structure is primitive. Of course, it may happen that a primitive simple type, or at least an old simple type, may have survived to our own day; this may have been the case in decaying families, where the less advanced members have had the best chance of evading the competition of ascendant races; but, on the whole, it is very unlikely that, among all the changes and chances of the world's history, a really primitive simplicity should have been preserved. "The eternal ages are long," and there has been time enough for many ups and downs on every line of descent.

The subject of reduction, so essential a clue in any attempt to trace the course of evolution, suggests a reference to the question of the simpler angiospermous flowers. While the older morphologists were wont to interpret such flowers (*e.g.* those of Aroideæ, Piperaceæ, Cupuliferæ) as reductions from more "perfect" types, there has been a tendency in more recent times to accept the simpler flowers as primitive structures from which more elaborate forms have been evolved. Quite lately, however, a reaction has set in, due to the discovery by Dr. Wieland of the wonderful bisexual flowers of the Mesozoic cycadophyta, which are constructed on the same plan (though, of course, with many differences in detail) as the more perfect angiospermous flowers, such as those of Magnoliaceæ. If the angiospermous flower was derived from a source allied to the Bennettiteæ, its evolution, as suggested by Wieland, must have been essentially a process of reduction. I only wish to point out that this view is not inconsistent with the great relative antiquity of simple and, *ex hypothesi*, reduced forms, for which, in the case of the Amentiferæ, there seems to be good geological evidence. Reduction appears to have often been a rapid, indeed a comparatively sudden, change, as shown by the frequent occurrence of much-simplified forms in the same family in which the prevailing structure is typically complete. It appears quite probable that some groups with very simple flowers, though not "primitive," may be very ancient, tracing their origin from forms which in quite early days underwent reduction (as a means of specialisation) from the highly developed flowers which probably characterised the first autonomous angiosperms.

The tentative and somewhat fragmentary observations which I have here stated tend to the following conclusions:—

(1) That at all known stages of the past history of plants there has been a thoroughly efficient degree of adaptation to the conditions existing at each period.

[1] "Darwin and Modern Science." XII. The Palæontological Record. II. Plants. (1909.)

(2) That the characters of plants, having always been as highly adaptive as they now are, natural selection appears to afford the only key to evolution which we at present possess, for all periods covered by the palæontological record.

(3) That this record only reveals a relatively short section of the whole evolution of plants, during which, though there has been considerable change, there has not been, on the whole, any very marked advance in organisation except in cases where the conditions have become more complex, as shown especially in the floral adaptations of angiosperms.

(4) That simple forms existing at the present day are, as a rule, of a reduced rather than a primitive nature, but that such reduction may have often set in at a relatively early stage of evolution, and is, therefore, consistent with a considerable degree of antiquity in the reduced forms.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. C. G. BARKLA, demonstrator and assistant lecturer in physics at the University of Liverpool, has been appointed professor of physics in King's College, London, in succession to Prof. Harold A. Wilson, F.R.S., who has accepted an appointment in McGill University, Montreal. Mr. P. H. Kirkaldy has been appointed an assistant professor in chemistry in the same college.

HARVARD has this year conferred only one honorary doctorate of science. The recipient is Mr. S. F. Emmons, of the U.S. Geological Survey. The University has conferred upon its late president, Dr. C. W. Eliot, not only the honorary LL.D., but the honorary M.D. "It has not been our custom," said the new president, Prof. Lowell, "to confer the degree of Doctor of Medicine *honoris causa*, but an exception is fitting in the case of one who, in the opinion of professors of medicine, has accomplished more for the progress of medical education in this country than any other living man, Charles William Eliot. Not in its buildings alone, but also in the instruction and research within its walls, he found our medical school brick and left it marble." At Yale the honorary D.Sc. has been conferred on Profs. E. W. Morley, W. T. Sedgwick, and E. H. Moore—a chemist, a biologist, and a mathematician respectively.

A FOURTH series of lectures on scientific microscopy is to be held at the institute for microscopy of the University of Jena from October 11–16 next. Prof. H. Ambronn will give two lectures, the first on Abbe's theory of the formation of the microscopic image, and the second on the method of testing objective systems. Dr. H. Siedentopf also will lecture twice, dealing with dark-ground illumination and ultramicroscopy. Dr. A. Köhler's two lectures have for their subjects photomicrography: (*a*) projection of the image on the plate, (*b*) illumination of the object with transmitted and incident light, and photomicrography with ultra-violet light. In connection with each lecture suitable practical work has been arranged, and demonstrations also will be provided. Application for admission to the lectures should be made to Dr. Ehlers, Jena, Beethovenstr. No. 14. A fifth series of lectures will be held from March 7–12, 1910, in the anatomical institute of the Leipzig University.

THE first volume of the report on attendance, compulsory or otherwise, at continuation schools, prepared by the Consultative Committee for the Board of Education, was published (Cd. 4757) a few days ago. The evidence on which the recommendations of the committee have been based will be issued later as a separate volume. The committee was instructed to consider, among other matters, "whether any means, and if so what, can be devised, in respect of rural areas and of urban areas respectively, for securing (i.) that a much larger proportion of boys and girls should on leaving the public elementary school commence and continue attendance at evening schools than at present do so, and (ii.) that employers and other persons or bodies in a position to give effective help shall co-operate in arranging facilities for such attendance on the part of their employees, and in planning suitable courses and subjects for the schools and classes." The witnesses examined by the committee included representatives of employers of labour, of labour organisations, the Public Services, local education authorities, teachers of all grades, inspectors of schools, and persons specially interested in philanthropy. The volume available, with its careful consideration of every aspect of the problem, brings home forcibly to the reader its complexity and importance, and we hope to deal more fully with the whole question in a future issue. Here we will only express satisfaction that the views of enlightened educationists are being brought prominently into public view by reports such as that before us. The resolutions as to leaving age and continuation schools contained in the report of the Education Committee of the British Science Guild (NATURE, January 28, vol. lxxix., p. 382) receive substantial support from the Consultative Committee's conclusions, and it may be hoped that action will be taken before long in the direction indicated by them. Most of the German States have compulsory continuation schools, and Scotland was placed in the same position by its Education Act of last year. It remains for England to adopt a like standard of educational efficiency for its children.

ON the vote of 13,648,792*l.* for the expenses of the Board of Education, Mr. Runciman, President of the Board, made a statement in the House of Commons last week reviewing the state of education in the country. Dealing with technical education, the Minister spoke hopefully. It has been, he said, the object of the Board of Education to make technical education more practical, with a closer bearing on the duties likely to be required from the young men and women who pass through technical classes. In agriculture there is one remarkable fact, namely, that garden classes in elementary schools have been enormously on the increase, and during the last few years the number of these classes which are now carried on in these schools has been trebled. There has been considerable development in technical classes which can be attended by those who intend to enter on an agricultural career, by young farmers and young labourers who at the present time have to spend long and laborious days in the fields or farmhouses, but who are prepared to devote one or two evenings a week to the specialised training which can be provided in technical classes. The cumulative effect of technical training on the young men and women of our country must show itself sooner or later. The great employers have been giving help, said Mr. Runciman, in many parts of the country to those who organise the technical schools. Messenger boys, for instance, are induced more and more to take advantage of the classes in the evening. Some great employers, like the General Post Office, not only give direct inducement to their messenger boys, but put a certain amount of pressure on them to take advantage of classes, and many employers all over the country have made it a condition of service in their works or their great business establishments that the boys should attend a certain number of classes every week. The inspectors of the Board are not only taking a keen interest in the curriculum, but they are also acting as missionaries in what is one of the most useful forms of educational work initiated during the last few years. In concluding his speech, Mr. Runciman pointed out that we still have nothing but an old, temporary building in which our valuable science collection is housed, and he expressed the hope that it may be possible in the near future to give this great collection a better building in which it may be exhibited, and to give to those who have lent or given to that museum some security that the objects which they have given will be well preserved and well exhibited.

THE new engineering buildings of the University of Manchester were opened by Sir Alexander Kennedy on July 15. The general scheme comprises four adjacent buildings; the main block, a three-storied building, contains the lecture rooms, tutorial rooms, drawing offices, private rooms, and research room. The hydraulic and testing laboratory covers the space at the back of this building, and connected to it by a covered way are the thermodynamic laboratories and the workshop. Principal Hopkinson presided at the opening ceremony, and in the course of his remarks pointed out that the example set by the Owens College in 1866, in providing for the professional education of engineers, has been followed by all the important universities in the country. During his speech Sir Alexander Kennedy made it clear that the old system of apprenticeship has become inadequate. The function of the laboratory, he said, is to try to let a man learn by handling, experiment, and measurement the nature of the materials with which he will have to deal later. The extraordinarily rapid progress which has been made in mechanical and electrical engineering during the last generation has been largely due, Sir A. Kennedy thinks, to the good training all over the country of the men who have to carry out the details of the work. On the part of colleges and universities, he continued, there is a tendency to attempt to make students do a great deal too much. While it is necessary that an engineer shall have a knowledge of a great many things before he gets to his profession, he cannot acquire much knowledge in three years. It may be hoped that a strong university with a strong man at its head will draw a very distinct line in some common-sense fashion in defining what knowledge shall be imparted to the students. Sir William Mather proposed a vote of thanks to Sir A. Kennedy, and expressed his disappointment at the neglect displayed by the large engineering firms of the Manchester district in connection with the higher development of engineering science among young men. The success of engineering in the future will depend almost wholly on elements quite different from those which have distinguished it in the past. The next generation of engineers must be trained carefully by methods enabling them, above all things, to combine economy with efficiency. The technical school must perforce stop short of what may be called the practical part of applying machinery in the best possible way. To ensure success, there must, he continued, be a certain number of young students devoting themselves to laboratory work, and this extension of Manchester University must prove of great usefulness.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, June 25.—Dr. C. Chree, F.R.S., president, in the chair.—A transition point in zinc amalgam: Prof. H. S. **Carhart**. The paper gave the preliminary results of an investigation which has for its primary object the determination of the heat of dilution of zinc amalgams. This heat of dilution is negative, that is, the dilution of zinc amalgam by the addition of mercury absorbs heat. In the course of the experimental work, which was conducted by Dr. W. D. Henderson, phenomena so extraordinary were encountered that the concentration at which they occur was called a transition point in zinc amalgam. The method employed was electrical, by means of a concentration cell, the only difference between the two legs of the cell of H-form being in the concentration of the amalgam composing the electrodes.—A method of producing an intense cadmium spectrum, with a proposal for the use of mercury and cadmium as standards in refractometry: Dr. T. M. **Lowry**. Of the twenty-six wave-lengths that have been used in the study of rotatory dispersion (Proc. Roy. Soc., lxxxi., p. 472, November 19, 1908) the following seven have been found to be the most suitable for general use:—

Li	Cd	Na	Hg	Cd	Cd	Hg
6708	6438	5893	**5461**	5086	4800	4358

In refractometry it has been customary to use the series:—

Hα	Na	Hβ	Hγ
6560	**5893**	4861	4341

This series has the disadvantages (1) that the chief standard Na 5893 is a doublet, and (2) that the other three lines are of such weak intensity that they are useless for the majority of optical measurements. It is therefore urged that—in view of the readiness with which the mercury and cadmium spectra can now be produced—the mercury green line should be generally adopted in place of sodium as chief standard in optical work of all kinds, and that the hydrogen lines should be abandoned even as secondary standards in favour of the series of wave-lengths set out above.—The measurement of wave-length for high-frequency electrical oscillations: A. **Campbell**. The experiments had for their object the calibration of wave-meters for the measurement of the high frequencies (200,000 up to 1,000,000 ~ per second) used in wave-telegraphy. Two wave-meters (A and B) were tested, both being of the type consisting of a series of self-inductance coils used singly (L) in series with a variable air-condenser (K) and a thermo-ammeter, the reading of K being obtained by altering the capacity until the circuit shows resonance with the working circuit. The coils of wave-meter (A) were wound with solid wire, those of (B) with stranded wire (7/36s), each strand being separately insulated. The absolute value of the frequency was determined by photographing spark-trains in the primary circuit by means of a rotating mirror running at a constant and accurately measured speed. The value of the frequency deduced from the measured values of K and L with wave-meter (B) were in close agreement with the actual frequency deduced from the spark-photographs. With wave-meter (A) the agreement was naturally not nearly so close, but was much improved when the values of the self-inductances of the solid wire coils were corrected to the high-frequency values by the formulas of Heaviside and L. Cohen.—An electromagnetic method of studying the theory of and solving algebraical equations of any degree: Dr. **Russell** and Mr. **Alty**. The problem of finding the roots of an algebraical equation of the nth degree is identically the same as that of finding the positions of the "neutral points," that is, the points where the resultant force due to the earth and definite currents in n long vertical wires is zero. The n wires are arranged at any convenient distances apart in a plane which is at right angles to the magnetic meridian. The currents in the wires are then adjusted to certain values which are readily found by the methods of partial fractions. If x_1 and y_1 be the coordinates of one of these neutral points measured with reference to certain definite axes, $x_1 \pm y_1\sqrt{-1}$ is a pair of roots of the original equation. All the real roots lie on the axis of X which cuts the wire at right angles. The positions of the neutral points thus determine all the roots, real and imaginary, of the given equation. The peculiar advantage of the method is that it is easy to see, in many cases almost at once, what effect varying the value of the coefficient of any power of x will have on the roots of the equation.—The sine condition in relation to the coma of optical systems: S. D. **Chalmers**. The condition for the correction of coma in a centred optical system is the well-known sine condition. This has been proved by Clausius, Helmholtz, Hockin, and others, and the importance of this condition in the design of optical systems has been pointed out by Abbe, Steinheil, Conrady, and others. The present paper shows how to obtain the relation between the coma of a system and the errors in the sine condition.—A new Féry thermo-electric calorimeter: Dr. C. V. **Drysdale**. This form of calorimeter can be used continuously, and permits the value of the gas produced in a gas-works or producer-plant to be watched from time to time.—An instrument for measuring the strength of an intense horizontal magnetic field: F. W. **Jordan**. The method consists in measuring directly the transverse force on a conductor traversed by a current in a direction at right angles to the field.—A method of determining the sensibility of a balance: Prof. **Poynting**.—The balance as a sensitive barometer: Mr. **Todd**.

Challenger Society, June 30.—Dr. A. E. Shipley in the chair.—Colour changes in tropical sea perches from the Bermudas: C. T. **Regan**. In one case an individual specimen exhibited successively the coloration of three so-called "species."—Recent observations of Prof. Otto Pettersson on tide-like movements in deep water: Dr. H. R. **Mill**. Daily observations on temperature and salinity were made at close intervals from surface to bottom in the Gullmar Fjord, when covered by ice, between January 30 and March 25 of this year. The effect was that of an invasion of sea water from the Skagerack twice in a lunar period, followed by a withdrawal of the sea water and the filling up of the upper part of the fjord with brackish land water in rhythmical succession, and Prof. Pettersson inclined to the belief that these movements were of tidal origin. Dr. Mill pointed out that Sir John Murray and he had shown that similar effects of a non-periodical kind were produced in sea- and fresh-water lochs of Scotland by the action of wind, and that he had shown analogous effects on the Atlantic coast of the Hebrides.

PARIS.

Academy of Sciences, July 12.—M. Émile Picard in the chair.—The nature of the change undergone by crystals of heptahydrated sodium sulphate in contact with crystals of the decahydrate: D. **Gernez.** From an examination of the phenomena occurring with supersaturated solutions of sodium sulphate, sodium chromate, acetate, and hyposulphite, it is concluded that the opacity of the lower hydrated crystals in contact with the higher hydrate is due to penetration of crystals of the higher hydrate into the crystalline network of the lower. There is no evidence for any change in the proportion of water in the crystals first formed.—Observations on the nature and origin of the gases which form in volcanic fumaroles or which emerge from the craters of old volcanoes: Armand **Gautier.** The gases from the old crater of Agnano, near Naples, consist almost entirely of carbon dioxide (96 per cent. to 98 per cent.), together with traces of methane and a little more than 1 per cent. of nitrogen. The latter contains argon, neon, and helium, and possibly the other argon gases.—The influence of anæsthesia on the decomposition of certain glucosides in plants: L. **Guignard.** Plants of black mustard, submitted to the action of chloroform vapour, produce the mustard essence; cooling to the temperature of boiling methyl chloride produces the same effect. Similar observations have been described by M. Mirande regarding the formation of hydrocyanic acid.—A hæmogregarian of *Pituophis melanoleucus*: A. **Laveran** and A. **Pettit.**—The neutral carbonates of rubidium and cæsium: M. **de Forcrand.** A thermochemical paper.—The theory of functions: Henri **Lebesgue.** A correction of a previous paper.—The singularities of uniform analytical functions: D. **Pompeiu.**—Systems of reservoirs: Edmond **Maillet.**—Orthoscopic telescopes: M. **Tscherning.**—Chemical reactions and ionisation: G. **Reboul.** The apparatus described is capable of measuring ionisation over a wide range; details are given of the results obtained in numerous chemical reactions.—Remarks on the preceding paper: A. **Gautier.**—A new method of separating uranium X, and on the relative activity of this substance: B. **Szilard.** The method is based on the addition of ferric acetate, ammonium acetate, and acetic acid to the uranium solution, and the precipitation of the iron by heating; uranium X is concentrated in the precipitate.—The chemical action of the penetrating rays of radium on water: Miroslaw **Kernbaum.** Radium rays that had passed through glass decomposed water in accordance with the equation $2H_2O = H_2O + H_2$, both the hydrogen and hydrogen peroxide being determined quantitatively. An attempt to obtain a similar reaction by allowing Röntgen rays to act upon water for 100 hours gave negative results.—The diffusion of ions through metals: Georges **Moreau.** The passage of ions through heated plates of platinum, nickel, iron, and brass has been studied. A theory of the diffusion has been developed, and an experimental confirmation given.—The action of the α rays on solid dielectrics: Tcheslas **Bialobjeski.** A study of the alteration in the conductivity of sulphur produced by the α rays of polonium.—The hydrolytic decomposition of bismuth bromide: René **Dubrisay.** There is only one bismuth oxybromide produced in this reaction; a rise of temperature does not appreciably affect the hydrolytic dissociation of bismuth bromide.—A proposed solution for the equation of condition relating to the calculation of atomic weights: G. D. **Hinrichs.** The author points out that his equation of condition is diametrically opposed to that given by L. Dubreuil.—The cementation of iron by carbon in a vacuum: Léon **Guillet** and Ch. **Griffiths.**—The extraction of lutecium from the gadolinite earths: G. **Urbain,** MM. **Bourion** and **Maillard.** For the final purification from thorium and scandium, the oxides were converted into the chlorides by heating them in the vapour of sulphur chloride. This method of fractional sublimation of the chlorides promises to be of service in the separation of the rare earths.—The condensation of isopropyl alcohol with its sodium derivative: formation of methylisobutylcarbinol and dimethyl-2: 4-heptanol-6: Marcel **Guerbet.**—The iso-indogenides: A. **Wahl** and P. **Bagard.**—The production of peat on the rocks of tropical Africa: Aug. **Chevalier.**—The ferment of belladonna: C. **Gerber.**—The influence exerted by certain vapours on plant cyanogenesis. A rapid method for testing plants for hydrocyanic acid: Marcel **Mirande.** Any cyanogenetic plant, submitted to the action of chloroform vapour, at once gives off hydrocyanic acid. The latter can be detected by the use of Guignard's picrate paper.—The action of urohypotensine on the arterial pressure: J. E. **Abelous** and E. **Bordier.**—The proof of alimentary glycosuria in epileptics: MM. **Florence** and **Clement.**—The hypotensive action of serum from a dog which had been deprived of its suprarenal capsules: Jean **Gautrelet** and Louis **Thomas.**—The chemical composition of ox bile: N. A. **Barbieri.**—The life of yeast after fermentation: E. **Kayser** and A. **Demolon.**—The action of the ultra-violet rays on cider in fermentation: MM. **Maurain** and **Warcollier.**—Experimental reproduction of exanthematic typhoid in the ape: Ch. **Nicolle.**—The chemical effects of immersion in water of the quartz mercury-vapour lamp: J. **Courmont,** Th. **Nogier,** and A. **Rochaix.** No ozone is produced which would account for the observed bactericidal effects, and no other chemical change of importance could be detected.—Symmetry of organs in some species of Syllis: Aug. **Michel.**—The reactions of some mitochondria: E. **Fauré-Fremiet.**—The ichthyological fauna of Lake Victoria: Jacques **Pellegrin.**—The Silurian of Nova Zembla: V. **Roussanof.**—The earthquake of Provence, June 11, 1909: Louis **Fabry.**—The earthquake of July 7, 1909: Alfred **Angot.**

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THURSDAY, JULY 29, 1909.

HOW TO DIAGNOSE GENIUS: A STUDY OF HUMAN ENERGETICS.

Grosse Männer. By Prof. Wilhelm Ostwald. (Leipzig: Akademische Verlagsgesellschaft, 1909.)

THIS book is a study in comparative biography, and may be said to point the way to a new field of investigation. Prof. Ostwald was prompted to write it, as he tells us in his first sentence, by an ingenuous question put to him by one of his Japanese students as to how budding geniuses could be recognised. Much money, his student went on to say, is spent by various Governments in attempting to discover those people whose thorough education may be expected to bring in a return of value to the State, and the question how best to discover latent genius is an eminently practical one. After cogitation, Prof. Ostwald came to the conclusion that it is those students who cannot be kept on the rails—that is, who are not contented with methodical teaching—who have within them the seeds of genius; and the writer's experience would lead him to the same conclusion.

But in order to lay a basis for such a deduction, vague, to some extent, because derived only from personal impressions, a careful comparison has been made of the lives of six men, all of whom had a great influence on the thought of their time. These are:—Davy and Faraday; Julius Robert Mayer, who shares with Joule the honour of having shown the equivalence of heat and work; Liebig; Gerhardt, who, in his day, contributed to the revolution in chemical thought; and Helmholtz.

These names belong to men of science, exclusively; the reason for the choice is perhaps to be found in words penned by Liebig:—

"The history of the nations teaches us of the futile efforts of powers, political and ecclesiastical, to maintain spiritual and bodily slavery over mankind; future history will deal with the conquest of liberty, gained by the investigation of the reason of things, and of truth; a conquest gained by weapons unstained with blood, and on a field in which religion and morals take part only as feeble allies."

This, it may be remarked, is prophecy, and, as such, is at present beyond criticism; it may, however, be pointed out that to some of us, at least, the prospects held out by the remarkable conquests over what used to be called "the forces of nature" do not at present point to a speedy millennium. However, the retort is open that it is not the spread of the teachings of science, but a disregard for such teachings, which is the reason that our moral progress does not keep pace with our material progress.

Be that as it may, Prof. Ostwald has given, in his masterly style, delightful sketches of the lives of these undoubtedly distinguished men. The biographies differ somewhat from the usual "lives," inasmuch as the failings, as well as the virtues, of the subjects have been touched on. No character is perfect, and, without ample knowledge, it is impossible to attempt to draw just conclusions.

One notable characteristic of men of genius is that it is rare for them to have come from either a high or a low grade of society. Exceptions are confined practically to England and France, as witness Boyle, Cavendish, and Lavoisier; Faraday might perhaps be instanced as an example—almost the sole example—of the second class.

Another characteristic is the very early age at which such men develop. Goethe was twenty-four years old when he electrified the German nation by his "Sorrows of Werther"; Schiller was twenty-two when he published "The Robbers"; Newton had invented the calculus, discovered the law of gravitation, and had completed his analysis of light before his twenty-fifth year; Linnæus had evolved his sexual system of plants at the age of twenty-four; and the list might be extended indefinitely, to Carnot, Clausius, Scheele, Berzelius, Vesalius, the reformer of the science of anatomy, the physiologists Ludwig, Helmholtz, and Du Bois Reymond, to, last, though not least, Kelvin. Youths who make their mark at a later age, as already remarked, show a distaste for the formal instruction which is still given in the public schools of Germany and England. In this connection it is interesting to note the saying of a writer on English public schools, himself once a distinguished headmaster, that, while a classical or mathematical master does not fall off, indeed improves, with age, inasmuch as he perfects himself in methods of teaching practically unprogressive branches of learning, the science masters cannot but deteriorate, unless they keep abreast with the progress of science by increasing its bounds by their own efforts. Prof. Ostwald takes a strong view of the inutility of the training to be acquired from a linguistic, especially a classical, education, and believes that the usual duration of school life is far too great. In this the writer heartily concurs.

"Had Kelvin or Leibnitz been so unfortunate as to have come into the world in our days, and in Germany, their early development would have been of no avail; they would have sat on the school benches till their eighteenth year—an age at which they had gained a prominent position in science."

The temperaments of the men whose lives are chronicled may be divided under two heads, "Klassiker," or "phlegmatic," to quote an old classification, and "Romantiker," or "sanguine." To the former class belonged Faraday, Mayer, and Helmholtz; to the latter Davy, Liebig, and Gerhardt. These temperaments correspond to the rate of reaction to external stimulus. The romantic type is eager, alert, impatient, and impulsive; the classic type painstaking, conscientious to a fault, self-criticising, and accurate. It is remarked on as curious that most men who have achieved greatness belong to one or other of these classes; it would appear that average minds, who occupy a mean position, being neither very impulsive nor very critical, have not the qualities which raise them above their fellows.

The "yield" of such minds, to use an expression borrowed from chemical manufacture, depends, according to Ostwald, on their "economic coefficient." To transform one kind of energy into another implies the "degradation" of a portion; this is the second law of thermodynamics. Born into the world with the usual amount of energy, *i.e.* capacity for work, some minds are so constituted as to transform a large portion of it so that it is of service to humanity, while a comparatively small portion is, as it were, wasted. The sum of the action of such minds constitutes human progress. It is necessary that the progress of the individual genius should be hindered as little as possible by artificial and unnecessary obstacles, and it would appear that in some countries the path is made easier than in others. Taking the membership of national academies as a test, if only a rough one, of scientific eminence, the proportion of distinguished men to the inhabitants, reckoned in millions, is in Saxony 0·2, in Baden and Norway 0·25, in Switzerland 0·33, in Holland and Bavaria 0·41, in England and Prussia 0·49, in France 0·79, in Italy 2·17, in Austria 2·7, in the United States 3·08, and in Russia 16·3; that is, for example, there is in Russia only one member of international academies to 16·3 million inhabitants. It can hardly be doubted that this low number is due to the hindrances which stand in the way of the progress of youths who might, in Russia, display genius, and enrich the world by their efforts.

It is impossible to review such a book as this satisfactorily in a short article. It teems with interest, not only on account of the intrinsic attractiveness of the subject, but also because of the masterly grasp of it displayed by the author. Whatever Prof. Ostwald writes is sure to interest, owing to the originality of his mind and his lucid and attractive method of presentment. On every page there occurs some saying which excites attention, even although the reader may sometimes be disposed to challenge the conclusions drawn. The questions discussed are well worth the most careful consideration of all who have the welfare of humanity at heart. The problem considered is an eminently practical one—perhaps the most practical problem which exists—and we owe the author a debt of gratitude for having introduced it to us in such a charming manner. W. R.

SOME MEN AND MATTERS IN CHEMISTRY.

Essays, Biographical and Chemical. By Sir William Ramsay, K.C.B., F.R.S. Pp. vii+247. (London: Constable and Co., Ltd., 1908.) Price 7*s.* 6*d.* net.

IT is good to read about the pioneers of science, their trials and their triumphs. Even it is good for the student who has to "grind" up facts about scientific worthies and serve them up hot to a voracious examiner; albeit in such a case it smacks strongly of "turning old heroes into unworthy potions," as Sir Thomas Browne remarks in discussing the medicinal virtues of mummies. At any rate, such a student would get some of the facts about his heroes pleasantly enough in reading what Sir William Ramsay has to say in the present volume concerning Boyle and Cavendish, Davy and Graham, Black, Kelvin, and Berthelot.

The essays are a collection of lectures and magazine articles published, the author tells us, at various times during the last twenty-five years. It follows that they are of a popular character in the sense that little or no special knowledge on the part of the reader is assumed. They are somewhat unequal in scope and treatment, as may be inferred from the fact that the organs in which they first appeared included such diverse publications as the *Youth's Companion* and the Proceedings of the Royal Society.

Of the biographical essays, those upon Berthelot and Lord Kelvin seem to the present writer to show the author at his happiest. Perhaps that is because there is the personal note in them; for Sir William Ramsay was acquainted with the French *savant* as well as the English one. He gives us an attractive glimpse of the happy home life of the Berthelots. There was a touch of romance, too, about the meeting of young Marcellin Berthelot with his future wife, which is described in the essay, and which we may venture to quote almost in the author's words. Mademoiselle Breguet was beautiful and well-dowered, but presumably beyond Berthelot's reach. However, one day she was crossing the Pont Neuf in the face of a strong wind, wearing a charming Tuscan hat.

"Behind her walked her future husband; suddenly she turned round to avoid having her hat blown off, and practically ran into his arms. A case of love at first touch," says Sir William.

The stories of Boyle and of Cavendish will always appeal to chemists. The author describes and contrasts the work and character of the two men in an interesting little sketch. "Each was in advance of his age"; Boyle by reason of his calm philosophical spirit and clear judgment, Cavendish in his power of refined quantitative experiments and deductions. Neither was married; and the author, after reflecting that Boyle was too many-sided and Cavendish too reserved, remarks:—"It is perhaps legitimate to draw the conclusion that man's nature does not culminate in its best without the influence of a helpmeet." It may be so; but another conclusion, perhaps equally legitimate, is that if there had been a Mrs. Boyle and a Mrs. Cavendish there might have been no "Sceptical Chymist" and no "Experiments on Air." Black also, it may be noted, remained unmarried, though a particular favourite of the ladies. Perhaps they missed much, these three distinguished chemists, both in personal happiness and in perfection of character; but it may well be that their loss was mankind's gain, and that chemical science has cause to bless the circumstances which enabled them to pursue their researches with singleness of aim, undistracted by either the joys or the troubles of matrimony.

A sketch of the careers of Davy and Graham completes the essay on the "Great London Chemists." Space allows only a brief mention of the author's comparison of the four. Graham, with his philosophical mind, more resembled Boyle than Cavendish or Davy. While Cavendish carried his devotion to science so far that it deprived him of the ordinary pleasures of a human being, and while Davy, in relation to fashion, could not escape the accusation of playing to the gallery, Graham pursued a happy mean, beloved by his friends, esteemed by all. "Of him, as of Faraday, it might have been said with no shade of misgiving, 'He was a good and a true man.'"

The second half of the volume is devoted to essays on various chemical topics. A few titles will indicate their nature; thus there are "The Becquerel Rays," "What is an Element?" "Radium and its Products," and "The Aurora Borealis." This last is an interesting discussion of the evidence for regarding krypton as a noteworthy constituent of the aurora. An oration upon "The Functions of a University," delivered some eight years ago at University College, concludes the work, and ends with the remark:—

"As it exists at present, a University is a technical school for theology, law, medicine, and engineering. It ought to be also a place for the advancement of knowledge, for the training of philosophers, and of those who love wisdom for its own sake. . . ."

Surely; and if examples were wanted of men who loved wisdom for its own sake, who "scorned delights and lived laborious days" in pursuit of it, yet by whose labours was wrought incalculable material benefit to posterity, what better instances could be found than those of the pioneers of chemistry?

With two or three exceptions, neither the biographical nor the chemical essays pretend to be more than popular presentations of their several subjects, and if here and there they seem perhaps a trifle superficial and jejune, it is only fair to remember the circumstances of their production, and to recall the fact that some were written when their distinguished author's powers were less mature, by a quarter of a century's growth, than they are to-day.

C. SIMMONDS.

EXPERIMENTAL PSYCHOLOGY.

A Text-book of Experimental Psychology. By Prof. C. S. Myers. Pp. xvi+432. (London: Edward Arnold, 1909.) Price 8s. 6d. net.

THIS book supplies a want which has been long felt by both students and teachers. Until now there has been no text-book to meet the special needs of those attending a course of instruction in experimental psychology. There have been books on psychology written on an experimental basis which have differed little, if at all, from others not so characterised, and there have been handbooks for the laboratory, notably that of Titchener, but there has been no book which attempted to give in reasonable compass a general account of experimental methods and of the results which have been gained by the experimental movement in psychology. Such a book was needed for two classes of persons, for those definitely committed to the study of the subject, and for the large class of people who know that experimental psychology exists but do not know what it means.

It may be said at once that for each Prof. Myers's book will be of the greatest service. It gives a concise and yet clear account of what has been done by means of experiment in psychology, and it is surprising to find so vast an amount of information in a book of the size. At the same time, there has been admirable judgment in the selection of the material and in the discussion of the many thorny topics in which the science at present abounds. The only fault to be found is that its conciseness will make it difficult for the beginner, but this has been anticipated by the author, who has distinguished the more difficult parts by means of brackets to indicate that they should be left by the beginner for a second reading. Further, the last eighty pages are devoted to an illustrated description of laboratory exercises, and the performance of these will go far to remove any difficulty due to the conciseness of the main body of the text.

To pass to detail, the earlier chapters are devoted to the senses, and those on hearing are especially full. There is no other book in which a summary of the very important researches of recent years on this subject can be found. The accounts of the psychophysical and statistical methods, given under these titles and in the chapter on identity and difference, are admirably clear, though, perhaps, not enough stress has been laid on the use of the psychophysical methods for purposes other than threshold determination. These methods were devised with the idea that by their means sensation and other psychical states might be measured. They are, however, coming to be used more and more for the exact comparison of the effects of different conditions on mental processes in which there is no question of the actual determination of a threshold, either absolute or differential, and the attention of the student might have been more forcibly directed to this aspect of the use of the methods.

The subject of memory is very fully treated, it might be thought a little out of due proportion. The space devoted to it is, however, fully justified, for we have in this branch of the subject what is, perhaps, the greatest achievement of the experimental method in pure psychology apart from those advances which are rather physiological than psychological.

In a short chapter on muscular and mental work an excellent account is given of modes of research which are now taking a very important place in applied psychology and especially in pedagogy, and the author rightly insists on the difference between the mental work of laboratory methods and that of ordinary life. There is at present a great danger that the value of this line of work will suffer depreciation owing to premature application to practical problems. The last two chapters chiefly serve to show how little the experimental method has so far accomplished in the study of such subjects as attention and feeling.

It is to be regretted that want of space has not allowed the author to deal with the comparative and pathological sides of psychology so far as these can be studied by the methods of experimental psychology. The result of the perusal of this book, in which the accomplishments of the science have been so ably portrayed, is to confirm an impression that the experimental study of the developed mind will not take us very far, and that it is in the study of the developing mind and of the dissociations and destructions produced by disease that there lies the chief prospect of advance. It is to be hoped that the author will be able to deal with these subjects, either in another book or in a future expansion of the present volume.

Although this country has been very late in recognising the experimental movement in psychology, the subject has at last succeeded in making a position for itself, and its existence is recognised in the chief universities of England and Scotland. Its further progress will certainly be assisted by this able account of the methods and accomplishments of the science.

SPEECH.

The Science of Speech, an Elementary Manual of English Phonetics for Teachers. By Benjamin Dumville. Pp. xii+207. (Cambridge: University Tutorial Press, Ltd., 1909.) Price 2s. 6d.

THIS is a concise, accurate, and interesting little manual, written by one who is evidently a master of the subject of phonetics, and knows how to communicate information. Nowhere have we seen so good an account of the muscular movements and the positions of the articulating apparatus. The book is intended for teachers, who often, in these days, are required to teach the elements of phonetics, or, at all events, to train children in the art of correct pronunciation and good reading. It is not a book to be read hastily. It requires a careful experimental study of the movements described, with the aid of a mirror, but the descriptions are so clear and the methods so simple and convincing that the accurate knowledge acquired will well repay all the trouble. The nature of vowels, consonants, diphthongs, digraphs, the distinction between voice and whispering, the various kinds of whispers, and the nature of the aspirate are fully explained.

There is an interesting chapter on the sounds in connected speech, such as accent, emphasis, intonation, assimilation, and variations in pitch. The author, perhaps, scarcely attaches the importance to pitch, or rather to variations in pitch in the words or syllables of a spoken sentence, which we are inclined to do, and which is brought out in a striking way when the vibrations of the sounds of a sentence are recorded on a rapidly moving surface. We are much interested in the chapter on "The Organic Basis of English," which must appeal to physiologists, the point being that, by repetition, during the early period when speech is acquired, a kind of habit is imposed on the articulating organs, and, we would add, on the nerve centres involved; this will be determined by the sounds the child imitates, or is taught to pronounce. There will thus be a kind of organic habit for each language, a consideration that may explain how difficult it is for one trained from early days in the English language to acquire, in later life, the true intonation of good French. The author gives a striking illustration, p. 141, of the difference between the English *t* and its French equivalent, so that an Englishman uttering the sentence *Ton thé t'a-t-il ôté ta toux?* (Has your tea taken away your cough?) would probably not give the *t* the peculiar softness or quality that can only be obtained by pronouncing the *t*, as the French do, by starting with the tip of the tongue from the back of the front teeth, instead of a little behind, as is done in English speech (see Fig. 27).

The last two chapters deal with spelling reform and with the important pædagogic question of whether a phonetic training is helpful to children who are learning to read. We will not follow the author here, but be content with stating that he presents his arguments forcibly but with fairness. Children must at first be taught by the ear alone, and by frequent repetition; sounds that are distinctly bad, like the peculiar tone of many resident in London or in the south, or the nasal drawl of the west of Scotland, must be got rid of; and the ear of the child must hear, at all events during school hours, the tones of pure English. In not a few cases, probably, the work of the teacher may be undone by the sounds of the child's home. The author refers briefly to the use of the phonograph. The intonation of the gramophone is far superior, and we would advise that the Gramophone Company should be induced to take, say, a dozen records from highly trained and correct voices, illustrating the tones of pure and undefiled English. These would be of immense service to teachers. The Gramophone Company has a record of the voice of the late Canon Fleming, uttering some of the prayers in the Morning Service of the Church of England, which fully illustrates what we mean.

It is a pity that a better set of symbols for phonetic speech sounds has not been invented. Some are very grotesque, but, still worse, with a weak eyesight, some of the symbols are difficult to discriminate. The symbols of Graham Bell seem to us to be better than those mostly in vogue, and it is only right to mention that these are used by so high an authority as Mr. Sweet in his "Primer of Phonetics." Mr. Dumville is to be congratulated on having produced an excellent book on what is truly the *science* of speech.

John G. McKendrick.

A TEXT-BOOK OF OTOLOGY.

Lehrbuch der Ohrenheilkunde für Ärzte und Studierende. By Dr. Paul Ostmann. Pp. viii+533. (Leipzig: Verlag von F. C. W. Vogel, 1909.) Price 18 marks.

THE name of Dr. Paul Ostmann is well known to otologists, not only in Europe, but in the British Islands and the United States. A text-book upon diseases of the ear from his pen is, therefore, welcome, even though it be disappointing. Like all text-books which hail from the German Empire, however, it is marked by that peculiar German conceit which, whilst giving ample prominence to the work of compatriots, ignores, or, at the most, dismisses with curt comment, that of equally prominent scientific labourers of other countries. Dr. Paul Ostmann's text-book abounds with references to German aural surgeons, but in all its 533 pages only some seventeen British or American otologists receive mention, and the names of some of these are spelled incorrectly. Picking out, from motives of curiosity, the names quoted from among those surgeons who belong to our own country, we find that Handfield Jones, Toynbee, Hinton, Ogston, Macewen, Walker Downie, Dundas Grant, and Yearsley alone receive acknowledgment for their work, whilst Cheatle, Pritchard, Barr, and many other names of equal lustre in the domain of diseases of the ear are ignored completely. In a work issued at the present time, when so much that is of lasting value has been done for the advancement of otology, one expects to find mention at least of that which fairly may be described as epoch-making. Yet the pioneer work of Lake, Marriage, Armour, and Yearsley in operations upon the labyrinth for the relief of distressing and incurable vertigo and tinnitus receives no attention, whilst the still more recent researches of Bárány are barely noticed, and those of West, Scott, Crum-Brown, and Alexander are passed over in silence.

For the work as a text-book we can speak with moderate approbation. There is no dissertation upon anatomy to swell the book, but the author plunges straightway into methods of examination and diagnosis. This portion is not too much padded with unnecessary pictures of instruments, and the diagrams are adequate, with the exception of Fig. 13, which is exaggerated and wholly unnatural. A considerable number of pages is devoted to the functional testing of the ears, and this appears to be treated very fully and exhaustively. In dealing with anomalies of the hearing, a series of useful charts is given from actual cases. In treating of the various diseases of and operations upon the ear, we can find no mention of the use of the hand-gouge in place of the chisel and mallet in performing operations upon the mastoid, an improvement in technique which we owe to British surgery. We fully approve of the classification of otosclerosis with diseases of the bony labyrinthine capsule. This is a distinct advance upon those text-books which continue to describe it as a middle-ear condition.

An excellent section deals with the effects of general diseases upon the ear, and another is devoted to the toxic effects of quinine, the salicylates, iodide of potassium, arsenic, aspirin, chloroform, tobacco, alcohol, mercury, silver, carbon dioxide, and phosphorus. Sections such as these are so rarely met with in the works of specialists that they deserve unstinted praise.

It is disappointing to find so important a subject as deaf-mutism dismissed in four pages.

The volume is an average text-book, and deals with its subject in an average manner, but it does not add markedly to the now voluminous literature of otology. As a guide for the student and junior practitioner, it will, no doubt, find a useful place.

OUR BOOK SHELF.

Zenographical Fragments, II. The Motions and Changes of the Markings on Jupiter in 1888. By A. Stanley Williams. Pp. xiii+104; 9 plates. (London: Taylor and Francis, 1909.)

MR. WILLIAMS has been known for about thirty years as a very painstaking planetary observer, and, considering the small sizes of his telescopes ($5\frac{1}{4}$-inch and $6\frac{1}{2}$-inch reflectors), his results have been remarkable in their comprehensiveness and importance. To Jupiter especially Mr. Williams has devoted attention, and, as a continuation or supplement to the "Zenographic Fragments" which he published twenty years ago, and dealing with his observations in 1887, has now issued a similar contribution for 1888. The individually observed transits of the various spots are given, and the periods of rotation are derived and compared with the results of 1887 and subsequent years. In 1888 the number of spots followed with sufficient fulness and accuracy to enable their rotation period to be well determined was 76. Of these, 48 were equatorial markings, and 15 were north tropical spots. The power used on the telescope was 150, and consisted of a single plano-convex lens. The planet was badly situated for observation, its meridian altitude only slightly exceeding 20° even in the south of England.

Notwithstanding the difficulties encountered, however, Mr. Williams succeeded in securing a mass of useful observations, the number of spot-transits recorded being 888. These are carefully discussed, and the results presented in a series of tables. The rotation periods deduced during the opposition of 1888 are included with many others by Mr. Williams and other observers in later years in summaries exhibiting the changes of relative velocity from year to year. It is by comparisons of this character extending over a long period of time that we may hope finally to unravel the problem offered by the changing scenery of Jupiter's vaporous envelope and by the remarkable series of different currents circulating in various latitudes. A number of painstaking observers, including Mr. Williams, Prof. Hough, Major Molesworth, Rev. T. E. R. Phillips, Mr. Bolton, and others, have accumulated extensive materials, to this end, during the past quarter of a century, but much more remains to be done.

The comparisons which Mr. Williams has instituted at the end of his volume are not so valuable as they might have been in consequence of omissions in quoting the results of various observers. Thus, in the table of rotations of spots in the south equatorial current, Mr. Phillips's values for 1898 and 1906–7 are given, but similar figures for the intervening years are not mentioned at all. Similarly the writer's rotation periods for 1905–6 (*Monthly Notices*, vol. lxvi., p. 434) are altogether omitted. On the whole, however, Mr. Williams's new contribution to zenographic study is very valuable and ably executed. There are few typographical errors, and the volume is well got up, while the illustrations are excellent, though the differences between the light and dark markings are intensified, perhaps purposely, to assist the eye in noting the details more readily.

W. F. D.

Introduzioni Teoriche ad Alcuni Esercizi Pratici di Fisica. By Alfonso Sella. Edited by A. Pochettino and F. Piola. Pp. viii+133. (Firenze: Successori Le Monnier, 1909.) Price 2.50 lire.

THIS is a short treatise on a few selected subjects of practical physics. They comprise the testing of a balance and calibration of a thermometer tube, the measurement of specific heat by the method of mixtures, the determination of the constants of a ruled grating, the measurement of magnetic field-intensity and its horizontal component, and the use of the Wheatstone bridge and the quadrant electrometer. The various problems involved are treated very fully, but in a purely theoretical manner, evidently intended to point out to the instructor the difficulties and limitations likely to be encountered. Thus, in the determination of a magnetic field, the lack of uniformity is dealt with at exceptional length, and the mathematical reasoning is given in full at every step. In the measurement of the magnetic quantities M and H, account is taken of such sources of error as the rigidity of the suspending fibre, and the variation of the magnetic moment and the moment of inertia with the temperature. In adding the dimensional equations, the author unfortunately adheres to the old practice of expressing them in terms of M, L, and T only. That $M/H = L^3$ (*recte* L^5) implies that it has something to do with a volume, but conveys no information concerning the physical constitution of the quantities in question.

The whole of the work dealt with belongs to the second term of the physics course in the University of Rome. The author compiled it while yet Prof. Blaserna's assistant. His untimely death after succeeding to the chair prevented him from publishing it himself, but that duty has been admirably carried through by his two able disciples.

Azimuth. By G. L. Hosmer. Pp. v+73. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 4s. 6d. net.

This work is avowedly not a text-book; it is a handbook for the practical surveyor, and, as such, should prove very useful. Prof. Hosmer gives just the ordinary methods for checking the angles of a survey by observation of the sun and stars, but the book is removed from the commonplace by the conciseness of its instructions and the numerous practical hints given at all the necessary points. The tables for computing the results are given in the latter part of the book, and the examples are worked out on specimen forms calculated to obviate clerical errors.

The book is nicely printed, illustrated with useful diagrams, and well bound. These features, combined with its handy size, make it a very useful work for the practical surveyor to carry with him as a pocket-book for easy reference. 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.*]

Notes on a Stone Circle in County Cork.

In view of several references made in NATURE lately to stone circles in Ireland (vol. lxxix., p. 488, February 25), the following notes on one situated at Drumbeg, near Glandore, County Cork, may prove of interest, especially as this circle contains the characteristic "recumbent stone" of the "Aberdeenshire" type in the south-western half of its circumference, a feature not hitherto met with outside that locality.

Drumbeg Circle. Recumbent stone and supporters, viewed from centre of circle, showing notch in hills (solstitial sunset line).

The accompanying photograph shows this stone and its supporters, of which the following dimensions may be given:—recumbent stone, 7 feet long, 1 foot 8 inches deep, 2 feet 6 inches high; right supporter, 4 feet 8 inches high, 1 foot 9 inches deep, 3 feet wide; left supporter, 5 feet high, 1 foot 6 inches deep, 3 feet wide.

The circle stands on a hill-side facing the sea, upon an artificial plateau with a well-defined edge, 160 feet long, on the southern (seaward) side. This edge, otherwise straight, is indented by a "cove" 20 feet in length, directed towards the centre of the circle, which it almost touches externally on its southern side.

A row of four small ovals, and mounds of stones (probably burial-sites), lie in a line a short way outside the plateau to the south-eastward. The remains of (?) a hut-circle of rough stones occur at a distance of 170 feet westward from the main circle, and there is a large solitary outlying boulder situated on a small eminence 100 feet to the north-eastward.

The following astronomical features (sight-lines) are observable in the above remains:—

(1) From the recumbent stone; solstitial summer sunrise over one of the two most important stones of the circle; sky-line elevated 3° 40′. (This line passes almost over the outlying boulder.)

(2) From the same position, May sunrise over the second of the two important stones; hill-line elevated 2° 20′.

(3) From same position (or from centre of circle, see photograph), solstitial winter sunset over a conspicuous gap in the hills, distant one mile.

(4) Edge of the plateau lies in the line of May sunrise or November sunset.

(5) Side of the cove is directed to the solstitial summer sunset over centre of circle, nearly.

(6) Line of stone ovals, outside plateau, is practically that of May-sunrise.

(7) From centre of (?) hut circle, over the northernmost stone of circle (a slab with a rounded profile, thus differing from the remainder, which are of "pillar" form), to the outlying boulder, is the May-sunrise line.

There are no indications of a burial-mound in the centre of the circle. BOYLE T. SOMERVILLE.

Admiralty Survey Office, Tenby, S. Wales.

Musical Sands in Chile.

The interesting letter of Mr. Carus-Wilson, dealing with the existence of musical sands, suggests to me that some fact in my experience relating to this subject may be worth putting on record, and may, through the courtesy of your columns, possibly lead to the elucidation of an occurrence which has hitherto lacked explanation, at least in my mind.

Some few miles to the west of the town of Copiapo, in Chile, and, so far as my recollection of the locality carries me, about half a mile to the southward of the railway line, there is a tailing off of a ragged hill-range, which runs about north and south. In a ravine—it is too small to be called a valley—the sand which covers the greater part of that portion of Chile has, blown doubtless by the sea-breeze, been carried up the gully to which I refer, and lies there at a slope equal to the flowing angle of dry sand. The place is locally known by the name of "El Punto del Diabolo," as, given conditions of wind and weather, which time did not allow me to study, a low moaning sound, varying in intensity, can be heard for quite a quarter of a mile away. Amongst the superstitious natives the place is avoided. Thinking it worth a visit, I went there with the late Mr. Edwards, who was then the British Consul in that district. On our arrival we found that the sands were quite silent, but on making a glissade down the slope a gradually increasing "rumble" was heard, which increased in volume as the sand slid away before us. As the sound increased we were subjected to an undulatory movement, so decided that it was difficult to keep one's balance, and as we both had heard that this sand had swept over an old silver mine, there was a clear impression on the minds of both that the vibration might break in the roof of the old workings. I write of this experience for what it is worth. I do not know whether the ground under the sand was hollow or solid, and although I have ventured to theorise on the subject, as yet I have found no satisfactory solution of this, to me, quite unique experience. M. H. GRAY.

Lessness Park, Abbey Wood, Kent.

The Æther of Space.

As one who has read with the greatest appreciation the work recently written by Sir Oliver Lodge on this subject, I take it that the following statements represent fairly well the condition of scientific opinion at the present time:—

(1) The fundamental units of which matter is composed are probably individualised regions of the universal æther, neither condensations nor rarefactions, but distinguished by some kinetic structure from the unmodified æther surrounding them.

(2) The æther, as a whole, is stationary, there being nothing of the nature of æther currents, but it possesses an exceedingly fine-grained circulation in closed curves, its elasticity being of kinetic origin.

(3) So far as the motion of a mass of matter is concerned, there is no ætherial viscosity, and, consequently, the earth carries no æther with it in its motion. We therefore live in an æther stream due solely to the earth's motion in space, and having the full value due to its velocity, the failure of Prof. Michelson's delicate experiment being due to a lessened cohesion (of electromagnetic origin) in any length of matter carried at right angles to the æther stream.

The question arises as to whether the æther which forms any mass of moving matter remains the same. Assuming the above statements, there appear to be two alternatives. Either the æther, distinguished by special structure, which composes the ultimate units of which matter is built up, has a bodily transfer through space, or the æther in the line of approach must be rapidly caught up in the advancing vortices (or whatever the structure may be), fused into their being, and as rapidly liberated along the line of recession.

If the former supposition be correct, there must be a region of slip in the æther surrounding the ultimate units (electrons); if the latter, we have the very interesting conception of matter being incessantly made and unmade as regards its fundamental units with a speed proportional to the velocity of motion. All the physical properties of a given mass of matter would remain constant, while the æther, the substratum of its existence, was changing.

If this reasoning be not in error, I shall be glad if Sir Oliver Lodge or any other physicist will indicate which of these views obtains acceptance.

CHARLES W. RAFFETY.

Wynnstay, Woodcote Valley Road, Purley, Surrey, July 15.

Botanical Surveys.

REFERRING to the review, in NATURE of July 15, of Mr. F. Morey's "Guide to the Natural History of the Isle of Wight," in which it is suggested that the Isle of Wight affords wide scope for a botanical survey on the lines followed by Dr. W. G. Smith and his school of plant-ecologists, it may be of interest to the reviewer and others to state that already the primary survey of the district has been completed and maps made by the writer, in association with the Central Committee for the Study of British Vegetation.

As suggested by "F. C.," a bare species list, even if complete, can do but scant justice to the variety of the vegetation of the Isle. Though in some types it is second in interest to the opposite mainland of South Hampshire, as, for example, in the calcareous grasslands and dry and wet heathlands, yet the almost full development of maritime associations and the diversity of the woodland formations do much to restore the balance.

The island has been under a long-continued civilisation, yet there still remain, almost untouched by man, several station-associations which, according to the plan of Prof. Conwentz, would be among the first to be scheduled as "natural monuments." In this last respect the island is but typical of much of Britain, and the regret expressed by your reviewer that the makers of county floras are not animated even by the spirit of Baker's "North Yorkshire" is shared by all who know the standing of British plant-ecology. To such it is sad that the period which saw the publication of Wheldon and Wilson's "West Lancashire" saw also the publication of the arid lists of many of the Victoria county histories, as of Lancashire itself. W. MUNN RANKIN.

Storey Institute, Lancaster, July 19.

The *Acarus Crossii*.

SOME months ago (NATURE, February 4) a correspondent directed attention to the account of Crosse's remarkable experiences when experimenting with electric currents, and the appearance of quantities of an acarus in the solutions treated, as fully narrated in Chambers's "Vestiges of the Footsteps of Creation," and the question was asked whether any explanation of such strange phenomena had ever been heard of. No reply seems to have been made, and, presumably, no recent attempts to investigate the mystery have taken place. It may be of interest to note that Chambers's account is fully corroborated in the "National Dictionary of Biography," and it appears that Crosse, though he did not make any suggestions as to "spontaneous generation," but merely related the facts and left explanations to others, found himself the victim of such a shower of abuse that he thenceforth entirely abandoned all research work and retired into obscurity. His experiments would probably have been forgotten but that they were repeated with complete success by another worker. Considering how much more easily prolonged electric action can nowadays be applied, would it not be well if someone would have the patience to repeat once more the exact conditions so amply described by Chambers, and so, if possible, clear up what is undoubtedly a very mysterious occurrence? CHARLES E. BENHAM.

28 Wellesley Road, Colchester, July 7.

Barisàl Guns in Australia.

IN NATURE of June 4, 1908 (vol. lxxviii., p. 101), under the title of "Barisàl Guns in Western Australia," you published a note from me describing a peculiar, loud detonation heard by my companions and myself while on the Strelley River, in the north-west of Australia. In reading Captain Sturt's "Two Expeditions into the Interior of Southern Australia during the Years 1828, 1829, 1830, and 1831," I find that, when camped on the newly discovered Darling River, near what is now the town of Bourke, in New South Wales, in February, 1829, a very similar sound was heard by the explorers. Sturt's words are as follows:—"About 3 p.m. on the 7th Mr. Hume and I were occupied tracing the chart upon the ground. The day had been remarkably fine, not a cloud was there in the heavens, nor a breath of air to be felt. On a sudden we heard what seemed to be the report of a gun fired at the distance of between five and six miles. It was not the hollow sound of an earthly explosion, or the sharp cracking noise of falling timber, but in every way resembled a discharge of a heavy piece of ordnance. On this all were agreed, but no one was certain whence the sound proceeded. Both Mr. Hume and myself had been too attentive to our occupation to form a satisfactory opinion; but we both thought it came from the N.W. I sent one of the men immediately up a tree, but he could observe nothing unusual. The country around him appeared to be equally flat on all sides, and to be thickly wooded: whatever occasioned the report, it made a strong impression on all of us; and to this day, the singularity of such a sound, in such a situation, is a matter of mystery to me" (2nd edition, 1834, vol. i., p. 98).

J. BURTON CLELAND.

Bureau of Microbiology, Sydney, New South Wales, June 19.

THE STONE CIRCLES OF KESWICK AND LONG MEG.[1]

IT has frequently been shown that the site on which a stone circle was erected was chosen with reference to the elevation of the northern horizon. At Keswick and Long Meg it appears that a further choice was exercised, in that, when possible, natural features were utilised in place of outlying stones or circles. In each case Arcturus rose in a well defined gap between two hills, whilst at Keswick, where the Pleiades were used for the May warning, the alignment passes over the crest of Great Mell Fell.

At Keswick the circle consists of thirty-eight unhewn stones with an internal diameter of about 50 feet. The rectangle or chapel involves ten additional stones, and there is a single outlying stone. These are all shown on the plan accompanying the paper, those which appear to have fallen being indicated by cross-hatching. The stones range from 2 to 7 feet in height.

As the result of a preliminary survey, the following alignments were carefully measured:—

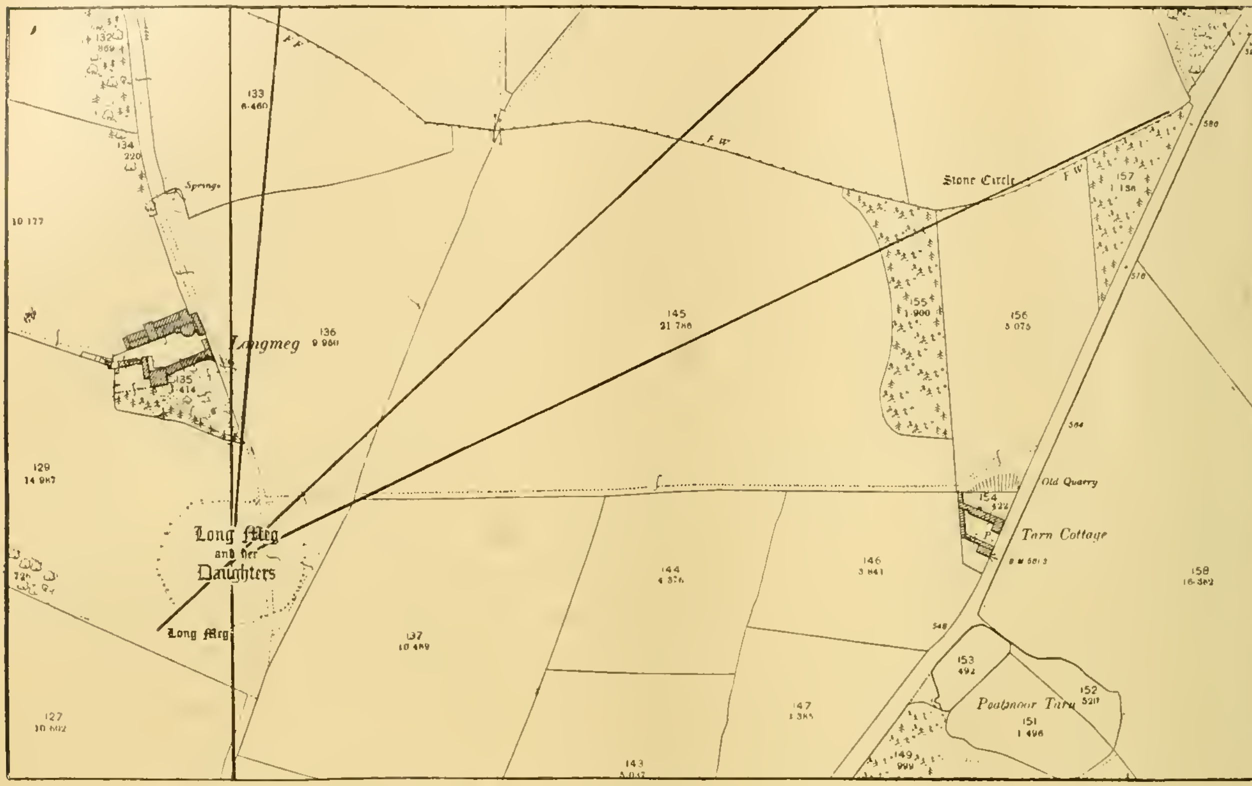

FIG. 1.—Portion of Ordnance Map—Long Meg. From the Proceedings of the University of Durham Philosophical Society.

(1) From the centre of the circle over the tip of the pointed stone, No. 1, to the gap on the horizon between Blencathra (Saddleback) and Skiddaw; (2) from the eccentric centre along the centre line of the chapel, over the tip of the pointed stone, No. 10, to the crest of Great Mell Fell; (3) from the outlying stone to the centre of the circle, proceeding along the valley of the Greta.

FIG. 2.—The Chapel or Rectangle, Keswick Circle. From the Proceedings of the University of Durham Philosophical Society.

The observed altitudes and azimuths and the calculated declinations are given in Table I.

[1] Abstract of a paper on "Sun and Star Observations at the Stone Circles of Keswick and Long Meg," by Dr. John Morrow (Proceedings of the University of Durham Philosophical Society, vol. iii., part iii, 1908–9).

Table I.—*Keswick Circle* (*Lat.* 54° 36′).

Alignment	Altitude	Azimuth E. of N.	Decl. N.	Object
Circle to Gap (Saddleback-Skiddaw)	2° 38′	8° 25½′	37° 19′	Arcturus rising.
Centre line of chapel to Great Mell Fell	1 42	79 38½	7 6	Pleiades rising.
Outlying stone to centre of circle	−0 29	64 45½	13 25	May and August Sun.

The Pleiades and Arcturus were the warning stars for the May and August festivals respectively. Of these, the Arcturus alignment is the better preserved, and this gives the date of erection of the circle as about 1400 B.C.

The stones known as "Long Meg and her Daughters" are in the neighbourhood of Little Salkeld, a few miles from Langwalby. There are sixty-eight stones in the circle, and at least one other is buried. The 25-inch Ordnance map gives a fairly accurate plan. The diameters are about 350 feet in an east and west direction, and 305 feet north and south.

Between six and seven hundred yards to the north-east there is a small circle of some 15 feet diameter composed of eleven good-sized stones.

The only shaped stone, Long Meg, is to the south-west of the main circle. It is more than 12 feet in height, and is deeply notched at the top.

The alignments taken were:—

(1) From the centre of the large circle, over a stone which is now recumbent, to a well defined gap on Newbeggin Fell (the only well defined gap on the horizon); (2) from the centre of the large circle to that of the small outlying circle; (3) from Long Meg to the centre of the large circle.

These are dealt with in Table II., and we here also get the date from the Arcturus alignment. This date is 1130 B.C., showing that Long Meg was probably erected after the Keswick circle had fallen into disuse.

Table II.—*Long Meg* (*Lat.* 54° 43′ 20″).

Alignment	Altitude	Azimuth E. of N.	Decl. N.	Object
Circle to Gap (Newbeggin Fell)	1° 11′ 20″	4° 52′ 20″	35° 36′ 35″	Arcturus rising.
Large circle to small circle	3 12 0	64 24 40	16 44 35	May and August Sun.
Long Meg to centre of large circle ...	2 40 0	49 37 20	23 53 40	Summer solstice.

Fuller descriptions of the circles, and details of the alignments and the degrees of accuracy to be expected, are given in the original paper in the Proceedings of the University of Durham Philosophical Society. An appendix contains the results of a geological examination of the stones made by Dr. Woolacott. These circles are now brought into line with, and render an additional verification (if such were needed) of, the theories first formulated by Sir Norman Lockyer.

THE FLORA OF SOUTH AFRICA.[1]

While ostensibly forming a part of the scientific results of the *Valdivia* expedition of 1898–9, the present volume is in reality much more than this. Indeed, it represents the results of many years of work and experience of the flora of South Africa. For an account of this flora, the editor of these memoirs has been singularly fortunate in securing the cooperation of Dr. Marloth. The author has given to botanists an excellent and comprehensive survey, which for many years must form a standard reference work on the plant-geography of South Africa. The volume contains a full historical summary of the work of previous investigators and travellers, adds much that is new, and supplies a series of vivid descriptions of the peculiar vegetation of this quarter of the globe.

After giving an account (accompanied by a series of maps) of the various floral regions as suggested by earlier plant-geographers, the author proposes a scheme of his own. This resembles, on the whole, that proposed by Dr. Bolus in 1905, but differs in several essentials from any previous scheme. The following are the larger divisions now suggested:—

(A) The Cape Province of the South-west.

(B) The Southern Palæo-tropical Provinces, which include:—

(1) The grass steppes of Rhodesia, the Northern Transvaal, part of Natal, &c.

(2) The South-eastern Littoral.

(3) The forests of the South Coast.

(4) The Central Region, including the Karroo, the Karroid uplands, and Little Namaqualand.

(5) The Western Littoral.

The essential differences between Dr. Marloth's scheme and earlier ones consist in (*a*) the more accurate delimitation of the Cape Province, (*b*) the separation of the forest region of the South Coast from the Cape Province, and (*c*) the smaller subdivisions which he proposes for the above provinces. Though brief descriptions are given of the others, the only regions treated in detail in this volume are the Cape Province, the South Coast forests, and the Central Region. Each of these may now be briefly noticed.

The Cape Province.—The peculiar systematic character of the Cape flora is, of course, well known. It is exceedingly rich in species, many of which have a very limited range, and includes numerous endemic forms of the orders Proteaceæ, Thymelæaceæ, Ericaceæ, Restionaceæ, &c. The dominant vegetation is a "Macchia," composed of sclerophyllous evergreen shrubs, with small, entire, xerophytic leaves. Mixed with the shrubs, but subordinate to them, are many xerophytic dicotyledonous herbs, together with bulbous and succulent monocotyledons, and many Restionaceæ. This Macchia (see Fig. 1), which somewhat resembles that of the Mediterranean region, forms the real climatic type of vegetation of the Cape region. Other ecological types, *e.g.* those found in marshes, or on rocky ground, sand dunes, &c., are due to local edaphic influences. The Macchia is typical only where the original vegetation has not been destroyed, and Dr. Marloth is of opinion that if the land were freed from the influence of bush fires and of grazing herds of domestic animals, in fifty years' time it would become entirely covered with a dense, impenetrable Macchia.

Dr. Marloth has explored many of the mountains outside the area of the Cape Province proper, and finds that outliers of the Cape flora occur as "islands" on the higher mountain ridges, both in the Karroo and also in Little Namaqualand. The occurrence of these Cape "islands" is, he considers, largely due to the fact that the ridges are sufficiently high to experience the effects of the rainy south-east winds. Their climate thus more nearly resembles that of the Cape than that of the dry desert plains below them. Besides this, wherever edaphic and other factors permit, there is a reciprocal invasion between Cape and Karroid forms. For instance, even those parts of the Cape region which have the greatest rainfall are not entirely devoid of succulent immigrants from the Karroo. Comparatively few succulents, however, can survive the effects of an exceptionally rainy winter.

[1] "Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer *Valdivia*, 1898–1899." Edited by Prof. Carl Chun. Zweiter Band, Dritter Teil. Das Kapland, insonderheit das Reich der Kapflora, das Waldgebiet und die Karroo, pflanzengeographisch dargestellt. By Rudolf Marloth. Pp. 436; with 20 plates and 8 maps. (Jena: Gustav Fischer, 1908.) Prices 100 marks and 81.50 marks.

The Forests of the South Coast.—Though formerly more extensive, the true forests of South Africa are now practically confined to a small strip of coast-land in the Knysna district. Floristically, the Knysna forests are so distinct from the Cape Province that Dr. Marloth has classed them (for the first time) as a separate region. In this district, where the annual rainfall amounts to some 36 inches, the woodland has all the characters of a typical temperate rain-forest. Epiphytes are common, and lianes are not infrequent. Westwards the forests become more dwarfed, and finally pass into the Macchia of the Cape Province.

The Central Region.—Passing northwards from the South Coast the rainfall rapidly diminishes, and in consequence the country becomes increasingly arid and desert-like. Thus the Central Province (including the Karroo, the Karroid uplands, and Little Namaqualand) forms a vast area, over which semi-desert conditions prevail. But the only true desert in South Africa is the narrow strip of coast-line known as the Western Littoral. Elsewhere, the streams arising in the mountains somewhat lessen the severity of the conditions, and even in the "Gouph" we can only speak of a stony semi-desert. The term "Gouph," a word of Hottentot origin, signifying barren, empty, void, is employed to denote the most arid and desert-like part of the central Karroo. The vegetation, for the most part, consists of dwarfed, rounded shrubs, with reduced, often ericoid leaves, and numerous succulent herbs scattered between the shrubs. Here and there, one or the other type of plant is so dominant as to render it possible to distinguish a succulent steppe from a dwarf-shrub steppe, but in general they are mixed. Eastwards the Karroo passes into grass steppes, and to the south and west into the richer vegetation of the Cape Province.

The Karroid uplands, which occupy large tracts of the northern part of Cape Colony, are still comparatively little known botanically, except from the collections of Thunberg, Lichtenstein, and Burchall, made more than a hundred years ago. In fact, according to Dr. Marloth, many parts of this region have never yet been visited by botanists.

Ecology.—The chief value of Dr. Marloth's work is on the floristic side of plant geography. He has travelled extensively, and, although many parts of South Africa are still incompletely known botanically, he has considerably advanced our knowledge of plant distribution in this part of the world. But, in addition to this, Dr. Marloth has not lost sight of the ecological point of view. Throughout the work the dependence of vegetation on rainfall (which is nowhere better seen than in South Africa) is emphasised, and rainfall and temperature tables are introduced wherever possible. One very interesting point brought out is the importance, especially at higher altitudes, of moisture deposited on the vegetation from the thick clouds which so often cover and obscure the mountain tops. An apparatus for collecting the moisture precipitated from clouds has been employed on Table Mountain. On one occasion, during a period of six days, this instrument registered a precipitation of 152 mm., while an adjacent rain-gauge only recorded an actual rainfall of 4 mm. The author devotes a special section of more than fifty pages to the "General Ecology of South African Plants." Under this heading are discussed the various growth-forms found in different plant formations, such as annuals,

FIG. 1.—Macchia from the North side of Table Mountain, showing Protea, Leucadendron, Brunia, &c. Reproduced from "Das Kapland," by Dr. R. Marloth.

tuberous and bulbous plants, shrubs, &c. Epiphytes (as is to be expected in a climate of such general dryness) are few, but parasitic phanerogams are abundant. A good deal of attention is paid to the various contrivances for storing water and reducing transpiration. Other matters discussed are insects and birds as agents of pollination, the influence of wind, light, &c. Several curious instances are adduced, especially in the genus Mesembrianthemum, of so-called protective resemblance. Though supposed cases of mimicry in the plant kingdom should be received with caution, it must be admitted that the resemblance, both in colour and form, between some of these curious plants and the stones and rocks amongst which they grow is exceedingly striking.

The closing chapters of the volume are occupied by a useful discussion on the affinities and origin of the South African flora in general, and that of the Cape Province in particular. The older theories of Hooker and Wallace, as well as those of later authors, to account for the resemblances between the floras of South Africa, Australia, and temperate South America, are given at some length, and discussed in the light of what is known of geological and climatic changes since the Cretaceous period.

Not the least interesting feature of the volume is a series of short, posthumous sketches of the vegetation of various districts, by the late Prof. A. F. W. Schimper, who was botanist to the *Valdivia* expedition. These sketches, which are marked by Prof. Schimper's usual lucidity, supplement Dr. Marloth's descriptions in many respects.

On p. 188 is a photograph, taken in the Knysna forest district, in which both Prof. Schimper and Dr. Marloth appear. The latter, however, with characteristic modesty, has omitted his own name from the description of the figure. The volume is copiously illustrated by line drawings and photographs. Some of the latter take the form of particularly beautiful heliogravures. There are also a number of useful maps, illustrating the rainfall, geology, and phytogeographical regions of South Africa. Karte 6 would be improved by a clearer method of indicating the regional boundaries.

To sum up, the work presents a most useful account of the present position of geographical botany in South Africa. Its very limitations, particularly in the ecological sections, afford a graphic indication of the enormous (and in many directions practically untouched) field which awaits future investigators.

R. H. Y.

PALÆOLITHIC MAN.[1]

RECENT discoveries have filled up to a great extent the gaps in our knowledge of Palæolithic man. The skeleton find in the lower grotto of Le Moustier (Dordogne) in the main confirms Klaatsch's conclusions, based on a comparison of the face-skeleton of the Neanderthal race with that of the present Australians. *Homo mousteriensis* belongs to the older Diluvial race, that is, to the Neanderthal type, not to *Homo sapiens* found in more recent Diluvium. The subject was about sixteen years old probably a male. That *Homo mousteriensis* belongs to the Neanderthal type is further shown by the character of the femur and radius (of which the length is estimated at 195 mm., while the upper arm measures 210 mm.). The Neanderthal race had short extremities, in which fact Klaatsch sees an approximation to the present Arctic races of Mongoloid relationship.

[1] "Recently discovered Fossil Human Remains and their Bearing upon the History of the Human Race," by Moritz Alsberg (*Globus*, vol. xcv., No. 17, May 6, 1909).

Mention must also be made of the extraordinarily massive proportions of the absolutely chinless lower jaw. The knobs on the backs of the incisors recall the Krapina find. All the upper front teeth have much curved roots adapted to the round arching of the upper jaw-bone.

The position of the skeleton at Le Moustier, like that of the find at Grimaldi, proved that Diluvial man buried his dead with care. The posture is that of sleep, with the face turned to the right, and the right arm under the head, which was surrounded by flint flakes. Beside the skeleton were found, in addition to flint implements of the Mousterian type, some of the Acheulean type, among them a splendidly worked "hand-wedge." A mark on the right femur is traceable to burning, but there is no sign of the cannibalism ascribed by Kramberger to Krapina man.

Another important find in France is that of a male skeleton, brought to light by the Abbés A. and J. Bouyssonie and Bardon near La Chapelle-aux-Saints (Corrèze), in an absolutely undisturbed archæological stratum. The subject is an old man of about 1·60 m. in height. The skull is actually 208 mm. long by 156 mm. broad, that is to say, dolichocephalic, with an index of 75. The height from basion to bregma is only 116 mm. The breadth-height index is 62, far outside the variation in living man. The huge, almost round orbits and very wide nasal aperture agree with what has been noted as very remarkable in skulls of the Neanderthal type. Though the face is defective, its prognathous nature is clear. The mandible is of great dimensions, and in so far as senile atrophy has not produced changes, exhibits a formation which agrees in the main with those of lower jaws from Spy, Krapina, La Naulette, &c. Here, too, we have absence of chin, "negative chin-formation" (Klaatsch). The occipital and temporal regions have Neanderthal characteristics. The old man's grave contained no tools of the Acheulean stage. This fact, and the predominance of reindeer-bones in the grave, would lend some degree of probability to the supposition that La Chapelle man belongs to a rather later cultural phase than Le Moustier man. Both are to be taken as representatives of the Neanderthal type, and as belonging to the Middle Diluvium.

P. Adloff has in several publications dealt with the question as to whether the above physical characteristics comprised under the term "Neanderthal race" represent an absolutely fixed human type, or whether they were subject to variations. As regards differences of dentition in different specimens of the Neanderthal type, he comes to the conclusion that by no means insignificant differences do exist; Krapina man especially exhibits a form sharply distinguished from other representatives of the genus Homo. Obviously, in a type like the Neanderthal, scattered over a vast area, and doubtless existing for many thousands of years, certain variations must arise by way of adjustment to different climatic conditions, food, mode of life, &c.

Dr. O. Schoetensack has recently made a notable find at Mauer, near Heidelberg, of a fossil human lower jaw, which he has called *Homo heidelbergensis*. It unites two at first seemingly contradictory qualities: (1) massiveness of the body of the jaw, combined with entire absence of chin-projection, breadth and thickness, and special form of the ascending rami—phenomena usually taken as indicating a development little advanced, so-called pithecoid qualities; (2) a set of teeth agreeing with that of present man in all essentials, the size of the teeth not surpassing the scale of variation in some still extant primitive peoples (*e.g.* Australians). No doubt, as Adloff says, the teeth of man are in many respects more primitive than those of anthropoids, and the pithecoid characteristics met with in human dentition are actually primitive features. A glance at the lower jaw of a young gorilla or of a South American howler shows a remarkable resemblance of the mandible to that of *Homo heidelbergensis*. Dr. W. Wright has given an account and illustrations of this jaw in Nature of June 3, p. 398.

In determining the exact position of *Homo heidelbergensis* in the human pedigree, it must always be borne in mind that a huge difference in time exists between *H. heidelbergensis* and the members of the Neanderthal race. Fossil remains of Neanderthal man belong to the Middle Diluvium, coinciding in general with the Mousterian culture period; whereas the remains (of *Elephas antiquus, Rhinoceros etruscus*, Falc., and *Equus stenonis*, Cocchi) were found undisturbed in the same stratification with *H. heidelbergensis*, which points to earliest Diluvium or to the transition period from Diluvium to late Tertiary age (Pliocene). The long periods intervening between Neanderthal man and *H. heidelbergensis* are shown by Penck's climatic curve of the Glacial periods (Ice ages), mainly coinciding with the Quaternary age, with warmer inter-Glacial periods between and the Palæolithic culture periods introduced into his diagram. The culture epoch, called Mousterian by the French prehistorians, corresponds, according to Penck, together with the subsequent divisions of Palæolithic culture (Solutrean, and perhaps partly Magdalenian), to the Ice-age divisions, comprising the inter-Glacial epoch, which falls between the Riss- and Würmeiszeit. On the other hand, Penck makes the oldest divisions of Palæolithicum correspond: Acheulean and the preceding Chellean, to the warm intervening epoch of specially long duration between the Mindel- and Risseiszeit. Obviously, the late Palæolithic age (of successive Mousterian, Solutrean, and Magdalenian cultures) lies very much nearer to the present than that earlier division of the Palæolithic age (of Acheulean and Chellean cultures).

The supposition that a very long interval elapsed between Middle Diluvium (with Neanderthal man in Europe) and that earliest Diluvium (of *H. Heidelbergensis*) receives indirect confirmation from recent excavations by R. R. Schmidt (Tübingen). He devotes himself chiefly to later divisions of the Palæolithic age, and, working back from the Neolithic age, shows the relatively long duration of the culture-sections which he calls late, high, and early Magdalenian; later and earlier Solutrean; late, high, and early Aurignacian; and late Mousterian. However, the slow and gradual earliest cultural progress of the human race leads one to attribute to those oldest divisions of the Palæolithic age, commonly called Chellean or Acheulean, a still longer duration than to all those later divisions.

Thus an enormously long period must have elapsed between Neanderthal man (generally coinciding with Le Moustier culture) and *H. heidelbergensis* (of earliest Diluvium, or Pliocene-Diluvium transition). No fundamental objection stands against the view of Rutot, Klaatsch, Verworn, and others that the first beginnings of human cultural development reach far back beyond Diluvium into the middle division of the Tertiary period (Oligocene, according to Rutot), and that the much debated eolith is to be regarded as the primitive implement of man at the lowest cultural stage. It is obvious that an extremely long period of slow development must have preceded the production of the "hand-wedge," the characteristic implement of the Chellean age.

Neanderthal man, then, is of slight antiquity as compared with *H. heidelbergensis*. Klaatsch has for years upheld the theory that to discover the roots of the human race we must go very far back, perhaps even to the roots of the mammalian genealogical tree, and additional probability is lent to this idea by the Heidelberg find. The teeth of the Heidelberg jaw undoubtedly prove that no anthropoid stage preceded that to which the Heidelberg mandible belongs, so that to explain the similarity of human and anthropoid forms we must go back to the remote ancestor from which there branched off on the one side the genus Homo and on the other the genera of anthropoids and perhaps of other ape-species. The fact that the origin and development of anthropoids reaches back to the Middle Tertiary age (Miocene) prevents the assumption that the Heidelberg mandible is itself the stage of development at which the anthropoids branched off from the genus Homo; this is also rendered improbable by the discovery of eoliths in Middle Tertiary beds. There is nothing to preclude the supposition that the Heidelberg fossil, as regards formation, stood fairly near the point of separation. The line of descent Pithecanthropus–Neanderthal man–recent man has to a certain extent been shaken by the recent researches, which attribute less antiquity to Pithecanthropus than was hitherto supposed to be the case.

At the conclusion of the paper is a brief discussion of the genealogical tree of the phylogeny of man and the anthropoids, recently published by Prof. G. Bonarelli, of Perugia. According to this table *Pithecanthropus erectus, Homo heidelbergensis*, and Neanderthal man may be regarded either as successive stages in the direct line of descent of Hominidæ or as offshoots from those stages.

A. C. Haddon.

THE ORIGIN OF THE PLANETARY SYSTEM.

Dr. See contends that the planets and satellites of the solar system were captured and their orbits made remarkably circular by a resisting medium. In his view, therefore, Laplace's nebular hypothesis is altogether wrong, whereas the current view is that it is in the main right, though in need of considerable modification and extension.

Dr. See's paper contains a single table, the object of which is to show that, when the sun and planets are expanded to fill the orbits of the bodies revolving about them, their rotations must have been so slow that it is inconceivable that they could have flung off planets or satellites. As an extract from the tables we may quote that, assuming the law of internal distribution remains unchanged, the principle of conservation of angular momentum implies that the sun, when it filled the orbit of the earth, rotated in 3192 years instead of in 25·3 days, as at present. It is no doubt inconceivable that the matter which now forms the earth was being carried round as an integral part of a nebulous sun at one instant, and shortly afterwards revolving as a planet with 3000 times its former velocity; but Dr. See's figures involve the assumption that the law of internal distribution remains unchanged. He probably regards 3000 as a sufficient factor of safety.

A precisely similar point is made with regard to thirty-three other bodies in the solar system. Dr. See then continues that, as detachment has been disproved, capture is the only other alternative. This is not a proof. There are more things in heaven and earth than Dr. See has dreamed of in his philosophy. Capture is a possibility, but Dr. See has done nothing to raise his theory beyond a mere conjecture, even though he points out, in addition, that a resisting medium would diminish the mean distance and the

[1] "On the Cause of the Remarkable Circularity of the Orbits of the Planets and Satellites and on the Origin of the Planetary System." By T. J. J. See.

eccentricity of an elliptic orbit, and that in the case of Jupiter's satellites the outer orbits are highly eccentric, and the inner orbits nearly circular. It may be mentioned that Mercury is an exception to his rule.

Suppose that Laplace had not thought of the possibility of capture. Then Laplace would have been as much entitled to say detachment was the true explanation, because no other was possible, as Dr. See is now entitled to say that capture survives as the only possible explanation. Laplace, of course, would not have reasoned in this way. His theory explains many features of the solar system, in fact so many that when new discoveries showed that his theory was incomplete, there has been a nearly universal reluctance to say that it was altogether wrong. We do not see that Dr. See's hypothesis explains anything. Why, for instance, on the hypothesis of capture are the vast majority of orbits near the plane of the ecliptic and their motion direct?

STATE AID FOR UNIVERSITY EDUCATION.[1]

THE grant in aid of university colleges originated in the demand for advanced education in 1889 arising from the university extension movement, and was intended to help university colleges in providing suitable courses. In twenty years conditions have changed, and some of the university colleges have become universities, but they are still claimants for the aid. The members of the University Colleges Advisory Committee had a difficult task before them, and they submitted a report dated July 24, 1908. On this a Treasury minute, June 3, 1909, has been founded which lays down the conditions for participation in the grant. The conditions are summarised thus:—

(1) Any institution to secure a share of the grant must be prepared to afford satisfactory instruction of university standard, which should normally include English, classics, French, German, history, philosophy, mathematics, physics, chemistry, biology.

(2) The courses of instruction must be attended by a reasonable number of students capable of profiting by the education afforded.

(3) The buildings and initial equipment must be adequate for the courses established.

(4) The aggregate income of the institution, whether derived from grants or otherwise, must be sufficient to maintain all the departments in a state of efficiency, and to provide a superannuation scheme.

(5) The grants should be confined to institutions serving great centres of population, and no new institution should be admitted unless it serves a district not already adequately provided with instruction of a university standard.

(6) Due regard must be paid, not only to the standard and the efficiency of the teaching, but also to the spirit animating the institution and its influence as an intellectual centre.

These are the conditions, and it must be agreed that they appear very just, except number five, concerning the admission of new institutions to the privileges, as there may be two or more institutions in a great centre which afford equal or identical advantages, one, however, receiving the grant to the exclusion of the other. This is the case in London, where there are two large institutions fulfilling the conditions, but excluded because certain other colleges are sharing already in the grant. Both Birkbeck College and East London College more than satisfy all the conditions, and there are several other institutions and polytechnics which fulfil, or come very near to fulfilling, the qualifications.

It will naturally be asked why the grant in aid is to be limited to certain favoured institutions in some centres, and the answer must lie in the miserable inadequacy of the grant. The advisory committee had before them, not the difficulty of the standard of the colleges, but how to make quite too small a meal satisfy the demands of a large, hungry, and rapidly increasing family. In domestic affairs the difficulty has to be met by the father increasing the family allowance, and it would be more logical for Parliament to increase the allowance. The solution of allowing part of the family to starve is indefensible. We have alluded to the condition of affairs in London particularly because London has come off worse in amount than any other city in proportion to its population. London, too, has suffered from want of civic spirit. In the lesser cities strong civic spirit pushes their claims on Parliamentary notice.

It must be noted that the advisory committee is fully alive to the fact that many of the universities and university colleges are drawing grants from several sources, *i.e.* Board of Education, Board of Agriculture, Parliamentary grants, and local rates, and there is danger of their being paid twice over for the same work; but the advisory committee does not suggest at present any way out of this difficulty other than getting a return made to them from each of the granting authorities.

It has been suggested before that all higher institutions should receive their grants from one authority, which should be able to take a survey of the whole kingdom. At present many higher institutions have to depend largely on the local education authority, which secures neither breadth of treatment nor sufficient continuity. The institutions find that there are fat and lean years, and it is not likely that the best educational results will be obtained when there is so much uncertainty. In an article which appeared recently in this journal it was suggested that the control of the higher technical institutions throughout the country should be under a central authority, for prosperity in trade is a national affair, and not local. The same view must be taken in regard to the university colleges and universities. They should be as free from local restraint as possible. This is foreshadowed in the report in the following words:—

We trust, however, that it may be found possible to regard such a scheme as being merely transitional, and to replace it in the near future by one on the more simple lines we have indicated. . . . a scheme that would comprise in a single vote the whole aid granted by Parliament to universities and university colleges for education of university character and standard. The coordination of the institutions which provide higher education in the country in accordance with the principles of administration embodied in the Education Act, 1902, is proceeding apace, and the universities and university colleges have taken the initiative in connecting themselves with the local education authorities most closely related to them by locality and communications. Universities, however, are non-local as well as local institutions, and it is of importance that this two-fold aspect should be appreciated by the central administration, which has to dispense the State subvention for higher education by way of grants to this or that locality, and which must at the same time pay due regard to the interests and necessities of the country as a whole.

[1] University Colleges (Great Britain). Grant in Aid. Parliamentary Paper 182. (London: Wyman and Sons.) Price 1½d.

NOTES.

THE present summer promises to be one of the coldest on record, but for rainfall it is likely to be several inches short of the measurement in 1903, when at Greenwich the total fall for the three months, June to August, was 16·16 inches. So far, the highest temperature at Greenwich since the commencement of June is 77·7°, on July 18, whilst at the observing station of the Meteorological Office, in St. James's Park, the highest temperature is

75°. The Greenwich records only show three days in June with the thermometer above 70°, and the observations since 1841, a period of sixty-eight years, only show one June, 1860, with an equally small number of warm days; but as recently as 1907 June only had five days with the thermometer above 70°. For the first twenty-seven days of July there have been only fifteen days with a temperature above 70°; this is precisely the same number as during the whole month in 1907, whilst in 1879 there were only eight equally warm days, and in 1888 only twelve. In 1907, the summer of which approximates somewhat to that of the present year, there were twenty days in August with a temperature of 70° and above. In 1868, which is about the warmest summer on record, there were in the three months seventy-seven days above 70° and thirty-three days above 80°, whilst in the coldest summer, 1860, there were only twenty-three days with 70° or above, and the sheltered thermometer on no day touched 80°. Taking England as a whole, the temperature this summer has been largely deficient of the average, and the rainfall has been generally in excess, but not to any great extent, whilst the sunshine is everywhere deficient.

M. Blériot accomplished a flight across the English Channel in his monoplane in the early morning of Sunday, July 25. He started his flight at 4.35 a.m. from Baraques, near Calais, and, having travelled across the Channel, he landed in safety in a field near Dover Castle. According to M. Blériot's own account of the flight, his engine at the time of starting made 1200 revolutions—almost its highest speed—to enable him to get over the telegraph wires along the edge of the cliff, but as soon as this was accomplished the speed was reduced. The monoplane travelled at a height of about 250 feet, and at the time of passing the *Escopette*, the destroyer in attendance, in the Channel the rate of travel was at least 42·5 miles an hour. Twenty minutes after leaving the French coast M. Blériot was able to make out Dover Castle, and, heading the monoplane westward, he followed the coast-line to Dover. Eventually catching sight of his friend, M. Fontaine, waving a large French tricolour to guide him to a suitable place of descent, the monoplane was brought to earth with little damage. The flight represents an achievement of great interest in the history of aërial navigation. On being informed of this notable feat, M. Quinton, president of the Aërial League, remarked, "Before five years are out England will have ceased to be an island. The sea is no longer a barrier. Relations between nations will undergo a change. The strategic and political situation of certain peoples will be transformed." The *Times* gives the following particulars of M. Blériot's monoplane, *Blériot XI.* The area of its sustaining surface, which was at first 14 square yards, was increased last February to 17 square yards. Its spread is 8½ yards. Under these conditions the small monoplane left the ground very easily, but could not stop in the air more than two minutes. Its motor was then replaced by a three-cylinder Anzani of 105 mm. (4·13 inches) bore and of 22–25 horse-power, weighing 132 lb. in working order. With this modification the *Blériot XI.* has made some very successful flights, including one on July 4, when the aëroplane stopped in the air for 50m. 8s., and another on July 13, when it flew from Étampes to Chevilly, a distance of twenty-six miles. It then went to Calais, where it underwent a few tests, with the present result. The framework of the *Blériot XI.* is of ash and poplar stiffened with piano strings. It weighs 45 lb., and is about 23 feet long; it can easily carry a load of 660 lb. placed at its middle point. The landing *châssis*, including the wheels and springs, weighs only 66 lb. The inclination of the tail of the machine, and the warping of the wings, ensuring lateral stability, are effected by means of a hand-lever, whilst the vertical rudder is moved by a bar pressed down by the foot of the aviator. The propeller, which is a Chauvière one of the type known as "Intégrale," is placed in front of the machine, and is so designed that the air it throws back does not meet the framework of the aëroplane. It has a diameter of a little less than 7 feet, and working the *Blériot XI.* it has an efficiency of 85 per cent.

The Civil Service Supplementary Estimates of sums required to be voted for the year ending March 31, 1910, include 6500*l.* to the Royal Society, as grant in aid of the expenses of the aëronautical section of the National Physical Laboratory. The grants under the Irish Universities Act, 1908, amount to 28,150*l.*, namely, Queen's University, Belfast, 4700*l.*; University College, Dublin, 16,000*l.*; University College, Cork, 5700*l.*; and University College, Galway, 1750*l.*

Mr. H. Garrett, writing from Greensted Rectory by Ongar to the *Times* (July 28), says:—"During the severe thunderstorm on the 13th inst. a meteoric stone fell in the stable yard here with a terrific explosion when within a few feet of the ground, embedding itself in the gravel about 8 inches, the ground around for several feet being perforated with small holes caused by the fragments. The main part and fragments which we could collect weighed 1 lb. 13 oz. The fall was witnessed by my daughters, who were sheltering about eight yards away."

A Reuter message from Melbourne states that it is proposed to invite the British Association to meet in Australia in 1913. The University of Melbourne is communicating with the different Australian universities with the view of formulating definite proposals. It is suggested that the invitation should proceed from the Commonwealth.

The local secretaries for the forthcoming British Association meeting at Winnipeg desire it to be known that the proposed excursion up the coast of British Columbia to Alaska, now being organised in connection with the Natural History Society of Canada, is unofficial, and is not part of the local committee's arrangements. Those desiring, therefore, to make this journey before the meeting should communicate with Mr. M. B. Cotsworth, Victoria, B.C.

The death is announced of Prof. G. Arth, professor of industrial chemistry in the University of Nancy. Prof. Arth's first researches were concerned with organic chemistry, his work on menthol and its derivatives being well known. For some years Prof. Arth had been engaged in perfecting methods of metallurgical analysis.

We notice with regret the death, at Naples, of Dr. V. R. Matteucci, instructor in geology in the University of Naples, and director of the observatory on Vesuvius. It will be remembered that during the eruption of Vesuvius in 1906 Dr. Matteucci followed successfully every phase of the eruption at grave risk to his own safety.

Mr. P. W. Stuart-Menteath desires to direct the attention of our geological readers to the instructive sections to be seen in the neighbourhood of Gavarnie, in the Pyrenean region. The subject has been fully discussed in a paper on the Gavarnie overthrust, and other problems in Pyrenean geology, by Mr. E. E. L. Dixon, with an appendix by Mr. Stuart-Menteath (*Geol. Mag.* for August and September, 1908).

By the will of the late Miss E. S. Wolfe, who died on June 10, leaving estate of the gross value of 71,520*l.*, with net personalty 60,295*l.*, the sum of 1000*l.* is to be given to each of the following societies among other institutions:—the Royal Anthropological Institute, the Royal Archæological Society, and the Royal Geographical Society. Subject to the payment of duties on the estate, the residue is left to King Edward's Hospital Fund, the Royal Institution, and the Royal Society.

The National Trust for Places of Historic Interest or Natural Beauty makes an appeal for upwards of 1000*l.* to purchase the central portion of the Cheddar Cliffs with the view of preserving the beauty of that natural monument of scientific interest. There is grave danger that the beauty and grandeur of the gorge may be obliterated before long if the extensive quarrying operations, which have been in progress during the last seven years, are not discontinued. Donations may be sent to the secretary of the trust at 25 Victoria Street, London, S.W.

The French Association for the Advancement of Science will meet this year at Lille on August 2–7, under the presidency of Prof. Landouzy, dean of the faculty of medicine in the University of Paris. The gold medal of the association, which was instituted last year, is to be awarded to Prof. H. Poincaré, who will deliver a lecture during the course of the meeting. In addition to minor visits to the industries of the neighbourhood, three more extended excursions have been arranged in connection with the meetings. The first of these will be to Douai, where demonstrations by the best-known aviators are to be given; the second excursion will be to the mines of Sessevalle, Aniche, and Gayant, and the third to Gand, Ypres, Bruges, and Furnes. A large number of papers will be read at the meetings, among them being communications from Prof. Poincaré, on integral equations; Prof. A. Gautier, of Paris, on the existence of water vapour in volcanic gases and the origin of thermal springs; Prof. A. Bertillon and Dr. A. Chervin, on metrical anthropology; and Dr. Lewkowitsch, on a new refractometer. The secretary of the association may be addressed at 28 rue Serpente, Paris.

An important paper on the determination of the bovine or human origin of tuberculosis in the human subject is contributed by MM. A. Calmette and C. Guérin to the current number of the *Comptes rendus* (July 19). They have found that tubercle bacilli of bovine origin can be readily cultivated on a glycerinated ox bile; tubercle bacilli from human beings or birds refuses to grow on this medium, whilst developing readily on human bile or bile from the bird respectively. Another distinction is afforded by the fact that injection of the infected matter into the mammary gland of a goat causes grave mammitis, leading to the death of the animal, if the tubercle bacilli are of bovine origin, whilst cultures of human origin produce a very mild and non-fatal infection. The method has been applied to the diagnosis of a fatal case of acute tuberculosis in a child, aged five months, which had been bottle-fed, and both of whose parents were healthy. The result of applying both the above tests was to show that the tuberculosis was of bovine origin. The authors point out the importance of being able to determine with exactness the relative frequency of tuberculous infections of bovine and human origin.

Fifty years of Darwinism forms the subject of an article contributed by Dr. W. Breitenbach to Nos. 4 and 5 of *Neue Weltanschauung.*

A list of the birds, by Dr. G. M. Allen, forms the eleventh part of the "Fauna of New England," now in course of issue in Occasional Papers of the Boston Society of Natural History.

The dragon-flies of the Mississippi valley collected during the pearl-mussel survey of that river in 1907 are catalogued by Mr. C. B. Wilson in No. 1692 of the Proceedings of the U.S. National Museum.

The fresh-water sponges in the collection of the U.S. National Museum are in course of description in the Proceedings of that institution by Dr. N. Annandale, the first instalment (No. 1690) dealing with those from the Philippines and Australia.

In vol. v., part vii., of the Annals of the South African Museum, Mr. E. Meyrick describes a number of new local Microlepidoptera, while Mr. L. Peringuey discusses new or little-known Hymenoptera of the family Mutilidæ from South Africa.

In the *Irish Naturalist* for July Dr. R. F. Scharff describes and figures a speckled otter from Lough Sheelin, recently acquired by the Dublin Museum. Although albino specimens are known, this appears to be the only speckled otter on record.

In the July number of the *Entomologist's Monthly Magazine* Mr. G. H. Verrall announces that he is attempting to re-introduce the large copper butterfly (*Chrysophanus dispar*), in the shape of its Continental phase *rutilus*, into Wicken Fen, where he has turned out a number of the larvæ.

New fishes from Japan and the Liu-kiu Islands are described by Mr. J. O. Snyder in No. 1688 of the U.S. National Museum Proceedings, while two new electric rays from the South Atlantic coast of the United States are named and described by Messrs. Bean and Weed in No. 1694 of the same publication.

We have recently had occasion to notice several papers on crinoids published by American workers, and we have now to add to the list two by Mr. A. H. Clark, published respectively as Nos. 1691 and 1693 of the U.S. National Museum Proceedings, the first of these dealing with seventeen new species belonging to various genera, while the second is devoted to four new species of Rhizocrinus.

The absence of aquatic forms among the mammals of the Miocene beds of Nebraska has led Dr. F. B. Loomis to the conclusion that these deposits are of aërial rather than lacustrine origin, and this view is confirmed by the study of the tortoises, or turtles, as the author calls them, in American fashion, from the Harrison beds, of which several new species are described by him in the July number of the *American Journal of Science.* All these are land-tortoises of the typical genus Testudo.

The thorax and the articulation of the wings of insects form the subject of an important memoir, by Mr. R. E. Snodgrass, published as No. 1687 of the U.S. National Museum Proceedings. In this paper, which amplifies conclusions reached in earlier communications, the author attempts to show the uniformity of thoracic structure prevailing throughout all orders of insects, and urges that in no case is there evidence that any of the constituent elements of any one thoracic segment have an origin apart from that particular segment. In his study of the wings he adopts the venation-nomenclature proposed by Comstock.

The determination of the ages of eels inhabiting the fresh-waters of Sweden and the deductions to be drawn therefrom form the subject of No. 46 of the *Publications de Circonstance* issued at Copenhagen by the Conseil Permanent International pour l'Exploration de la Mer. As the result of these investigations it has been found that the great majority of the five-year-old eels collect at the mouths of the rivers discharging into the Gottland and Botten lakes, where they remain in a barren condition from five to seven years, after which they make their way, as ten- to twelve-year-old fishes, *viâ* the Kattegat, the Skagerack, and the North Sea to the Atlantic for the purpose of spawning.

The mystery so long shrouding the young of the sanderling has at length been solved, and in the June number of Witherby's *British Birds* Dr. Eagle Clarke gives an excellent coloured plate of four of the long-sought chicks. This brood was discovered by Dr. Bruce on August 3, 1906, in the north-eastern portion of Prince Charles's Foreland, Spitsbergen, and the chicks and their parent are now mounted in the Royal Scottish Museum. Other chicks were subsequently obtained, in 1907 or 1908, by the Danish expedition to N.E. Greenland. In ground-colour the chicks are greyish-buff, variegated with black and deeper buff, and flecked with white, longitudinal stripes being absent. There is a collar of uniform buff on the back of the neck, and the under-parts are nearly white.

The July number of the *Journal of Economic Biology* is devoted to three papers on injurious insects and their relations. In the first of these Mr. R. S. Bagnall describes certain new British species of thrips (Thysanoptera), with notes on injurious kinds. In the second Mr. H. H. King has notes, with plate, on a boring beetle of the family Buprestidæ, referable to the genus Sphenoptera, the larvæ of which are doing considerable damage in the Sudan by attacking the stems of cotton. The third paper, by Messrs. W. E. Collinge and J. W. Shoebotham, is devoted to the description of a new genus and species (*Amerus normani*) of Collembola, based on specimens taken in a greenhouse in the garden of the Rev. Canon Norman at Berkhampstead, Herts. A second species of the group, *Neelus murinus*, typically from Cambridge, Mass., U.S.A., has likewise been taken at Berkhampstead.

The much-discussed problem of the nature of the "ciliated funnels" of the leeches is dealt with at length, and in a very interesting manner, by Rudolf Loeser in the first part of the ninety-third volume of the *Zeitschrift für wissenschaftliche Zoologie*. The author has investigated these organs in three species of Gnathobdellidæ and four of Rhynchobdellidæ. He concludes that in no case can the ciliated funnels be regarded as nephrostomes, their connection with the nephridium being entirely secondary. They are to be compared with the "ciliated urns" of Gephyreans, and, like the latter, are primarily blood-purifying organs, in the "central mass" of which phagocytosis, and also the formation of new amœbocytes, takes place. In the Glossiphonidæ the "capsules" are the phagocytic organs, connected with the body-cavity through the funnels, and giving off their products by osmosis to the nephridia. In Herpobdella (Nephelis) and in the Hirudinidæ the ciliated organs are the places where blood corpuscles develop, while the excretory products are conveyed to the nephridia through botryoidal vessels. The author has also investigated, by injection methods, the relations of the various blood-containing spaces, and his observations tend to support the conclusions of recent authors, such as Oka, on this subject. He regards it as certain that the lateral blood channels of the Gnathobdellidæ are not true vessels, but merely parts of the body cavity with muscular walls.

An illustrated pamphlet of forty-seven pages, describing how Rio de Janeiro has been freed from yellow fever, has reached us; its title is "Comment on assainit un Pays. L'Extinction de la Fièvre jaune a Rio de Janeiro," by Nerêu Rangel Pestana. The pamphlet is issued by La Mission Brésilienne d'Expansion économique, and is published in Paris by MM. Aillaud et Cie. The deaths from yellow fever in Rio de Janeiro were 1078 in 1898, whereas in 1908 there were only four. The sanitary budget has risen from one million to seventeen million francs. Sanitary works on a large scale were carried out, such as port works, canalisation of marshes, construction of new avenues and roads, with proper alignment through the old unhealthy parts, re-construction of drainage, fumigation of houses, oiling of pools, introduction of pipe water-supply, and so on, and, perhaps as important as anything, a sanitary code, rigorously enforced against obstinacy, ignorance and ridicule, the usual means employed for resisting such measures. As illustrating the activity of the sanitary staff, more than 153,000 breeding-places of mosquitoes were dealt with in 1906. In 1907 the death-rate was 19·2. The general mortality is now no greater than that of Vienna. It must be remembered that occasionally yellow fever disappears quite independently of an attack on the mosquito, but it can hardly be doubted that these splendid triumphs of tropical medicine in Rio de Janeiro, in Santos, and in other places have been entirely due to the war without mercy waged against *Stegomyia fasciata*, and that soon yellow fever will be a disease of the past.

An account of the American mistletoe, *Phoradendron flavescens*, dealing with the anatomy and some of its biological aspects as a hemiparasite, is presented by Mr. H. H. York in Bulletin No. 120 of the University of Texas. Dissemination is attributed to the agency of birds that eat the seeds. The commonest host plants are hackberry, mesquite, elm, and osage orange. The seedling first forms an attachment disc on the outside of the host, then sends in a primary haustorium which spreads in the cortex; from the haustorium sinkers are developed, which penetrate the wood along the medullary rays. The growth of the parasite is very slow, but it may attain a length of 3 feet in about twenty years. The host plants become misshapen, but are not seriously injured, unless indirectly by wood-boring insects, which first attack the mistletoe.

The expectation that many striking new plants would be discovered in the collection made by Mr. E. Ule in the State of Bahia is fully borne out by the first list of diagnoses published in Engler's *Botanische Jahrbücher* (vol. xlii., part ii.). Two xerophytic bromeliads from the mountains furnish the types of new genera, Sincoræa and Cryptanthopsis, allied to Fascicularia and Cryptanthus; new species, chiefly rock-inhabiting, are added to Encholirion, Hohenbergia, and other genera. Two root-climbing parasites are additions to the genus Struthanthus, and a new bushy Phoradendron was taken on a Cæsalpinia. Dr. H. Harms, one of the collaborators with Mr. Ule, describes a number of new species for the Leguminosæ, notably species of Calliandra, Mimosa, and Cassia. Under Euphorbiaceæ, new species of Euphorbia, Jatropha, and Manihot are recorded, and Dr. I. Urban distinguishes a new species of Loasa.

A highly interesting number of the Proceedings of the Boston Society of Natural History (vol. xxxiv., No. 7) is devoted to the flora of the islands of Margarita and Coche, lying off the mainland of Venezuela. The author, Mr. J. R. Johnston, has twice visited the islands, and has made a close study of the flora of Venezuela. The list comprises about 650 species, of which two-thirds are common to tropical America, thirty-seven are west Indian, and eighty-two are confined to South America, of which one-half are endemic. The Leguminosæ is the predominant family, and supplies many of the common plants, such as species of Cæsalpinia, Cassia, and Calliandra. The family of Cactaceæ is individually, although not specifically, well represented, and the species of Bromeliaceæ are conspicuous on account of their striking colours and appearance. The paucity of species in comparison with the number of genera is marked, the proportion being 1·6 to 1; the specifically largest genus is Croton, with eleven species; Capparis provides nine species.

MESSRS. BAUSCH AND LOMB, Thavies Inn, the makers of the high-class Minot microtomes, have issued a new catalogue of their various patterns to indicate recent improvements. Additional features are noted for the well-known Minot automatic rotary microtome; the knife can be moved to and fro, from side to side, or can be rotated, owing to its insertion in a special knife block; split nuts with releasing lever allow of rapid adjustment, and the feed wheel is provided with a guard. The new model Minot automatic precision microtome, a powerful and rigid type designed for heavy work, although equally efficient for light cutting, has been re-modelled; the gearing between fly-wheel and crank produces an exceptionally smooth feed. A freezing microtome for fixing on the nozzle of a cylinder containing carbon dioxide is a new instrument, intended to provide surgeons with an apparatus for preparing sections that can be examined on the spot.

WE have received the *Studi e ricerche di chimica agraria* for the years 1906–8 from the agricultural chemistry laboratory of the University of Pisa. The volume includes a paper by the director, Prof. Italo Giglioli, on the stimulus to plant growth occasioned by small quantities of manganese salts, &c., and studies by A. Quartaroli on certain properties of phosphates of agricultural interest.

A SUBJECT of great practical importance and scientific interest is discussed in a recent issue of the *Cairo Scientific Journal* (No. 29). For the past twelve years there has been a steady fall in the average yield of Egyptian cotton per feddan, and the loss now amounts to five pounds per feddan per annum at current prices. The late Mr. Gibson, in 1906, attributed the loss to the rise in level of the subsoil water, which is a direct consequence of the canal system now being introduced. One case was noted on the State Domains where a high-level canal raised the water-table of the adjoining land by seepage from a depth of 3 metres to $1\frac{1}{2}$ metres, and the yield of cotton fell off considerably. The remedy appears to lie in a great extension of the drainage system.

ATTENTION has recently been directed in the pages of the *North British Agriculturalist* to the use of soya beans as cattle food. The bean is well known in America and in Asia, but has hitherto not been used in the British Isles. After removing some of the oil, the residue is made into oil-cake containing about 7 per cent. of oil and 40 per cent. of "albuminoids" (*i.e.* 6·4 per cent. of nitrogen, albuminoid being defined as nitrogen × 6·25), and is at present cheaper than other foods of like composition. During the spring of this year about 50,000 tons of beans have been imported, it is understood, from Manchuria, and at present prices the cake promises to form a very useful addition to the list of cattle foods.

MR. E. S. THOMAS contributes to the May number of the Journal of the Cairo Scientific Society a useful article summarising the facts of the early mining industries of Egypt. The gold of the desert has been worked from a very early period, an ingot having been found buried with a corpse of the first dynasty, while gold-handled flint knives and stone jars, the mouths of which are ornamented with gold, testify to the artistic skill of the people of the same period. The earliest direct references to expeditions in search of gold date from the twelfth dynasty. Western Asia drew large supplies of gold from Egypt during the period represented by the Tel-el-Amarna letters, and the records of tribute paid in the precious metal by subject races show that immense treasures were at the disposal of the Pharaohs. Silver was also received in large quantities from Crete, Attica, and probably from Cilicia. The first systematic scheme for gold-mining under Egyptian management dates from the nineteenth dynasty, and it continued to be carried on until it became impossible to protect the workers from Bedouin marauders. Large workings in the quartz reefs at Um Rus and Haimur show the vast extent of these operations. Altogether about ninety old workings in search of gold have up to the present been identified in the eastern Egyptian desert, and twenty more known to exist remain to be traced. Exclusive of workings in the Sudan proper, all these lie between lat. 22° and 28°, that is, between Minia and the Sudan border, and east of long. 33°. Many others will probably be discovered in the more remote desert area.

THE Director-General of Indian Observatories has issued a memorandum (dated June 8) on the meteorological conditions prevailing before the south-west monsoon of 1909. Past experience shows that the most important indications regarding monsoon rainfall are afforded by the pressure conditions in South America and the Indian Ocean, and these for the past two months have been decidedly favourable, being above the normal in the former and below in the latter regions. Late and excessive snowfall is unfavourable to the monsoon, especially in north-west India, but since April none of any significance has occurred. From these and other data referred to in the memorandum Dr. Walker draws the following useful inferences:—(*a*) the general conditions are such as have, in a decided majority of years, been followed by a total monsoon rainfall of more than the average amount; (*b*) the indications regarding the geographical distribution are by no means well marked, but suggest that the outlook for the plains of north-west India during the earlier part of the season is somewhat less favourable than that for the field of the Bay current.

ALTHOUGH much work has been done on the relation between the magnetic qualities of steels and their composition, we are still far from being in a position to state what it is exactly which confers on a steel the property of magnetic permanence. The most recent work in this field is that of Mr. T. Swinden, described in the June number of the Journal of the Institution of Electrical Engineers. Mr. Swinden, after examining a number of steels containing 3 per cent. tungsten both magnetically and microscopically, comes to the conclusion that magnetic permanence depends more on the constitution than on the state of crystallisation of the steel.

THE July number of the *Journal de Physique* contains Dr. Hale's address to the Société française de Physique on the magnetic fields of sun-spots. By means of a very careful and detailed comparison of the intensities and polarisations of the doublets and triplets obtained in the Zeeman experiment in the laboratory with the corresponding effects obtained in the spectra of sun-spots by the help of the Snow telescope at Mount Wilson, California, at an altitude of 1700 metres, Dr. Hale shows that sun-spots consist of columns of ionised vapours circulating in opposite directions in the two solar hemispheres, the axis of rotation being, in general, inclined at a considerable angle to the normal to the solar surface. There appears to be evidence of connection beneath the solar surface of the vortices observed north of the solar equator with those south of that line. The whole of the observations afford strong support to the theory that sun-spots are the normal products of the convection currents which occur in the sun.

THE *Bulletin international* for 1907 of the Bohemian society, L'Académie des Sciences de l'Empereur François Joseph I., was published in 1908, and a copy has just reached us. Drs. B. Kučera and B. Mašek write in English on the radiation of radio-tellurium, and continue a description of their researches, which have led them to the following conclusions among others. The absorption of the α rays from radio-tellurium in metals and gases investigated by Bragg's method is manifested similarly as with α rays of radium and its first transformation products by lowering of the ionisation curve. The atomic stopping power is very nearly proportional to the square root of the atomic weight, and possesses almost the same values as Bragg found for radium C. It is probable, though, that the proportionality constant increases slightly with atomic weight. For the same gas (air) the ranges corresponding to the α rays of the same velocity are inversely proportional to the pressure (density) of the gas. The ranges for the rays of the same velocity in different gases (air, oxygen, carbon dioxide) are inversely proportional to the mean square roots of their atomic weights. The existence of a secondary radiation of α rays which ionises air at ordinary pressure cannot be taken as ascertained.

FROM the account, published in *Engineering* for July 16, of the trials conducted recently by the Scottish Automobile Club, it is evident that electric ignition can be made perfectly trustworthy if well carried out. Fifty-eight cars were fitted with high-tension magnets, four used accumulators only, and three low-tension magnets. Only one car fitted with high-tension magnets had any stops at all, except for cleaning or changing sparking-plugs, a matter which often depends more on the lubrication than on the ignition apparatus. Of the other systems, there was only one small stoppage in any of the cars having accumulator ignition, and two considerable stops in cars fitted with low-tension magnets. The Albion car, fitted with low-tension magnets, went through without an ignition stop, as it has done on previous occasions, and it may be taken for granted that the low-tension system, like the high-tension, can give completely satisfactory results.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST:—

Aug. 3. 23h. Mercury in superior conjunction with the Sun.
5. 4h. 15m. Mars in conjunction with the Moon (Mars 0° 13′ S.).
,, 23h. Saturn stationary.
6. 9h. 45m. Saturn in conjunction with the Moon (Saturn 1° 32′ N.).
10-12. Perseid maximum.
11. 19h. 2m. Venus in conjunction with Jupiter (Venus 0° 12′ N.).
13. 8h. Mars in perihelion.
17. 11h. 36m. Jupiter in conjunction with the Moon (Jupiter 4° 17′ S.).
18. 0h. 13m. Venus in conjunction with the Moon (Venus 4° 15′ S.).
23. 3h. Mars stationary.

A LARGE GROUP OF SUN-SPOTS.—During the past week a group of sun-spots, of abnormal size for this period of the sun-spot cycle, has been visible on the solar disc—even to the naked eye. This large group has developed from a few scattered, small nuclei which came round the eastern limb on July 18, and now includes a leading spot of large dimensions and two separate trails of smaller spots. In addition to the large group there was another, preceding, group of medium size and two smaller ones to be seen on the disc on Saturday last. This outburst still further emphasises the extension, in time, of the sun-spot maximum of 1905–6.

PHYSICAL INTERPRETATION OF LUNAR FEATURES.—In presenting the eleventh fascicle of his photographic map of the moon, M. Puiseux placed before the Paris Academy of Sciences some ideas as to the nature and history of the lunar landscape, suggested by the study of the photographs. From the absence of any appearance of division into parallels of the dark and light areas, M. Puiseux argues that the moon certainly has not polar regions of ice and snow such as those seen on the earth and Mars. Then, considering the probable presence or absence of water, it follows that the moon's surface must either be glaciated completely or shows no trace of water areas.

Against the former suggestion, which, it will be remembered, is the one upheld by Herr Fauth, the noted selenologist, there is the relatively low albedo, comparable to that of the terrestrial volcanic and siliceous rocks, but certainly much less than that of snow or ice, and there is also the fact that extremely bright and extremely dark areas are mixed up indiscriminately in small areas. M. Puiseux promises a further communication dealing with the subject of the form and distribution of the dark lunar spots seen on the same photographs (*Comptes rendus*, No. 26).

DOUBLE-STAR MEASURES.—No. 158 of the Lick Observatory Bulletins contains the fourteenth list of double stars discovered and measured by Prof. R. G. Aitken with the 36-inch refractor of the Lick Observatory. All the pairs measured are separated by distances of less than 5″, and in eighty-two cases less than 2″. The present publication contains the measures of 100 double stars, and brings the total number discovered by Prof. Aitken to 2000, 74 per cent. of which are separated by distances of less than 2″.

A discussion of the available data of 7500 known pairs leads Prof. Aitken to the conclusion that, among the stars down to the ninth magnitude, the number of doubles having separations of less than 2″ is greater than those separated by distances exceeding 2″, but less than 5″, in the proportion of 3/1. Hence follows a strong confirmation of the probability that practically all the closer doubles are in reality binary systems, not merely optical pairs.

No. 4338 of the *Astronomische Nachrichten* contains the measures of a number of double stars made by Mr. E. D. Roe, jun., with the 6½-inch refractor of his observatory at Syracuse.

MAXIMUM OF MIRA IN 1908.—Observations of the brightness of *o* Ceti were made by M. Luizet, at St. Genis-Laval, between September 18 and November 28, 1908, and show that the maximum brightness, 3·6 mag., occurred on October 12; this agrees within one day with the epoch given in the *Annuaire du Bureau des Longitudes* (*Astronomische Nachrichten*, No. 4340, p. 332, July 16).

OBSERVATIONS OF JUPITER'S FIFTH SATELLITE.—Although finding it a difficult object to measure, Prof. Barnard succeeded in obtaining measures of Jupiter's fifth satellite during 1908 and 1909 sufficient to determine the times of, and distances at, elongation, and to give a new value of the satellite's period. Western elongations took place at 1909 February 21 14h. 25·4m. (central standard time) and 1909 March 14 12h. 29·6m., and the apparent distances were 56·47″ and 56·00″ respectively; taking $\Delta = 5{\cdot}20$, the latter become 48·08″ and 47·93″. Combining these values with those determined in 1892, the period becomes 0·49817906d., which agrees within one-thousandth of a second of time with that previously determined. It therefore appears that the period is now quite accurately known, and has suffered no sensible change during the seventeen years that the satellite has been under observation (*Astronomische Nachrichten*, No. 4339).

THE FEEDING HABITS OF MŒRITHERIUM AND PALÆOMASTODON.

THROUGH the discoveries in the Oligocene[1] of the Fayûm Mœritherium and Palæomastodon have become famous as two of the earliest, and more or less direct, stages in the ancestry of the elephants. In restorations by various authors each of these animals has been provided with a proboscis of less or greater length, as would befit a more or less remote ancestor of an elephant. As first announced by Dr. C. W. Andrews, to whom we are chiefly indebted for our present knowledge, Mœritherium does anticipate the Palæomastodon type in the enlargement of the second pair of upper and lower incisors and in the general pattern of the grinding teeth. Since the wish is always father to the thought, and nothing is more to be desired than a primitive progenitor of the Proboscidea, it was altogether natural to place Mœritherium in or near the line of ancestry of the elephant, and in such ancestry, as a member of the Proboscidea, the animal has gone into general literature.

A first more cautious note was sounded by Dr. Andrews in his memoir of 1906,[2] p. xvii, in which he observes:—"As already mentioned, Mœritherium was probably an amphibious, shore, or swamp living animal, and it was no doubt owing to the continuation of the conditions favourable to its mode of life that it persisted into the Upper Eocene period. In the meantime, however, either from this or some closely allied type, there had arisen another animal more adapted to terrestrial life and showing a great advance in the direction of the typical Proboscidea: to this creature the name Palæomastodon has been given." Elsewhere (p. xxi) Dr. Andrews notes that Mœritherium favours the view, first put forward by de Blainville, of an original relationship between the Proboscidea and Sirenia. Later on in the same work (p. 119) the same author, in commenting on the similarity between the pelvis of Mœritherium and that of the Eocene sirenian Eotherium, observes:—"Then it may fairly be suggested that Mœritherium and Eotherium, both occurring in the same region (one the most primitive Proboscidean, the other occupying the same position with regard to the Sirenia), are, in fact, closely related, and had a common ancestor in early Tertiary times, probably in the Lower Eocene." On p. 105 we find a comment on the remarkable likeness between the brains of Mœritherium and the Sirenia.

Since these suggestive comments were written other materials have been secured, including a nearly perfect skull and jaws of Palæomastodon by the British Museum and a skull of Palæomastodon and two partly preserved skulls of Mœritherium by the American Museum.

The question of habits and of affinity seems so important and interesting that the writer has taken it up afresh with these additional materials. The inquiry was suggested by the general resemblance which the skull of Mœritherium bears to that of a Sirenian as seen from above and in palatal view. The method of comparison adopted is that of making life-size models of the skulls of Mœritherium and Palæomastodon, then placing the sense organs and the mouth parts in position, guided solely by comparison with existing mammals showing more or less analogous modifications and by the actual condition of the hard parts themselves. This work was done by Mr. E. Christman under the writer's direction.[1] Palæomastodon itself in all probability had not developed a proboscis, although there is no question as to its being in the direct line of proboscidean ancestry. Mœritherium not only had no proboscis, but was totally different from Palæomastodon both in its appearance and habits, and only very remotely related to this animal, if at all. The study shows, further, that Mœritherium is closer to the Sirenians and less close to the Proboscidea than has hitherto been supposed.

A profound difference between these animals is brought out in comparing the top and side views of the skull, when it is seen that, whereas the eyes of Palæomastodon are in the typical mammalian position above the first permanent grinder, those of Mœritherium are very far forward, well raised in the front part of the head, and of very diminutive size, as shown by the shallowness of the sockets. All these are also characters of the Sirenian head. As indicated by the auditory meatus, the ears are relatively in a more elevated position than in Palæomastodon. Both these peculiarities are adaptations to aquatic life to protect the sense organs and bring them near the surface of the water in swimming, so that they will emerge first and disappear last.

FIG. 1.—Side view of the head of Palæomastodon modelled by Mr. E. Christman under direction of the author.

The cutting teeth and mouth parts of Mœritherium are also opposed in an entirely different manner from those of Palæomastodon, so that it may be said safely that there was not the most remote resemblance either between the mouth parts or the feeding habits of these two animals. In the former the nasal bones do not greatly recede, and there was consequently little or no free retractile power of the upper lip, which is always the rudimentary condition in the evolution of a proboscis, as witnessed in the living tapirs. Comparison with Hyrax, the beaver, and other animals with an enlarged pair of front teeth tends to show that the upper and lower lips were heavy and fleshy, somewhat similar in form and function, that is, in prehensile power, and that the blunt tusks may have been covered when the mouth was closed, somewhat as in the hippopotami. These tusks were feeding rather than fighting weapons, probably because Mœritherium was protected from attack by its aquatic habitat. The conclusion is that Mœritherium was a confirmed and continual river-living animal, feeding mainly under water and on the banks, more specialised for aquatic life than the hippo-

[1] These Palæomastodon beds were at first regarded as Upper Eocene, but closer comparison with those of Europe has shown that they should be rather considered as Lower Oligocene.

[2] "A Descriptive Catalogue of the Tertiary Vertebrata of the Fayûm, Egypt." (London, 1906.)

[1] The models have been reproduced and copies presented to the British Museum. The writer is indebted to Mr. W. K. Gregory for many valuable suggestions.

potami, as indicated by its feeble pelvis, but less specialised than the Sirenians. It would not be far from the truth to say, from our present knowledge of the animal, that Mœritherium is an offshoot of the Proboscideo-Sirenian stock, with *slightly* nearer kinship to the elephants than to the Sirenians.

The distinctive peculiarities of Palæomastodon are that its eyes are in the position typical among mammals, that is, above the first true grinders. The reason that they appear to be so far back is that the lower jaw is extended unusually far forward. The upper jaws, on the other hand, recede, practically terminating at the sides in the very sharp, laterally compressed tusks, which at this stage were chiefly developed as fighting or defensive weapons, while only indirectly of value as feeding organs. It is noteworthy that when the upper and lower lips are restored in such a manner as to enable the animal to close the mouth, the upper tusks are so largely covered that they are not especially prominent.

In contrast with Mœritherium, the nasal bones and openings deeply recede; thus a very wide space is left to be filled by a large retractile upper lip, which could undoubtedly be raised or lowered. The question now arises, How far had this lip begun to transform into a proboscis? Was there a free projecting proboscis as represented in several previous restorations? A negative answer appears to be furnished by the structure and mode of wear of the lower incisors. Together these form a broad, protrusive, spoon-shaped feeding organ, which is invariably greatly worn on the upper surface and somewhat less at the ends. This worn upper surface seems to prove that in the prehension of food the edge of the upper lip was constantly pressed downward against these teeth, thus, with the aid of fine particles of grit and sand, which were occasionally taken in, causing wear. In brief, the food appears to have been seized between the upper lip and the spoon-shaped lower teeth. Palæomastodon was a browser, and this lip could be turned up and retracted effectively to pull down smaller branches, but there is no reason to suppose that it had the free curling and independent prehensile power which characterises a true proboscis. If we critically consider the theory of the animal possessing a proboscis of considerable length, we find it rests upon the idea of kinship with the elephant rather than upon careful study of the mouth parts themselves.

If, now, we consider the elephant, we find that one of its many unique features is entire loss of the prehensile power of the anterior portion of the lower jaws, these parts having receded and disappeared. The elephant thus presents the widest possible contrast with Palæomastodon, in which the most prominent part of the face is the projecting lower teeth and jaw. It is obvious that the development of a proboscis took place step by step with the recession and loss of prehensile power in the lower jaw. If Palæomastodon had possessed an independent prehensile proboscis extending beyond the line of the mouth for the seizing of food, we cannot assign any function to these large and much worn lower incisors. A more probable view, therefore, seems to be that here presented in the model of the head and mouth parts, which were made directly upon a model of the skull itself. In the stages between Palæomastodon and the *M.* (*Trilophodon*) *angustidens*, the Lower Miocene elephant of Europe, the lower incisors have begun to transform into tusks to be employed in uprooting plants and smaller trees, just as the upper tusks are used by elephants now. With this change their prehensile function was gradually abandoned and assumed by the upper lip, which thus began its slow evolution into a freely projecting and prehensile proboscis.

All restorations contain a large element of conjecture; we shall certainly never know how these most interesting animals of the Lower Oligocene rivers of the Fayûm actually appeared, but the first rule of restoration is not to be too much influenced by kinship, but to adhere to the evidence afforded by the hard parts themselves. This rule has evidently been broken by the writer in attributing a small elephantoid ear to Palæomastodon. Unfortunately, there is no means of even conjecturing the shape of the ear of this animal, except to exclude the small aquatic type of ear which may be attributed to Mœritherium.

H. F. OSBORN.

FIG. 2.—Side view of the head of Mœritherium with the eye and ear in position. The form and position of the nostrils is somewhat conjectural. Modelled by Mr. E. Christman under the direction of the writer.

THE HEALTH CONGRESS AT LEEDS.

THE Royal Sanitary Institute and the Royal Institute of Public Health combined this year, for the first time, to hold under the auspices of the Corporation and University of Leeds a joint session.

No more fitting person than Colonel T. W. Harding could have been selected to fill the presidential chair, who fills at the present moment the important office of chairman of the Royal Commission on Sewage Disposal. It is difficult within the space of a few paragraphs to present a comprehensive review of the varied topics which came up for discussion in the different sections, and embraced anything from the treatment of tuberculosis to that of trade effluents, and from the ventilation of cowsheds to the hygiene of the mouth.

Although many of the views expressed, especially in the recently formed child-study section, were of a tentative nature and the result of incomplete experience or of individual opinion, a striking feature of the congress was the earnestness displayed by those participating in it, a remarkable fact when one considers how much of the work connected with sanitary matters is self-imposed, largely unofficial, and purely disinterested.

It seemed appropriate that the president, an old Leeds citizen, should have referred in his opening remarks to the sanitary improvements of the town, which had nearly halved the death-rate in fifty years; but the greater part of his address was devoted to a general survey of the growth of public interest in and control of sanitation, and the present-day problems of urban life. Among the present-day problems he referred to the continued high mortality from phthisis, pneumonia, and diphtheria, and the heavy death-rate among children. Although the president pointed to the great advances which have been made in sanitary reform in nearly every direction, he raised the important question as to whether the present system of elementary education is wholly good. "We are spending," he said, "large sums in elementary education; would it not be well to pause awhile and see if we are moving on right lines? We are cramming young minds in frail and half-fed bodies with all the information we can get into them, and most of it will soon be forgotten. By all means let us teach what we can, but without impairing physical development, which is much the most important work to be seen to."

In Mr. J. T. Quinton's (Liverpool) address to the conference of sanitary inspectors we were introduced to the inner working of the local sanitary machine and to the difficulties encountered by sanitary inspectors by the self-interest of those in the council whom they serve. He further touched on the subject of alcoholism, welcomed the introduction of systematic instruction in public elementary schools on its effects, and deprecated the view advanced by some that alcohol constitutes an article of food. He demanded further State interference in the matter of alcoholism, and the repeal of the exemption of patent and proprietary goods from the Food and Drugs Act.

One of the most thoughtful and comprehensive of the sectional addresses was that delivered by Dr. Newsholme (principal medical officer of the Local Government Board) to the preventive medicine section on some conditions of social efficiency in relation to local public administration, which can only be appreciated by a full perusal. Dr. Newsholme began by showing how closely interrelated are the social and sanitary problems, and how a more accurate knowledge and wider outlook will enable social problems to be seen more nearly in their correct perspective. By way of illustration he pointed out that "if the avoidable loss of life and health from communicable diseases were realised by the members of the sanitary authority, they would be less likely to build extravagant town halls while the water supply of the town is impure, or to provide municipal Turkish baths while backyards and streets remain unpaved. . . . And this more accurate knowledge and wider outlook means the abandonment of the old hand-to-mouth and empirical method of dealing with social evils. The conception of poverty and destitution as an element when it is, in fact, a complex compound will disappear, and with it will disappear administration which supplies doles to relieve the symptoms of destitution, without making efficient efforts to investigate its varying causation and to initiate preventive measures against its recurrence." "We have to realise the close interdependence of social evils, which often form a vicious circle where evil effects become, in their turn, sources of evil." As sickness is one of the main causes of sickness, poverty is one of the most potent causes of poverty. The growing tendency is to stop disease, whether communicable or not, at its source, the prompt and early treatment being one of the chief means of securing social efficiency, and the better organisation for the treatment of the sick, from whatever disease, must be regarded as a chief object of the preventive medicine of the future. The monetary value of lives lost, including cost of sickness, through phthisis, enteric fever, and other diseases, is so large that measures of prevention may be regarded as the best possible investment for the community. In the latter part of this suggestive address Dr. Newsholme pointed out the insecurity of tenure of medical officers, who are re-elected for periods of one to five years, and, unlike district medical officers, relieving officers, and vaccination officers, can be removed without the consent of the Local Government Board. He further referred to the overlapping and waste produced by the great variety of authorities dealing with closely related conditions.

In the presidential address to the engineering and architectural section, by Mr. G. F. Bowman (Leeds), reference was made to the question of back-to-back houses, and a strong case was made out for the erection of buildings of the modern type already existing in Leeds; but whether in this connection the working classes "should be the best judges of what is best for themselves" is a dictum open to grave criticism.

Dr. Newman (principal medical officer of the Board of Education) chose for the subject of his address in the child-study section child mortality. He began by pointing out that, of the annual half-million deaths in England and Wales, one-third occur under the age of fifteen years, and of this third 85 per cent. are under five years of age.

Whereas the death-rate at all ages above one year shows a steady decline, there is no such indication below that period. The first two years of life "form a veritable fire through which we pass the vast majority of the children of the nation, losing in the process approximately 150,000 of them every year, and marking many of the survivors with the signs of the flame." The three primary causes, then, are the physique of the mother, infant mismanagement, and exposure. "It is idle," said Dr. Newman, "to patch up children at school age if we first make them all pass under damaging and devitalising conditions at the beginning of their lives."

In the industrial hygiene section Dr. Whitelegge (London), as president, gave an address on the relation of health to industry. He began by referring to the improvements in industrial conditions brought about by the combined action of employers and employed, and to the responsibilities thrown upon local authorities in respect to initial construction of buildings. He pointed out the difficulties which attend an investigation into the causes affecting health in certain complex trade processes unless the different operations are separately grouped, and he further emphasised the importance of keeping safety appliances in an efficient state. In this connection he mentioned the importance of permanent local exhibitions of safety appliances, such as exist abroad, especially in textile centres, in metal and mining localities, and in the Potteries. Thus, in the removal of dust, as in metal grinding, there is no source of information, and unless expert advice is taken costly mistakes may result. There are standards of ventilation, of humidity, and of soluble lead in which employers and employed should have opportunities for instruction. Lead poisoning from glazing has been reduced by three-quarters in the last twelve years, but phthisis, or "potters' rot," from dust inhalation is still prevalent. Clearer definitions as to factory lighting and temperature in reference to humidity are required, and further information should be obtained in reference to fatigue in different arduous employments. The welfare of operatives in certain industries is affected by demands on the part of consumers. A large section of the public had grown accustomed to phosphorus matches, and it was not until the match manufacturers agreed unanimously to the prohibition of phosphorus, coupled with prohibition of import, that the Government was able to put an end to this needlessly dangerous branch of industry.

In his presidential address to veterinary surgeons, Mr. H. G. Bowes (Leeds) welcomed the recognition accorded by the President of the Local Government Board to the necessity of proper veterinary inspection of dairy cattle, though, he continued, "why the farce of the M.O.H. inspecting the cows, accompanied by a veterinary surgeon, should be kept up I don't know," nor why the inspection of cowsheds and byres should not be done by the same inspector. He further advocated the appointment of a veterinary adviser to the Local Government Board, whose advice in dealing with bovine tuberculosis would be invaluable. He emphasised especially the necessity for more rigorous treatment of this disease, which, it is unanimously agreed, is transmissible to, and a recognised cause of, disease in human beings. In view of the wide-spread nature of the disease at present, the slaughter of all tainted cattle would be impracticable, but a gradual weeding out of the worst cases as centres of infection might be initiated. A most important step has been taken in the Tuberculosis Order which comes into force on January 1, 1910, which requires compulsory notification and slaughter of all cattle obviously affected. He claimed further attention to the condition of cowsheds throughout the country, as exercising an important effect in diminishing the disease. In the conclusion of his address Mr. Bower referred to the abuse of tuberculin by the indiscriminate sale.

The treatment of sewage was among the subjects which came up for discussion at a joint meeting of the engineering, bacteriology, and chemistry sections, when interesting papers were contributed by Messrs. E. J. Silcock,

A. J. Martin, J. T. Thompson, and G. A. Hart. Mr. Silcock dealt with a new method now at work at Rothwell, in which, after removing grit, the sewage is pumped on to a revolving fine-mesh screen, then taken to deep percolating bacteria beds, then through sand filters, and discharged.

In the section of preventive medicine an important paper was read by Dr. Robertson (Birmingham) initiating a discussion on tuberculosis. He pointed out that more human suffering is due to tuberculosis than to any disease, that it was produced by infection derived from cases of phthisis, from milk, and possibly from meat, and developed slowly after the germ is taken into the system. He emphasised the importance of milk and meat in carrying infection, and pointed out that more than 30 per cent. of dairy herds are infected. In this connection more attention should be given to the ventilation of cowsheds. Dr. Woodcock (Leeds) followed with a paper on the physique of the phthisical as a means of diagnosis, whilst Dr. Trevelyan (Leeds) discussed the methods of preventing infection from those already suffering from the disease. An interesting discussion followed, and a resolution was passed "that the Health Congress wishes to direct the attention of agricultural societies to the great assistance which they might render to the community by making it one of their conditions in offering prizes for dairy cattle that the animals should be free from tuberculosis."

Subsequently papers were read on the protection of the food supply. Imported and canned foods were dealt with by Dr. H. Williams (London) and Dr. W. F. Dearden (Manchester), whilst Dr. Savage (Colchester) discussed the administrative measures for examining food supply in general, Mr. W. G. Barnes (London) advocated measures for eradicating tuberculosis from the milk supply, and Dr. Stedman explained methods of administering the "Dairies' Order." In the bacteriology section papers were contributed by Mr. J. Johnstone; on the significance of leucocytes in milk as indicating a need for detailed examination, by Dr. Savage (Colchester); on the catalase of milk as an indicator of disease, by C. Revis (London); and on the growth of the bacillus tuberculosis, by Dr. Moore and R. S. Williams (Liverpool). In the latter the important observation was made that the bacillus will only grow between certain definite limits of oxygen pressure, being equally stopped by absence of oxygen or by more than 60 per cent. To stop and kill the organisms completely about 70 per cent. of oxygen must be present, which does not interfere with the majority of other organisms tested. In the same section a joint paper was read by Prof. Grünbaum and Dr. M. Coplans (Leeds) on the selective action of preservatives, in which they discuss the effect of different preservatives on the growth of organisms. Papers were also contributed by Mr. J. C. G. Ledingham (Aberdeen), on the bacteriology of summer diarrhœa; by Dr. S. G. Moore (Huddersfield), on the advantages derived from its notification to the authorities; and by Dr. Buchan (St. Helens), on administrative measures for its reduction.

An interesting series of papers was read in the engineering and architectural section on water supply and treatment of trade water, and in the section on industrial hygiene lead poisoning, its pathology and prevention, abstracts of which, from want of space, cannot be given.

Sir Charles Cameron gave an attractive popular lecture on underground and overground air.

During the congress the University of Leeds took advantage of the occasion to confer degrees *honoris causa* on the president of the congress, Colonel T. W. Harding, and on Sir James Crichton-Browne, F.R.S., and Major Ronald Ross, F.R.S.

LANCASHIRE FISHERY INVESTIGATIONS.[1]

THE report of the Lancashire Sea-fisheries Laboratory at Liverpool for 1908 gives evidence of sustained investigation into problems that demand several years' work for their solution. The articles are in almost every case continuations of those contributed to the report of 1907, and it is therefore unnecessary in a brief review to do more than summarise the findings of the several workers on the fishery questions with which they have been so long occupied.

Prof. Herdman gives a further instalment of results obtained by tow-netting with modern nets in the Irish Sea. This method of obtaining the floating or drifting organisms is now becoming more delicate, and the catching power of the nets is more accurately known than was formerly the case. The object in view being an exact determination of the distribution and fluctuation of the "plankton," no trouble is too great and no determinations are too laborious to deter the director of the fisheries work. Accordingly, this paper contains an immense amount of data both as to methods and results with regard to the seasonal and local variations in this fauna, and also with reference to the influence of conditions upon its abundance and behaviour. The statistical work involved in such a report is very great, and the credit of these laborious tables is due to the zeal of Mr. Andrew Scott. On the whole, the results of 1908 show the correctness of the conclusions arrived at in the previous contribution to this "intensive study" of plankton round the Isle of Man, but they also demonstrate some seasonal divergences which are in all probability of considerable importance to fishermen, as affecting the arrival of spring or autumn migrants. The only criticism that we feel justified in making upon such a heavy and valuable undertaking is the absence of any analysis of the light-factors that influence plankton, but we hesitate to press this criticism, as Prof. Herdman has not published the whole of his results.

Of the more striking fishery papers, attention may be directed to Mr. Johnstone's important experiments on quarantining mussels. Mr. Johnstone has determined the degree of bacterial pollution in a number of shell-fish taken from Welsh and Lancashire bays, and finds that the contamination, though, as a rule, not serious, is probably due to general contamination of the water or sea-bed in these districts. In some cases, however, the pollution is more serious, and, by transferring these heavily infected mussels to cleaner open water, Mr. Johnstone finds that in four days' quarantine the maximum amount of sterilisation is effected. The bare fact, of course, has long been known, for oysters infected by typhoid, for instance, but this report is a continuation of that more extended investigation which is needed in order to enable fishermen themselves to increase a healthy supply of shell-fish near the larger towns. Mr. Johnstone also contributes papers on the temperatures of the Irish Sea, on the growth and migration of plaice, on parasitic growths in flat fish, and a joint paper with Capt. Weigall on the outfit of the fine new boat, *James Fletcher*, which the Lancashire Sea-fisheries Committee commissioned recently. In addition to these papers, the wider aspects of biological investigations are not overlooked, and we are glad to see that Dr. Bassett has continued his hydrographical study of the Irish Sea by a further analysis of its salinities. It is to be hoped that aid will be forthcoming to provide the Lancashire committee with a member of staff specially devoted to such work.

Lastly, reference must be made to an excellent *résumé* of the method for finding the coefficient of plankton-nets (in regard to catching power) by Mr. Dakin. This gentleman's elaborate study of Pecten, forming an appendix to this report, has been noticed already in these columns (May 6, p. 273), and we may merely, therefore, refer to it as an example of the good results obtained by bringing different methods to bear upon the study of an organism.

[1] Report for 1908 on the Lancashire Sea-fisheries Laboratory at the University of Liverpool and the Sea-fish Hatchery at Piel, No. xvii. Pp. 366+9 plates. Drawn up by Prof. Herdman, F.R.S., assisted by Andrew Scott and J. Johnstone. (Liverpool, 1909.)

ORIGIN AND RITES OF GYPSIES.

IN the *Journal of the Gypsy-lore Society* for April Miss D. E. Yates publishes a translation of a paper by Prof. R. Pischel, originally published in the *Deutsche Rundschau* for 1883, on the home of the Gypsies. Reviewing various references to the origin of this race, he comes to the conclusion, on the evidence of philology, that the Gypsy dialects are closely connected with those of Dardistan, and he accordingly fixes this region as the original Gypsy home. This view is based largely on materials collected by Drew, Biddulph, and Leitner. It is unfortunate that this opportunity was not taken to utilise the results of Dr. Grierson's linguistic survey, which now supplies ample glossaries and grammars by which the problem may be solved. Pischel's view is accepted by Dr. Grierson in his chapter on the languages of India in the first volume of the Report on the Census of India for 1901. He regards the Indian origin of the Gypsies as fully established, and while it is doubtful from which Indian tribe they really sprung, he believes that they spoke one of the non-Sanskritic Indo-Aryan tongues, which are by him grouped under the heads of Shína-Khowár, Káfir, and Kalasha-Pashai. The work of Sir G. Robertson on the Kafirs of the Hindu-Kush also supplies materials which might have been utilised in re-editing Prof. Pischel's paper.

Mr. E. O. Winstedt contributes to the same number of the journal an interesting paper on the Gypsy rites connected with birth, marriage, and death. It is a good collection of material, much of which has been gathered from comparatively obscure sources, but it is to be regretted that before publication it did not pass through the hands of a competent student of comparative ethnography. Among birth rites, he notes the customs of laying the child on the ground, the passing of the mother and baby through fire into which, among some of the subtribes, drops of the father's blood are allowed to fall. In connection with marriage, we have references to the customs of exchanging wives; the use of the broomstick and tongs as marriage symbols; the lifting of the bride over the doorstep; the exchanging of vows over a dead horse or hen; the blood covenant; the dance upon layers of sweetmeats; the custom of placing lighted candles, eggs, and apples in a stream; a custom, probably misinterpreted, of so-called marriage by capture; methods of divorce; and the curious custom, which has Indian parallels, of the father-in-law cohabiting with his daughter-in-law during the youth of his son. Among death rites, he mentions that of burning the clothing and other property of the dead man at the time of his burial, a custom of which various interpretations are suggested; interment without a coffin; disinterment of the dead; and the pouring of liquor on the grave. The variance of custom among the different Gypsy groups points to the conclusion that they have assimilated much from the races with whom they successively came into contact. It is now probably too late to fix the exact provenience of customs such as are described in this paper. If this could be done it might furnish valuable material for the investigation of the origin of this mysterious people.

CLIMATOLOGICAL REPORTS.

THE climate of the island of Norderney (lat. 53° 43′ N.) forms the subject of part iii., vol. xxxi., of *Aus dem Archiv der deutschen Seewarte*. The observations were very carefully made several times a day for nearly ten years (between 1880 and 1890) by the late Mr. O. J. Ommen; the instruments and exposure were not all that could be desired, but Dr. R. Assmann, of Lindenberg, has taken great pains to correct these defects, as regards temperature, by comparisons with hourly observations at Hamburg, Bremen, &c., the result being that the paper becomes a very useful contribution to the meteorology of the coast of East Friesland. The moderating influence of the sea upon the air temperature is plainly shown; the autumn and winter months have higher, and the summer months lower, temperatures than the Continental stations; the yearly variation at Norderney is only 17·1° C., while at Berlin it is 19·2°. It is interesting to note that the equinoctial gales maintain their old reputation at Norderney, the stormiest months being March and October.

The year-book of the Austrian Meteorological Service for 1907, which has recently been published, contains, as in previous years, hourly (1) readings or means at observatories possessing self-recording instruments; (2) daily observations and monthly summaries at a number of selected places; and (3) temperature and rainfall tables for all stations. Many of the stations are situated at great elevations, and the data are consequently of especial interest. The observations at purely rainfall stations are not included in the year-book, but are published separately by the hydrographic department. With the aid of the Academy of Sciences, the Austrian Meteorological Society and other bodies, the investigation of the upper air by means of balloons has been regularly continued, and the detailed observations are published in the *Anzeiger* of the academy. The reports of earthquake phenomena at various stations are also published in the *Anzeiger*, and, in addition, a weekly report is issued. This special service was taken over during the late Prof. Pernter's administration, and to it the office owes its present name, "Zentralanstalt für Meteorologie und Geodynamik." In connection with its system of weather telegraphy, forecasts are sent by wire daily, free of charge, from April to November, to all post and telegraph offices in Austria; to south Tyrol they are sent all the year round.

The report by Captain H. G. Lyons, director-general of the Survey Department, Egypt, on the rains of the Nile basin and the Nile flood of 1907, contains valuable statistics of the monthly and mean rainfall at a large number of stations in and near the Nile basin, with particulars of the lake- and river-levels of 1907 and previous years. The rainfall at Lake Victoria was 20 per cent. to 30 per cent. in defect, and caused famine in parts of Uganda, while on the Bahr el Jebel, the White and Blue Nile, the rains were mostly weak and irregular; the basin of the Atbara alone had a fair amount. The Nile flood was late in commencing, and very weak throughout the year; the volume of water which passed Wadi Halfa and Aswan respectively, between July and October, was only 0·65 and 0·60 of an average flood. That a flood which was so complete a failure should not have had a disastrous effect on Egyptian agriculture, Captain Lyons remarks, is due to improvements in the irrigation system of recent years and to rains on the Abyssinian tableland in the early part of the year. The investigation of the rainfall of Abyssinia is of great importance in estimating the supply of water, but there is at present an almost complete absence of trustworthy observations. The stations established by the Italian Government in Eritrea furnish most valuable results for understanding the meteorological conditions of the eastern Sudan; telegraphic rainfall reports sent daily from Addi Ugri in August and September rendered important assistance in connection with forecasts of the flood.

The year-book and rainfall report for 1908, issued by the Norwegian Meteorological Institute, have been received. These volumes contain:—(1) Hourly readings and means for Christiania, observations taken three times a day at selected stations, and monthly and yearly summaries at other places; (2) daily rainfall values at 200 stations, with monthly and yearly summaries and other details at 449 stations, and yearly amounts and averages for each year from 1867. The charts showing the yearly distribution of rainfall (isohyets) for each 200 mm. clearly exhibit the effect of the rugged land on the water-laden currents from the Atlantic. The isohyets on the western coasts show amounts of 2000–3000 mm.; these amounts rapidly decrease to 1000 and even to 400 mm. in the interior of the country. The weather forecasts issued by the institute are generally very accurate; those for the Christiania district show an average success of 88·3 per cent. This result is to some extent due to daily telegrams from Iceland and Færöe Islands, and to reports of weather at British stations, now received through the medium of the Deutsche Seewarte.

PROCESSES FOR THE FIXATION OF ATMOSPHERIC NITROGEN.

THE fixation of atmospheric nitrogen on a commercial scale has already been the subject of articles in NATURE (February 8, 1906; August 30, 1906; July 23, 1908). The method used by Birkeland and Eyde depends upon the well-known fact that an electric arc may be broadened out into a fan shape under the influence of a magnetic field. Through the arc thus formed air is driven. Since, however, only a small portion is raised to the temperature necessary for the reaction, while the greatest part serves for cooling, the gases escaping from the Birkeland furnace at a temperature of from 600° C. to 700° C. do not contain more than from 1 per cent. to 2 per cent. of nitric oxide. For further cooling, the gases are led under boilers or through a distilling apparatus, and, finally, at a temperature of about 50°, into an oxidation chamber, where further oxygen is taken up, forming nitrogen dioxide, which in turn is absorbed by water, and thus converted into nitric acid.

To facilitate shipment, not a pure calcium product, but a basic nitrate less hygroscopic was obtained. By a new process (German patent 206,949) the nitrous gases are absorbed by calcium cyanamide, forming a mixture of nitrate of ammonia and nitrate of calcium. When this solution is tested with sulphate of ammonia (Norwegian patent 18,029 of Birkeland) calcium sulphate is deposited, leaving a solution of an ammonium product. By testing this again with sulphuric acid, and distilling, nitric acid is given off, and sulphate of ammonia remains. By this means, therefore, concentrated nitric acid is also obtained from the nitrous gases. The furnaces, used in the Norwegian plants (the first at Notodden) for the production of nitric acid from the air, work with 500 to 700 kilowatts at a pressure of 5000 volts. The coefficient of reduction of these furnaces is 0·7 to 0·75.

The method of Schönherr (Badische Anilin- und Soda-Fabrik) is said to be much more economical in the use of electric energy. In this process a perpendicular tube is employed having at the lower end an electrode, between which and the walls of the tube or an upper electrode a long arc is maintained. The air rushes whirling through the tube, filling it throughout its length, which may be several metres, with a steadily burning arc. There are now three furnaces, each employing about 600 horse-power, and using an arc about 5 metres long. Single-phase current is used at high pressure.

Recently Birkeland has lengthened his furnace and considerably increased the distance between the electrodes. By means of the magnetic field a long arc is produced which takes the shape of a screw and rotates in the furnace; by this means the air, which enters in the direction of the arc, is set in violent motion (American patent 906,682, dated December 15, 1908).

Mention should also be made of the method of Haber and König (French patent 392,670), which may be regarded as a great step in the development of the processes just mentioned. Here the mixture of nitrogen and oxygen is led under a low pressure into the narrow tube in which the flaming arc burns, the tube being well cooled on the outside. By this means, it is stated, gaseous mixtures are obtained from the air which contain from $9\frac{1}{2}$ per cent. to $10\frac{1}{2}$ per cent. of nitrous oxide, whereas in the older Birkeland-Eyde furnace only 1 per cent. was obtained.

In a paper read at the recent International Congress of Applied Chemistry Mr. Bagley directed attention to the production of nitric acid and nitrate of ammonia direct from ammonia gas. A plant is working successfully in connection with a battery of coke ovens in Germany. Ammonia gas mixed with air is forced rapidly through a plug of platinum. Every seventeen parts by weight of ammonia produces sixty-three parts by weight of nitric acid of 36° Be. Nitrate of ammonia is also produced by neutralising the nitric acid with a further supply of ammonia obtained from crude gas liquor. By a modification of the Mond process ammonia is also obtained from the gasification of peat.

IMPROVEMENTS IN PRODUCTION AND APPLICATION OF GUNCOTTON AND NITROGLYCERINE.[1]

FOR centuries the only explosive known to the world was that mechanical mixture of saltpetre, charcoal, and sulphur called gunpowder. Chemical explosives may be said to date from the discovery of guncotton by Schönbein, and it is a fact worth noting on this occasion that the first sample of guncotton in this country was one which accompanied a letter of Schönbein from Basle, dated March 18, 1846, and addressed to Michael Faraday at the Royal Institution. Schönbein referred to guncotton in this letter as follows:—

"There is another point about which I take the liberty to ask your kind advice. I am enabled to prepare in any quantity a matter which, next to gunpowder, must be regarded as the most combustible substance known. So inflammable is that matter that on being brought in contact with the slightest spark, it will instantly be set on fire, leaving hardly any trace of ashes, and if the combustion be caused within closed vessels a violent explosion takes place. That combustible substance is, as I will confidently tell you, raw cotton, prepared in a simple manner, which I shall describe you hereafter. I must not omit to mention that water has not the least action upon my matter, that is, that it may be immersed ever so long in that fluid without losing its inflammability after having been dried again. A substance of that description seems to be applicable to many purposes of daily life, and I should think that it might advantageously be used as a powerful means of defence and attack. Indeed, the Congreveian rockets can hardly be more combustible than my prepared cotton is. What shall I do with that matter? Shall I offer it to your Government? I have enclosed a little bit of that really frightful body, and you may easily convince yourself of the correctness of my statements regarding its properties."

In a subsequent letter he gave this body the name of guncotton.

Attempts to manufacture guncotton in accordance with the method devised by Schönbein were made both in this country and abroad. Accidents which occurred, however, both in Great Britain and France in the early days of manufacture, led to the abandonment of attempts to produce it in these countries; it was only in Austria that its production was persevered with, and a system of manufacture worked out there by Baron von Lenk. Having succeeded in producing guncotton on the manufacturing scale, von Lenk turned his attention to adapting it for propulsive purposes, and although at one time his efforts appeared to have met with a certain amount of success, and batteries of field artillery in Austria were actually equipped with guncotton cartridges, the difficulty of moderating its rate of combustion was never satisfactorily overcome. While this question was still the subject of experiments, serious accidents, due to the spontaneous combustion of guncotton in store, led to its production being given up even in Austria.

In 1863 Sir Frederick Abel took up the study of the manufacture of guncotton in this country with the view of adapting it for propulsive purposes, and, at the same time, of improving its stability, so that its spontaneous combustion in store might be prevented.

He was not successful in the first object, but, as regards the production of guncotton of good stability, the modifications that he introduced into the von Lenk system of manufacture resulted in the production of stable guncotton.

The process of manufacture devised by von Lenk was briefly as follows:—

Skeins of long staple cotton yarn were immersed in a mixture of strong nitric acid of 1·52 sp. gr., one part, and sulphuric acid of 1·84 sp. gr., three parts, contained in iron pans. The skeins were stirred about in the acid bath for a few minutes, removed to a grating above it, and some of the acid squeezed out with a suitable iron tool. The cotton, while still thoroughly wetted with acid, was transferred to earthenware pots, in which it remained for forty-eight hours. The pots stood in cold water to prevent decomposition of their contents. At the end of two days the conversion of the cotton into guncotton was complete; the skeins were removed from the pots, and as much as possible of the acid removed in centrifugal wringing machines. After centrifugalling the skeins were drowned as rapidly as possible in a cascade of water, the object being to remove the rest of the free acid. The final purification was effected by immersing the skeins for about three weeks in running water, boiling for a few minutes in an alkaline solution, and finally washing for a few days in flowing water.

In all that concerned the actual process of nitration Abel followed von Lenk, but instead of using skeins of long staple cotton he introduced the use of cotton waste from the spinning mills, suitably cleaned, and after the free acid had been removed in the preliminary drowning the

[1] Discourse delivered at the Royal Institution on Friday, January 29, by Sir Frederic L. Nathan, R.A.

guncotton, still in the same physical condition as the cotton waste from which it had been produced, was reduced to a fine state of division in a beating-engine. The effect of this important modification was to remove the last traces of "free acid" and of unstable bodies, so that the prolonged washing in cold water could be dispensed with, and, at the same time, a much more stable product obtained.

Cotton fibre is of a tubular structure, and so long as these tubes exist in long lengths the impurities in the interior of the tubes, derived from the evaporated juices of the cotton plant, and more or less affected by the nitration process, are extremely difficult of removal. Not only is the cotton in the form of long tubular fibres, but these fibres are themselves matted and entwined to such an extent that the former process of washing in running water even failed to remove impurities from amongst the bundles of fibre.

The operation of pulping introduced by Abel breaks up both the bundles of fibre and the fibres themselves, reducing the latter to short lengths or destroying them altogether by crushing. In this fine state of division the removal of impurities is much more readily effected by washing.

The manufacture of guncotton by the von Lenk-Abel process was commenced in this country about 1865. Foreign countries took it up in quick succession, and the process was the one universally followed for the next forty years. Some modifications of the nitration process were made towards the end of that period, in one case in the direction of dipping larger charges of cotton waste, and of allowing them to remain in the original acid mixture until nitration was completed, and then transferring the whole contents of the nitrating pan into the acid centrifugal; in another case the nitration process was actually carried out in the centrifugal itself.

In 1905, however, an entirely new system of nitration, hereafter referred to as the "displacement process," was invented by Messrs. Thomson, of the Royal Gunpowder Factory, and this process has been perfected and has entirely replaced the pot system of nitration there, and at Nobel's Explosives Factory at Ardeer, in Scotland. It is also being adopted at other factories both in this country and abroad.

The nitration of the cotton waste is carried out in shallow, circular earthenware pans. These pans are grouped together and worked in sets of four. The bottom of the pan slopes downwards to a central hole, connected by suitable pipes and cocks to a pipe supplying the nitrating acid, and to other pipes through which the waste acid is removed on completion of nitration. The pans are covered with aluminium hoods connected to an exhaust fan, for carrying off fumes.

Nitrating acid is then run in up to a definite mark, and a charge of 20 lb. of dry cotton waste is immersed in the acid in each pan in small quantities at a time. An aluminium fork is used for the purpose. When the charge of cotton waste has been dipped, perforated earthenware plates are placed on the top of it to keep it all under the surface of the acid; a film of cold water is run on to the surface of the plates and serves as a seal to prevent fumes getting into the room, and the aluminium hoods are removed. The cotton waste remains soaking in the acid for two and a half hours; at the expiration of that time its conversion to guncotton is complete. The cock leading to the waste acid pipe is then opened, and the waste acid allowed to flow away from the guncotton at a definite rate, whilst cold water is allowed to flow on to the top of the perforated plates at an equal rate. The water follows up the acid through the guncotton without any appreciable mixing of the water and the acid taking place, and when the whole of the acid has been displaced in this way the water is allowed to drain away from the guncotton, which is then ready for the final purification process. This system of manufacture possesses many advantages over the systems which it is superseding. Foremost among them are:—

(1) Decreased cost of manufacture, due to the facts that for a given output very much less labour is required; that the plant is both very cheap and very durable; that no power is required to work it; that less acid is lost in the washing processes; and that, owing to the absence of fumes and spilt acid, the cost of maintenance of the buildings is reduced.

(2) Increased safety so far as personnel is concerned, because there is no escape or splashing about of acid, which in the old processes was a fruitful source of acid burns, and also because decompositions, which used to take place both in the digesting pots and in the acid centrifugals, with the consequent evolution of poisonous oxides of nitrogen, no longer occur.

(3) A better guncotton is obtained. It is freer from unconverted cotton, and as the whole of the nitration and preliminary washing operations are carried out in earthenware receptacles, it is freer from mineral impurities.

(4) An increased yield to the extent of about 7 per cent. is realised.

The manufacture of guncotton was not commenced at the Royal Gunpowder Factory, Waltham Abbey, until the year 1872. Shortly after that date an improvement was made in the purification process. It consisted in subjecting the guncotton, while still in the waste form, to a series of steam boilings in large wooden vats. In the early days of this process boilings of long duration were used throughout. Later, a system was introduced in which a large number of short boilings at the commencement was followed by a couple of final long boilings. With the introduction of the displacement process of nitration, a thorough investigation of the chemistry of the boiling process was undertaken at Waltham Abbey, and as a result it was ascertained that a more rapid purification was effected by means of two long boilings, each of twelve hours' duration, followed by a series of very much shorter ones.

It is very probable that the displacement system of nitration is itself responsible for the reduction in the amount of boiling required to produce a stable guncotton. Although there is no appreciable amount of mixing taking place between the displacing water and the waste acid, still, mixing at the surface of contact does occur to a slight extent, sufficient to produce a distinct rise of temperature. The zone of warm acid liquid produced passes very slowly through the whole of the guncotton, removing in its course various impurities. The purifying action of this liquid is no doubt due to the fact that it possesses strong oxidising and solvent properties.

The pulping process introduced by Abel is still universally employed, and although its value from a purification point of view is no longer of such great importance now that guncotton is boiled as it was in the early days of cold-water washing, it is, undoubtedly, still of use in effecting a final purification of the guncotton.

In the beating-engine the mechanical process of reducing the guncotton to a pulp is effected, but no actual removal of impurities takes place, because the water is not changed during the operation. The impurities still present in the guncotton at this stage are both mechanical and chemical. The mechanical impurities consist chiefly of particles of metal of various kinds, sand and fine grit, wood and similar substances, introduced originally in the cotton waste and during the processes of manufacture. The chemical impurities are bodies produced by the action of the nitrating acid on bodies other than cellulose; they are not entirely removed in the boiling process, but are set free in the pulping. To remove the mechanical impurities the guncotton pulp, in a large volume of water, is at Waltham Abbey run from the beaters over flannel laid on long shallow troughs, the troughs having pockets with baffle plates at intervals. The rough surface of the flannel retains the fine particles of grit, &c., and the larger particles settle in the pockets or grit-traps. In the last pocket an electromagnet is inserted to remove iron or steel particles which may have escaped retention in the grit-traps.

The guncotton thus freed from mechanical impurities runs into large oval iron tanks called "poachers," where it receives several cold-water washings. The contents of the poacher are agitated by means of a power-driven wooden paddle-wheel, and then allowed to settle. The washing water containing the impurities is drawn off from the surface of the guncotton by means of a large skimmer, in order that not only impurities in solution may be removed, but also any light solid impurities in suspension.

The finally purified pulp is passed to a moulding machine, where it is lightly compressed to remove the bulk of the water, and converted into a form in which it can be easily handled. If intended for use in mines or torpedoes, or for demolition purposes, the lightly compressed shapes are submitted to heavy hydraulic pressure, converting them into dense hard blocks.

The other high explosive of which I am to speak, viz. nitroglycerine, enters into the composition of many modern propellants. Nitroglycerine was discovered by Sobrero in 1847, but it remained for a long time a chemical curiosity only.

Alfred Nobel commenced its manufacture as a blasting agent about 1868, for which purpose he absorbed nitroglycerine with an infusorial earth known as kieselguhr, and gave the compound the name of dynamite; but, prior to this, nitroglycerine had been made on a large scale in America, where it was frozen after manufacture for purposes of transport, and used for blasting.

Nitroglycerine is a liquid, and is a much more violent explosive than guncotton, and whereas the manufacture of guncotton is absolutely safe throughout, that of nitroglycerine is dangerous. The risks attendant on the manufacture of nitroglycerine are due to the facts that the temperature resulting from the chemical reaction is not so easily controlled, and that nitroglycerine, being a liquid insoluble in water, the processes after nitration have to be carried out with a substance not rendered inert, as guncotton is, by admixture with water. For these reasons the nitration of glycerine in the early days of the production of nitroglycerine on a manufacturing scale was carried out in very small quantities.

With the introduction of dynamite, the small pots used for the nitration of glycerine, standing in vessels full of ice water, were replaced by lead tanks, in which considerable quantities of glycerine, amounting to several hundred pounds, were nitrated at one operation. In these vessels the temperature was controlled by means of cold water circulating through lead coils fixed in the tank, and the whole contents of the tank were kept in agitation during the nitration by means of mechanical stirrers or by compressed air escaping through small holes in lead pipes situated at the bottom of the nitrating vessel. On completion of the nitration it was the practice in the early days to drown the whole of the charge of nitroglycerine and waste acid in a large bulk of water, from which the nitroglycerine separated out and was removed for subsequent purification by washing with alkaline solutions in lead tanks. This system entailed the loss of the waste acid, and was superseded by a process in which the nitroglycerine and waste acid were run from the nitrating vessel into another vessel termed a separator, and allowed to separate in it. The nitroglycerine, being lighter than the waste acid, came to the top, and was run off into a third tank for preliminary purification, consisting of several water washings.

This preliminary purification removes most of the free acid adhering to and dissolved in the nitroglycerine, but in order to obtain a stable product a further and prolonged purification is necessary, as in the case of guncotton. This is effected in lead tanks by repeated washings with warm, dilute sodium carbonate solution. The alkali remaining in the nitroglycerine after this treatment is thoroughly removed by washing with purified warm water. As nitroglycerine is a somewhat viscous liquid, special care has to be taken that the washing solutions are brought into very intimate contact with every portion of the charge of nitroglycerine. For this purpose the method universally employed is to agitate the contents of the washing tanks by means of the escape of air under compression through small holes in the bottom of the tank. As a result of this very thorough agitation the nitroglycerine, even after the removal by skimming of as much as possible of the washing liquid, still contains a small proportion of water suspended in it in a very fine state of division. It also contains small quantities of flocculent impurities and mineral matter derived from the glycerine and acids. To get rid of these bodies filtration is resorted to; coarse crystalline salt is very usually employed as a medium, but at Waltham Abbey it has been found that a filter in the form of a mat of sponges is more efficacious and free from the objections salt filters possess.

After the removal of the nitroglycerine from the waste acid, which takes place in a comparatively short space of time, the waste acid was run out of the separator into large lead vessels, where it remained for days, in order to allow of the formation and removal of the last traces of nitroglycerine. This process is known as after-separation, and was necessary to enable the waste acid to be dealt with without risk, because so long as it contained any traces of nitroglycerine it could not be stored or handled without risk of violent decompositions, or even of explosions, taking place.

This system of manufacture, comprising nitration, separation, preliminary washing, final washing, and after-separation, all carried out in different vessels and in different houses, was the one which, with slight modifications in detail, was followed almost universally, and is still in use in many of the older factories in this country and abroad. Its disadvantages are several. In the first place, owing to the fact that it is unsafe to transport or to carry liquid nitroglycerine about, factories are always designed so that it may flow from process to process by gravity. The result, obviously, is that nitroglycerine houses must be built on the side of a hill, or, as this is not always possible, the alternative of building a nitrating house, and also, probably, a separating house, on artificial mounds, has to be resorted to, entailing a very considerable expense.

In the next place, owing to the corrosive nature of the mixture of nitroglycerine and waste acid, and to the acid nature of the nitroglycerine even when separated from the waste acid, the only material which can be used for the cocks necessary to allow the nitroglycerine and acid to run from vessel to vessel is earthenware. The use of earthenware cocks is attended with considerable risk, owing to the fact that there is friction in them between the key and the body of the cock, and there is always the risk in moderately cold weather of the nitroglycerine freezing and fixing the key; force, if used in these circumstances, would be very liable to cause accident. Again, the necessity of storing the waste acid under observation for long periods is a costly one, both as regards labour and plant required.

It was to overcome these disadvantages that the whole system in current use for the manufacture of nitroglycerine received very careful consideration at the Royal Gunpowder Factory some years ago.

The first step that was taken to improve matters was to abolish the use of earthenware cocks in the preliminary and final washing tanks. As the nitroglycerine when it was ready to leave these tanks was thoroughly free from acid, it was possible to get rid of the cocks on these tanks, and to replace them by rubber tubes. During the washing operations this tube is secured to a nozzle fixed to the outside of the tank at a point above the level of the liquid. To run off the nitroglycerine it is only necessary to slip the rubber tube off the nozzle and direct it into another vessel or into a lead gutter used to convey the nitroglycerine to the next operation.

Rubber, however, could not be used in the case of the separator or the nitrator, where either acid nitroglycerine or a mixture of nitroglycerine and acid had to be drawn off. To overcome the difficulty in this case an entirely new system was invented at Waltham Abbey. Instead of running the nitroglycerine and waste acid on completion of the nitration process into the separator, the separation is allowed to take place in the nitrating vessel itself. Nitroglycerine as it separates from the waste acid comes to the top, it being the lighter of the two liquids, and to remove it from the nitrator all that is necessary is to raise the liquid contents of the vessel gradually until the nitroglycerine reaches the top of the nitrator, where a pipe or gutter is fixed to lead the nitroglycerine away into the preliminary washing tank. This raising of the charge is effected by introducing into the bottom of the nitrator, through the same pipe by which the nitrating acid is admitted, the waste acid from a previous charge. The rate of inflow of the waste acid is regulated, so that the nitroglycerine displaced is as free as possible from acid in suspension.

The waste acid has still to be dealt with. It was discovered that the addition of a small percentage of water to this acid, after the nitroglycerine has been separated from it in the nitrator-separator, entirely prevents the further formation and separation of the small traces of the nitroglycerine, which the after-separating bottles were required to deal with.

The advantages of the Waltham Abbey plant and system of manufacture over others are briefly as follows:—

(1) *Increased Safety.*—By the abolition of all cocks through which nitroglycerine had to pass, the risks attendant on their use have disappeared. By the presence of cooling coils in the one and only vessel in which nitroglycerine and acids are in contact, any undue rise in temperature, always a possibility in the circumstances, can be at once checked. It was not usual to have cooling coils in the separator and after-separating bottles.

(2) *Reduction in Total Elevation for, and Area of a Factory.*—The abolition of the separator, and the running off of the nitroglycerine from the top of nitrator, effect a very material saving in the height required.

The after-separating house being no longer necessary, or the separator house when one existed as distinct from the nitrating house, the number of buildings, and therefore the ground area, is substantially reduced.

(3) *Reduced Cost of Production.*—This results from the fact that the capital outlay for a factory is much less, that fewer men are required for a given output, that there is less plant and fewer buildings to maintain, and that the plant itself suffers slower deterioration. Finally, the yield of nitroglycerine is increased by at least 5 parts for every 100 parts of glycerine nitrated.

The substitution recently of Nordhausen for ordinary sulphuric acid has further improved the yield of nitroglycerine, and whereas a few years ago a yield of 210 parts of nitroglycerine for every 100 parts of glycerine nitrated was considered excellent, the average yield at Waltham Abbey is now 230 per cent., a very high figure in view of the fact that the theoretical yield is 246·74 per cent. The use of Nordhausen sulphuric acid also permits of a considerable reduction in the proportion of nitrating acid to glycerine, so that a larger output is obtainable for any given sized plant.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Harvard University has recognised the growing importance of public health and preventive medicine by establishing in its medical school a department exclusively devoted to those subjects. It has appointed Dr. Milton J. Rosenau to the professorship of hygiene and preventive medicine, with the headship of the new department. Dr. Rosenau has lately been professor of bacteriology at the Washington Post-graduate Medical School.

The council of the Institution of Mining and Metallurgy is prepared to offer five scholarships for the current year (provided suitable candidates present themselves) of the value of 50*l.* each, to assist graduates in mining or metallurgy to take a practical course in mines or works at home or abroad. The scholarships will be awarded to graduates of the Royal School of Mines and other recognised British mining colleges or schools. Further information may be obtained from the secretary of the institution, Salisbury House, E.C.

The following doctorates have been conferred by the University of London upon internal and external students for the theses mentioned and other papers:—Miss Annie Abram, "The Effects produced by Economic Changes upon Social Life in England in the Fifteenth Century"; Mr. P. Hartley, "On the Nature of the Fat contained in the Liver, Kidney, and Heart"; Mr. E. T. Mellor, "The Geology of the Neighbourhood of Middelburg, &c."; Mr. J. Stephenson, "Studies on the Aquatic Oligochæta of the Punjab"; Mr. W. Makower, "On the Active Deposit of Radium"; and Mr. H. Stansfield, "The Echelon Spectroscope, its Secondary Action, and the Structure of the Green Mercury Line."

At a recent meeting of the council of the University of Bristol Dr. Lloyd Morgan tendered his resignation of the office of Vice-Chancellor, and in accepting the same the council placed upon record its sense of the distinguished services rendered by him to the cause of university education during the twenty-two years of his tenure of office as principal of University College, Bristol, and its hearty acknowledgment of the unsparing manner in which he has devoted his time and influence to the promotion of the scheme for the foundation of the University of Bristol, now brought to a successful issue. Sir Isambard Owen, principal of Armstrong College, Newcastle-on-Tyne, has been elected Vice-Chancellor of the University, and Prof. J. Michell Clarke Pro-Vice-Chancellor.

Many evidences of the numerous activities of the Association of Teachers in Technical Institutions are to be found in the July issue of the association's journal, which is published by the St. Bride's Press, Ltd. Addresses and papers read at the annual conference, of which an account appeared in Nature of June 10, are printed in the periodical, and, in addition, there are several contributions by members of the association on various branches of technological chemistry. Prof. A. F. Holleman, of the University of Amsterdam, writes on substitution in the benzene-nucleus, Mr. Frank E. Weston discusses thermic reactions, and Mr. E. B. Naylor describes a course of instruction in chemistry designed to meet the needs of a mining centre. Full particulars are given also respecting the administrative work both of the parent association and its branches.

Messrs. Cornish Brothers, Ltd., of Birmingham, have published in pamphlet form the address delivered last January by Sir Alexander B. W. Kennedy, F.R.S., in his capacity of warden of the Guild of Undergraduates, to the students of the University of Birmingham. The address is entitled "The Complete Student," and contains much wise and kindly advice to young men entering upon life. Early in the address Sir Alexander says:—"I am sure that the exclusive use of our mental apparatus for technical or professional or business matters, or equally for artistic or scientific matters, renders the large part of that apparatus which is adapted for far wider uses useless and inert. The owner of only half a mind—especially if it be only the money-making half—is a very poor person. Moreover, even the one used half tends to become smaller and less elastic as its owner grows older. As regards his friends, such a one grows every year duller and more stupid; as regards his profession, he becomes less and less able to appreciate its continually changing aspects; as regards himself, he has as deliberately thrown away half of the pleasure of existence as if he had chosen to shut himself up all his days in a tube railway, beautifully illuminated by arc lamps, but absolutely cut off from the light of the sun."

The London County Council Education Committee has had under consideration lately the question of the attendance of pupils residing outside the metropolitan area at secondary schools within the administrative county of London. The inquiry has led to some interesting comparisons as to the ratio existing between the gross cost per pupil of the education provided in London secondary schools and the amount of fees paid by the pupils. Taking the case of the seventeen secondary schools provided and managed by the committee, the gross estimated cost of education per pupil, apart from capital charges, varies from 12*l.* 14*s.* in the case of the Dalston County Secondary School for Girls to 27*l.* 1*s.* in the case of the Holloway County Secondary School for Boys. The Board of Education grant of 4*l.* 10*s.* is uniform throughout these schools, so that the net cost of education per pupil varies from 8*l.* 4*s.* to 22*l.* 11*s.* The fees charged to fee-paying pupils vary from 4*l.* 10*s.* to 12*l.* a year per pupil. In the great majority of the schools the fee charged is only about one-half that of the net cost, and nearer one-third that of the gross cost. In other words, London parents who send their children to these county secondary schools are called upon to pay only about one-third of what that education costs. It would be a wise policy for the Education Committee to take steps to bring this fact home to the parents, for at present evidences are not wanting that the facilities which London now enjoys for secondary education are insufficiently appreciated both by the parents and their children.

The second volume of the report of the U.S. Commissioner of Education for the year ended June 30, 1908, has been received from Washington. An important chapter, running to some 122 pages, provides exhaustive statistics relating to the universities, colleges, and technological schools of the United States. The total value of all gifts and bequests reported by the institutions, of which the Washington Bureau takes cognisance, during the year under review, amounted to 2,964,200*l*. Of this amount 1,029,600*l*. was given for buildings and improvements, 1,468,300*l*. for endowment, and the remainder for current expenses. Twenty-four institutions received 20,000*l*. or more during the year, the most fortunate of the universities being Chicago, which benefited to the extent of 419,700*l*.; Princeton, 200,850*l*.; California, 187,200*l*.; and Harvard, 138,400*l*. The statistics deal with 464 American universities, colleges, and technological schools. For the year 1907–8 these institutions received 3,448,500*l*. from students' fees, 811,000*l*. being for board and lodging. The grand total of the receipts of the institutions reached the large sum of 13,360,000*l*. In their libraries were 12,636,656 volumes. The value of their scientific apparatus, machinery, and furniture was 5,588,300*l*.; their grounds, 11,714,300*l*.; their buildings, 42,878,000*l*.; and their productive funds, 51,954,000*l*. The institution had a teaching force of 21,960, the number of men being 19,254. The number of students under the tuition of this large staff was 265,966.

On July 21 Lord Monk Bretton asked in the House of Lords what steps had been taken to define the spheres of the Boards of Agriculture and Education, respectively, in the matter of agricultural education. At the same time he referred to the memorandum recently issued by the Board of Education, which implied that a sum of 21,000*l*., in part at any rate, is available for agricultural education. He stated that he has been in communication with the university authorities and others, and can find no evidence that the money is used for this purpose. Similarly, the Treasury grants and the block-grant system of the Board of Education have not helped agricultural education; money from the latter source, indeed, goes to the relief of the rates. British agriculture, he pointed out, receives much less money than the amount granted in foreign countries, a result due to the absence of agreement and coordination between the Board of Education and the Board of Agriculture. Earl Carrington, in reply, stated that an understanding had that morning been arrived at by the two Boards as to the general lines of their future policy. There will be direct cooperation in regard to educational work, and in particular with the view of improving and extending specialised agricultural instruction. An inter-departmental committee of officers of the two Boards will consider the questions that may arise as to the correlation of work and of grants. Everything is working harmoniously between the two departments. Lord Belper strongly urged that any arrangement between the two Boards should follow the recommendation of the Agricultural Education Committee that agricultural education provided by colleges, farm institutes, and winter schools should be under the direction of the Board of Agriculture, while agricultural instruction given at evening classes connected with elementary schools should be under the Board of Education. The Marquis of Lansdowne emphasised the great importance of the subject. Quoting Sir Horace Plunkett's dictum, that what is wanted in these days is not merely economic holdings, but an economic system and an economic man to carry it out, he went on to say that we cannot get the economic man to carry out the economic system unless the Government takes some pains to give him a proper education.

The Staffordshire County Council Education Committee has issued its scheme of agricultural education, and a perusal of the circular shows that the committee is fully alive to the difficulties involved. Provision is made (*a*) for those already engaged in agricultural pursuits, and who therefore can only devote their evenings to study, or, at most, a few weeks during the slack winter time; (*b*) for boys and girls leaving elementary schools. The former class always proves difficult to get at. Lecturers in agricultural and horticultural subjects are provided, at a merely nominal cost to the locality, to give courses of six to twenty lectures. Practical demonstrations are also arranged in cooperation with the Harper Adams College. These include:—(1) Manurial experiments to show the effect of different manures on crops and to compare different varieties of crops; (2) hedge-layering and ditching courses, which are necessarily held in the day-time, and for which prizes are therefore given by way of recompense; (3) horticulture and fruit-growing. There are also scholarships for short winter courses, tenable at the Harper Adams College or the Midland Dairy College, which, however, have been very inadequately taken up in the past. Coming now to provision for children leaving school, we find:—(1) Minor scholarships awarded for the Brewood Grammar School (agricultural side); (2) major scholarships for the Harper Adams or Holmes Chapel College, or, in the case of women, the Swanley Horticultural College. Farmers are apt to grumble because boys who take up agricultural scholarships subsequently find something they are better fitted for. Such grumbling is, of course, wholly unreasonable, and shows a want of appreciation of the true meaning of education. We are therefore sorry to see a proviso that "candidates who accept Brewood scholarships are expected to take up agriculture on leaving school. No appointment as pupil-teacher in any elementary school under the county committee will be given to boys who have held Brewood scholarships." How can a boy of fourteen be expected to know just what career he will succeed at best? Why should he be penalised if he elects to go in for farming, and discovers, two years later, that his bent is for teaching? Does not the education committee know that to discover what a boy can do, and to set him at it, is one of the great objects of all education?

SOCIETIES AND ACADEMIES.

Edinburgh.

Royal Society, June 28.—Dr. R. H. Traquair, F.R.S., vice-president, in the chair.—At the request of the council Prof. Louis **Dollo**, of the Royal Museum at Brussels, delivered an address on the extinct gigantic reptiles of Belgium. The history of their discovery and the manner of their preservation were detailed in a most interesting and racy lecture, the peculiar skeletal arrangements of the iguanodon being specially dwelt upon.

July 5.—Prof. Cossar Ewart, F.R.S., vice-president, in the chair.—Notes on the skeleton of a Sowerby's whale (*Mesoplodon bidens*) stranded at St. Andrews, and on the morphology of the manus in Hyperoodon and in the Delphinidæ: Sir William **Turner**, K.C.B. This species of whale was first recognised in 1800 from a specimen cast ashore on the Moray Firth, and described by Sowerby. Not until 1872 were other specimens found on the Scottish coast. The present specimen led to some corrections of former conclusions, especially in regard to the differences of sex. Some interesting results were given in regard to the comparative anatomy of the hand in this whale and the allied genera of Hyperoodon and dolphins. The occurrence of five distal carpal bones in the Sowerby's whale disposed of the theory that this number did not occur in mammals.—Current and temperature observations in Loch Ness: E. M. **Wedderburn** and W. **Watson**. The observations were complicated, and at times conflicting, secondary currents and cross-currents being frequent, and evidently forming part of the circulation of the lake. Of the general conclusions the following may be mentioned. When the lake is of uniform temperature the direct current produced by wind is felt to considerable depths, and the return current is also felt in the deepest parts. When the lake has become stratified and the temperature discontinuity has appeared, the return current is almost always above the discontinuity. When the wind changes direction or follows a calm, the direct surface current is felt to considerable depths, but after the wind has been blowing for about twelve hours the return current asserts itself, and the direct current is restricted to a narrower zone.—Pettersson's observations on deep-water oscillations: E. M.

Wedderburn. In the Gullmar Fjord, off the Skagerack, Pettersson observed oscillations of temperature and salinity with a period of fourteen days. This he attributed to the action of the moon, although he admitted that he could not give any reason for the effect. Mr. Wedderburn suggested that it was due to a temperature seiche in the Skagerack. When a layer of depth h and density ρ floats on a layer of depth h' and density ρ' in a land-locked bay of length l, the period is given by the formula

$$T = 4\pi l \sqrt{g(\rho + \rho')/(\rho/h + \rho'/h')}.$$

With $l = 250$ metres, $h = 20$ metres, $h' = 100$ or 200 metres, $\rho = 1{\cdot}023$ and $\rho' = 1{\cdot}027$, the calculated periods are 13·9 days for $h' = 200$ metres and 14·2 days for $h' = 100$ metres.—A Carboniferous fauna from Novaia Zemlya: Dr. G. W. **Lee.** This was an account of a collection of fossils found by Dr. W. S. Bruce during a cruise with Major Andrew Coats in the yacht *Blencathra*. The fossils were found at Cape Cherney in 71° north latitude, and proved that the Carboniferous seas had extended some six hundred miles further north than had hitherto been supposed. The collection contained more than thirty species similar to the fauna of the lower limestone of the Scottish coal-fields and of the Yoredales of England.—Note on the flight of Nigerian arrows: Dr. C. G. **Knott.** These were unprovided with feathers, and rotation seemed to be given to the arrow by the action of the air upon the head, the asymmetrical form of which was probably originally occasioned by the manner in which the wings and barbs were forged. Experiments on the rotation were described.—The development of the auditory ossicles in the horse, with a note on their possible homologues in the lower Vertebrata: Ray F. **Coyle.** The malleus, stapes, and lucus were developed from an area which is originally homogeneous, and lying between the proximal ends of the first two visceral bars. Later the malleus and lucus are split off, bearing a close relation to the first bar. The stapes is related neither to the first or second bar nor to the auditory capsule, arising as an element peculiar to the Mammalia.

July 12.—Dr. Horne, F.R.S., vice-president, in the chair.—A further contribution to a comparative study of the dominant phanerogamic and higher cryptogamic flora of aquatic habit in Scottish lakes (Scottish Lake Survey): George **West.** The lochs studied were those of Kirkcudbrightshire, Wigtonshire, Fife, and Kinross. In north-west Kirkcudbrightshire the lochs are of highland character, but the flora, though resembling that of the Ness district, does not thrive to so great a depth. This is due partly to the comparative shallowness of the Galloway lochs and to the deposit of dead leaves of grasses over the floor of the loch. The lochs of south-east Kirkcudbrightshire are of lowland type, and have in many cases a rich and luxuriant flora. In Wigtonshire both types of lochs are found, those in the open moor being scanty in flora, while those within the zones of active agriculture are of lowland type and of rich and varied vegetation. The populous mining, manufacturing, and agricultural regions of Fife and Kinross are characterised by many lochs of the lowland type, some of them being very luxuriant in aquatic flora, because the non-peaty water contains a rich supply of food-salts, due in many instances to the activity of man in the surrounding district. The paper enumerated about 250 species of plants found in the lochs of the areas named.—Osteology of Antarctic seals (Scottish National Antarctic Expedition): Dr. R. B. **Thomson.** The seals brought home by Dr. Bruce numbered in all forty-four, and included all the Phocidæ except the elephant seal. The most interesting capture was that of two Ross seals, the dentition of which differs markedly from that of other Antarctic seals. The dentition is remarkably feeble. The chief food being soft-bodied cephalopods, the incisors and canines have developed into needle-pointed re-curved hooks of great delicacy, while the post-canines have been allowed to degenerate. Other anatomical peculiarities were described, one interesting anomaly being presented by the fifteenth dorsal or last rib-bearing vertebra. On one side there is the normal condition, an articular facet bearing a feebly developed rib; on the other there is a well-marked process representing the absent rib, showing that the costal processes in the lumbar vertebræ are the homologues of the ribs.—A negative attempt to detect fluorescence absorption: Dr. R. A. **Houstoun.** Results which seemed to indicate fluorescence absorption have been obtained by Burke, by Nichols and Merritt, and by Miss Wick, but, after careful experimenting and making every allowance for the uncertain nature of the phenomenon studied, the author is inclined to refer these positive results to systematic errors in the photometric arrangement.—The effect of internal friction in cases of compound stress: G. H. **Gulliver.** The minimum resistance to deformation and the inclination of the surfaces of sliding were given for any system of stress in a body, the internal friction being supposed to be operative. The application of the formulæ to experimental data did not yield very consistent results. With internal friction taken into account, the modified expression for the equivalent bending moment of a shaft under combined bending and twisting gives values intermediate between those given by the formulæ of Rankine and Guest.—A new experimental method of investigating certain systems of stress: G. H. **Gulliver.** The lines of maximum shear in a strained solid, as indicated by surface changes in the manner already described by the author, were compared, by superposition, with the stream lines of a viscous fluid in channels of definite shape obtained by the method of Hele Shaw. The comparisons were extremely satisfactory, and showed how analogous the equations of strain in the one case are to the equations of flow in the other.—Motion of Neptune's satellite: David **Gibb.** The calculations were made under Prof. Dyson's supervision, and were based upon the numerous observations which have been made in the American observatories since 1892, when Struve discussed all that had until then been made. From 650 equations of condition, twenty-two sets of normal equations were formed and solved. The results led to various corrections to be applied to Struve's elements. The eccentricity of the orbit of the satellite was found not to exceed 0·001. From the changes in the node and inclination, which are due to the spheroidal form of Neptune, the inclination of the orbit to Neptune's equator could be found—about 21°. The longitude of the node of Neptune's equator on the earth's equator was found to be about 205°, and the inclination of the two equations 132·8°. From these it was deduced that the pole of the satellite's orbit describes a small circle about the pole of Neptune in about 580 years, and that Neptune's equator is inclined at an angle of about 27° to the plane of its orbit round the sun.—The monsoons of the Chilian littoral: R. C. **Mossman.** The paper was a general discussion of the prevailing winds in this region of the southern hemisphere, showing how they are influenced by the circumpolar distribution.—The super-adjugate determinant and skew determinants having a univarial diagonal: Dr. Thomas **Muir.**—The illuminating power of groups of pin-hole burners: R. G. **Harris.** The variation of the illuminating power of symmetrical groups of two, three, and four burners with the distance between contiguous members of the groups was found to require somewhat complex equations for its expression. The graphs were of the same general form, and could be accounted for qualitatively on the assumption that the variation of illuminating power was due, for the most part, to a two-fold effect of the increase of distance between the burners on the supply of oxygen. The more open distribution of burners increased this supply, but the diminished draught attending such open distribution diminished it.—The life-history of *Hydrolius fuscipes*, L.: F. Balfour **Browne.** A complete and detailed monograph on this common and interesting form of life.

PARIS.

Academy of Sciences, July 19.—M. Émile Picard in the chair.—Researches on the movements of the upper layer of the solar atmosphere: H. **Deslandres.** Details of the spectroheliograph at the Observatory of Meudon are given, together with some of the results of a study of the calcium line K_3.—The determination of the displacements of the axis of rotation of meridian telescopes: Maurice **Hamy.**—The reduction of plant assimilation during cloudy weather: A. **Müntz** and H. **Gaudechon.** During direct exposure to sunlight the quantity of carbon fixed by plants is about five times as great as during cloudy or rainy weather.—The determination of the bovine or human origin of Koch bacilli isolated from tuberculous lesions in human beings: A. **Calmette** and C. **Guérin** (see p. 135).—The origin of the contrasts of colour and sudden changes of level which are found in the moon: P. **Puiseux.** The hypothesis of snow or ice being the cause of bright spots on the moon is considered and rejected, as is also the suggestion that the dark spots are caused by deposits of cosmic material.—Observations of the comet 1909*a* (Borrelly-Daniel) made at the Observatory of Marseilles with the comet finder: A. **Borrelly.** Positions are given for June 21, 26, and July 8 and 13.—Observations of the comet 1909*a* (Borrelly-Daniel) made at the Marseilles Observatory with the Eichens equatorial of 26 cm. aperture: M. **Coggia.** Positions are given for June 18, 20, 24, and 25.—Systems of differential equations: Edmond **Maillet.**—The existence, in the magnetic decomposition of the absorption bands of a uniaxial crystal, of dissymmetry of positions observed parallel to the lines of force, the field, and the optical axis of the crystal: Jean **Becquerel.** The author has repeated his earlier experiments on this subject with a more powerful magnet (field-strength, 34,000 Gauss). The unsymmetrical change of position, as also the changes in the intensities of the lines, are in accord with the theory of W. Voigt.—The relation between the electric double refraction of mixed liquids and the optical double refraction of the solid constituents of these solutions: J. **Chaudier.**—Harmonic analysis and resonance: Henri **Abraham.**—The application of the magnetic properties of metals to automatic coin machines: Antal **Fodor** and M. **de Büty.** The use of a permanent magnet in a coin slot machine is applied in such a manner that the machine only works when a nickel coin is used. Discs of copper, zinc, or tin drop through without affecting the mechanism: iron blocks the machine, and prevents it being further used.—Researches on the phosphates of thorium: A. **Colani.** A description of the preparation of thorium chlorophosphate and double phosphates of calcium and strontium with thorium.—The synthesis of papaverine: Amé **Pictet** and A. **Gams.** The steps in this important synthesis are as follows:—veratrol, acetoveratrone, amino-acetoveratrone hydrochloride, homo-veratroyl-amino-acetoveratrone, and homoveratroyl-oxy-homoveratrylamine. This last substance is dehydrated in xylene solution with phosphorus pentoxide, and the base thus obtained is identical in all respects with natural papaverine.—The catalysis of the fatty acids: J. B. **Senderens.** It has been shown in a previous paper that thoria and alumina, heated to a suitable temperature, convert the vapours of the fatty acids into the corresponding ketone. The properties of the oxides of chromium, calcium, zinc, copper, and cadmium have been investigated from this point of view, but none of these oxides is so advantageous as thoria in this reaction.—The presence of dimethoxy-2:3-methylenedioxy-4:5-allyl-1-benzene in the essence of *Crithmum maritimum*: Marcel **Delépine.**—Some reactions of anthranol: Robert **Padova.**—The di-iodine addition derivatives of the higher fatty acids of the series $C_2H_{2n-4}O_2$: A. **Arnaud** and S. **Posternak.** The fixation of two atoms of iodine is nearly instantaneous in acetic acid solution.—A new base extracted from rye containing ergot; ergothioneine: C. **Tanret.** The method of extraction and the chemical and physical properties of this new base are described; its composition is $C_9H_{15}N_3O_2S$.—The constitution of perseulose: Gabriel **Bertrand.**—Contribution to the study of cultivated oats: M. **Trabut.**—The influence of the radium radiations on the chlorophyll and respiratory functions of plants: Alexandre **Hébert** and André **Kling.** No direct effects on these two functions can be traced; some secondary effects appear to be due to the slight changes induced in the plant cells.—The muscular work electrically provoked in the cure of diseases by reduction of the nutrition, and in particular the cure of obesity: J. **Bergonié.**—The anti-rabic properties of the cerebral substance: A. **Marie.**—The action of the pancreatic juice on esters: L. **Morel** and E. **Terroine.** The action of the pancreatic juice on esters is very slight, but is considerably reinforced by the addition of bile salts.—A new endoparasite of insects: Louis **Léger.**—The instability of the Swiss plateau in post-Glacial times: E. **Romer.**

CALCUTTA.

Asiatic Society of Bengal, July 7.—Some notes on mineralogy: Prof. E. **Sommerfeldt.** (1) Measurement of angles in crystals. An apparatus is shown (devised by the author) which permits the use of a simple goniometer like a theodolite-goniometer. (2) Isomorphism between anhydrite and barites. The method of Ostwald for recognising isomorphism was used for answering the question, Are the sulphate of barium and calcium isomorphous? The answer is that one salt is not able to remove the supersaturation of the other, and that, therefore, no isomorphism exists between them.—The Shou (pronounced Siau) or Tibetan stag: Lieut.-Colonel J. **Manners-Smith.** A note on the distribution and habits of *Cervus affinis*, and on specimens living in captivity in Nepal.—The Loranthus parasite of the Moru (*Quercus dilatata*) and Ban (*Quercus incana*) oaks: E. P. **Stebbing.** Mistletoes are exceedingly abundant on these two species of oak in certain parts of the north-western Himalaya. They attack the trees about Naini Tal and throughout Kamaon so extensively as, with the aid of boring beetles which follow them, to cause at times their death. It seems that moss aids the mistletoe seeds in obtaining a lodgment.—Decomposition of ammonium platinichloride and platinibromide under the influence of heat: Prafulla Chandra **Ray** and Atul Chandra **Ghosh.**

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THURSDAY, AUGUST 5, 1909.

WHAT THE ELECTRICIAN WANTS.

Modern Electric Practice. Edited by Prof. Magnus Maclean. New edition. In six volumes. Vol. i., pp. xii+302. Vol. ii., pp. vii+351. Vol. iii., pp. viii+340. Vol. iv., pp. vii+314. Vol. v., pp. vi+293. Vol. vi., pp. vii+362. (London: The Gresham Publishing Co., 1909.) Price, the six volumes, 54s.

A PUBLICATION of so ambitious a character as that which now lies before us courts severe criticism. Six handsomely bound volumes, which would adorn any bookshelf, beautifully printed on excellent paper, and copiously illustrated with still more excellent illustrations, should be, like Cæsar's wife, above suspicion. The indolent reviewer may well feel aghast when confronted with "a comprehensive treatise" which "no single writer could hope to issue," and which has consequently been compiled by "the cooperation of contributors, each of whom is an expert in his own department of study and practice"; and the editor may well comfort himself against the possibility of adverse criticism by the reflection that what no one man can write no one man can review—a comforting reflection and a true one; but therein lies the paramount necessity for being above suspicion; for, unable to criticise all, the reviewer must perforce base his judgment on selections, and if, perchance, those selections are unfavourable, good work runs the danger of being condemned merely on the strength of its association with bad, and the "experts" as a body stand or fall according as some amongst them have or have not proved worthy of their trust.

Let us, however, in the first place venture some criticism of the work as a whole. A publication such as this challenges comparison with a number of independent treatises, and in one respect at least it should be superior. Careful editorship should secure, not only no unnecessary overlapping, but also uniformity of treatment. When reviewing the first three volumes on their original appearance five years ago, the writer pointed out that the statement in the preface that the contributors had all been allowed to use their own units amounted simply to an admission of slipshod editing. We regret to find that statement still standing. But in our former review we directed attention to a more serious error, namely, that at different places different values were given to the same quantities. We have turned again to the two tables to which we referred, and find them unchanged, the editor being still apparently unable to make up his mind whether the conductivity of platinum is greater or less than that of iron. We pity the student or the engineer who consults such data as these for trustworthy information. It is a well-known rule of conduct when a number of people agree to disseminate incorrect information that the precise nature of the information is of less importance than that all should be agreed upon it; we think this rule should be borne in mind when the third edition is issued, if it is not found possible to obtain a correct table of conductivities.

Discrepancies such as these once discovered, suspicion is aroused, and one turns to individual articles to consider each on its merits. Here, as is naturally to be expected, one encounters varying degrees of merit. Some of the articles are well written, sound, and comprehensive monographs; others are exceedingly weak. We do not profess to have carefully read all, but can only judge the bulk by the average of those we have studied carefully, and it must be confessed the average is low.

Take, for example, the subject of primary batteries; the references in the index raised considerable hopes, but after they were traced we came to the reluctant conclusion that the index conveyed almost as much information as the articles. Primary cells are dealt with in section i., part i., chapter viii. Their treatment occupies five pages, about one-third beng woodcuts (Figs. 58 and 59, by the way, being crossed). The particulars given are most meagre; neither the E.M.F. nor the internal resistances are given, and one has no idea whether the Leclanché cell, for example, gives 1 volt or 100; no particulars of life or output are given, and there is no comparison between the efficiency of different types. Dry cells are referred to in half a line, which conveys no impression whatsoever as to what they are like. Primary batteries are, it is true, again referred to in vol. vi., in the article on electromedical appliances, but only incidentally, and though the E.M.F.'s are mentioned here in one or two cases, this is about the only additional information given. The most elementary five-shilling textbook with the same ground to cover gives more valuable information on this subject than this comprehensive treatise written by experts; and it cannot be claimed that the primary battery is of no importance, as it is still enormously used for telegraph and telephone work, the consumption in England running into several millions a year.

Or, turn again to wireless telegraphy: this is not quite so easy as it sounds, for the entries under this heading in the index are of no use. There are two, of which one draws a blank, and the other leads to a casual reference to the subject in the article on secondary batteries. Under telegraphy we fare no better, but the recollection of the somewhat unfamiliar name of radiotelegraphy eventually leads us on the right track, only to find a bare five and a-half pages allotted to the subject. It is needless to say that no adequate treatment can be given in this space, even though one-half of it is occupied by diagrams. It is difficult to reconcile this with the allocation of four-and-forty pages to the description of electric fittings.

There is one respect in which a publication such as this is liable to compare unfavourably with the individual treatise—it is more difficult to keep up to date. If one branch of electrical engineering shows specially rapid development, it is easy for a treatise which deals with that branch alone to be revised or rewritten; but a production such as this is not likely to be revised when only one or two of its sections call

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loudly for revision. This is the always recurrent objection to the encyclopædia, which applies with special force to an encyclopædia of so progressive an industry as the electrical. If any real attempt is to be made to maintain such a publication in the front rank, it can only be done by very frequent and thorough revision. We have certainly no ground for complaint in the present instance on the score of frequency of revision—a new edition within four years of the original issue is as much or even more than could be expected—but some of the contributors do not appear to have taken the duty of revision with sufficient seriousness, and thus, whereas some of the articles have been entirely rewritten, others in which progress has certainly been no less marked appear to have been scarcely altered.

We need make no apology in this connection for referring to the articles on electric lamps. Probably in no other branch of the electrical industry has there been more startling progress during the past three or four years. Often though the expression is abused, it is true in this instance to say that both arc lighting and incandescent lighting are being revolutionised. The article on incandescent lamps has been brought well up to date, and the information given on metallic filament lamps, if not so full as some could hope, is as full as could be expected in relation to an industry still carried on with more or less secrecy; but the article on arc lamps appears to be untouched. We have the gravest suspicion that the author does not realise what the flame arc really is; if he does, he signally fails to convey a correct impression to his readers, and, at the best, his treatment of the flame lamp is grossly inadequate.

In reviewing one of the volumes on its first appearance we ventured to suggest that, in view of the generally inferior standard of the letterpress as compared with the illustrations, the latter should be published without the former. The publishers appear to have adopted this suggestion to the extent of attaching to the inside of the back covers of some of the volumes ingenious little folding paper models of electrical apparatus to which we have been unable to trace any reference in the text. Many a pleasant half-hour may be spent by the student of electrical engineering, unable to obtain access to real electrical apparatus, in unfolding these models and trying to fold them up again in the correct order.

We are at a loss what to say in conclusion; we suppose that, so long as there is a large number of engineers anxious to write, and several willing to read, there will be an output of treatises, good, bad, and indifferent; but, personally, we have a strong disposition against buying in bulk, taking the good with the bad, "as they come," in the phrase of the market.

The beneficent uncle anxious to make a suitable gift to a budding electrical engineer may find in these volumes a useful outlet for surplus wealth, but the discriminating student will be well advised to make other investments. We can well imagine that there will be many, when confronted with so imposing an array of information in so handsome a guise, who will be unable to believe that the matter can be less good than the manner; but we are loth to think that it is a comprehensive treatise such as this which really represents what the electrician wants.

MAURICE SOLOMON.

THE THERMODYNAMICS OF THE EARTH.

Radio-activity and Geology. By Prof. J. Joly, F.R.S. Pp. xi+287. (London: A. Constable and Co., Ltd., 1909.) Price 7s. 6d. net.

THOSE who are acquainted with Prof. Joly's presidential address to Section C at Dublin last year will not be surprised at the appearance of this volume from his pen. One of the most remarkable chapters the scientific historian has yet to write is the story of the rapid progress of research into the phenomena of atomic instability. In the spontaneous disruption of atoms, showing itself in the phenomena of radio-activity, we have learned of a store of energy of immense magnitude hitherto undreamt of. The fact alone that atoms are unstable systems has enlarged immeasurably the scope of our speculations regarding all inorganic evolution, while the knowledge of the forces locked up in them has still more directly affected almost every department of science. It is impossible that the geologist should long remain indifferent to this new phase of scientific inquiry, and it is Prof. Joly's endeavour to show him that already he must give heed to its teachings, and to point out where attention must be given. As being himself an active investigator, able both as physicist and geologist, no one better qualified for the task could be found, and his work must be carefully considered by every thoughtful geologist, however much any of his conclusions may be controverted.

The volume is wisely opened with a couple of chapters in which the fundamental principles and methods of radio-active inquiry are simply but accurately explained. These we would especially commend to the reader who may be inclined to a not unnatural scepticism as to the trustworthiness of conclusions based on the investigations of quantities of material habitually measured in billionths of a gram. It is of the utmost importance, too, for the geologist to realise to what degree the intra-atomic changes are independent of physical conditions, and that such changes do not affect the atoms of radium alone, but in varying degrees those of many substances.

In the chapter on radium in the earth's surface materials we are supplied with fairly ample data on which to judge of the general distribution of this element and its associates in the rocks. It is a significant fact that the rarer an element the more uniformly it appears to be distributed in nature. In spite of the natural variation of the quantities in different rock-specimens, and of considerable divergence among the averages of different investigators, we are still left with the conviction that the almost uniform presence of radium in fairly well ascertained quantity throughout the earth's crust is assured, and may be safely assumed as a basis of speculation. The demonstration at the end of the chapter, that the well-known pleochroic halos in certain minerals are due to the radio-active discharges from the minute inclusions forming their centres, will specially interest petrologists.

Thus assured of the general prevalence of radium, Prof. Joly proceeds to trace its effects as a factor in terrestrial thermodynamics. The variations in the temperature gradient below the surface naturally suggest investigation, and an attempt is made to connect the high temperatures met with in the Simplon tunnel, and that near one end of the St. Gothard, with local variations in the radium content of the rocks. In the succeeding chapter is worked out a very ingenious theory to account for the well-known fact that mountain chains arise on the sites where sedimentation has been most extensive, *i.e.* from the great geosynclines. Having shown that the rocks cannot retain the comparative richness in radium, which they possess normally at the surface, to a depth of more than ten or fifteen miles, and that detrital rocks contain almost the whole of the radium which was in their parent rocks, it is then pointed out that denudation results in the thinning of this radium-rich surface-layer in one locality and the piling up of such material in the area of sedimentation—it leads to "a convection of energy." Not only is a much larger quantity of radio-active material accumulated in the sedimental area, but—and this is still more important—the *thickness* of the radio-active layer is there greatly increased. As a result, the heating effect is there emphasised, and the area of sedimentation becomes an area of weakness; the geosyncline becomes a mountain chain.

In natural sequence comes an inquiry whether the same cause of instability may in any degree account for the more general movements of the ocean bed which were first referred to by Darwin. This involves a preliminary discussion of the probable depth of oceanic deposits. The radium content of globigerina ooze is found by numerous determinations to be four or five times that of normal sediments, but its efficacy will depend much more on its thickness. Such meagre data as are available in the few examples of upraised oceanic sediments are carefully discussed, and a thickness of 4 kilometres is assumed as probably not excessive. This is estimated to lead to local weakening to the extent of bringing the 800° C. isotherm 10 per cent. nearer the surface, even assuming the radio-activity of the ooze no greater than that of ordinary sediments. It is, therefore, concluded that the accumulations of ooze which surround all the great coral areas may well account for some at least of their instability.

Returning again to the mountains, some of their more specialised problems are dealt with—the great overfolds and the extensive metamorphism which appears in some cases to have been effected at depths of only a few kilometres.

Finally, the larger problems of earth-heat in general are considered. Kelvin's estimate of the comparatively short interval since the attainment of the *consistentior status*, on the assumption of the simple cooling earth, is taken as evidence against the truth of that assumption. It is well maintained that the known radio-activity of the surface rocks, even if continued to only very moderate depths, is sufficient to account for all the present heat loss; and, in view of the fact that some of the loss must be due to interior heat and to decay of the radio-active supply, a limiting depth of 10 to 15 kilometres is obtained for the rich surface layer. At the same time, it is shown that the low conductivity of the rocks allows the assumption of considerable quantities of interior radium, as the interior might rise in temperature for many millions of years without the surface being affected. The determination of the age of minerals by measurement of the quantity of helium evolved from their contained uranium concludes the work. The results of Strutt are strongly criticised on the ground of their disagreement with the ages determined from the rate of accumulation of sediments and of oceanic sodium, though hope is entertained that the method may yet give accurate results.

As a kind of appendix, a useful chapter is added, explaining in detail the methods of investigating the radio-activity of the rocks.

It is necessarily easy to criticise a work of this character. Almost all its conclusions are involved in assumptions. Yet the fundamental position is sound. The radium is there, and in such quantities that its energy must be a primary factor in the evolution of the earth. Its distribution within the globe is perhaps the most crucial point awaiting settlement. On the existence of the rich surface layer of very small depth, much of Prof. Joly's argument rests. The very unsatisfactory state of our knowledge of underground temperature-gradients seriously interferes with the estimate of this depth, while the average radium content of the surface rocks can scarcely be considered as settled. Should Eve's average be anywhere near the mark, the story would be considerably altered. When Prof. Joly adduces Alpine metamorphism as evidence of radio-active heating, we think he scarcely allows sufficiently for hydrothermal action. The assumed depths of 20 to 40 kilometres, below which the rocks are supposed to yield hydrostatically, are much greater than those indicated by earthquakes and the formation of thrust-planes for the attainment of that condition. The explanation of the great overfolds of the Alps as due to the pushing of the rigid crust over these hydrostatically yielding layers might apply in that case, assuming that such folds in fact exist, but the same phenomenon may be observed on very much smaller scales, and there the theory fails. It appears to us that the estimates of the "geological age" from sedimentation and sodium accumulation are rather overweighted. The former method probably fails because the thickness of sediments is usually governed by the rate of subsidence rather than by the supply of sediment, while the data for the latter are very uncertain.

Some of the speculations may be considered rash, but the treatment of the subject is intentionally light; and it is well so. The book is full of suggestion and new lines of thought. It will compel interest, and should do much to encourage and direct investigation into what cannot fail to be a richly fruitful field.

ARCHÆOLOGY AT AVEBURY.

A Guide to Avebury and Neighbourhood. By R. H. Cox. Pp. 68. (London: E. Stanford, 1909.) Price 2s. net.

"A GUIDE to Avebury" a fascinating title, giving hope of a learned speculation as to the uses of this, the most stupendous work of ancient times in this island. Was it within the circle of this great earthwork that the astronomer-priests conducted their observations, and was the great bank thrown up to form an artificial horizon to mark the lapse of time and change of season by the movements of the sun and stars, or was it simply to veil the mysteries and maintain the secrecy of the rites of a dominant priesthood, on whom the people, in those days before almanacs were thought of, were dependent for instructions when to sow and when to carry out any other of the operations of agriculture or of life that are subject to the seasons for their accomplishment? But no! there is little upon these questions to be found in this "Guide," which gives, indeed, a sort of general introduction to the study of the ancient remains in and around Avebury, and catalogues the camps, the tumuli and the trackways to be found in a long excursion from Barbury Castle round by Oldbury Castle, Oliver's Camp, St. Ann's Hill, Rybury, and Martinsell to Marlborough, but we look in vain for any real conception of the grandeur and mystery of the place.

The maps are a feature of the book, but they are difficult to understand; on p. 22, for instance, there is nothing to show what the red lines mean, and the red spots marking tumuli and camps cannot be distinguished, and do not by their size in any way indicate which are the more important; then there are only two indications of sarsen stones, the northern labelled "Grey wethers," and we wonder if the author has ever seen the vast sea of sarsen stones near "Glory Ann" and "Totterdown."

On p. 44 we are informed that near Urchfont is the watershed between the head-waters of the Wiltshire Avon and the "Stour," an extraordinary statement, as the Stour rises some thirty miles away to the south-west, and the waters from Urchfont (Hart's fount) flow into the Bristol Avon.

On p. 53 we have the statement that the West Kennet Long Barrow is now taken over by H.M.'s Board of Works, and on the same page the author writes of it as "the Government's long barrow," all of which is pure imagination, as the barrow is no more the property of the Government than is Silbury Hill or Avebury. These inaccuracies make us chary of accepting the author's statements, but they are insignificant compared with Lord Avebury's statement on p. 6 that the earth and chalk from the ditch have been thrown up on the *inner* side, whereas, of course, the curious fact at Avebury is that the bank is on the outside of the ditch.

As the author makes no mention of the late Rev. A. C. Smith's "British and Roman Antiquities of North Wiltshire," we presume he does not know the book or the elaborate maps contained in it, showing every road and trackway, every camp, tumulus, or sarsen stone that exists, or of which there is tradition, in the 100 square miles round Avebury, and we venture to think a careful study of it would have been useful to the author.

We hoped, when the delving archæologists were collected at Avebury this summer, that something might be done to protect the most interesting relic of all—the two remaining stones of the "cove" of the northern circle—but apparently the use of these stones as protection for a hayrick was deemed quite appropriate.

R. H. C.

VENOMS AND ANTI-VENOMS.

Venoms, Venomous Animals, and Anti-venomous Serum-therapeutics. By Dr A. Calmette. Translated by E. E. Austen. Pp. xvi+403. (London: John Bale, Sons, and Danielsson, Ltd., 1908.) Price 15s. net.

WHATEVER may be thought of their reputed powers in other directions, there is no question of the peculiar fascination exercised by snakes upon the popular imagination, so that a translation of a work by Prof. Calmette, whose name in all that relates to snake-venoms and antivenoms is familiar in men's mouths as household words, is certain to command attention.

The volume consists of five rather unequal parts, dealing respectively with the classification, habits, and geographical distribution of poisonous snakes; the chemistry and physiology of snake-venom; immunisation, and the preparation of antivenoms; the venoms of various classes of animals other than Ophidia; and records and results of numerous cases of snake-bite treated with the author's antivenin.

The book is addressed particularly to medical men, naturalists, travellers, and explorers, and the author believes that physiologists also may read it with profit. Its value to the physiologist is diminished by the fact that, as a summary of our knowledge, its design is hardly catholic enough; but that it will prove of very great service to the medical man, and particularly to the medical officer stationed in the tropics, there can be no two opinions. For just those things that the medical man wants to know, and the medical officer is expected to know, about snakes—what venomous species he is likely to encounter in his own province, how those species may be recognised, how their various venoms manifest their action and to what degree they are dangerous, and on what rational principles the treatment of snake-bite is based—are here to his hand in a single volume of convenient size and of moderate price.

The first part of the book, which deals with poisonous snakes from the systematic and geographical points of view, may be described as a condensed extract of the British Museum Catalogue, leavened with remarks on habits, and finely flavoured with well-chosen figures. The British Museum Catalogue, which itself is a marvel of conciseness, does not lend itself to condensation of this sort, but the figures in this instance make it good. What one misses, in a book meant for medical men and travellers, are good, plain descriptions and diagrams giving the names and explaining the relations of all those parts of the snake's skeleton and integument that are of applied value in classification. Here there are descriptions and figures, but they do not explain *all* the terms employed in the specific and generic diagnoses; moreover, some of the terms used are not those commonly current, and some do not correspond in text and figure. Thus the well-known quadrate bone is referred to as the tympanic; and the shields which in the text are called, in accordance with the authorised British version, internasal, prefrontal, frontal, and parietal, appear in the figure under other names. Seeing that the differentiation of species, and even of genera, largely depends upon scale-characters, this is hardly a matter of little moment.

The second part, which treats of snake-venoms, describes the methods of collecting venom and the chemical composition of the secretion, and gives an account of the way in which in the laboratory the various constituents of the venom act upon the blood and tissues. The gross effects of cobra-bite and viper-bite are also contrasted. The author naturally draws largely on his own experiments, but the work of other investigators is duly considered. It is rather surprising, however, not to find any mention whatever of D. D. Cunningham, who for many years was in India the observed of all observers in this field.

The third part brings us to the cream of the subject, namely, the acquisition of immunity against snake-venom and the use of the serum of immunised animals as a cure for snake-bite. This subject is so largely the author's own that criticism can only be offered with deference. But, considering merely the way in which the matter is represented in the book under review, the author appears to rely rather too much on his own large experience with cobra-venom, and also to be hardly consistent; for although he seems to adhere to the untenable opinion that neurotoxin is the essential toxic constituent of *all* venoms, whether colubrine or viperine, he allows that cobra-antivenin is of no avail against what, by a strain of language, he calls the "local" effects of viperine venom, and he concedes the practical point that an antivenin of general efficacy can only be obtained from an animal that has been immunised against *both* kinds of venom, colubrine and viperine.

The only other part of the book that requires notice is that concerned with the venoms of animals other than snakes. Here we find many interesting fragments of information about the venom of polyps, sea-urchins, arthropods, molluscs, fishes, and amphibia. The venomous Mexican lizard, Heloderma, and the spur and femoral gland of Ornithorhynchus are also remembered, but, strange to tell, the dreadful sting-rays, the notorious jelly-fishes, and the molluscan Toxiglossa are quite forgotten.

As to Mr. Austen's translation, it is as near as possible perfect, being wonderfully faithful to the original, and yet, so far as technical terms do not interfere, good English. In the case of some of the technical terms, however, Mr. Austen's unflinching fidelity sometimes goes near to make the reader wince. There are expressions, such as "gingival fold," "ergastoplasmic venogen," "sanguinolent serosity," "laccate," "chloridate," "asporogenous," to which even the hardest-mouthed jargonmonger will object.

THE SCOTTISH LAKE SURVEY.

Bathymetrical Survey of the Fresh-water Lochs of Scotland. Under the Direction of Sir John Murray, K.C.B., F.R.S., and Laurence Pullar. Pp. viii+288; maps and plates. (London: Royal Geographical Society, and Edward Stanford, 1908.)

IN some countries it appears so natural that the national surveys should present a complete delineation of the solid surface of the land that the accident of certain hollows being filled with water does not excuse the surveyor from continuing his contour lines across the submerged slopes. With us, however, until the Survey Department was supplied with the necessary data by private investigators, no sub-lacustrine contour lines appeared even on maps of the largest scale, and large surfaces of paper remained blank save for the artistically graduated lines which indicated the difference between a water and a land surface. Most of the English lakes were surveyed in 1893 and 1894, and the contour lines appear on the later editions of the six-inch maps, with due acknowledgment of the source whence they were derived.

The volume now before us completes the preliminary publication of the survey of the lakes of Scotland undertaken by Sir John Murray and Mr. Pullar in 1896, and now brought very near completion. It represents an immense amount of work of national importance carried out at the personal cost of the authors, and its very magnitude makes it impossible to give any serviceable summary here of the additions to limnology it contains. Eighteen papers appeared in the *Geographical Journal* between 1900 and 1908, illustrated by bathymetrical maps of 213 fresh-water lochs, and this volume, published separately by the Royal Geographical Society, gives particulars and bathymetrical maps of a further series of 349 lochs, making a total of 562 surveyed and described. The number is so great that we cannot help regretting that it has not been made complete, but the rule appears to have been that no steps were taken to survey those lochs on which a boat was not available. In this way some sheets of water of considerable size and great interest have been left unsounded, a fact the more regrettable because difficulties due to sporting rights in some of the nearly inaccessible valleys in the heart of the great deer forests may prove insuperable to less known investigators in the future, while the high distinction of Sir John Murray's name might possibly have smoothed a way in the course of his great survey.

Apart from this, the record of the Loch Survey is one that Sir John Murray, Mr. Pullar and their numerous assistants may well be proud of. How great a body of work it represents may in part be gathered from the complete index, which includes all lakes described here and in the articles which have appeared in the *Geographical Journal*; but a mass of additional material bearing on the physics and biology of the waters has still to be published.

The bathymetry of the lake-basins was determined by series of close soundings in lines transverse to the long axis, and the scale of the maps is sufficiently large (3 inches to 1 mile) to allow of all the soundings being represented in figures as well as by contour lines. We think that a longitudinal line of soundings along the axis of maximum depth would have been a useful addition in all cases, and a valuable check on the transverse series. Supplementary soundings would also have been useful in many places where the exceptional run of the contours suggests some unusual configuration. Such additional lines have been run on some of the lochs, and the maps of these inspire a more complete confidence as to detail than do the others. We should have liked to see some larger-scale surveys of such individual features as the sub-lacustrine slopes of delta fans, screes, steep rocky shores, and the transition belt between the steep sides and flat floors of many of the basins.

The sounding of the large area of fresh water which fell between the two stools of the Admiralty and the Ordnance surveys is a splendid example of public-spirited private enterprise undertaking and carrying through work which should have been included in the routine of a Government department. It is, happily, not the only case in which the collective shortcomings of the nation in matters affecting the advancement of scientific knowledge have been made good by individual effort and at private expense. When the right men are at the head of such an investigation, and their labours are not trammelled by the want of means, we are of opinion that better work can be done at a smaller outlay than if the operations were conducted by an official department or under the auspices of a committee of many specialists on different subjects; but when the right men are not to be found the lack of Government interest in the completion of our knowledge of our own land and its resources may lead to unhappy consequences. It is fortunate, indeed, that Sir John Murray and Mr. Pullar have had both the will and the power to carry out the work, which, when completed by the publication of the additional material already collected, will form a noble monument to the memory of the late Mr. Fred Pullar, to whose energetic assistance the early stages of the research were so much indebted.

H. R. M.

THE OLD AND THE NEW MECHANICS.

(1) *A First Dynamics.* By C. S. Jackson and W. M. Roberts. Edited by W. J. Greenstreet. Pp. viii+412. (London: J. M. Dent and Co., 1909.) Price 5s.

(2) *Elementary Mechanics.* By Prof. C. M. Jessop and Dr. T. H. Havelock. Pp. viii+277. (London: George Bell and Sons, 1909.) Price 4s. 6d.

(1) SO many new series of mathematical school-books have appeared during the last few years that the present series has remained almost unnoticed. This is the more remarkable in view of the wide reputation of the editor, Mr. Greenstreet, and also of the fact that the contributors are also mostly well-known authorities in the mathematical teaching world. Messrs. Jackson and Roberts have fully justified the existence of their book by the amount of freshness and originality they have put into it, and particularly by the extent they have treated the subject from a common-sense, practical point of view. As the authors point out in the preface, there have been in the past two classes of book in which the relations between force, matter, and motion are dealt with. There has been, first, the book on applied mechanics, in which the principal object has perhaps been to describe machines, and there has next been the "academic" book, in which dynamics might perhaps better be described as "dogmatics," the most prominent feature of which has been a collection of exercises in algebra.

It has been the object of the present authors to make the principles of dynamics the prominent feature of their book, and to illustrate them by applications to phenomena of everyday life rather than by algebraic drill. In this they have been very successful, so far as can be judged without an extended trial of the book in the class-room.

The main crux in writing a book on dynamics is the question of units. Shall the author use poundals and please one class of teachers, or shall he use slugs and be commended by another section? It seems to have been generally forgotten that there is a third alternative which still allows those who wish to do so to replace Newton's "proportional" by "equal" in the laws of motion. That alternative is to take the gee (g) as unit of acceleration, and write force in lbs. wt. = mass in pounds and acceleration in gees; and if any writer chose to champion the claims of the gee, he could point to the fact that the foot, if defined by the length of the seconds pendulum, is really a gravitation unit of length.

Messrs. Jackson and Roberts, while discussing the two generally recognised systems, adopt the more rational plan of basing their treatment on the proportion:—

$$\frac{\text{force}}{\text{weight}} = \frac{\text{acceleration}}{g}.$$

It has been popularly supposed that this plan is theoretically good, but how would the equations of motion of complicated systems be written? Now in Mr. Jackson's hands the equations all look delightfully simple; not only is there no more difficulty than occurs somewhere in every system, but *it is very easy to see if the results written down are correct in their dimensions.* The suppression of constant multipliers in physical equations does not always conduce to simplicity; it more often causes confusion, especially in connection with electrostatic and electromagnetic units, and also in hydrodynamics, where problems of discontinuous motion are solved for jets of one particular breadth (generally π) with one particular velocity, and the solution appears inapplicable to other jets differing in size and velocity. A little doubt may occur as to whether momentum should be defined as Wv/g, as Mr. Jackson does, or simply as Wv; but this is a matter in which experience will indicate the wisest choice.

The subject-matter treated includes such applications as the instantaneous centre of a connecting rod, two-speed gears, and the elements of dynamics of rotation. There are many reasons why the latter subject should be included in an elementary treatise; indeed, the authors claim that, "frankly, unless a student means to know, in broad outline, about as much of the principles of mechanics as we have given, he may with advantage allot more time to some other subject."

In certain details the book leaves something to be desired. It would surely be better, for example, to give the rule for composition of relative velocities after, instead of before, the construction for the relative displacement and velocity of two moving bodies. The present order is a survival of the old idea that because the parallelogram of forces is the fundamental proposition in statics, the parallelogram of velocities ought to be the fundamental proposition in kinematics. In the proof of the relations between angular and linear velocity, a 60 is introduced unnecessarily and then cancelled by considering the space described in a minute instead of in the unit of time (a second) assumed in the definitions. In several places where uncertainty exists as to how much should be included in the text and what should be omitted, the final result suggests that the authors were not given sufficient facilities for making alterations when the proofs were in type. The paragraphs are unnumbered, and this is a great drawback, but the worst feature is the illustrations, which are badly reproduced, with coarse, unsightly lettering. In one of them, on p. 177, a capital V looks like a Greek γ. If books of this class are to hold their own in the field of competition, not only should the figures be above reproach, but a large amount of time and thought must be devoted to minor alterations and emendations such as only suggest themselves when the text has been seen in print.

(2) If novelty and originality is one of Mr. Jackson's strong points, this cannot be said of Prof. Jessop and Dr. Havelock's book. It brings back to memory days of long ago, with its "forces of 1, $\sqrt{2}$, and $\sqrt{3}$ lbs.," its Roman and Danish steelyard, its three classes of lever, the oar being included in the second regardless of the man's thrust on the rowlock, its mechanical advantage instead of the more modern velocity ratio and efficiency, its systems of pulleys which only lift a weight a small fraction of the height of the supporting beam—and perhaps do not lift it at all if the ropes are extensible, and its Attwood's machine neglecting inertia of pulley, in the first instance, although this is now taken into account at the end of the book. But Jessop's "Elements of Applied Mathematics" was an excellent book when it was written, and it is not the book which has gone backward in its present revised edition, only other people have moved forward. Moreover, the present reviewer can ill afford to find fault with an author who is prevented by his professorial duties from completely rewriting his text-books when his opinions on certain points have changed. At the same time, in view of the fact that revision has been undertaken by Prof. Jessop's lecturer, we think something more might have been done. The separate formulæ for the resultant at angles of 30°, 45°, and 60° might surely be struck out *now*, although the present reviewer pleads guilty of having perpetrated the same barbarisms (under protest) when he was younger and was informed that certain classes of students required them. On the other hand, the addition of sections on harmonic motion, bending moment, and shearing force (under graphical statics), and the chapter on energy of rotating bodies are valuable additions. In the latter chapter the moments of inertia of simple figures are stated without proof. Perhaps this is the best way, in view of the fact that integral calculus is now usually taught at an early stage; had this not been the case, the use of the geometric progression formula for making the necessary summations would have been recommended.

A student might do worse than use Prof. Jessop's book for algebraical drill, supplementing it by a course of experimental mechanics, or by Mr. Jackson's book; and whatever else may be said, no exception can be taken to the general appearance of the book, or the diagrams, which fully maintain the high standard that characterises Messrs. Bell's text-books.

OUR BOOK SHELF.

The State and the Farmer. By Prof. L. H. Bailey. Pp. xii+177. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 5s.

Less than a generation ago farming and farmers made very small figures in the public eye; men of affairs, when they gave the subject a thought, regarded British agriculture as a dying craft, something that had ceased to pay and might be left to extinguish itself quietly, leaving the country for the recreation of the town-dweller, to provide sport for the rich industrial, health and the gratification of his æsthetic tastes for the employee. Business men paused sometimes to make pharisaical remarks about the wastefulness of the farmer; men of science scolded him for sticking to his old ways, not adventuring his substance on the crude generalisations which were put forward to represent the infinitely complex life of animals and plants; the politician had no use for the agriculturist, whose vote he knew was safe in the landlords' pockets; and the journalist saw little but comic copy to be got out of Hodge and its ways. As Sir Horace Plunkett said in his British Association address, modern civilisation has joined the rural exodus.

But latterly there have been signs of change; the triumphal march of industrial progress, with its concomitants of vaster factories and ever extending suburbs of mean streets, has proved less satisfying than its prophets had promised; the nation has begun to awake to the essential instability of such a system, and to the need of keeping up agriculture as the soundest basis of the State and the only means of creating wealth, whether of men or things.

To some men the necessity of drawing men back to country life seems little less than a holy cause into the service of which they are ready to put their whole strength, and among such men Prof. L. H. Bailey, of Cornell, is perhaps most prominent on the other side of the Atlantic. In the little book before us Prof. Bailey pleads for the better organisation of rural life with eloquence and conviction; rural life, not merely because it pays, but because it is the life best worth living, most calculated to raise a sober and strenuous race of men. The author's particular text is the function of the State in fostering agriculture; left to himself, the farmer is normally a strong individualist, who readily becomes isolated and hidebound. His sole chance of success in modern life is collective action, and Prof. Bailey discusses in successive chapters the extent to which the State can profitably intervene in the organisation of rural life by education and by starting various forms of cooperative work which will lead the farming community to act together. Different as the agricultural conditions are in this country and in America, the problems are the same in both places, and Prof. Bailey's discussion of the subject gains a special interest for us at this moment, when the Chancellor of the Exchequer has just set aside a "development grant" to be devoted to the promotion of all agencies for encouraging rural life.

The Problem of the Feeble-minded. An Abstract of the Report of the Royal Commission on the Care and Control of the Feeble-minded. With an introduction by Sir Edward Fry, G.C.B. Pp. x+113. (London: P. S. King and Son, 1909.) Price 1s. net.

THE appearance of this abstract is most opportune. The small committee of persons interested in social problems which is responsible for its publication is anxious to bring before as large a section of the public as possible the urgency of the matters in question, and points out in the preface of the book that the Poor Law Commissioners have given it as their opinion that if the recommendations of the Commission on the Care of the Feeble-minded were carried into effect, a system of control over the feeble-minded would be initiated which would free the Poor Law administration from one of its greatest difficulties and, we may add, the country from a cause of enormous expenditure. In his introduction Sir Edward Fry quotes Bagehot's sad reflections upon the undue haste and benevolent thoughtlessness with which so much philanthropic effort is attended, and the terrible question which he poses as to whether the benevolence of mankind does not do more harm than good. Sir Edward Fry can, however, recommend the work of the Commission on the Feeble-minded as one done with deliberation and not with "a wild passion for instant action." The various problems which came before the Commission, such as mental defect and drink, mental defect and crime, and mental defect and illegitimacy, are adequately epitomised, and the far-reaching recommendations of the Commission duly considered as to the essential points. The book also contains some special articles, of which that upon segregation, by Mr. Galton, we can especially recommend to our readers.

The Economy and Training of Memory. By Henry J. Watt. Pp. viii+128. (London: Edward Arnold, 1909.) Price 1s. 6d. net.

THE training of the memory is undoubtedly a part of any good education, and it has hitherto been too much the peculiar field of the faddist and of ingenious but ignorant *a priori* system-makers. This little book, which aims at making of practical value to student and teacher the results of scientific experiment into the subject, is therefore to be welcomed. It is true that some of its precepts appear obvious, but where there are so many conflicting truisms the selection of the right obvious is not unimportant; and much definite information is given on particular points where the merely empirical adviser is quite at a loss, *e.g.* the advantages and disadvantages of specific types of mental imagery, and the variations of method corresponding to differences in the material to be memorised. Moreover, if the book did no more than free the ordinary adult from that excessive distrust of his memory, which is so bad in effect, and is, perhaps, too optimistically believed by Mr. Watt to be quite ungrounded in fact, it would be abundantly justified.

Mr. Watt considers the mechanical memory of association to be, in a sense, more fundamental than the intelligent memory based on connection of thought, since the association between word and "meaning" is in itself mechanical. It seems doubtful if that ultimate "association" of meaning and imagery can be expressed so simply; but the point, though of great interest, is of minor importance in a confessedly practical 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.]*

Rate of Helium Production from the Complete Series of Uranium Products.

A KNOWLEDGE of this constant is essential to the estimation of the ages of minerals from their helium content. In a paper published in Proc. Roy. Soc., July 28, 1908, I gave the ages of some minerals provisionally on the assumption that the rate was $9 \cdot 13 \times 10^{-8}$ c.c. per gram U_3O_8 per annum. This rate was calculated from Rutherford's indirect data. It has received much support from Sir J. Dewar's determination of the rate of production by radium with its immediate products. I am now in a position to confirm it further by an experiment on the rate of growth of helium in a solution of pitchblende; I speak of *a* solution, but it has been found impracticable to take up all the constituents by one solvent. Two solutions were necessary.

The pitchblende solutions contained 115 grams of U_3O_8, and yielded in sixty-one days a quantity of helium which was measured as 2×10^{-6} c.c. in the capillary of a McLeod gauge. This gives the rate as $10 \cdot 4 \times 10^{-8}$ c.c. per gram U_3O_8 per annum. No stress can be laid on the close agreement with Rutherford's estimate in view of the very small gas volume measured. The experiment proves, however, that that estimate is of the right order of magnitude. Larger scale experiments are in progress, and these, in conjunction with similar experiments on thorianite, will, it is hoped, enable data on the quantity of helium in minerals to be translated into estimates of time with full confidence. R. J. STRUTT.

Imperial College of Science, South Kensington,
July 27.

A Kinematic Illusion.

PEOPLE are sometimes amazed by noticing that in a motor-car seen through railings the wheels appear to revolve the wrong way. As the eye follows the moving objects it is convenient to imagine that the car, which may be actually running to the right, is stationary, while a vertical rail is moving past it to the left with an equal velocity. The apparent intersection of this rail with the upper edge of the wheel is a point running round in a contrary direction to that of the rotation of the wheel. This moving point suggests rotation of the wheel. When oblique lines swing in front of vertical lines the movement of the intersections is curious to watch. It is true that the lower half of the wheel goes against our theory, but at a given moment its effect may be less noticeable, either from being hidden in dust or because the eye has a very small range of close attention. I have seen the appearance, and have had reports of it from others, but cannot speak with precision as to the condition of seeing it effectively.

It is common to rotate vacuum tubes while a discontinuous spark illumines them. A spark may pass at the instant of starting one revolution, and the illumination may recur slightly before or after the beginning of a second round; in either case there is a false suggestion as to the rotation. The railings would make discontinuous vision of the spokes of the motor wheels, and a spoke might be seen upright in one gap but at slightly different angles at other gaps. I do not feel that the solution of the problem lies in this direction.

Winchester College. W. B. Croft.

Natural Selection and Plant Evolution.

Many readers of Nature must have been browsing with delight in the goodly volume on "Darwin and Modern Science" which Prof. Seward, of Cambridge, has taken such admirable pains to collect. Of all its many chapters few are more significant than that on the palæontological plant record by Dr. D. H. Scott, because there, perhaps for the first time, the evidence of the fossils with regard to the influence of natural selection has been fairly tackled by competent hands.

Dr. D. H. Scott does not attempt to maintain that the record to-day is nearly so imperfect as it was when Darwin wrote his famous chapter thereanent, fifty years ago. Dr. Scott's namesake and collaborator from Princeton speaks even of the record as, in some parts, "crowded with embarrassing wealth of material"; and yet what about evidence of natural selection? The present writer ventured to say (*Contemp. Rev.*, July, 1902, p. 83):—"Modern palæobotanists furnish us with next to no evidence at all of the work of Natural Selection in evolving new species." Prof. Seward vehemently challenged my statements next month; yet, seven years later, Dr. Scott feels constrained to tell us:—"As regards direct evidence for the derivation of one species from another there has probably been little advance since Darwin wrote."

To put it more plainly, Dr. Scott is forced to admit that he can adduce absolutely no satisfactory evidence at all. All he does is to affirm his own firm conviction (as it is Prof. Seward's too) that natural selection must have been the chief agent; and he instances two cases where he thinks the possible inference extremely plausible, viz. (1) the case of the pollen tube, quite absent in the Palæozoic seed-plants, found very short and imperfect in the living cycads and ginkgos, and fully developed in the angiosperms, but fossil proof of linking forms there seems none; (2) the embryo in the angiospermous seeds, whilst Palæozoic seeds contain none. It may, as he says, be "impossible" to some "to resist the conclusion" that the nursing of the embryo by the seed was a process of adaptation. But, at any rate, there is no fossil proof thereof; and yet, as Dr. Scott will scarcely deny, there surely ought to have been some hint and trace thereof, the record being so comparatively rich and full as it is. In the case of the Tertiary mammals the action of natural selection can be very clearly demonstrated in numberless cases. If natural selection was *the* factor in plant evolution too, why is the record so obstinately silent?

Dr. Scott, like Prof. Seward, takes refuge in the thought that our plant record, for many purposes, begins far too late. "An immense proportion of the evolutionary history lies behind the lowest fossiliferous rocks." My chief object in writing this letter is to ask, Is there any valid proof of this in regard to *land plants*, the matter specially in hand? Their record begins, actually, in the Upper Silurian, and though it is very, very meagre and imperfect, the traces are too widespread to be denied. To deny the existence of known Upper Silurian plants is rankest scepticism, though Dr. Scott avoids all reference to them whatsoever. Why, even so very cautious an investigator as Mr. Robert Kidston tells us of "a plant showing woody structure," a plant so high as that, in the Lanarkshire Ludlow beds (Summary of Progress of Geol. Survey for 1897, p. 74). The most important Upper Silurian plant-remains are probably those from the Tanne Greywacke of the Harz, a fairly numerous and well-developed series, of age a good deal lower than Wenlock. Drs. Scott and Seward ("Encyclop. Brit.," Supplement) wish to pronounce all these fern-like and other plants Devonian, because of their facies; but Sir Archibald Geikie ("Textbook of Geology," ii., p. 976) tells us that these Tanne plants are found a long way below shales with graptolites, which surely is proof enough of Silurian age.

We have, then, fair evidence of land plants in the Upper Silurian. Our very first air-breather or land animal, a cockroach, comes from the top of the Lower Silurian; and the fossil record of the whole Silurian is rich, varied, widespread, without gap. Yet it yields no hint of conditions favourable to land life below the top of the Lower Silurian. Is it, then, scientific to postulate dogmatically land plants earlier than the Silurian, simply because a theory requires it? Dr. Scott admits quite freely that the known facts go the other way.

He tells us not only of the opposition of the mighty like Nägeli, he also tells us that, as regards the succession of species, there are no greater living authorities than Grand'Eury and Zeiller, and that, in their opinion, "the evidence from continuous deposits favours a somewhat sudden change from one specific form to another." This is most certainly true of the palæontological record as a whole. The evidence is overwhelming here, if only our men of science would be brave enough to forget their theories for a little while. Why insist on exalting the *a priori* methods of the schoolmen on the fair field of modern science? Why insist on refusing all evidence that does not suit? Why? Surely it is not, and cannot be, to enjoy the pleasure of barring out all design from the world in which we dwell.

James B. Johnston.

St. Andrew's Manse, Falkirk.

Musical Sands.

I cannot call to mind the occasion upon which Dr. Irving suggested that grains of hyaline quartz might produce the notes from musical sands, but, as a matter of fact, the grains do not "ring," or vibrate individually as sonorous bodies, and there is no apparent resonance or sensible continuance of the note after the plunger is withdrawn. I do not think any particular variety of silica is essential, because coral-sand is often musical, and my artificial musical sands are made up almost entirely of silicate of iron.

I have already shown that the natural sorting action of winds and waves is a requisite condition for the formation of musical patches on sea-beaches.

Mr. M. S. Gray's letter in Nature of July 29 giving interesting particulars of his visit to the musical sandhill near Copiapo, in Chile, confirms the statements made by the inhabitants to Darwin in 1835. In his "Journal during the Voyage of H.M.S. *Beagle*" Darwin referred to this hill of sand as "El Bramador"—"the roarer or bellower," but he did not personally visit the spot.

The extraordinary sensations experienced by Mr. Gray were probably similar to those which have been described by the various writers who, from time to time, visited Rig-i-Rawán and Jebel Nakous, both of which were referred to at length in my paper on musical sands in 1888. Particulars of the artificial production of notes from certain sands were also given by me in Nature of August 6, 1891.

Cecil Carus-Wilson.

A Question of Percentages.

If a student obtains 37 out of 50 in one paper, 50 or full marks in a second, and 71 out of 100 in another, what is his percentage on the three taken together? If we add the marks as they stand we get 158 out of 200, or 79 per cent. If, on the other hand, we double the marks on the first two papers, we have 74 per cent., 100 per cent., and 71 per cent. If we add these we get 245 out of 300, or $81\frac{2}{3}$ per cent. Will any of your mathematical readers kindly tell me which of these two different results is the true percentage for the three papers taken together? The answer may be very obvious; I can see that the two results must be different, but I cannot see which is the more correct method to use.

J. T. Cunningham.

60 Milton Park, Highgate, N., July 24.

THE UPPER CRETACEOUS IGUANODONT DINOSAURS.

DISCOVERIES of the last few years in Wyoming and Montana have thrown a flood of light upon the great herbivorous dinosaurs of the Upper Cretaceous which Joseph Leidy named Trachodon, so that now they are by far the most completely understood group of the dinosaurs, not excepting the famous iguanodonts of the Wealden or Lower Cretaceous of Bernissart.

It has long been known that Trachodon is readily distinguished by the elaborate and compound nature of its multiple grinding teeth, which present as great an advance upon those of Iguanodon as the teeth of Equus do upon those of the Eocene Orohippus; but there prove to be other characters indicative of the fact that Trachodon followed a fundamentally different line of evolution from that initiated by Iguanodon, or by the nearly contemporary, closely related Camptosaurus of America. These true Lower Cretaceous iguanodons are probably typical terrestrial forms, as shown in the familiar restorations of the Bernissart specimens, possessing a short manus with the first digit set well apart, as if adapted to grasping the branches of trees or shrubs, or to supporting the animal while browsing.

Trachodon also has been represented as a terrestrial animal. One of the skeletons mounted under the direction of Mr. F. A. Lucas in the United States National Museum, and another mounted under the direction of the late Prof. Charles E. Beecher in the Yale Museum, represent the animal in a walking or running position, using the tail as a balancing organ. On the other hand, Mr. Barnum Brown, who has been the leader of the American Museum expeditions, under the writer's direction, to the Laramie or Upper Cretaceous of northern Montana since 1902, is convinced that these animals were principally aquatic or swimming forms, which used the tail chiefly for propulsion through the water, a view shared by Mr. Charles H. Sternberg, another field explorer. It may be added parenthetically that observation in the field often affords the most important indications as to mode of life.

It will be interesting to discuss the question of the appearance and habits of these animals from materials in the American Museum, which are being very thoroughly studied by Mr. Brown in preparation for a memoir. Of the two skeletons represented in the accompanying photograph (Fig. 1), this museum has acquired three skeletons. The one mounted in the quadrupedal pose (Fig. 1) was discovered in South Dakota, north-east of the Black Hills, by Dr. J. L. Wortman, in 1882, while collecting for Prof. Cope. It had been complete, and the skeleton was surrounded by impressions of the skin, most of which were destroyed during excavation. Some epidermal parts were preserved on the broad bill, showing an interlocking, tooth-like series of points on the horny sheath. As the skeleton lay in the rocks a stream had cut through it, carrying away both femora, most of the pelvis, and twelve presacral vertebræ. The erect specimen (Fig. 1) was found in central Montana by Mr. Oscar Hunter in 1904, and originally "swapped" for a "six-shooter" revolver. In 1906 it was purchased by the American Museum and excavated by Mr. Brown. An important feature of this skeleton was that the vertebral column was connected throughout, and all the bones which the Cope specimen lacked were preserved, together with both lower jaws and two bones of the skull; the rest of the skull is restored after the Cope specimen. In both specimens the tip of the tail is missing.

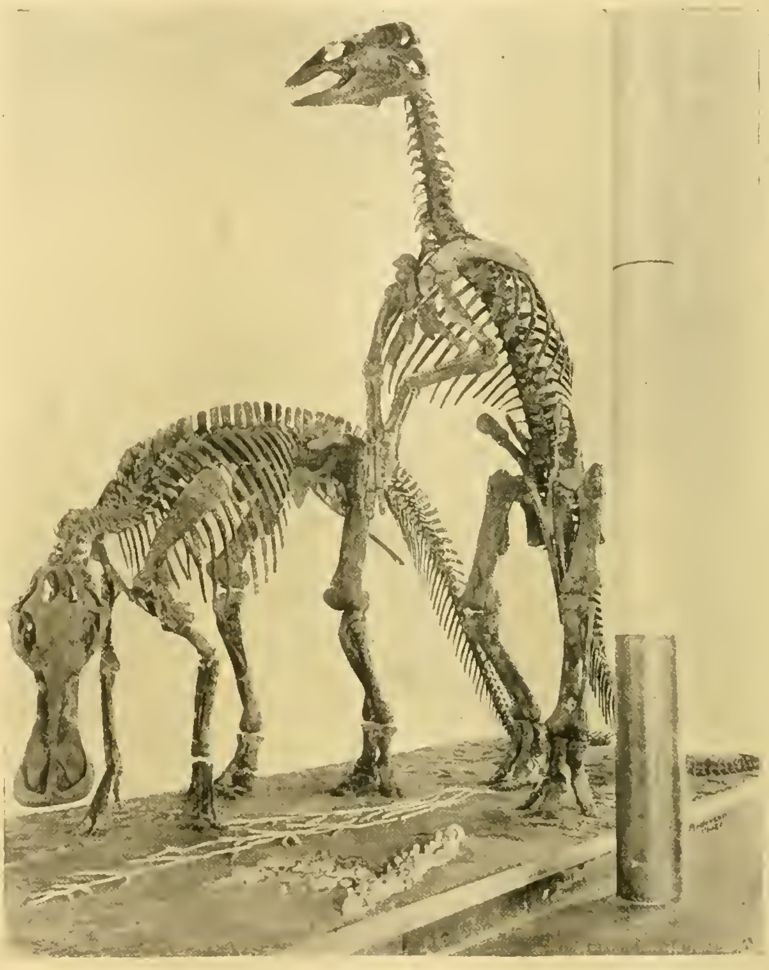

FIG. 1.—Oblique front view of two specimens of *Trachodon mirabilis* as mounted in the American Museum of Natural History.

The difference in the preservation of these two animals partly controlled the design which has been adopted for the mounting; the animal with the perfect head, well known through the descriptions and figures of Cope as *Diclonius mirabilis*, is represented in a feeding posture, which brings the head where it can readily be examined, while the imperfect skull of the second skeleton is "skied" where it cannot be seen. The conception of this group takes us back to the close of the Cretaceous period, when trachodons were among the most numerous of dinosaurs; as two of them are feeding along the marshes, one is startled by the approach of a carnivorous enemy, Tyrannosaurus, and stands on tip-toe better to overlook the foliage; the other, unaware of danger, continues browsing. On the base of the group are shown impressions of leaves, fruit, wood, and shells, replicas of fossils actually associated with the bones of Trachodon. The leaves of the ginkgos, natives of China, were mingled with the cones of Sequoia, or big tree of California. Horsetail (Equisetum) rushes were abundant and luxuriant in growth, an imperfect specimen here represented measuring sixteen feet in length. Fruit and leaves of the fig are also abundant, and with the leaves of a species of banana and numerous palms attest a warm climate in the northern United States during the period.

Hardly was this carefully studied group completed late in 1907 when the fortunate discovery was made in Converse County, Wyoming, in August, 1908, by Messrs. Charles and George Sternberg, father and son, of another specimen of Trachodon with the epidermal impressions very extensively preserved. This completes our knowledge of the animal. Among many other new features it especially brings out the very important difference between the fore feet of Trachodon and of Iguanodon. As noted above, the manus of Iguanodon is a short organ with grasping function. In Trachodon the manus is long and very slender; the thumb, or first digit, is not free, but closely appressed to the side, and still more remarkable is the fact that the entire hand was encased in an epidermal web, so that the digits are not freely movable, but closely united, and thus strongly indicative of a paddle function while moving in the water. This bears directly on the question whether these animals were aquatic, amphibious, or terrestrial. The terrestrial theory may apply to Iguanodon, but certainly not to these animals. The littoral or amphibious theory was that held by Prof. Cope. The familiar restoration by Charles R. Knight, which was made under his personal direction, represents one Trachodon on the shore in a sitting position, a second wading and feeding in shallow water. The enormously powerful hind limbs, provided with three large digits incased in hoofs, together with the long lines of osseous tendons connecting the vertebræ of the back with the vertebræ of the tail, both point to capacity for land progression on the hind limbs, with the use of the tail as a balancing organ. No habitually swimming animal would retain such limbs or acquire such inflexibility of a large region of the backbone as is suggested by the ossification of the tendons. On the other hand, river-frequenting or littoral habits are indicated first by the webbed nature of the epidermis on the fore feet, as well as by the observation of Mr. Brown that of all Upper Cretaceous dinosaurs these are the only ones the remains of which are found in off-shore marine deposits. This fact may be cited as a proof, either that they frequented shallow- and still-water bays of the sea, or that their remains were carried seaward in rivers.

Fig. 2.—A portion of the tail of *Trachodon mirabilis* preserving the pavement epidermal scales.

The position selected for the group accordingly represents these animals as on a ripple-marked shore; one, the Cope specimen, in the quadrupedal position, with the tips of the digits of the manus lightly resting on the ground rather as balancers than as supporters. This is the first time an iguanodont has ever been mounted or represented in this position, and the justification for it is found in the fact that the fore limbs do readily reach the ground and terminate in expanded phalanges, which indicates the retention and occasional use of hoofs. If the trachodons in this phylum had never assumed a quadrupedal position, or used the fore limbs in this way, it is safe to infer that the limbs would have been either still more reduced and degenerate, or else the digits would have spread or expanded into true swimming paddles.

This method of mounting two or more specimens together, but in different poses to illustrate the supposed habits of feeding and of locomotion, is one which is being generally adopted. In the present case it brings out in side and rear views every important feature in the osteology of these animals. By an accident the tail in both these specimens terminates at the same point, but in other specimens in the Yale and National Museums smaller terminal vertebræ have been found which would add about five feet to the tail beyond the parts preserved in these specimens.

The actual height of the head above the ground in the standing Trachodon is seventeen feet; the total length of the body is thirty feet. Remains of still larger individuals of this species have been found which indicate greater height and length.

It is first of all evident from these skeletons and models that these Trachodons, like all the iguanodons, were full-chested and slim-wasted, to use the terms of fashion; while the longitudinal diameter of the pelvic region is enormous, the vertical diameter is very slight. Thus the proportions of the abdominal girdle directly reverse those of the Sauropoda and carnivorous dinosaurs, in which the vertical diameter is the greatest. The shape of the chest is exactly preserved in the new Sternberg specimen, as well as in the indications of the muscular outlines of the limbs and of the presence of a dermal frill on the neck and anterior part of the back. The neck and chest regions are relatively short. The gape of the mouth is placed exactly at the front of the great rows of grinding teeth, as in the mammals. There is evidence that the skin was thrown into loose folds at the junction of the arms and legs with the body, as well as on the sides of the chest.

The Trachodon with the epidermal impressions was found in the region of Converse County, Wyoming, made famous by the explorations of Hatcher for remains of the great horned dinosaurs or Ceratopsia. The entire animal lay in a normal position on its back. The left fore limb was outstretched at right angles to the body, while the right fore limb lay stretched over the under surface of the head. The hind limbs were drawn up and doubled on themselves. The hinder portion of the pelvis and the entire tail had been removed by erosion. The epidermal impressions are best shown on the throat and anterior part of the neck, on the arms and fore limbs, the entire right side of the body, including the axillary region, and especially over the abdomen. The skin is inflected like a curtain over the entire abdominal region without a single break, with brilliant impressions of the scale pattern. This abdominal infolding, the close appression of the skin to the surface of the bones, and the sharp transverse folds all indicate that after death the body was exposed for a long time to the sun, and the muscles and viscera became completely dehydrated; in other words, the body became thoroughly dried and mummified, while the epidermis became hardened and leathery under the action of the sun. In this condition the dinosaur mummy was caught in a freshet, and rapidly buried in fine river sand, which took a perfect cast of the epidermal markings before the tissues disintegrated under the solvent action of the water.

There is no evidence in any part of the epidermis either of coarse tubercles or of overlapping scales;. on the contrary, the epidermis is extremely thin, and the markings are very fine for an animal of such large dimensions. In all parts of the body observed, the epidermis is covered with scales of two kinds—namely, smaller tubercular scales and larger pavement or non-imbricating scales. The latter are perfectly smooth, and, as grouped in clusters or rosettes, assume a rounded or irregularly polygonal form. Over the throat, neck, sides, and ventral surface these clusters are regularly disposed in different patterns, separated by rows of finer tubercular scales, but in the tail, as indicated in the specimen of *Trachodon mirabilis* (Fig. 2), it is probable that the cluster arrangement disappears, and that the entire tail is covered with the tesselated or pavement scales. The vigorous use of the tail among Iguanodontia as a balancing, and perhaps partly as a swimming, organ would lead us to expect this strong development of the scales in the tail region. This disposition of the scales into larger pavement groups and smaller tubercular rows is unlike that observed by the writer in any Lacertilia; it appears to be unique.

H. F. O.

NATURE STUDIES IN NEW ZEALAND AND AT HOME.[1]

(1) MR. THOMSON is well known among zoologists by his discovery of Anaspides, a very interesting genus of Crustacea, on Mount Wellington, Tasmania. In this volume he has collected observations made in the neighbourhood of Dunedin during the last thirty years. The articles appeared originally in the New Zealand Press, and were obviously written without any intention of subsequent issue in volume form. They are necessarily somewhat slight, and touch upon a great variety of topics without systematic treatment. Yet they possess a value which often attaches to first-hand observation written down at the time, for the animals and plants of the island are undergoing a rapid change. Destruction of the bush and the importation of a European element has transformed the neighbourhood, not only of Dunedin, but of other parts of New Zealand. The indigenous plants, insects, and birds are, in many places, becoming scarce, or have disappeared, and only a few more tenacious or more resistent have survived the process of change which has accompanied the development of the South Island. Hence these notes of garden and field life will be of interest to all who are anxious to preserve records of older societies, whether of animals or plants. It would be of the greatest interest to discover how rapidly and completely the introduced flora and fauna acquire the new periodicity of the seasons in New Zealand, and Mr. Thomson's notes may give the requisite stimulus to observers for further investigation on the indigenous and alien organisms of that country.

(2) This work has already appeared in serial form, and will prove a welcome gift-book to many a budding naturalist. The illustrations are excellent, and bring

A Marten moving along a Bough. Photo. by Mr. Douglas English. From "The Nature Book."

[1] (1) "A New Zealand Naturalist's Calendar." Notes by the Wayside. By Geo. M. Thomson. Pp. 224. (Dunedin: R. J. Stark and Co., 1909.)
(2) "The Nature Book." A Popular Description by Pen and Camera of the Delights and Beauties of the Open Air. Vol. ii. Pp. iv+373-752. (London: Cassell and Co., Ltd., 1909.) Price 12s. net.
(3) "The Book of Nature Study." Vol. iii. Edited by Prof. J. Bretland Farmer. Pp. 228. (London: Caxton Publishing Co., n.d.) Price 7s. 6d.

out the characteristic features of the subject with the utmost faithfulness; the topics range from thunderstorms to valley formations, and through a great variety of field and garden forms of life. Amongst such a feast of good things it is invidious to select, but we may mention the articles on British carnivores and rodents, on the grasses and sedges, on the "cryptozoic" fauna, and on certain British trees, as among the most attractive. The physiographical papers by Dr. Lockyer, Mr. M. Duncan, and the late Mr. Lomas are of great interest. No more fascinating work could be easily suggested that would appeal to the eye with such success as this volume does, and though the text is of unequal merit, it has throughout the advantage of being the work of trained observers in the field.

(3) By this new volume of Prof. Farmer's "Book of Nature Study" the student is introduced to plant life. The headings of the first four chapters seem to us remarkably chosen. They may be summarised thus:—Seeds and seedlings, the bud and its growth, vegetative methods of reproduction, the importance of hairs. Surely this is a very inadequate and unequal manner of treating the subject. Miss Laurie has, however, described the objects under discussion well, and the illustrations are good. May we point out that two of the experiments could not be got to work as described and figured? An incompletely described experiment is worse than useless in an elementary book. On p. 40 (Fig. 29) carbon dioxide would enter by the lower edge of the bell-jar, and thus vitiate the experiment. One inch of water is, of course, needed. Fig. 30 (p. 50) represents an experiment which even the author would find physically impossible to set up in the manner described. Sufficient stress, furthermore, is not laid on the fact that all parts of the plant breathe. On p. 56 the storing function of the stem is not referred to. We must, in fact, state that the four chapters give one an inadequate idea of plant life. Prof. Lang's chapters on some flowering plants require no comment. We have here a few flowers, or, rather, complete plants carefully described. The types chosen are readily obtained, and thus every student can have a living plant by his side when working through the descriptions in the book.

RESEARCHES AT THE NATIONAL PHYSICAL LABORATORY.

VOL V. of the Collected Researches of the National Physical Laboratory, which has recently appeared, consists of reprints of thirteen memoirs emanating from the laboratory, and extends to 266 pages. Engineering subjects are answerable for about eighty of these pages, while the rest are about equally divided between electricity, metallurgy, and cosmical physics.

Of the engineering memoirs that dealing with wind pressures is of great importance. By experiments on plates and on lattice-work structures, both in natural winds and in pipes within which a uniform flow of air was maintained, it is shown that the pressure is proportional to the square of the velocity, and further, that the actual pressure on a lattice-work structure when exposed to the wind may be found by observations taken on a small model placed in a pipe through which a uniform current of air is flowing.

A second memoir of interest to engineers is that on a new fatigue test for metals. The material tested is in the form of a ring, which is kept rotating about its own axis under pressure by means of three rollers which bear on its outer surface. Under a test of this kind the superiority of nickel steel rails for railway work is well brought out.

In the electrical section, one of the most important memoirs deals with the history of the standards of electrical resistance kept at the laboratory. The ultimate standards are of mercury in glass, and were first set up in 1902. They show no change in the interval, but many of the secondary standards have increased in resistance by a few parts in 10,000 since they were constructed, some ten, others twenty, years ago. Some of the secondary standards have, however, proved more satisfactory, those of platinum, some of those of platinum-silver, and some of the manganin ones, appearing to be unchanged.

As the result of a comparison of the new electric current balance of the laboratory with the standard ampere balance of the Board of Trade set up fourteen years ago, it appears that the two agree to within 1/100th part of 1 per cent.

In the metallurgical department the alloys of lead and tin have been investigated in considerable detail, both thermally and microscopically, and the eutectic found to be 37 per cent. lead, 63 per cent. tin. A new method of determining the phosphorus in phosphor tin has been also worked out, and promises to be both shorter and much more convenient than the older methods.

Only a portion of the work of the department which deals with cosmical physics is recorded in this volume. This portion consists of a discussion of the magnetic declination as recorded at Kew during the years 1890–1900 in the light of, or, rather, the obscurity provided by, the multitude of theories of terrestrial magnetism now in the field. It is shown that the records are incompatible with any theory which regards magnetic disturbances as directly dependent on the area of the sunspots visible at the time. From the report of this department we note that at Kew the mean declination during 1908 was 16° 16′ W., the mean dip 67° 1′ N., and the mean horizontal force 0·1852 c.g.s. units. By the end of the present year it is hoped that the new observatory at Eskdalemuir will be in full working order, many of the recording instruments being already installed.

From this short summary it will be seen that vol. v. is well worthy to rank with its predecessors, as a contribution to science of which the nation may feel proud.

C. H. L.

JOHN REID, 1809–1849.

UNDOUBTEDLY 1809 was an *annus mirabilis*. Nineteen hundred and nine is, therefore, the hundredth anniversary of the birth of certain great ones in letters, in politics, and in science. Several epoch-makers have their statues in the intellectual Valhalla of the nation, but it would not be well if we allowed the statues on their pedestals to make us overlook the busts in the smaller niches. One of the busts in the Hall of Shades is that of the Scotsman, John Reid, born April 9, 1809, the son of a cattle-dealer, dying July 30, 1849, Chandos professor of anatomy and medicine in the United College of St. Salvator and St. Leonard in the University of St. Andrews. Forty-nine years only intervened—they were filled with the activities of a strenuous Scottish character.

John Reid, the sixth child of Henry Reid and Jean Orr, his wife, was born in the little town of Bathgate in Linlithgowshire, the same in which two years later James Young Simpson, the epoch-maker, first saw the light.

From his native parish school, Reid passed, at the age of fourteen, to the University of Edinburgh. In 1824 he entered for the classes of humanity and Greek; in that year "Richard Owen, Lancaster," was a fellow-student. In 1825 Reid "signed on" for the class of chemistry, and thus entered the faculty of medicine; two years later, "James Simpson, Linlithgowshire," did the same thing. In 1825 the third Munro was in the chair of anatomy, which he was to occupy for forty-eight years, and William Pulteney Alison in that of the "Institutes of Medicine," a subject he taught from 1821–42. From the former, Reid got the least, from the latter the most, inspiration which as a student he received from his teachers.

Early in his studies, Reid showed a preference for anatomy and physiology, and as these formed part of the one and "final" examination for the degree of M.D. (there being no M.B.), Reid dissected from the beginning to the end of his student days. He graduated on August 7, 1830, his Latin thesis being "De aneurismate."

Reid was, therefore, dissecting during 1827 and 1828, the very years in which the Burke and Hare murders were committed. It is believed that "the rooms" both at the University and at Dr. Knox's (Surgeons' Hall) were supplied by the miscreants just named.

His parents had hoped that Reid would study for the Church of Scotland; after having graduated, he himself thought of a surgeonship in the Royal Navy; but neither the Church nor the Navy was to have him whom Science had marked for her own.

Early in 1833 Reid received an invitation from Dr. Knox to become his assistant at Surgeons' Hall, so large had the classes there become. Prof. Monro's dullness had driven the majority of the students over to Knox's rooms. For three years Reid demonstrated for Knox, and so laid for his subsequent physiological researches that surest of all foundations—a sound knowledge of human anatomy. For the session 1835–36, John Reid was one, and J. Y. Simpson was the other, of the presidents of the Royal Medical Society, which presidentship has always been regarded as the "blue ribbon" of the Edinburgh Medical Societies.

Towards the end of 1836, Reid received a most gratifying invitation to succeed Dr. Fletcher, lately deceased, as extra-academical lecturer in physiology. The requisition was signed by no fewer than eighty-six persons, one of them being later the well-known writer on physiology, Dr. W. B. Carpenter, of London University. They asked him to accept the lectureship, for, by so doing, they said, he would "increase the reputation of this city as a school of medicine." "The zeal and success with which you have hitherto prosecuted physiological investigations being already well known to the public." Reid replied to this flattering invitation in the most modest way, and immediately consulted Prof. Alison. Alison not only advised him to take the step suggested to him, which virtually transformed Reid into Alison's own rival, but he proposed him for the Fellowship of the Royal College of Physicians of Edinburgh, into which learned body he was admitted on October 4, 1836.

During 1835 and 1836 Dr. Reid published papers upon obliteration of the vena cava superior at its entrance into the heart; phlebolites; peculiarities of the fœtal circulation; monsters; mesenteric glands in the whale; transposition of abdominal viscera; venisection relieving the heart; and the anatomy and physiology of the heart.

During the next two years Reid carried out the most important of his experimental researches—namely, that into the functions of the ninth, tenth, and eleventh pairs of nerves. Hughes Bennett tells us in his "Memoir" that between 1836 and 1838 he performed upwards of one hundred experiments on animals in order to unravel the functions of the so-called "eighth pair of nerves." A copy of this paper lies before me; it extends to sixty-two octavo pages, and consists of a thorough investigation into the activities of the glossopharyngeal, the pneumogastric, and the spinal accessory nerves. After giving a full account of the French, German, and Italian literature accessible to him, he details the experimental procedures employed to arrive at an understanding of the functions of the many branches of these three great nerve-systems. When we consider the technical difficulties under which he worked, having no stimulus more satisfactory than the galvanic current or chemical or mechanical irritation, no anæsthetics other than prussic acid and morphia, and the knowledge of no procedures known as antiseptic, we are amazed that he discovered so much and of so elusive a character. This work on the nerves was his *magnum opus*, probably the last important piece of work in physiology anterior to the introduction of the stimulus of the "interrupted current" from the laboratories of Germany. It is curious to notice the absence of tracings in the paper; Reid was the last pre-graphic physiologist in Scotland. Amongst other things long since fully corroborated, Reid showed that the heart had the double innervation through the vagi and the sympathetic. He came within a very little of discovering the cardio-inhibitory functions of the vagus. The memoir was published in full in the *Edinburgh Medical and Surgical Journal* (No. 139), but an *epitomé* of it had been read at the Liverpool meeting of the B.A. in 1837.

One or two paragraphs from this admirable paper are worth quoting in the light of to-day:—"It may appear to some that I have repeated many of these experiments with unnecessary frequency and a wanton sacrifice of animals, but I naturally felt diffidence and distrust in the accuracy of the results I obtained when opposed to those of more experienced observers, and it was only after repeated and careful examination of the phenomena that I could feel myself justified in calling these in question. It is also sufficiently obvious that nothing is more injurious to the progress of science than hasty and partial observations, and I was anxious to avoid . . . adding to that mass of conflicting evidence which there is already so much reason to deplore."

"It is obvious that, without the aid of active and intelligent assistants, it would have been perfectly impossible to have proceeded with such an investigation."

It is interesting to us to be told that one of these assistants was Sharpey.

Had Reid lived only a little longer, so as to have used the DuBois' Inductorium, he would unquestionably have discovered much more; the pity was, he had to cease working "in the rich dawn," physiologically speaking, "of an ampler day."

In 1838 he was appointed pathologist to the Edinburgh Royal Infirmary, and a year later superintendent of the Pathological Department. As the result of his observations at this time, he compiled "Tables of the Weights of some of the most important Organs of the Body at different Periods of Life" (published 1843). In 1839 he brought out a paper, "On the Effect of Lesion of the Trunk of the Ganglionic System of Nerves in the Neck on the Eyeball."

Dr. Reid had unsuccessfully contested first the chair of medicine, and later the chair of anatomy in the

University of Aberdeen, but in 1841 he was unanimously elected to the Chandos chair in St. Andrew's. In the same year he published his important paper, "On the Relation between Muscular Contraction and the Nervous System," whereby he made a contribution to a controversy then already quite a century old—as to whether the irritability of muscle was or was not "inherent." The great Haller had taught it *was* inherent (the "vis insita"). Robert Whytt, professor of medicine at Edinburgh just a hundred years before Reid's time, had been a strenuous opponent of the doctrine of inherent irritability. Follow-Boerhaave, the leader of the Batavian school, who had trained so many of the professors of Edinburgh, Whytt considered that his experiments confuted the opinions of Haller. When Reid took up the subject in 1834, it was still a controversy.

Reid, using frogs, demonstrated :—

(1) That the muscle of a nerve-muscle preparation, fatigued by stimulation through its nerve, could still contract when it was stimulated directly.

(2) That a muscle, the nerve of which had been cut, would not waste away, provided it was "daily exercised by galvanism."

He even then pointed out the now obvious therapeutic application of this latter fact. His position was: irritability is indeed inherent, but the muscle must be constantly in use in order not to suffer from "dis-use atrophy."

Amongst his collected papers we find one "On Sensational and Emotional Reflex Actions," from which we may conclude that Reid had grasped the essence of the conception of reflex action in such a way as to see that the presence of consciousness need not make the action any the less truly "reflex."

After going to St. Andrews, Prof. Reid published two long papers on the epidemic of fever in Edinburgh in 1836. He began to study the marine biology of the bay, and papers on polyps, molluscs, and medusæ were, between 1844 and 1847, communicated to the "Philosophical Society of St. Andrews," a society still existing.

In 1844 John Reid was married to Miss Ann Blyth, of Edinburgh. Their two sons died in infancy; their two daughters died before their twenty-fifth year; his widow, who was married to a Mr. Foster, survived him more than forty years.

Prof. Wilson, his biographer, describes Reid's appearance in these words :—"Tall, with a strong figure, diminished in height by a stoop acquired by so much bending over books, dissections, and microscopes, his complexion fresh and even ruddy, his forehead expansive, his eyes small, but of a bright black; his hair, which matched his eyes, was worn long."

By August, 1848, it had become evident that Reid was suffering from cancer of the tongue and throat. On August 31, at Prof. Simpson's, 52 Queen Street, Edinburgh, John Reid underwent an operation at the hands of his friend, Mr. (later Sir) William Fergusson; Goodsir, James Duncan, and Hughes Bennett (his old pupil) assisting. On November 29 a second operation was considered necessary; this was carried out at Prof. Goodsir's, 55 George Square, by Duncan, Spence, and Goodsir. For a third time (January 1, 1849) did poor Reid submit to the knife; he warned them about admitting air into the veins of the neck; they could not have forgotten that he had written on "Death by Admission of Air into the Venous System." Doomed at forty, Prof. Reid, after visiting Keswick and Innerleithen, returned for the last time to his house in North Bell Street, St. Andrews (now re-named Greyfriars Garden). On his death-bed he collected all his published papers in a large octavo of 659 pages. He had the courage to review a work by Hughes Bennett on "Cancer." His sufferings were extreme: morphia and the newly-discovered chloroform alone could assuage them. The end came none too soon on July 30, 1849.

In the "Life of John Reid" (Edinburgh, 1857) Prof. Wilson tells us that he attended the funeral on a "singularly bright and beautiful day."

We who know the old city have seen such days, rare indeed, but memorable in their rare beauty when they come. We can so well picture the sad, slow procession from the Town Kirk to its goal within the ruins of the noblest of Scottish cathedrals; there, amongst green graves, they laid John Reid to rest where the murmur of the everlasting sea makes moaning music through the roofless fanes.

Scotland has produced greater anatomists, pathologists, zoologists, and physicians than was John Reid, but I question whether, having regard to the limitations of his scientific environment and to the imperfections of the methods and of the technique with which he worked, anyone would undertake to deny his right to be considered one of the most original and prescient physiologists of purely Scottish birth and training.

I venture to believe that in this year of centenary commemorations no man of science will grudge John Reid his own. D. Fraser Harris.

NOTES.

The collection of fossil Brachiopoda formed by the late Mr. J. F. Walker, of York, has been presented to the British Museum (Natural History) by his executors, Mrs. Walker and Mr. Gelson Walker. It consists of several thousand specimens arranged in groups to illustrate the variations of species and the gradation of several so-called species into each other. It therefore supplements the Davidson collection, which was bequeathed to the museum in 1885. It is especially rich in material from the English Jurassic and Cretaceous formations, to which Mr. Walker devoted much attention; but it also contains important series of specimens from other English strata, besides several small collections for comparison from the European continent. The greater part of the collection will be kept for reference in the original cabinets, but more than a hundred important specimens, described and figured in Davidson's "Monograph of the British Fossil Brachiopoda," will be placed in the exhibition cases of the public gallery.

Mr. W. R. Boelter writes to urge the institution of a people's "Arbour Day" in October for the purpose of planting fruit trees along roadsides as they are in some parts of Germany. From a report issued by the Minister of Agriculture of Saxony it appears that the department in charge of these trees made a profit of 12,000*l.* during 1908 from a countryside corresponding to our Black Country. As, however, the system of road maintenance in Germany differs completely from that followed in England, similar success can scarcely be anticipated here, where the roads are controlled by numerous district and county authorities. Farmers object to trees on the roadside near arable land, and road surveyors in general dislike trees, because the highway does not dry up well under them after rain. Even when permission has been obtained to plant fruit trees along roadside waste in some districts, it will be necessary to appoint officers whose duty it is to protect the trees and promote their satisfactory growth. We are afraid that few local authorities are likely to add to their responsibilities by undertaking the care of young trees along the roadside, much as we are in sympathy with Mr. Boelter's suggestion.

The *British Medical Journal* announces the death of Prof. A. Fraser, occupant of the chair of anatomy in the Royal College of Surgeons, Dublin.

From an obituary notice by Herr von Konkoly, appearing in the *Astronomische Nachrichten*, we learn with regret of the death of Herr Eugen von Gothard, known throughout the astronomical world for his brilliant researches on the spectra of comets, nebulæ, novæ, and other celestial objects at his private observatory at Herény, Steinamanger, Hungary. In 1892 von Gothard photographed the spectrum of Swift's comet on the same plate as the spectrum of the base of a Bunsen flame, and thereby showed the two spectra to be identical so far as the fourth band. He also obtained illuminating spectra of Nova Persei in 1901, and did a great deal of experimental work on the construction of various astronomical instruments. At the time of his death, May 29, von Gothard was only fifty-two years of age, a fact which makes the loss of a devoted worker, possessing exceptional abilities, more keenly felt by all those interested in the progress of astrophysical science.

Prof. F. H. Seares has resigned the directorship of the Laws Observatory, of the University of Missouri, to become superintendent of the computing division at the Mount Wilson Solar Observatory. This post he assumed on August 1, and asks that all correspondence, pamphlets, &c., shall be addressed to him at the Solar Observatory, Pasadena, California.

The Baly medal, awarded by the Royal College of Physicians of London every alternate year to the person who shall be deemed to have most distinguished himself in the science of physiology, has been awarded to Dr. Emil Fischer, professor of chemistry in the University of Berlin; and the Moxon medal, awarded every third year to the person who shall be deemed to have most distinguished himself by observation and research in clinical medicine, has been awarded to Sir W. R. Gowers, F.R.S.

The recorder of the Engineering Section of the British Association has sent us a copy of the provisional programme of the proceedings at Winnipeg, in which the following papers appear in addition to those mentioned in the article on July 15:—the National Transcontinental Railway, Duncan MacPherson; improvements in the navigation of the St. Lawrence, Lieut.-Colonel William P. Anderson; great engineering works on the Canadian Pacific Railway, J. E. Schwitzer; losses from high-tension overhead lines due to brush discharge, E. A. Watson; on the calculation of the charging currents in three-core cables and overhead transmission lines supplied with three-phase currents, E. W. Marchant.

Reuter messages state that two severe earthquake shocks were experienced in Mexico City at 4.20 a.m. and 4.25 a.m. on July 30. Half the city is said to have been destroyed by the earthquake. Chilpanzingo and Chilapa are reported to have been destroyed. Earthquakes are also reported as having occurred at intervals for fourteen hours at Iguala and Guerrero. At Acapulco not a single building escaped some damage; in this locality the most disastrous shock occurred during the afternoon of July 31, when the water in the harbour is said to have receded 33 feet and then to have risen with great force, causing much damage. Seventy-three shocks were felt during the three days July 30 to August 1.

The second International Congress for the Repression of Adulteration in Food, Chemical Products, Drugs, Essential Oils, Aromatic Substances, Mineral Waters, &c., is to be held in Paris on October 17–24. There are likely to be representatives present from every civilised country, and official delegates have been appointed by many Governments. The particular object of the congress is to define what operations are permissible in the handling of food, and follow upon the definitions accepted at the congress held in Geneva last year. The Society of the White Cross of Geneva originated the idea of holding these international congresses, and four congresses have been arranged; the third will be held probably at The Hague in 1910, and the fourth in London in 1911. The work of this year's congress will be held in three sections:—the first, on alimentary technology, will be presided over by Prof. Muntz, director of the chemical laboratories of the National Agronomic Institute, Paris; the second section, dealing with hygiene, will be presided over by Prof. Landouzy, of the faculty of medicine in the Paris University; and M. Guignard, director of the School of Pharmacy, Paris, is the president of the third section, which will be concerned with crude drugs, essential oils, chemical products, and mineral waters. Prof. Bordas is the president of the executive board, and M. Maurice Rivière, 16 Place Vendôme, Paris, the treasurer. Mr. Loudon M. Douglas, 3 Lauder Road, Edinburgh, is the honorary secretary for the United Kingdom, and men of science and others in this country proposing to attend the congress are asked to send an intimation of their intention to him. Subscriptions, which vary in amount according to the character of the membership, should be sent direct to the treasurer.

No. 1 of vol. xvii. of the Proceedings of the Royal Physical Society, Edinburgh, is devoted to the presidential address of Mr. William Evans, in which our present knowledge of the fauna of the Forth area is discussed at considerable length.

We have been favoured with a copy of the report of the Colombo Museum for 1908, in which the director, Dr. H. Willey, emphasises the fact that the scope of that institution is restricted to the products, natural and artificial, of the island of Ceylon. Special attention is directed to a collection of bronzes and stone implements, several of which are figured, found by the Archæological Survey in 1907, and deposited in the museum last year.

We have received from the author, Dr. E. Balducci, a copy of a paper, issued in the *Pubblicazoni de R. Istituto di Studii Superiori Practici e di Perfezionamento in Firenze*, on a forest-hog from the Upper Congo, for which the new name *Hylochoerus gigliolii* is proposed. No mention is made of *H. ituriensis* from the same region, named in 1906 by Dr. P. Matschie in the Annals of the Congo Museum, but there can be no reasonable doubt that the supposed new species is identical with that form.

To vol. v., part vii., of the Annals of the South African Museum, Dr. R. Broom communicates further particulars with regard to the milk dentition of the aard-vark. The full dental formula he believes to be $i.\frac{3}{3}$, $c.\frac{1}{1}$, $p.+m.\frac{9}{9}$. Dr. Broom accepts, provisionally, the opinion that Orycteropus is not an edentate; but there is at present insufficient evidence to determine its true affinities. It is suggested that the above-mentioned dental formula is inherited from an early ancestor, and that the genus may consequently be allied to the Mesozoic mammals, a number of which, he states, may probably have had a similar formula.

At the conclusion of an article on the sense of direction in man, published in the July number of the *Revue des*

Idées, Mr. V. Carnetz, who bases his opinion on observations made on natives of the Tunisian Sahara between the years 1891 and 1894, denies that the power of orientation is due to the possession of a sixth "sense." We have to deal rather, it would seem, with an instinct, if it may be so called, acting as an intermediate innate agent between the external medium and the sense of vision, of which it forms a kind of offshoot. It cannot act without vision, but the latter alone is insufficient for the purpose of finding the direction.

IN the summer number (vol. iii., No. 6) of *Bird Notes and News*, attention is directed to the transference of the offices of the Royal Society for the Protection of Birds from No. 3, Hanover Square, to 23, Queen Anne's Gate, Westminster, this transference having become necessary owing to the impending removal of the Zoological Society's offices from the former address. The summer number is accompanied by a pamphlet giving a summary of the arguments in favour of bird-protection and of the efforts which the society has made in this direction, together with an appeal for further assistance in carrying out and developing the society's work.

THE July number of the *Zoologist* contains an article by Dr. E. Menegaux, of the Paris Museum, translated by the author from *La Nature*, on American egrets as victims of fashion. According to statements made by the well-known traveller and naturalist, Mr. Geay, large quantities of "ospreys" are collected as shed feathers by the natives of Venezuela and Colombia, and also that when the plume-hunters kill the birds themselves, they always spare the young birds, which yield no ornamental feathers; while it is further stated that when the parents of nestling egrets have been slain, the latter are fed by other birds, so that deaths from starvation do not take place. As an appendix the editor reprints a document published by the Royal Society for the Protection of Birds as a kind of counterblast to Mr. Geay's assertions.

THE degeneration of armour in animals forms the subject of an article by Dr. Felix Oswald in the July number of *Science Progress*. As instances of this disappearance the author refers, among many other examples, to labyrinthodonts as contrasted with modern amphibians, to the disappearance of the solidly armoured glyptodonts and the survival of the less immovably shielded armadillos, the disappearance of the Palæozoic ostracoderms and placoderms and the emancipation from armour of modern fishes, and very specially to the numerous independent instances where the shell has been more or less completely discarded by gastropod molluscs. He might also have referred to whales and dolphins as contrasted with the zeuglodonts, and to the evidence recently quoted in NATURE as to the presence of vestiges of a dermal armour in the fox.

To *Naturwissenschaftliche Wochenschrift* for July 18, Prof. H. Kolbe communicates an interesting article on the theory of a former extension of the Antarctic continent, with remarks on the distribution of animal life in the southern hemisphere. Commencing with a reference to the hypothesis that the Arctic region formerly enjoyed a mild climate and a large continental area which served to a great extent as a centre of dispersal and radiation for animals in the northern hemisphere, the author proceeds to adduce evidence in favour of the former existence of very similar conditions at the opposite pole. Reference is made to recent discoveries indicating the large area still occupied by the Antarctic continent, and to the occurrence of a fossil flora in high southern latitudes which must have required a comparatively warm climate for its development. Ortmann's work on the Lower Miocene marine deposits of Patagonia, New Zealand, and Australia, which are certainly of littoral origin, is next cited as evidence of an inter-continental connection in later Tertiary times in high southern latitudes. Further testimony to the same effect is adduced from the present faunas of the great southern continents, more especially from beetles and other insects. The idea that such resemblances as exist between the different southern faunas may be explained by "convergence" is shown to be untenable, as convergence consists in resemblances between different groups, not the likeness of allied forms. A South Polar union of the southern continents in later Tertiary times is considered by the author to be now demonstrated.

THE anatomical structure of the Holothurians is described and discussed in an elaborate manner by Dr. Siegfried Becker in the third part of vol. i. of Dr. Spengel's "Ergebnisse und Fortschritte der Zoologie" from the point of view of the phylogenetic relationships of the various members of the class. In the opinion of the author, considerable modification of the generally accepted phylogeny of the group, as given, for instance, in the "Cambridge Natural History," is necessary. The Synaptida, for example, are regarded as a very ancient group, which, with certain other forms, are widely distinct from the modern types. The Dendrochirota and the Molpadiida, again, in place of being, in common with the Synapta, derived from a hypothetical common stock, are regarded as of independent development. The remainder of the part last quoted is devoted to a memoir, by Dr. Max Rauther, on the morphology and mutual relationships of the nematode worms.

THE *Journal of Comparative Neurology and Psychology* for June (vol. xix., No. 3) contains an interesting paper by Mr. R. E. Sheldon on the sensitiveness of the general body surface of the smooth dogfish to those chemical stimuli which in man provoke sensations of taste and smell. Both normal and "spinal" dogfish were under observation; in other dogfish the spinal cord had been destroyed, in others, again, the olfactory crura or the four branches of the trigeminal nerve had been divided. The author finds that the dogfish reacts to chemical stimuli applied to any spot on the body surface or to the mouth or nostrils, that acids and alkalis, even when very dilute, are potent stimuli, that salt and bitter substances are less powerful, and that no reaction occurs towards sugars. The results of experimental interference indicate that the extreme sensitiveness of the nostrils of the fish is due to the trigeminal rather than to the olfactory nerve. The nerves of the lateral line appear not to be concerned in these "chemical" sensations, as no reactions occur after destruction of the spinal cord, the fish being viable for some weeks in this state. Cocaine is found to abolish tactile sensibility before response to chemical stimulation is affected. The author concludes that the sensitiveness to chemical stimuli is due almost exclusively to the nerves of general sensation, not at all to the olfactory and very little to the gustatory nerves, and that a special nervous mechanism, distinct from that for touch, constituting the apparatus of a distinct "chemical" sense, exists alike in the vertebrate and in the invertebrate world.

AN essay by Miss B. Freire-Marreco on the hair- and eye-colour of school children in Surrey appears in the July number of *Man*. The essay was prepared for the diploma examination at the Oxford School of Anthropology—a welcome indication of the progress being made in this department. The observations, which extended to 591 subjects, have been tabulated on the plan recommended by Dr. John Beddoe, and have been examined by the aid of the index of nigrescence adopted by the same authority, and also by the index of M. Collignon. According to the former, the people of these Surrey parishes turn out to be four times as fair as the fairest people of Scotland; according to the latter the result is inconclusive, the reason being that the outstanding feature of the record is the predominance of medium eyes and the comparatively high percentage of brown hair. On the whole, girls are slightly darker than boys, and as the difference lies mainly in eye-colour, this is possibly a sex characteristic; and there seems to be some connection between red hair and medium eyes. The author suggests a third method of examination in addition to those of Beddoe and Collignon. The paper, on the whole, shows a decided aptitude on the part of the author for statistical work of this kind, and it may be hoped that she will follow up the subject, largely increasing the area of her inquiry and the number of subjects.

One of the most interesting of the numerous writings to which the recent Darwin anniversaries have given occasion is the first article in the current number of the *Quarterly Review*. The article, which is by Prof. Poulton, discusses the various criticisms that have been directed against the Darwinian theory both in early and in recent times. The author passes in review the work of Weismann, of Mendel, and of de Vries, showing the relation of the results obtained by each of these investigators to the conclusions reached by Darwin. He demonstrates by an ample series of quotations that the idea of "mutations" was constantly present to Darwin's mind, and that he only rejected the supposition that they might be concerned in the production of new species after giving the fullest consideration to the whole question. Prof. Poulton concludes, on several lines of evidence, including that of palæontology, that the mutationist theory of evolution is untenable, and that the only explanation of the course of evolution which really accounts for the facts is the principle of the accumulation of small differences by natural selection, as maintained by Darwin and Wallace. He is inclined to attach weight to de Vries's distinction between "elementary species" and varieties, as exemplified by their different behaviour in relation to Mendel's law, but he considers that the only fundamental change in the original Darwinian doctrine which is actually valid is that brought about by Weismann's denial of the transmissibility of acquired characters.

A first volume of Transactions has been issued by the Liverpool Botanical Society, in which are published several papers read before the society, and a biographical list of deceased Lancashire botanists, prepared by the secretary, Mr. A. A. Dallman. A communication by Prof. R. J. Harvey-Gibson on the problem of photosynthesis concludes with a reference to experiments supporting the hypothesis that formaldehyde is produced in the leaf from carbon dioxide by electric currents generated by the chlorophyll. Messrs. J. A. Wheldon and W. G. Travis contribute a list of hepatics for South Lancashire.

In the course of an article in the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften*, Vienna (vol. cxvii., part viii.), describing certain fungi collected in Java, Prof. F. von Höhnel adduces convincing evidence to show that there has been indiscriminate naming of tropical fungi, due partly to great variation in the species, partly to the examination of insufficient or dried material. Thus, with regard to fungi growing in the nests of white ants, all the portions of agaric material collected were referable to a single species, which the author assigns to *Volvaria eurhiza*; two species of Xylaria were also found in the nests, and a species of the nature of a Hypocrea. Another variable species is determined as an Oudemansiella. Among the new species identified are a Sphærocreas and a Corditubera.

We have received a copy of the schedule and rules of the International Agricultural Exhibition to be held at Palermo (Buenos Aires) by the Sociedad Rural Argentina from June 3 to July 31, 1910, under the auspices of the Government of the Argentine Republic, in celebration of the emancipation of the Argentine, May 25, 1810. The conditions of entry of live-stock, implements, &c., are clearly set forth, and full information is given for intending exhibitors.

The education committee of the Durham County Council has issued a report on further experiments on the feeding of dairy cows at Offerton Hall, by Messrs. F. P. Walker and S. H. Collins. The effect of brewers' grains has been again tested, both on the quantity of milk produced and on the percentage of butter-fat present. Mr. Collins also shows, in another experiment, that boric acid can get into milk if the cows are fed on food which, like Indian cotton cake, contains much of that substance.

The reports on experiments with crops and stock carried out during the past year at the Midland Agricultural and Dairy College, Kingston-on-Soar, and in the contributing counties, have just been published, and they show a very commendable zeal and activity on the part of the staff. The experiments deal with varieties of mangolds, potatoes, swedes, and oats, and also with the manuring of swedes and oats, and are designed to assist the farmers in selecting varieties of crop and the combinations of manure likely to prove profitable.

An interesting series of papers by Dr. Juritz has been appearing in recent issues of the *Agricultural Journal of the Cape of Good Hope*, discussing the soils of Cape Colony. Large numbers of chemical analyses and a certain number of mechanical analyses are quoted, and references are made to the special agricultural characteristics of some of the soils. Whilst the work in question forms by no means a complete soil survey, it marks a beginning, and shows that the Cape agricultural authorities are fully alive to the necessity of making systematic examinations of their soils.

A number of bulletins have reached us from the United States Department of Agriculture Bureau of Entomology, including papers on the codling moth in the Ozarks (E. L. Jenne), the striped cucumber beetle, *Diabrotica vittata*, Fab. (F. H. Chittenden), the hop flea-beetle, *Psylliodes punctulata*, Melsh. (F. H. Chittenden), the spring grain-aphis, *Toxoptera graminum*, Rond. (F. M. Webster), and the wheat-straw worm, *Isosoma grande*, Riley (F. M. Webster and G. I. Reeves). A very useful pamphlet gives a list of all the publications issued from the Bureau since it was established in 1863.

The *Journal of Agriculture for South Australia* for June publishes the report of the experiments made at the Roseworthy College for the seasons 1907–9. The most important experiments are naturally those on wheat. Land values in many parts of South Australia are rising, and the old plan of growing wheat as the main crop with frequent fallows is no longer so profitable as before. The experiments show that the fallow is not necessary, but can be displaced by another crop; a rotation system has therefore to be evolved. The average rainfall is 17·4 inches.

FUMIGATION under tents with hydrocyanic acid gas has been the principal means of controlling scale-insects on citrus fruit trees in California for many years. Most of the commercial orchards in the State are fumigated at intervals of one or two years, at a cost ranging from 25 cents to 1·50 dollars a tree. The results of the work of different manipulators, and against different scale pests, show considerable discrepancy, and a good deal still remains to be done to put the whole method on a sound basis. Mr. Woglum has recently published the results of investigations made in California with the view of clearing up some of the discrepancies; the paper, which is well illustrated, forms Bulletin No. 79 of the United States Department of Agriculture Bureau of Entomology.

THE summary of the weather for the week ending July 31 shows that the period was again cold for the time of year over the whole country. The highest maximum shade temperature for the week over the United Kingdom was 73° in the east of England and in the Midland counties, whilst in the north and east of Scotland and in the north of Ireland the thermometer did not exceed 68°; the rainfall over England was everywhere largely in excess of the average. The summary for the eight weeks of summer, as yet expired, shows that the thermometer has not exceeded 77° in any part of the kingdom, and in the north-east of England the highest temperature is 73°. The excess of rainfall for the eight weeks amounts to 1·6 inches in the west of Scotland and in the north-west of England, and to 1·3 inches in the Midland counties. At Greenwich the excess of rain for June and July amounts to 2·4 inches, the aggregate measurement being 6·85 inches. The duration of bright sunshine for the summer, so far, is largely deficient of the average, the deficiency exceeding eighty hours in the north-east and south-east of England.

IN the *Archiv for Mathematik og Naturvidenskab* (vol. xxix., No. 12), Mr. A. S. Steen discusses the mean temperature of the sea surface on the Norwegian coast, "reduced" for the thirty-year period 1874–1903. With one exception the observations were made at light-stations between Torungen in the south-east and Gjesvær in the extreme north (lat. 71° 6'). The lowest mean values occur in February and March, and the highest in August. Selecting two stations on the Atlantic coast, we find at Utsire (lat. 59° 18') those values to be 39·2° F. and 58·5°, and at Andenes (lat. 69° 20') 33·3° and 51·1° respectively; up to lat. 63° the mean annual temperature of the 30-year period does not fall below 46·4° F. The tables also include departures of the monthly means from the normal value for each of the separate years 1874–1903.

AMONG several useful papers on the climatology of Italy recently received from Dr. Eredia, we may refer to two of special interest, relating to torrential rains in Sicily (1879–1907), and to the disastrous floods, especially in the provinces of Syracusa and Catania, caused by severe thunderstorms in November last. The heaviest rains occur on the eastern slope of the island between September and April; at Riposto a fall of 7·64 inches within twenty-four hours occurred in November, 1889, and one of 8·12 inches at Catania in September, 1902. In the thunderstorms of November 17 and 18, Riposto recorded daily falls of 18·29 inches and 8·11 inches; 5·91 inches fell in twenty-five minutes. At Sant' Alfio the falls were 8·68 inches on November 17, and 14·39 inches on November 18. This remarkable downpour was caused by a shallow barometric depression passing from the south of Spain to Algeria, with high barometric pressure existing at the time over the Balkans and Upper Italy.

AFTER the Kangra earthquake of April 4, 1905, Prof. Omori, who had been sent by the Japanese Government to India, lent to the Indian Meteorological Department a portable seismograph of his design. This instrument was set up in Simla, and in vol. xx., part iii., of the Memoirs of the Indian Meteorological Department a list is given of the seismographic records obtained with it between June, 1905, and November, 1908. The instrument is of the pattern which records by the movement of a tracing point on a travelling sheet of smoked paper, and has a heavy mass of about 10 kg. at the end of a boom 75 cm. in length. Experience has shown that instruments of this type seldom give satisfactory records of the preliminary tremors unless the heavy mass is at least 25 kg., and the seismograms, reproduced in the memoir, show that the Simla instrument is no exception to this rule.

IN a recent number of *Globus* (xcvi., 1), Mr. W. Reinhard gives a short description, with facsimile, of a MS. map of the British Isles preserved in the British Museum, which does not seem to have hitherto met with the attention it deserves. It is of interest as occupying an intermediate position between early productions such as those of Matthew Paris, and the more precise work of Christopher Saxton, or even of Mercator and Ortelius. It is without date or author's name, but may be assigned with some confidence to the middle of the sixteenth century, being thus about contemporary with (Mr. Reinhard says *earlier* than) the map of George Lily (1546), stated by Gough to be the first exact map of Great Britain. While not quite so correct as this as regards the outlines, especially of Scotland, it is perhaps superior as regards the amount of detail supplied, at least for England. Besides most of the principal towns and villages, it names a number of physical features. Among islands, we find Holy and Farne islands (Northumberland); Mersea and Foulness (Essex); Mt. St. Michael (Cornwall); Priestholm or Puffin island, near Anglesey. The name Portland appears on the mainland, while Corfe and Selsea are both shown as islands. Of towns and villages swept away by the sea, we find Dunwich, Orwell (misplaced), and others, but not Ravenspur, though this had been destroyed only about 1530. A large island seems indicated within the mouth of the Humber, though it would probably be risky to argue changes of coastline from such evidence. There is still much room for research as regards the data on which such maps were based.

THE June number of *Terrestrial Magnetism and Atmospheric Electricity* contains a frontispiece showing the magnetic survey yacht *Carnegie* under full sail, and an article describing her construction and the work she is intended to do. She has a displacement, when fully equipped, of 568 tons, and is built almost without iron, her bolts and metal fittings being of bronze, copper, or gun-metal. The observation rooms are amidships. The yacht is to make a magnetic survey of the oceans during the next fifteen years, with the object of correcting the magnetic charts and compass data at present available. Her first voyage will be to Hudson Bay and the North Atlantic Ocean.

THE *Electrician* for July 16 contains an article, by Mr. L. W. Wild, on the comparative merits of photometers of the Bunsen type, of the Lummer type, and of the flicker type, for testing the brightness of lights of different colours. Mr. Wild has used two or three photometers of each type in the comparison of a carbon with a tungsten filament lamp, and comes to the conclusion that for accurate work photometers of the Bunsen type are to be preferred to those of the flicker type. He considers the latter, although more sensitive than the former, give readings for the comparative brightness of the two lamps about 6 per cent. from the true value. He finds photometers of the Lummer type come short of the Bunsen in sensitiveness, and he thinks that in time the Bunsen will displace the other photometers at present in use.

BULLETIN No. 30 of the University of Illinois consists of an important paper, by Mr. J. K. Clement, on the rate of formation of carbon monoxide in gas producers. The numerous theoretical works on the processes taking place in the fuel bed of the producer have been built up on a rather slender experimental basis, and the present communication fills a decided gap in our knowledge. The experiments deal more especially with the rate of formation of CO in the reaction $CO_2 + C = 2CO$, previous researches having been rather directed to the study of the final equilibrium than to the rate at which the reaction takes place. Three authors contribute to this memoir, J. K. Clement, L. H. Adams, and C. N. Haskins, dealing with the subject from the physical, chemical, and mathematical point of view respectively. The result of this collaboration is a valuable monograph, which cannot be neglected by anyone interested in gas producers.

MR. W. B. CLIVE has published a second edition of Mr. William Hall's "Modern Navigation." The text-book deals also with nautical astronomy, and is intended to meet the needs of cadets of the Royal Navy and the syllabus of the Board of Education. The scope of the volume is limited to instruction in navigation so far as, and including, the problem of fixing position by one position line derived from sights of the sun and another derived from a bearing of land. The book has been entirely re-cast. Its price is 7*s*. 6*d*.

AN abstract of Dr. John Morrow's contribution to part iii. of the third volume of the Proceedings of the University of Durham Philosophical Society was published in NATURE of July 29 (vol. lxxxi., p. 128). The volume contains, in addition, other articles of interest, among which the following may be mentioned:—Prof. Thornton describes a new method of measuring π; Prof. G. H. Stanley contributes a note on an artificial formation of zincite; Dr. D. Woolacott writes on borings at Derwenthaugh and Dunston; Mr. A. S. Horne describes observations on protoplasmic structure and streaming in potato; Messrs. Harold Crofts, H. Tiplady, and A. Forster discuss certain chemical experiments; and Messrs. T. Herdman and E. Merrick record observations in local geology. The third report of the Boulders Committee is also included in the volume.

OUR ASTRONOMICAL COLUMN.

MOVEMENTS IN THE SUN'S UPPER ATMOSPHERE.—In continuation of his previous papers, giving the results of the solar researches carried on at Meudon, M. Deslandres has a paper in No. 3 of the *Comptes rendus* (p. 179, July 19) wherein he describes and discusses more recent results dealing with the question of motion in the upper layers of the solar atmosphere. First he mentions the connections previously shown to exist between spots, "filaments," and "alignements," and points out that owing to the greater size, frequency, and distribution of the latter, they afford much more trustworthy and continuous data on which to base any researches or theories dealing with solar changes than does the study of spots alone; but for any exhaustive study of these phenomena the velocities of the solar vapours in the line of sight must be determined, and it is to this determination that M. Deslandres has in the more recent work returned. As Meudon is the only observatory employing the *spectroenregistreur des vitesses radiales*, the results are of great interest.

To measure the radial velocities all over the disc would take much more time than the Meudon staff are able to devote to the work, so, for the present, only those in the neighbourhood of filaments near the centre of the disc have been measured. A diagram of a typical radial-velocity curve shows that in the filament, shown on the "K_3" image, the vapours are moving towards the observer, the displacement of the line being towards the violet. At first glance this appears to contradict M. Deslandres's previous conclusions, and the fact that whilst, in May and June, when spots were scarce, or small, the filaments were well developed, yet further suggests that the two phenomena are not physically connected; but M. Deslandres thinks it necessary only to modify and enlarge these conclusions, and shows how solar convection currents, analogous to Benard's cellular liquid *tourbillons*, would account for the apparent discrepancy of the results, and, at the same time, afford an explanation of Evershed's radial motions observed in the penumbræ of spots.

SEARCH-EPHEMERIDES FOR COMET 1896 VII. (PERRINE).—In No. 4342 of the *Astronomische Nachrichten* Herr F. W. Ristenpart publishes a set of elements, brought up to the equinox of 1910, for the comet discovered by Perrine in 1896; the time of the next perihelion passage is given as 1909 November 4·12 (M.T. Berlin). Three search-ephemerides, computed from the elements by Messrs. R. Castro and A. Repenning, are also given, T being taken as October 27·5, November 4·5, and November 12·5 respectively. According to the second ephemeris, the comet is at present in Pegasus (August 6, 12h. M.T. Berlin, α = 23h. 44·2m., $\delta = +31°$ 40·2′), and will apparently travel, in a north-easterly direction, through Andromeda towards Perseus; on August 24 its position should be α = oh. 11·4m., $\delta = +40°$ 12·4′, and the comet should appear about as bright as when discovered. The computed brightnesses at perihelion are 6, 13, and 20·5 respectively, according to the date of perihelion passage.

OBSERVATIONS OF JUPITER.—Some incidental measures of the positions of Jupiter's belts and of the polar diameter of the planet are given by Prof. Barnard in No. 4339 of the *Astronomische Nachrichten* (pp. 307–10). For each recognisable feature he gives the distances from the south and north limbs and the apparent latitude; the observation on February 19 8h. om. (central standard time), 1907, gave the apparent polar diameter as 40·78″, and, reducing this to $\Delta = 5·20$, the polar diameter therefore becomes 36·11″.

On this date a narrow south belt, 2″ wide, in apparent latitude −9·88″, showed several ill-defined white spots, and on May 26, 1908, the north equatorial belt was double for part of its length.

THE ORBIT OF X SAGITTARII, A CEPHEID VARIABLE.—The variability of the star X Sagittarii was discovered by Schmidt in 1886, and the radial velocity detected by Slipher in 1904. In No. 157 of the Lick Observatory Bulletins Mr. J. H. Moore discusses a series of one-prism and three-prism spectrograms taken at Mount Hamilton during the period 1904–8. Plotting the velocity- and the light-curves for the same epoch, it is shown that the times of light-maximum and of greatest velocity of approach agree very closely, this being a fundamental characteristic, as Mr. Albrecht has shown, of all variables of the δ Cephei type. No such close agreement is shown, however, between the epochs of light-minima and maximum recession.

THE LEEDS ASTRONOMICAL SOCIETY.—The energy and activity of the Leeds Astronomical Society in popularising the study of astronomy is well illustrated in the Journal and Transactions for 1908. This journal contains abstracts of the papers read before the society, and a large number of astronomical notes contributed to various periodicals by Messrs. Elgie and Whitmell, members of the committee. Among the former there appear papers on sundials (Mr. T. Wright), variable stars (Mr. Ivo Gregg), and "other inhabited worlds" (Mr. T. Benton), while an interesting popular paper dealing with the fancied figures in the moon is contributed by Mr. Elgie.

THE SOLAR ECLIPSE OF JUNE 17, 1909.—Observations of the contacts, during the solar eclipse of June 17, were made by Father Rigge, at the Creighton University Observatory, Omaha, and showed that the phenomena actually occurred a second or two earlier than the computed times. At first contact the difference was 2·02s., and is trustworthy, but at the last contact a difference of 18·4s. was observed, and may largely be due to the extremely bad conditions under which the observation was made, the sun being within fourteen minutes of setting (*Astronomische Nachrichten*, No. 4340).

RECENT IMPROVEMENTS IN THE INTERNAL-COMBUSTION ENGINE.

I.

A SURVEY of the progress made during the last twenty-five years in almost any field of engineering work would show an immense advance. Even during the past ten years very considerable progress has been made in certain branches of applied science, and in none of them to a greater extent than in the internal-combustion engine. We need not in this comparison claim the gun as a form of internal-combustion engine, though we are naturally entitled to do so. We may leave lethal weapons aside, and think only of the remarkable development of the reciprocating internal-combustion engine, and of the many changes it has brought about in our times. It has revolutionised cross-country transit. It has given us the long-deferred, but now actually achieved, victory called the "conquest of the air." It is extraordinary to think of the numbers of men who have spent ingenious years in seeking a solution of the problem of flight. The solution has come in the unexpected form of a pair of long, sail-like arms, driven forward by a small high-speed internal-combustion engine. This simple form of design, which, owing to the relation between centre of pressure and angle of tilt, seems to be naturally stable, bids fair to be adopted in a great output of flying machines shortly to be constructed. The hardly less novel, but less interesting, dirigible balloon owes the whole of its dirigibility, whatever that may amount to, to the internal-combustion engine.

Less startling, but of considerable material importance, is the utilisation of "waste heat" in our coal- and iron-producing areas. Our coal supply is admitted to be limited, and there seems to be at least an indication that at the present rate of consumption mankind would, in a few centuries, have to be prepared to turn its attention to the unlocking of some other form of stored-up energy, perhaps a radio-active one. It is not too much to say, however, that if the power available from the waste gases of blast-furnaces and coke-ovens in this country—and the amount can hardly be less in the aggregate than 1,000,000 h.p.—were put to use, the saving in the coal consumption might perhaps give us another half-century or two in which to look about for some substitute for coal.

In writing of what has been already achieved, we have to remember that we are only yet at an intermediate stage in the development of the internal-combustion engine. The internal-combustion engine gives us a bigger return for heat put in than any other known form of engine. We cannot imagine the development of the future "going back," so to speak, on such an advance as that. The internal-combustion engine must come, and existing steam engines be replaced. This means the supersession of the steam turbine, and may therefore seem to suggest a retrograde step, since the rotary engine is mechanically an improvement on the reciprocating one. We have to remember, however, that evolutionary processes sometimes take a step backwards to an earlier form in bringing forward the latest and most developed creation. No one would look on any reciprocating engine as a final improvement on a rotary one, even although, as is now the case, large gas engines are capable of so uniform a rotary motion that alternators are easily driven by them in parallel—the standard test of excellence in this respect. The day of the gas-engine turbine must come. Numbers of men are working at the problem which it presents; but little has as yet been published as to the result of their labours—an indication that the many difficulties are not yet mastered.

The present stage in the development of the internal-combustion engine is a convenient one at which to summarise briefly what has been done in regard to its improvement. We therefore propose in this and the succeeding articles of the series to state the problem and the lines on which, with such a striking measure of success, its solution has been attempted.

The problem can be stated in a very simple form. Given one pound of carbon of, say, 12,000,000 ft. lb. calorific value, which is a normal estimate, find how to obtain the largest possible amount of useful power. So far this energy has always been liberated in the form of heat. This heat has been given to some body which, by its subsequent cooling, can give out mechanical energy—such a body is a mass of gas or vapour. Let us assume that a mass of gas is chosen as the working medium. It is obviously desirable that the heat liberated should be absorbed as completely as possible by the gas, but in investigating whether this has been effected one at once meets with a check. To tell whether the whole of the 12,000,000 ft. lb. of heat energy has reached the gas, we may either look out for possible chances of heat leakage or may measure the amount of energy in the gas at the end of the operation. But to do the latter is practically impossible, for we do not know the specific heat at high temperature of any gas, and to do the former is extremely difficult, owing to the very short time the heat transference usually takes, and owing also to our lack of knowledge as to the temperature of metal or other surfaces in contact with, and enclosing, the gas. Many attempts have been made to ascertain what happens to the heat liberated, and much has been written on such topics as "dissociation," "after-burning," and "increasing specific heats." There would be no difficulty in filling the whole of the allotted space with a discussion of the various experiments that have been made and theories that have been built on this subject, but as many other matters have also to be dealt with, and as the author has already written on this topic elsewhere,[1] he does not now propose to go into the matter at length.

Briefly summarised, the result of gas-engine experiment is to establish that only about 50 to 55 per cent. of the heat energy known to be liberated is accounted for by multiplying the measured rise of temperature by the commonly accepted figure for the specific heat at constant volume. The same ratio of 50 to 55 per cent. was found for all sizes and shapes of containing vessel, and for all mixtures of gas. This constancy at once disposed of the theory that the "suppression of heat" was due to dissociation, as such an effect would naturally be dependent upon, and increase with, the increasing temperatures due to the richer mixtures. Equally it showed that the cooling of the gas by convection currents, radiation, and conduction to the walls of the containing vessel was an inadequate explanation. The suggestion of the French physicists, MM. Mallard and Le Chatelier, that the effect must be due to increase of specific heat with temperature was open to precisely the same objection as that of dissociation, and involved values of the instantaneous specific heat much in advance of what was then thought likely. It is now generally recognised that the real explanation of the apparent suppression of energy is due to a combined cooling effect and rise of specific heat. "After-burning" is now generally believed, as a result of many tests, not to occur in normal circumstances. With a weak mixture the time of explosion, and therefore of cooling, is a long one, so that the cooling loss has time to become considerable, and this compensates for the lesser degree to which the theory of increasing specific heats is effective for these weak mixtures and low temperatures.

The constancy of this apparent "loss" made it clear that no great improvement in the internal-combustion engine could be looked for in any increase of pressure and temperature in a gaseous mixture of given strength. We cannot alter the specific heat law of a substance. We might, perhaps, alter our working medium, which now for the most part is nitrogen, but no other gas is so cheap or so easily obtained; but we may vary the part of the temperature scale over which we work, and, within limits, we may affect the cooling loss by altering the shape of the containing vessel or cylinder. Experiments have shown

[1] "The Internal-combustion Engine" (Constable and Co.)

that the less the ratio of cooling surface to volume the less the proportionate cooling loss, and therefore the greater the amount of thermal energy converted into work.

Engines that have "pockets," that is, cavities in their walls, in which to contain ignition plugs or valves, are known to be less efficient than those that have not. On the other hand, it must not be forgotten that although this loss of efficiency exists, it is at any rate partly compensated for by the greater flexibility of the engine. It has been found, particularly in motor-car engines, that "pockets" have a very useful effect in enabling very variable mixtures to fire. The ignition plug is placed in a pocket so that, even when the mixture is a very poor one, there will be sufficient local "richness" in its neighbourhood to start an explosion which, once started, proceeds throughout the mass of the gas. Another fact which may have the result of increasing "pocketing" is the recently measured temperature limit for pre-ignition. Prof. Hopkinson has found that surfaces below 700° C. will not cause pre-ignition, whilst those above may do so—if above 750° C. they are pretty sure to do so. Now the surfaces most likely to rise to such temperatures are those remote from the cooling water in the jacket. The projecting end of an ignition plug is such a surface, and when exposed to the full heat of the explosion, as it is when the plug is not pocketed, pre-ignition may well occur. Prof. Hopkinson has shown also that when once a point of metal gets hot enough to cause pre-ignition, the very ignition of the flame in its neighbourhood will tend to cause the temperature to rise still higher, so that the phenomenon grows on itself and persists. It is not everyone who is moved, however, by such considerations, and we have lately seen in the design of the new Daimler engine a clearly expressed intention to avoid pocketing and its consequent loss of efficiency without any apparent fear of introducing other features much less desirable. It is only fair to say, however, that this engine is still on its trial. The ideal plan would appear to be to pocket the ignition plug but not the valves, and so combine the good features of both systems.

This frank abandonment of the highest possible efficiency by those who use pocketed engines brings us naturally to the consideration of thermal efficiency and the laws that regulate it. One may say at once that the theory of the internal-combustion engine has, until lately, been in a chaotic condition. The standard of efficiency for gas engines laid down by an influential committee had been found subsequently to be unsatisfactory as giving an impossibly ideal figure. That such remarkable progress in invention and mechanical perfection should have gone on side by side with this uncertainty as to the true standard of performance has often struck observers with astonishment. The considerable scale of the practical side of gas-engine development is illustrated by the fact that of one well-known make of double-acting gas engines alone, no fewer than 247 engines of an aggregate output of 308,000 b.h.p. have been built or ordered during the last six years. This corresponds to the large figure of more than 50,000 b.h.p. per year for only one of the many firms engaged on the work. At the moment the total capacity of gas engines in use must be well over 2,000,000 h.p., and of petrol engines much more than 1,000,000 h.p., making a total of more than 3,000,000 h.p. in internal-combustion engines. These are striking figures. Some of these engines and plants work with solid fuel and some with liquid. It would not be possible, even were it considered desirable, to use liquid fuel to the entire exclusion of any other. The present output of petroleum over the whole world is only 20,000,000 tons, a very small figure compared with the yearly consumption of 800,000,000 tons of coal. Unless, therefore, fresh supplies of oil are discovered, there can be no development of the internal-combustion engine which would lead to liquid fuel replacing solid fuel altogether.

In the articles that will follow, the author intends to deal with the problem of efficiency, taking into account the now established increase of specific heat with temperature, its effect on rating, and the recent practical improvements in the design and operation of gas engines and gas-producing plant.

H. E. WIMPERIS.

CONTINUATION SCHOOLS AND NATIONAL EFFICIENCY.[1]

AMONG the numerous problems now confronting English educational administrators, probably the most urgent is that discussed in the valuable and exhaustive report on attendance at continuation schools recently issued by the Consultative Committee of the Board of Education. To some extent the report covers similar ground to that traversed in the educational sections of the Majority and Minority Reports of the Poor Law Commissioners, arriving at almost identical conclusions.

The essential features of the problem are as follows:—Under the existing Education Acts, children must attend school from their fifth to their fourteenth birthdays, subject to certain exemptions (prescribed by local bye-laws) during the last three years of the school period. Local education authorities may grant (*a*) total exemption from school attendance at eleven years of age to children engaged in agriculture, (*b*) full-time or half-time exemption, or both, to children between twelve and fourteen. The "leaving age" is generally twelve or thirteen. Full-time attendance at a day school until fourteen is now compulsory over areas comprising about 22 per cent. of the population of England and Wales. The committee estimates that in the year 1907, the latest year for which full statistics were available, there were about 211,000 children under fourteen years of age who had obtained full-time exemption from day-school attendance. Of these, only 40,500 were attending evening schools in the year 1906–7, leaving 170,500 children between the ages mentioned not attending any form of week-day instruction. Further, the estimated population of England and Wales between the ages of fourteen and seventeen is 2,022,300. After deducting from this the number attending elementary, secondary, technical, or evening schools, it is estimated that nearly 1,498,000 (or approximately 74 per cent.) boys and girls between the ages of fourteen and seventeen are not receiving any form of scholastic instruction. We have therefore, about 1,668,500 boys and girls from twelve to seventeen years of age whose formal education has entirely ceased for the time being. Recent inquiries in London and Glasgow render it highly probable that a very large proportion, if not the majority, of these boys and girls, if in wage-earning occupations, are employed in purely mechanical work of a monotonous, uneducational character, of no industrial value when the child becomes an adult.

Under these conditions the education, such as it is, given in the elementary school is being rapidly forgotten. The boys and girls are almost entirely exempt from parental control; they are falling victims to the prevailing passion for cheap amusements and to the attractions of the streets. Any slight gleam of intellectual aspiration which may have been aroused in the elementary school is rapidly being extinguished. The enormous sums spent by the State upon the elementary education of these young people are almost entirely wasted. All that remains is a certain facility in reading, writing, and very elementary arithmetic. Even if the boys are definitely apprenticed to a trade, matters are not much better. Under the present industrial conditions, involving the minutest possible specialisation in the works, the employer cannot possibly afford, even if he wishes, to give the boy the all-round training which was given by apprenticeship under the older industrial *régime*. Industry now requires, in addition to manual dexterity, a general industrial knowledge and a trained intelligence which will enable the worker to adapt himself to ever-changing industrial conditions; but this knowledge and training are not now given by apprenticeship. Hence, an education outside, but concurrent with, the workshop is essential. A further important factor is that even if a boy be apprenticed to a skilled trade, he is generally not taken on until about sixteen years of age. The intermediate years, between leaving school at thirteen and commencing apprenticeship at sixteen, are usually spent in "blind alley," uneducational occupations such as that of errand boy, van boy, messenger, &c.

For many years to come the formal education given to

[1] Report of the Consultative Committee of the Board of Education on Attendance, compulsory or otherwise, at Continuation Schools. Board of Education, White Paper. Cd. 4757. (London: Wyman and Sons.) Price 1s. 6d.

the bulk of the population of this country will be that imparted in the elementary school, the continuation evening school, and the evening technical (including by this term commercial, or art or craft) school. The nation, at enormous expense, has instituted a system of national education which is almost entirely confined to children under fourteen years of age. In addition to this, an elaborate system of evening technical education has been established, mainly for those above the age of seventeen; but no adequate national system of evening continuation schools, for the boys or girls between the ages of fourteen and seventeen, linking on the elementary school to the evening technical institution, has yet been developed. The boy or girl leaves the elementary school at the age of thirteen. At seventeen or eighteen the youth may realise the necessity of attending evening classes for technical instruction relating to his special industry, assuming he is engaged in some skilled occupation or other. At the technical school he finds that he is unable to profit by the instruction given. During the years between thirteen and seventeen his powers of assimilation have declined through disuse, he has lost the habit of study, and most of his previous small stock of knowledge, *e.g.* mathematics and English, has vanished. He speedily becomes disheartened and ceases to attend. As a result, the greater portion of such chances as he possesses of rising in his trade, or of even keeping his position in a few years' time, vanishes. Not only is the worker thus damaged in an industrial sense, but the community loses, first by his diminished efficiency as an industrial unit, and secondly by the lessening in the sum total of sustained intellectual effort made by its citizens. Every workman, who by systematic instruction passes from the level of the ordinary artisan to that of the trained, intelligent worker, becomes an asset of increased value to the nation.

The problem now is, What can be done to (*a*) carry on the education of the wage-earning youth of this country during the years from thirteen to seventeen, (*b*) bridge over the present gap between the elementary school and the centres of higher evening instruction, such as the technical school? The solution lies in the development and the increased efficiency of the evening continuation school. The following statistics for 1906–7 from the report are not without interest as showing to some extent the measure of success which has been obtained:—

	Number of evening schools	Number of scholars on register in evening schools	Average attendance in public elementary schools (from five years upwards)	Percentage of evening scholars to day scholars
Lancashire ...	436	49,833	230,584	21.6
Yorkshire (West Riding)	308	29,447	211,281	13.9
Surrey	132	10 788	70,047	15.4
Birmingham ...	31	12,544	77,540	16.2
Bradford	34	8,361	35,372	23.6
Halifax	15	3,578	11,334	31.6
London	438	175,482	509,800	29.3
Manchester ...	92	26,838	88,887	30.2
Total for all counties in England and Wales	4,506	315,522	2,846,653	11.1
Total for all county boroughs in England and Wales	1,427	420,990	2,063,569	20.4

In recent years special attempts have been made in some districts to persuade boys and girls on leaving the elementary schools to join the continuation schools without delay. Some striking results have been obtained. In Widnes about 80 per cent. of the boys leaving the elementary schools commence attendance at evening schools without a break. Halifax has secured 66 per cent. The Lancashire County Education Committee reported in January that in the larger boroughs 37 per cent., and in the smaller boroughs 22 per cent., of the boys and girls leaving school during the year ending October 30, 1908, to secure employment, joined the evening schools immediately.

The principal recommendations of the Consultative Committee are the following:—

(1) The leaving age should be raised to thirteen years, and after a short period to fourteen years.

(2) Full-time exemption from the day school should only be given to boys and girls under sixteen when the parents or guardians can show that the children in question are suitably employed.

(3) It should be the statutory duty of each local education authority to make suitable provision of continuation classes for the further education of young persons up to the age of seventeen.

(4) Local education authorities should be empowered to make bye-laws compelling attendance at continuation classes for young persons up to the age of seventeen, and employers should be compelled to make provision enabling such young persons to attend the continuation classes.

(5) Employers should be forbidden under penalty to employ any young person under seventeen years of age who fails to attend the evening continuation classes regularly.

(6) The curricula of the continuation schools should be such as to continue the general education given in the primary school. It should have reference to the crafts and industries in the district, and prominence should be given to practical and manual instruction.

Most educationists will heartily support the above recommendations. Numbers (3) and (4) of the above are taken from the Scotch Education Act of 1908. The committee points out that in Germany attendance at continuation schools is compulsory in portions of twenty-two out of twenty-six of the constituent States of the Empire, and in Switzerland in portions of nineteen out of the twenty-five cantons of the Republic. The committee is of opinion that there is now a strong and rapidly increasing body of public opinion ready to support its recommendations. The committee estimates that the total cost (imperial and local) of "maintenance" which would follow from raising the leaving age to fourteen would be about 490,000*l.* per annum. The corresponding cost of compulsory continuation classes (exclusive of new buildings) would be about 2,600,000*l.* per annum.

The proposals of the committee, if adopted, would have important educational and sociological results. Thus for example, one of the main causes of unemployment would be eliminated. Educationally the proposals would have a far-reaching effect upon the develoomeut of a complete national system of education. As has been before indicated, the continuation schools would take the boys and girls from the elementary schools, continuing without a break their general education, while specialising to a limited extent in either commercial, agricultural, technical, or domestic work, depending upon the requirements of the pupils. At the age of seventeen the boys and girls, after this preliminary training, could then be drafted on to technical, or commercial or art schools. The continuation schools would thus link on directly, and coordinate with, the elementary schools on the one hand and the technical institutions on the other.

The direct and indirect gain to the community from (*a*) the improvement of the general education of the masses, (*b*) the increased technical efficiency of the workers, would be incalculable. In this connection the following extracts from the report may be given:—

"An increasing stock of practical ability in a nation enlarges the range of its economic abilities and rapidly adds, through all the gradations of directive responsibility, to the number of well-remunerated posts which could never have existed if men had not been forthcoming to fill them."

"A rising level of education among the mass of workers increases the real level of their wages, though this may not be accompanied by a rise in their nominal amount. It conduces to wise expenditure of income and to the avoidance of thoughtless or harmful waste."

"Improvements in educational opportunity make possible forms of government which give to the working class in the community an effective voice in policy and administration."

"The temper, the outlook, the recreations, and the ideals of a nation may be so refined and raised by the right kind of training as to secure for the mass of the people a more choiceworthy life." J. WILSON.

CHANGES IN COLOUR AMONG TROPICAL FISHES.

THE Zoological Society of New York recently issued a very interesting paper written by Mr. C. H. Townsend on the instantaneous changes of colour among tropical fishes (thirteenth annual report, 1909). The specimens came from the Bermudas, and are kept under favourable

Dark Phase.

Banded Phase.

Two Colour-phases of the Nassau Grouper (*Epinephelus striatus*).

conditions in the aquarium of the society. The changes of coloration "begin to be in evidence within an hour of the arrival of new specimens, or as soon as they recover from the alarm produced by handling, and are produced as long as the fishes live in the tanks, which, in some cases, may be several years."

The phases of coloration are illustrated by a striking series of photographs, two of which are reproduced. From these it will be seen that the fish can pass from a uniformly dark (plumbeous) colour to a banded phase with white markings. Four other phases can also be assumed, including a uniformly creamy-white one. This plasticity of coloration is characteristic of most of the fish dealt with, which include Serranidæ, Scaridæ, Teuthididæ, and Scorpænidæ. There is frequently a pale and a dark monochrome phase when the fish is at rest. Under any excitement, such as the presence of visitors, the fish assumes a parti-coloured aspect. This paper clearly shows how inadequate and misleading are many of the descriptions of colour hitherto accepted, and is a very suggestive and attractive piece of work. An error occurs on p. 3, where it is said that "their different colours result from muscular action upon one or more kinds of cells." The mechanism of colour-change is not muscular, but nervous.

MINERAL OUTPUT OF THE UNITED STATES.[1]

THE well-known publication referred to below now appears in a form slightly different from the one to which we have hitherto been accustomed, being issued in two volumes, the first devoted to the Metallic products and the second to the Non-metallic products; this is done in consequence of a recent legislative enactment (Act of May 27, 1908), and presents some advantages, though it might be well to submit, with all respect, to the Government of the United States, that these (and sundry other) publications of the United States Geological Survey stand in far greater need of condensation than they do of expansion. When a work becomes unwieldy, there are two obvious remedies, either to issue it in two volumes or to compress the information it conveys into smaller compass; the latter is no doubt the more difficult proceeding, though the one that best serves the interests of the readers, and it is a matter of regret that, in this case, the line of least resistance has been followed. In the present instance it leads also to a few anomalies, as, for instance, the inclusion of crushed steel (as an abrasive) and of certain other metalliferous materials, such as arsenic, manganese, chromite, &c., in the volume devoted to non-metallic products.

It is greatly to be regretted that the mineral statistics of the United States are issued in a form that makes comparisons with the mineral output of other nations difficult; for example, the various values of the metals are reported, not in the form of ore, but in the metallic state, though obviously the value in this form includes the cost of reduction of the metal, and leads to very serious duplication, which the compilers appear to have overlooked, although the introduction lays stress on the statement that "all unnecessary duplication has been excluded." To take an example, the production of iron ore is not given, but instead of it that of the pig-iron smelted from it, namely, nearly 26 million tons, valued at about 530 million dollars. Now the production of coke for the same year was 40 million tons, produced from 62 million tons of coal, valued at nearly 73 million dollars. Practically the whole of the pig-iron produced was made with coke as fuel, and, in the absence of exact figures, it will probably be a near approximation to the truth if we assume that three-fourths of the coke production, or, say, 30 million tons, was consumed in the production of the above pig-iron, so that coal to the value of, say, 55 million dollars was utilised in this way, and this sum is accordingly included in the above valuation of the pig-iron production; it is, however, also included in the sum total of the value of the coal production, and thus enters twice

[1] Mineral Resources of the United States, Calendar Year 1907. Part I., Metallic Products. Pp. 712. Part II., Non-metallic Products. Pp. 897. (Washington: Government Printing Office, 1908.)

into the grand total of 1904 millions of dollars given as the value of the mineral productions of the United States. The same is true of every other metal on the list; in some cases, notably, perhaps, in that of aluminium, the value of the metallic product is many times greater than that of the mineral from which it is produced; thus the value of the aluminium produced is given as 5 million dollars, whilst that of the bauxite from which it is produced is about 450,000 dollars; surely it is the latter figure, and not the former, that should enter into a list of the values of the mineral productions of any country.

In the non-metallic products similar anomalies are also to be met with; cement, bricks, oilstones and millstones are articles that owe a very great, if not in every case the greater, part of their value to the labour, fuel, and power used in their preparation rather than to the crude material from which they are produced; if an American sculptor carves a statue out of native marble, should the value of the finished statue be included in the sum total of the value of the mineral resources? There can only be one answer to such a *reductio ad absurdum*, and yet the principle is exactly the same as that of including the value of the dressed grindstones instead of that of the sandstone or grit from which they are cut.

The above are matters of principle which present, no doubt, great difficulties in arriving at a satisfactory solution; the coordination of the methods of tabulating the mineral productions of different countries, so as to admit of just comparison, has often been tried, but has never been attained successfully yet, so that all that statisticians can do is to take care that they thoroughly understand the differences that obtain between the various systems in vogue. In other respects the present volumes are quite up to the high standard that we have been accustomed to in the United States Geological Survey publications. As already said, they suffer from want of compression, and there are many repetitions that might be avoided and much superfluous matter that might well be excised. In fact, they require more careful editing than they receive at present, and this is all the more necessary seeing that the different articles are written by different contributors, and are of very unequal value.

For example, no careful editor would pass such statements as we find under the item fluorspar, where we are told that the mineral is "only slightly harder than calcite, and consequently crushes easily," whereas the ease or difficulty of crushing has nothing to do with hardness; and again, "When fluorspar is associated with zinc-blende, complete separation of the two minerals has been difficult on account of their nearness in specific gravity"; the specific gravity of fluorspar is about 3·1, and that of blende about 4, a difference which should afford an ample margin for successful separation in a suitable appliance.

Finally, it may be pointed out that although these volumes in their final form may be considered somewhat belated, no serious inconvenience results therefrom, as the wise precaution is taken of issuing the various sections in pamphlet form as soon as possible after the end of the year to which they refer, an advance sheet of statistics being, moreover, issued usually with considerable rapidity. This is a procedure that might well be imitated with great advantage by a good many other nations, our own not excepted. HENRY LOUIS.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE summer meeting of the Institution of Mechanical Engineers opened at Liverpool on Tuesday, July 27. The president, Mr. John A. F. Aspinall, and the council and members of the institution, were welcomed in the lecture hall of the Municipal Central Technical School by the Lord Mayor of Liverpool, Councillor H. Chaloner Dowdall, and the members of the Liverpool reception committee. The importance of Liverpool as an engineering centre secured an attendance of nearly 500 members, who participated in the excellent arrangements made regarding visits to works and excursions. The institution dinner was held in the Exchange Station Hotel on Tuesday evening, and the Lord Mayor and Lady Mayoress of Liverpool received the visitors in the Town Hall on Wednesday evening. Meetings were held for the reading and discussion of papers on Tuesday and Wednesday mornings in the Municipal Central Technical School. Brief extracts from these are subjoined.

Locomotives designed and built at Horwich were described in a paper by Mr. George Hughes, who is the chief mechanical engineer of the Lancashire and Yorkshire Railway. This company possesses 1517 locomotives, of which there are about 1100 in daily use. When the works at Horwich were opened, Mr. Aspinall, president of the institution, and at that time chief mechanical engineer, resolved to introduce standardisation and, wherever possible, interchangeability. Joy's valve gear was adopted, as it was found that the mileage between repairs was greater, and also that there was a slight economy in coal per engine-mile.

Among other types of locomotives described it is of interest to note six engines which were fitted in 1902 with Druitt-Halpin thermal storage tanks. Where stopping places are frequent on rising gradients there is distinct economy. Certain tests carried out between Salford and Accrington resulted in a saving of one ton of water, and under similar conditions elsewhere the saving was 12 per cent. On other sections of the line, which are not so favourable, the all-round economy of these engines is brought down to 4 per cent.

A four-cylinder passenger and express goods engine, built to the author's designs in June, 1908, is also of interest. Absolutely perfect balancing could have been achieved without the aid of balance weights if the crank angles, the disposition of the cylinders, and the weights of the reciprocating parts had been arranged to neutralise amongst themselves the reciprocating disturbing forces; then, by balancing the revolving masses, the variations of rail load and the horizontal swaying couple would have disappeared. Excepting for a slight vertical component produced by the obliquity of the connecting-rod, the engine would then have been perfectly balanced. This arrangement, known as the Yarrow-Schlick-Tweedy system, would have involved an independent set of valve gear for each cylinder. Actually, the cranks were arranged in pairs at about 180° apart respectively, and the reciprocating masses, being made equal in weight, balance each other. The masses of the connecting-rods were divided between the rotating and reciprocating masses as suggested by Prof. Dalby, and the revolving masses were balanced by revolving balance weights. This engine is a very steady and smooth-running machine.

The discussion centred round the important questions of boiler deterioration, corrosion, and priming. Mr. Hurry Riches expressed the opinion that the best way of avoiding troubles due to the nature of the feed-water is to remove the impurities before feeding into the boiler; it is, however, inadvisable to reduce the hardness of feed-water below 6°.

A paper on reinforced concrete was contributed by Mr. Arthur C. Auden, of the firm of Messrs. William Cubitt and Co. Reinforced concrete is by no means a new thing; it has passed the experimental stage, as is evidenced by important structures erected in London in 1889, and still in use. On the Continent equally large structures exist which are now twenty-five years old, and have never been strengthened or patched. Failures have occurred through bad design or workmanship, but the proportion of these is small. The cost of the proposed structure is affected by the cost of its constituents, and these in turn by the cost of freight and carriage. Hence the author briefly classifies the materials, and gives useful hints on the properties of each.

For aggregates, the eastern counties' flint is often the only stone available locally. Good, tough concrete can be made with this, but is untrustworthy for fire-resisting purposes, owing to its tendency to crack and "fly" under heat. This tendency can be much reduced by first crushing all the stones. The same remarks apply to limestone, a material which is not more fire-resisting after being broken. As it is apt to disintegrate to powder under the action of heat, it is inadvisable to use this material where fire-resistance is an important consideration. Limestone always requires washing before use to get rid of the fine dust which covers it and prevents the cement properly bonding with it. Sandstone, as a rule, is too soft, porous, and absorbent for use in reinforced-concrete work. It may be safely used if it will stand about $1\frac{1}{2}$ tons per square inch under a crushing test, and also if the difference in weight when clean and dry, and after being two days under water, does not exceed 8 per cent. Quartzite stone is fairly good if not too soft and open in texture, in which case the same precautions apply as for sandstone. It should be noted that the test pieces for crushing tests should have an area of at least 10 inches or 12 inches.

With reference to artificially produced aggregates, broken earthenware and stoneware from the Potteries district make a good aggregate, but these must be unglazed, as the glaze prevents the proper adhesion of the cement. Burnt clay and gault may be used provided they are tough and hard, and do not soften or crumble after being left in water for two or three days. In general, broken bricks are not a good aggregate for reinforced concrete. They may be employed safely if hard and close in texture and free from mortar. Coke-breeze is cheap and readily obtained, but cannot be regarded as being really fire-proof. The effect of any sulphur present must also be considered. Ashes and clinkers may be used. In the case of ashes, only those which will float in water and are of uniform colour and texture, as well as being quite free from coal and dirt, should be used. Really hard and clean clinker alone is serviceable. In both of these sulphur must be considered. Slag from blast furnaces and cupolas makes a good aggregate if hard, tough, and free from dust; any sulphur present must be noted.

Sulphur is apt to attack the reinforcing steel with disastrous results. The maximum allowable percentage of sulphur in reinforced concrete aggregates is now being made the subject of experiments, and it is hoped an authoritative statement will soon be made. In the form of a sulphate sulphur is practically harmless, but is very deleterious if in the form of a sulphide.

It is of importance that no free lime be present in artificial aggregates; carbonate of lime is practically harmless. Washing and exposure to the air and sun will do much to convert sulphides into sulphates and free lime into carbonates. Good and accessible aggregates are often condemned because no discretion is exercised as to the form in which lime and sulphur occur.

A certain amount of sand is absolutely necessary in concrete, and no other material is at present known which can be substituted for it. Generally speaking, the better a sand is for moulding purposes the worse it is for reinforced concrete. Dirt in the form of slime, mud, or vegetable refuse is bad, but a little loam, enough to soil the fingers, but not enough to cause the sand to adhere to them, is no detriment. Small particles or nodules of clay do not appear to affect the strength of the concrete, but it is better to avoid them if possible. It is not good practice to use the stone aggregate, and its smalls and dust, together with some sand, upon the chance that they will be in proper proportion, and that the voids and spaces will be properly filled. Such a practice should not be allowed in reinforced work, where absolute homogeneity is so essential.

With reference to cement, any user is safe if he insists that his cement shall pass the British standard specification in every detail, and purchases from a trustworthy maker. It should not be one of the many mixtures imported into this country as cement, which do not deserve the name, and are costly at any price.

Methods of inserting the reinforcement in beams, slabs, columns, &c., together with hints on erecting various structures, take up the remainder of this valuable paper.

Prof. Unwin spoke of reinforced concrete construction as demanding excellent execution and supervision to be successful. In regard to formulæ of the empirical class, largely employed in this subject, the range of experimental work should rule the trustworthiness of the formulæ. Much of the present methods of design is based on guesswork. He took the opportunity of urging the necessity for more extended experiments.

In presenting his paper on the advance of marine engineering in the early twentieth century, Mr. Arthur J. Maginnis naturally devotes a great deal of his space to the marine steam turbine. While the use of turbines has produced practically no advance or improvement in fuel consumption since 1901, still, an advance has to be recorded in that a greater speed has been attained. During the past eight years experience has shown the trustworthiness of the Parsons turbine machinery. Notwithstanding that there are now more than seventy steamers continuously plying to and fro, no sailing schedules have been upset by a failure of machinery, nor has a turbine steamer ever had to be towed into port. The author has no hesitation in stating that rotary machinery must eventually replace the present system in cargo steamers as well as in liners.

Combined systems of reciprocating and turbine machinery were referred to, but the author does not think that an extensive adoption of this system will be made. In evidence of the saving in weight in the boilers where turbines are installed, owing to the lower steam pressure which may be used, the author states that in the case of the *Lusitania* and *Mauretania* the saving in weight on the boilers alone is about 120 tons over and above that which would have been required if triple or quadruple piston engines had been used.

The author gives a summary of the results attained by marine engineering to date as follows:—vessels of close upon 800 feet length and more than 38,000 tons displacement are being propelled across the Atlantic at an average speed of $25\frac{1}{2}$ knots by turbine machinery working up to about 70,000 horse-power, having a consumption of upwards of 1000 tons per day. Similar results have been obtained in the turbine-propelled warship *Indomitable*, of more than 40,000 horse-power, and maintained across the Atlantic with water-tube boilers.

The electrical operation of textile factories formed the subject of a paper by Mr. Herbert W. Wilson. The principal advantage claimed lies in the fact that a much greater steadiness of drive can be obtained, with consequent higher average speed and increased output. Slight variations in speed above that corresponding to the maximum safe tension breaks the threads, and unless absolutely constant speed can be obtained, it is necessary to allow a margin of safety and to run at a speed materially below the breaking point. In one case in Lancashire, with two mills under the same management and of about the same size, and working under the same general conditions, the results obtained from the electrically driven factory have been distinctly superior to those from the mechanically driven one. The improvement in the quality of yarn was so noticeable that the output from the electrically driven mill fetched a distinctly better price than that from the other factory, the increase being stated at about $2\frac{1}{2}$ per cent. As regards increase in production, mills in this country which have adopted electrical driving may be estimated as showing an improvement of 5 per cent.

A paper on the indicating of gas engines was contributed by Prof. F. W. Burstall, of Birmingham University. The Standards Committee of the Institution of Civil Engineers expressed the opinion in their 1906 report that the indicating of gas engines was open to very much greater errors than was the case with steam engines, and this matter has been considered by the Research Committee of the Institution of Mechanical Engineers. In the tests undertaken by the author, two indicators were used simultaneously, one of the ordinary string type and the other an optical indicator. A Premier gas engine was used having a cylinder 16 inches in diameter by 24 inches stroke, running at 165 revolutions per minute. The only variation in the four tests recorded was the amount of gas admitted, the mean pressure varying from $5\frac{1}{2}$ kg. per $cm.^2$ up to about $7\frac{1}{4}$ kg. per $cm.^2$

The string indicator employed was of the Crosby type, selected for these tests by the Crosby Company. Before and after each set of trials the indicator was tested for backlash and friction, and the spring also calibrated. The backlash was in all cases negligible, and the friction amounted to less than 1 lb. with a spring having a scale of 400 lb. per square inch. The optic indicator was lent by Prof. Hopkinson, and was calibrated at the University.

Both indicators were mounted on a branch piece connected to the engine cylinder, and the indicator diagrams were taken simultaneously. The indicator barrel of the Crosby indicator was rotated by a phosphor-bronze stranded wire wound round the barrel and led to a bell-crank lever. The bell-crank lever was driven by a steel wire attached to the usual lever driven by the engine piston. A very heavy spring, in which a compression of 400 lb. produced a contraction of 2 inches, controlled the bell-crank lever. The optic indicator was also driven by means of a phosphor-bronze stranded wire.

The mean diagrams were prepared from no fewer than twelve individual diagrams, each being divided by the method of ordinates, and the heights read by an accurate steel rule. With care it was possible to read the Crosby diagrams to an accuracy of half of 1 per cent. The optic indicator diagrams could readily be measured to the same order of accuracy. The diagrams were plotted on squared paper, and superposed one on the other, so as to exhibit whatever differences there were between the indicators.

Speaking generally, the compression curves are coincident. The maximum pressures practically agree in two of the tests; in a third, the Crosby indicator gave the higher initial pressure, and in the fourth the Hopkinson gave the higher. Down the expansion line the two indicators agree for the third of the stroke. After that the Hopkinson indicator gave a persistently higher expansion line, the difference between the two lines being higher than the probable experimental error of the measurements. The effect of this difference is to make the Hopkinson indicator give about 3 per cent. higher mean pressure than the Crosby.

In the Hopkinson indicator the spring was in the form of a flat bar rigidly fixed at the ends and loaded in the centre; the central deflection of this beam is a direct measure of the pressure on the piston. During calibration with dead weights, from which the scale of the spring is obtained, the ends of the bar may be assumed to be absolutely fixed, but when the indicator is in use it is possible that there is a slight slip in the bar through the screws which restrain it. The effect of this would be to prevent the pressure falling so rapidly in this indicator as in the Crosby indicator. The author believes that this explanation is more likely to be correct than that the effect is due to inertia or friction, and is inclined to prefer the results obtained from the Crosby indicator.

While the results of this comparison do not offer an absolute proof of the accuracy of either indicator, there is still strong evidence that both give results very close to the truth. The indicators are of entirely different types, one multiplying the indicator piston movement by six, the other by about 120, a very similar multiplication being the case with the rotation of the drum and the mirror. In the optic mirror inertia is certainly negligible. That the two give results to within 3 per cent. on the mean pressure, and very nearly the same figures for the initial pressure, is good presumptive evidence that, when either indicator is used with the precautions regarding driving described, the results so obtained are at least as accurate as any other measurement which can be made in engine testing. Unless these precautions are taken, the results can only be regarded as affording a clue to the valve setting, and give no trustworthy figures as to the power developed in the engine cylinder.

The council of the institution has issued the conditions under which the second award of the water arbitration prize will be made in 1910. The prize will have a value of about 30*l*., and will be awarded to the author of the best original paper dealing with any branch of the mechanics of the supply or distribution of water. The latest date for sending in papers will be September 1, 1910.

MR. HALDANE ON THE PROMISE OF AVIATION.

In Committee on the vote of 36,464*l*., including a supplementary sum of 6500*l*., to complete the sum necessary to defray the charge for sundry grants in aid, scientific investigation, and other grants, there was an interesting discussion in the House of Commons on August 2 on the subject of aviation for naval and military purposes. Mr. Haldane made a statement giving the views and intentions of the Government.

Mr. Haldane said he had made up his mind that there could be no real progress unless we proceed scientifically and in order—that is to say, unless we are perfectly clear about what we want, as to the structure of the machines which will be used for the purposes in view, and the production of them in a way which should be at least effective. The first thing done was to ask the Committee of Imperial Defence to investigate this question and to discuss it with the technical subcommittee. The report was to the effect that the class of machines must be divided into three heads:—rigid dirigibles, non-rigid dirigibles, and aëroplanes. For naval purposes the rigid dirigible is probably the only instrument of the kind which is of real value, at any rate in the present state of knowledge. For the army the rigid dirigible has certain disadvantages. It is more difficult to work, to bring back, and to bring to rest. It is more difficult for the army than for the navy. The non-rigid dirigible is the best for army purposes. The aëroplane may become available for army purposes, but at present it has certain defects. It will have to rise much higher before it can be a safe instrument for reconnoitring. But M. Blériot's splendid feat in crossing the Channel and the successes achieved in the United States point to a time when the aëroplane may be an instrument capable of achieving great results.

To the navy has been assigned the duty of investigating, with the view of constructing, the rigid dirigible, the ship of the Count Zeppelin type. To the army has been assigned the duty of experimenting with the non-rigid dirigible, the machine of varying type, and also with aëroplanes.

To make their study of aviation scientific, Mr. Haldane said the Prime Minister constituted the advisory committee, under Lord Rayleigh's presidency, on which there is some of the best scientific brains in the world. Continuous work has been going on at the National Physical Laboratory. Meetings have been held there and at Aldershot and the War Office. The committee is to advise, its purpose is to scrutinise inventions submitted in the course of the work of the departments concerned, and to conduct systematic experiments. In a few days the first report of this committee will be made public. The committee, said Mr. Haldane, has such men as Lord Rayleigh and Dr. Glazebrook on it, and such men on the practical side as Mr. Lanchester and Mr. Mallock, and others like Prof. Petavel and Dr. Shaw, and also such high authorities on the army and navy side as Major-General Hadden and Rear-Admiral Bacon, and is well furnished from the various points of view. This committee has been at work, and the first thing it has done is to determine the general question which should be studied. There have been various memoranda by the experts on stability, screw propellers, wind structures, petrol motors, and a very difficult thing which has arisen in connection with balloons, the accumulation of electrostatic charges. Everyone knows what a peril electricity is in the air. Then the committee has mapped out the general field of its work. There are certain general questions in aërodynamics, questions specially relating to aëroplanes, such as the mathematical investigations of stability, the effect of rudder action, gusts of wind, and half a dozen other things which I need not enumerate. There are propeller experiments; there are questions relating to these motors which have to be of special construction for air work, general questions relating to airships, and still more general questions relating to meteorology.

The committee has entered into communication with the Aëronautical Society, the Aërial Club, and the Aëro League. The design is to afford assistance to private inventors wherever this can properly be done, because progress in this matter will be, not merely a Government, but a national matter. The Admiralty is concentrating, under Admiral Bacon, Director of Naval Ordnance, on the building of a rigid dirigible of the very largest type, at least the size of the *Zeppelin*. That is being built at Barrow-in-Furness by Messrs. Vickers. The combination of experts and practical men may give us a practical result some time next spring. The War Office is reorganising its factory at Aldershot. The instruction, which is at present given to balloonists under the superintendence of Colonel Capper, is being separated from construction, and at present preparations are being made for the construction of a shed which will take in the largest size of dirigible. The Admiralty has in prospect one great rigid dirigible, the War Office has three, and besides those we have our balloons for war purposes. At the present time we have certain aeroplanes, and the prospect of two new aeroplanes which are to be presented for experimental purposes, and may hereafter be acquired. That is the actual position of things.

IMPROVEMENTS IN PRODUCTION AND APPLICATION OF GUNCOTTON AND NITROGLYCERINE.[1]

II.

In the year 1846 Schönbein discovered guncotton. In the year 1886, that is, forty years later, the French chemist Vieille invented his smokeless powder for military purposes. This explosive, which was primarily designed for use in the small calibre Lebel rifle, consisted essentially of guncotton, and the secret of its success lay in the fact that Vieille so altered its physical state that its rate of combustion, when confined, was under complete control. This condition was arrived at by treating the fibrous guncotton with suitable solvents which entirely destroyed the fibre and converted it into a colloidal, horny substance quite devoid of all porosity. The gelatinised guncotton resulting from this treatment burnt, when ignited, from the surface inwards, and by varying the surface area any required rate of combustion could be obtained. The use of smokeless powders manufactured in this way was very soon extended to all natures of ordnance.

The next step in the development of smokeless powders was the combination of nitroglycerine with nitrocellulose. The first powder of this type was the "ballistite" of Alfred Nobel, patented by him in the year 1888. The original ballistite was composed of equal parts of nitroglycerine and of soluble nitrocellulose, a variety of guncotton soluble in nitroglycerine, and no solvent was therefore required in its preparation, although a certain proportion of camphor was used to promote the solution of the nitrocellulose. Another form of nitroglycerine-nitrocellulose explosive is the British service powder, cordite, which originally consisted of nitroglycerine, 58 parts, guncotton, insoluble in nitroglycerine, 37 parts, and mineral jelly, a product of the distillation of crude petroleum, 5 parts. To effect the gelatinisation of the guncotton, the solvent acetone, obtained indirectly from the destructive distillation of wood, is employed. The result of subjecting nitrocellulose in suitable machines to the action of nitroglycerine or of solvents, of which there are several suitable ones besides acetone, is to destroy its fibre and convert it into a gelatinous mass, in which condition it can be formed into any desired shape. Where solvents are used to produce this result they remain in the mass during subsequent operations, and are finally driven off by means of heat. The resulting products, somewhat incorrectly termed "powders," which are manufactured in a variety of forms, such as grains and flakes of different shapes, ribbons or strips, solid cords, tubes, &c., vary in consistence with the quantity of nitroglycerine they contain. The more nitroglycerine present the softer the powder, pure nitrocellulose powders being hard to brittleness.

For practical purposes modern smokeless powders are of two types:—

(1) Those consisting entirely of nitrocellulose, and termed "nitrocellulose powders."

(2) Those consisting of a mixture of nitrocellulose and nitroglycerine, known as "nitroglycerine powders."

Opinions differ somewhat as to the relative merits of these two types; in this country the latter type is preferred. Their characteristic features are, briefly, as follows:—

A nitroglycerine powder is more powerful than a nitrocellulose powder, and the more nitroglycerine present the more powerful the explosive. Therefore, for equal ballistics, a smaller charge of the former than of the latter is required, and, consequently, the chamber capacity and the size and weight of the breech mechanism are reduced; on the other hand, the higher the proportion of nitroglycerine the higher is the temperature of combustion and the greater the erosive effects on the surface of the bore of the gun.

The presence of nitroglycerine in an explosive allows of the more easy and rapid elimination of the solvent used in manufacture and of moisture, a small quantity of which is always present in nitroglycerine and guncotton. The sooner this is attained the better, because the longer the time that the powder is being heated in order to dry it, the more likely is its chemical stability to be affected. Moreover, it is a well-established fact that with nitrocellulose powders it is impossible to remove the volatile matter with anything like the same completeness as can be done in the case of nitroglycerine powders. The consequence is that the slow evaporation from nitrocellulose powders of the residual volatile matter which takes place in store tends to produce changes in their physical character and renders them in course of time liable to alter in ballistic properties, and even to develop dangerous pressures in the gun.

Nitroglycerine powders are cheaper than nitrocellulose powders, weight for weight, and even more so for equal ballistic effects.

The original cordite, the manufacture of which commenced in 1890, contained a high proportion of nitroglycerine, 58 per cent., and the erosion produced, especially in large guns, was considerable. This led to experiments being carried out at Waltham Abbey with the view of the production of a less erosive explosive, and the final result was the introduction into the service, in 1901, of a modified cordite known as "cordite M.D.," in which the percentage of nitroglycerine is reduced to 30 per cent., so that the composition becomes:—nitroglycerine, 30 per cent.; guncotton, 65 per cent.; and mineral jelly, 5 per cent.

The constants of explosion of cordite and cordite M.D., determined at the Royal Gunpowder Factory some little time ago, are as follows:—

Explosive	Density of Loading	Heat of Explosion at Constant Volume, Water Gaseous	Total Gases, Water Gaseous at 0° C., 760 mm.	Temperature of Explosion
		Calories per gram	c.c. per gram.	C.
Cordite ...	0·2	1156	871	2663
Cordite M.D.	0·2	965	920	2374

An inspection of these figures shows that the alteration in proportions of the explosive ingredients results in a decrease in the heat of explosion of about 16½ per cent., and an increase in the volume of gases of about 5½ per cent., whilst there is a decrease of 289° C. in the temperature of explosion.

As would therefore be expected, the erosion produced by cordite M.D. is very much less than that produced by the original cordite for the same ballistics, and is certainly not greater, if as great, as that produced by the best forms of nitrocellulose explosives.

Although of minor importance to smokelessness, flamelessness is a desirable quality for propulsive explosives to possess. In this respect cordite M.D. is superior to cordite in the case of rifles and machine guns; unfortunately, a suitable ingredient has not yet been discovered which will render smokeless powders flameless in large guns.

A third ingredient in both natures of cordite, viz. mineral jelly, although present in a comparatively small proportion, is a very important constituent.

Cordite in the advanced experimental stage consisted of nitroglycerine and guncotton alone, and as their combustion produced no solid residue of any kind, the surface of the bore of the magazine rifle in which the early experiments took place was not fouled in any way. The result was that the cupro-nickel coated bullets, propelled in succession at high velocity through a clean barrel, deposited some of the cupro-nickel in the bore. In order to prevent this a number of substances were incorporated with the nitroglycerine and guncotton, with the object

[1] Discourse delivered at the Royal Institution on Friday, January 29, by Sir Frederic L. Nathan, R.A. Continued from p. 147.

of producing a deposit in the bore, which it was hoped would get rid of the difficulty of metallic fouling. Of all these various substances the one which appeared to answer the purpose most satisfactorily was refined vaseline, and this material became the third ingredient of cordite as eventually introduced into the British service. When the manufacture was commenced on a large scale, vaseline, which is the proprietary name of one of the refined products of the distillation of petroleum, was replaced by mineral jelly, the same material, but in a cruder form.

The original object with which mineral jelly was introduced was of no importance when cordite was substituted for the black and brown powders used in large guns, but in order to have but one nature of smokeless powder in the service mineral jelly was added to all cordite, whether for use in small arms or artillery. Subsequent experience has demonstrated how very fortunate was the selection of this material for rifle cordite and the extension of its use to all sizes of cordite.

Mineral jelly is one of the best ingredients it is possible to have in smokeless powders from the point of view of their chemical stability. This important fact, not recognised originally, was brought out in the following way. In order to facilitate the explosion of cordite in blank ammunition for the rifle it was cut into very thin flakes, and the non-explosive mineral jelly was omitted from its composition. After a comparatively short storage in a hot climate the stability of the smokeless blank, as it was called, was found to have suffered seriously, whereas the stability of normal cordite containing mineral jelly was not appreciably affected. These facts led to a thorough investigation at Waltham Abbey of the action of mineral jelly in preserving the stability of cordite, and it was discovered that mineral jelly contained constituents which had the valuable property of combining with the decomposition products (the result of prolonged storage of cordite at high temperatures) to form stable bodies, thus removing these decomposition products, which undoubtedly exert a deteriorating influence on the cordite from their sphere of action.

When Abel was engaged on his researches in connection with the production and properties of guncotton, it was obvious to him that some test of a chemical nature was required in order to ascertain whether or not the finished guncotton had been thoroughly purified in manufacture. It will be remembered that accidents occurred in the early days of its production because this purification had not been carried sufficiently far. The test which he devised was based on the principle that if guncotton be subjected to an elevated temperature, traces of oxides of nitrogen will be given off, and will reveal their presence by acting on a suitable reagent.

The test is carried out by heating guncotton in a test-tube placed in a water bath, and suspending over it a strip of moistened filter paper impregnated with potassium iodide and starch. If the purification of the guncotton has not been sufficient, the discoloration of the test paper takes place early; as the result of experience Abel fixed a time before which no reaction should take place. This test, known as the Abel heat test, is a test for the purity of guncotton and of nitroglycerine, and of freshly made explosives containing either one or both of these ingredients. For this purpose no test has yet been devised which equals it. But it was never intended to be, and is not, a quantitative test, and is therefore only a rough guide, though a very useful one, as to the stability of an explosive which has been in store for more or less prolonged periods, or under more or less adverse conditions.

Smokeless powders of the types dealt with are all subject to deterioration, and there is very little doubt that this deterioration is for any given explosive a function of the temperature of storage. The higher the temperature the more rapid the deterioration.

The necessity, therefore, of some quantitative test which would enable a judgment to be formed as to the extent of deterioration suffered by any given sample of cordite is obviously of great importance, because such a test would afford the means of determining how much longer it would be safe to store any given batch of cartridges or lot of cordite at any given temperature. Any such test must be a heating test, and it must be possible to correlate the temperature and duration of the test with any given temperature and duration of storage. The rate of deterioration as a function of the temperature was determined by Dr. Will for guncotton, and later by Dr. Robertson at Waltham Abbey for nitroglycerine. From these and other experiments carried out at Waltham Abbey, a factor of increase in rate of deterioration of cordite with increase of temperature was deduced. This factor having been determined, what is known as the "silvered vessel test" was worked out at the Royal Gunpowder Factory. In this test, of which the details will be described presently, cordite is heated in a specially designed vessel at 80° C., a temperature not too far removed from those to be met with when cordite is stored under the worst service conditions, and the number of hours' heating at this temperature any given sample will stand before it shows signs of active decomposition are ascertained. Then, by means of an equation, containing the factor connecting rate of increase of deterioration with rise in temperature, a calculation can be made converting the hours of heating at 80° C. the sample withstood to years and fractions of a year it would stand at any given temperature of storage, and therefore a knowledge is obtained of how much longer it would be safe to store this cordite at any given temperature.

This test was applied to a considerable number of samples of known age and thermal history. From these data, and knowing the number of hours at 80° C. that newly made cordite of good stability will stand before showing signs of decomposition, the number of hours that the different samples should stand the test were calculated. When the samples were actually tested, the number of hours' heating at 80° C. they withstood were in close agreement with the number of hours it was calculated they should stand.

The form of vessel in which the heating is carried out is the well-known vacuum vessel of Sir James Dewar. A glass bulb silvered externally is enclosed in an outer bulb silvered internally. The space between the two is highly evacuated for the purpose of limiting the dissipation of any heat evolved by exothermic changes on the one hand, and on the other for the purpose of minimising the effect of accidental slight changes in temperature of environment.

In the centre of the inner bulb is situated the bulb of a thermometer, the stem of which passes through a cork in the neck of the vessel. A side tube is attached for the purpose of making observations on the colour of the gases evolved. For heating the vessel a bath is provided with cylinders closed at the bottom, and wide enough to admit the vessel to such a depth as the side tube will permit. The bath is surrounded by insulating materials. The vessels are packed in the cylinders with wool yarn, and the tops of the cylinders are closed with felt discs to exclude draughts.

The bath is fitted with a gas regulator or other means for securing that the temperature of the explosive is kept constant.

The cordite is coarsely ground, and 50 grams are used.

Readings of the thermometer are taken at intervals, and the time is noted when a rise of 2° C. in the temperature of the explosive above the temperature of 80° C. occurs. At the same time, visual observations are made as to the colour of the column of gas in the side tube, since it is found that, previous to the rise in temperature occurring, orange-coloured fumes of nitric peroxide are evolved. When the temperature exceeds 82° C. the test is complete, and the flask is withdrawn. The number of hours which have elapsed since the start of the test is the measure of the stability of the cordite.

Until about sixty years ago, the only explosive known for all purposes was gunpowder. With the discovery of guncotton and nitroglycerine, gunpowder was gradually replaced by them for blasting purposes. In their early days the two explosives were used singly, guncotton as guncotton, nitroglycerine—first of all alone—and then as dynamite. Later on the two were combined as blasting gelatine and explosives of a similar nature, but it was quite forty years after their discovery before either became of practical use for propulsive purposes.

The invention of "Poudre B" by Vieille marked the commencement of a new era in connection with the science of artillery, and it was not long before smokeless powders made from the violent guncotton, or of guncotton combined with the still more violent nitroglycerine, entirely superseded the centuries-old gunpowder. Modern explosives are characterised by very greatly increased power, giving enormously greater range to projectiles fired from both rifles and artillery, thus altering entirely the conditions of both land and naval warfare.

It is at present not easy to forecast in what direction further improvements in propellants will take place. It is also difficult to conceive what the explosive of the future will be which will produce a change as revolutionary as that which took place when smokeless powders superseded the old-fashioned black powders. For some time to come, probably, the manufacturer of explosives will have to content himself with endeavours to improve them as far as he can, both from a ballistic and from a stability point of view, with the ingredients now at his disposal.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. A. ROBINSON, professor of anatomy in the University of Birmingham, has been appointed to the chair of anatomy in Edinburgh University in succession to the late Prof. D. J. Cunningham, F.R.S.

IT is stated by the *Frankfurt Gazette* that the National Assembly of Iceland has decided to establish a university at Reikjavik, the capital of the island. The new university is to have four faculties, with sixteen professors and lecturers.

MR. EDWIN TATE has presented new library buildings to Battersea Polytechnic. The total book accommodation is 20,000 volumes. The cost of the buildings, including fittings, is estimated at about 6000*l*., and the whole is being defrayed by Mr. Tate.

A CORRESPONDENT informs us that the appointments to the chairs of chemistry in the Technical High School at Munich have just been officially announced. The names of the various professors are:—organic chemistry, Prof. Semmler; inorganic chemistry, Prof. A. Stock; physical chemistry, Prof. R. Abegg. Each professor has an institute of his own, and Prof. Abegg retains, at the same time, his position as extraordinary professor in the University of Breslau. The Technical High School, which is being built at a cost of something like five million marks, is making good progress, and is to be opened officially in October, 1910.

THE commencement address last June at the South Dakota School of Mines, Rapid City, South Dakota, was delivered by the president of the Colorado School of Mines, Mr. Victor C. Alderson, who took for his subject "Artist or Artisan—Which?" "The artisan," he said, "understands machinery; the artist-engineer is a master of the kinematics of machines. The artisan works with his hands and lets his mind rest; the artist-engineer uses his brains to relieve his hands. The artisan becomes a skilled workman and no more; the artist-engineer sees beyond the mere machinery to the economic management of his plant, to the percentage saving possible, to the market for his product, to the efficient service of his employees, to the general success of the entire plant. To do all this he must have an ideal." Every young engineer, he proceeded to say later, should decide early in life whether he will become merely an artisan-engineer or an artist-engineer. Mr. Alderson then gave some inspiring advice to young engineers as to the physical, personal, intellectual, and moral characteristics they should strive to develop. Incidentally, he said the chance for the untrained or uneducated man to make a success in this age is practically *nil*. Taking "Who's Who" as a standard of national prominence in America, it is found, said Mr. Alderson, that it takes approximately 10,000 grammar-school pupils to produce one man worthy to be enrolled in "Who's Who." Of high-school students 250 suffice, while of fifty college graduates one will, on the average, rise to sufficient prominence to be enrolled in this book.

THE proceedings in connection with the celebration of the 500th anniversary of the founding of the University of Leipzig began on July 28, when a reception was given by the University to the representatives of German and foreign universities and learned societies invited to participate in the proceedings. On the following day a festival service in the University Church was attended by the King of Saxony. A commemorative meeting in the new theatre followed the service, and the King delivered an address and presented two medallions to the University to be worn in future by the rector of the University on his chain of office. The medallions bear images of the King of Saxony and of the founder of the University. The Saxon Minister of Education in an address afterwards outlined the history of the University. On July 30 further commemoration speeches were delivered. Prof. Wundt was the principal speaker, and during the course of his speech remarked, although the German people seem to be in the current of an intellectual movement in which the demand for higher education is hardly less strong than was the revival of learning in the Middle Ages, he said, in the words of Leibnitz, "It is the past which contains the future." Prof. Mahaffy spoke on behalf of the British delegates. The following honorary degrees were conferred among others:—Doctor of Medicine, Prof. E. B. Wilson, of Columbia University; Doctors of Philosophy, Sir Archibald Geikie, K.C.B., P.R.S., Prof. J. Loeb, of California University, Prof. J. Ward, of Cambridge University, and Mr. F. L. Griffith, reader in Egyptology, Oxford University.

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THURSDAY, AUGUST 12, 1909.

ASIATIC PALMS.

Annals of the Royal Botanic Garden, Calcutta, Vol. xi. Asiatic Palms—Lepidocaryeæ. Part i., The Species of Calamus. By Odoardo Beccari. Pp. iii+518; 2 4to plates; 238 plates large fol. (Calcutta: Bengal Secretariat Press, 1908.) Price 7*l*.

THE palms of Asia have received considerable attention in the Royal Botanic Garden at Calcutta, where there is an extensive Palmetum, with a noble collection of living species. Roxburgh, superintendent of the garden from 1793 to 1813, studied the palms of the Indian Peninsula, and left, in addition to descriptions posthumously published in his "Flora Indica," a series of drawings of the species he knew alive. Anderson, superintendent from 1861 to 1870, described the palms of Sikkim in the Journal of the Linnean Society, vol. xi., in 1869. Kurz, curator of the Calcutta herbarium from 1864 to 1878, dealt with the palms of Burma in the Journal of the Asiatic Society of Bengal, vol. xliii., part ii., in 1874. But the work of Roxburgh was only preliminary, the work of Anderson and Kurz only supplementary to that of Griffith, who acted as superintendent of the Calcutta garden during 1842–4. This able observer died at Malacca in 1845, and his treatise, "The Palms of British East India," was not printed until 1850. Less complete than he could have made it had he lived to see it through the press, this work by Griffith yet remained the standard authority on the subject until the appearance, in 1892, of the account of the Indian Palmeæ by Beccari and Hooker in the "Flora of British India," vol. vi. The long-standing association of the great Calcutta garden with the elucidation and illustration of Asiatic palms is now happily continued by the publication in its Annals of the first portion of a comprehensive account of the family by Signor Beccari, who dedicates his work to the memory of the gifted Griffith.

This volume commences the discussion of the tribe Lepidocaryeæ, palms the fruits of which are clad in a mail of reflexed, adpressed, closely imbricating scales, and deals with the genus Calamus, the largest and most important in that tribe. Workers who know these "Rotangs" as they grow are familiar with the difficulties that attend their study; those unacquainted with these fascinating but formidable "canes" in a wild state will learn something of these difficulties from the essay with which the volume opens. All will welcome a work on the subject by one whose knowledge of the species in the field is comparable with that of Griffith himself, and who has had the advantage, which was denied to Griffith, of access to practically all the herbarium material of the genus that exists.

The greater part of the letterpress is devoted to detailed accounts of the various species which the accompanying plates illustrate. Those who study these descriptions will be grateful to the author for the conscientious absence of uniformity in their presentation. Where his material is adequate, the author has provided full and carefully weighed statements of the specific characters; where his material is limited he has restricted himself to faithful accounts of the actual specimens on which his species are based. His work is thus free from that unconscious tendency to generalise more widely than the material at a writer's command will justify, which sometimes detracts from the value of treatises wherein the descriptions of species that depend on the study of perhaps a solitary example are cast in the same mould as those based on extensive suites of specimens. At the same time, he has shown himself fully alive to the advantages of methodical treatment, and, in a careful synopsis which immediately precedes his detailed descriptions, the author has characterised all the species he is able to recognise with sufficient fulness to admit of their determination, and in a manner that leaves nothing to be desired so far as uniformity of presentation is concerned.

In a systematic conspectus of the species, which follows the definition of the genus, the author has skilfully applied to the practical task of establishing order among what would otherwise be an undisciplined horde of forms that knowledge, at once comprehensive and minute, of the morphology of Calamus to which the introductory essay testifies. He is thereby able to throw his species into sixteen readily recognisable groups, some of which admit of further subdivision, while the whole of them are capable of aggregation into four series. One of these series, it is true, contains but a single group, the characters of which are admittedly anomalous, while the imperfect nature of the material as yet available renders it impossible, in the case of about 5 per cent. of the species, to state with certainty to what group they should be referred. But this conspectus will enable the worker in the field, whose needs should be the first consideration of conscientious systematists, to recognise with comparative ease at least the affinities of any "Rotang" he may encounter. The applied botanist, too, will feel indebted to the author for the many economic notes that accompany the detailed accounts of such species as are practically useful.

The plates which accompany the work are mainly phototype reproductions of the author's natural-size photographs of herbarium specimens; in a few cases, where the material available did not readily lend itself to this method, lithographed drawings take the place of phototypes. Photographic methods, though usually satisfactory so far as fidelity is concerned, when applied to the illustration of herbarium specimens often leave something to be desired from the æsthetic standpoint. Here, however, there is little ground for criticism on this score, and if it be true that specimens of Calamus lend themselves more readily to the requirements of photography than herbarium material usually does, this is not the whole explanation of the success that has here been achieved. That success is in large measure due to the care and skill of the author, who has, moreover, been fortunate in the matter of reproduction from his negatives, which reflects much credit on those to whom it has been entrusted. The size of plate adopted, it may be observed, is that of the double plates issued in former volumes of the Calcutta Annals, so that librarians who desire to bind the illustrations in conformity with the text are left free to do so. But there will probably be others who may prefer to leave the plates unfolded, and the editor of the series has earned the gratitude of those into whose hands this volume may come for his decision to issue the illustrations in a larger portfolio than that which contains the letterpress, thereby leaving them free to decide the course to be adopted. The work before us is a valuable addition to the series of volumes for the initiation of which the scientific world is indebted to the late Sir George King, and botanists generally will not only feel grateful to Signor Beccari for its preparation, but will desire to associate themselves with him in his appreciation of that "enlightened munificence" on the part of the Government of Bengal which has rendered its appearance possible.

GYROSCOPIC MOTION.

An Elementary Treatment of the Theory of Spinning Tops and Gyroscopic Motion. By Harold Crabtree. Pp. xii+140 and 3 plates; with illustrations. (London, New York, Bombay, and Calcutta: Longmans, Green and Co., 1909.) Price 5*s*. 6*d*. net.

THIS enchanting and bewildering subject has in recent years been admirably expounded in two well-known books, one somewhat more severe in its treatment than the other. The author has now provided a third, which will be valued by those who already possess and take pleasure in the other two even more than by those who approach the subject for the first time. The mathematical treatment is far more severe, so much so that the average student who scoffs at the term elementary on the back of some of his text-books will certainly in this case consider it inconsistent with the subject-matter of the last few chapters. However, if he will afterwards read the subject in, say, the "Encyclopædia Britannica," he will realise that the term is not so misleading after all.

The method by which the theory is introduced is admirable. In an introductory chapter, illustrated by twenty-six figures, all sorts of tops and spinning things, familiar and otherwise, are described, and their curious behaviour in each case simply stated. An interest is thus awakened, and the reader, if unfamiliar with the subject, realises at once what sort of thing he is going to have presented to him. In the writer's opinion this method would be advantageous generally where a difficult subject is being opened. If, for instance, before the first chapter of the typical book on the integral calculus or before Euclid's definitions there were a lightly written chapter giving more or less familiar experiences which are puzzling, but which will in due time be made clear, the reader would be more encouraged than he is by the existing openings.

The author clears the ground by giving very exact ideas on the subject of rotation about a fixed axis, laying stress at every point on the dimensional identity of the two sides of every equation. In dealing with the subject of precession, he is by no means content to handle the ultimate condition of steady precession, but he goes fully into that more difficult subject which may be summarised under the term gyrostatic elasticity, and which includes the immediate displacements and vibrations or wobblings of axes when disturbing couples are applied or removed.

The latter part of the book is in large part devoted to the difficulties connected with the motions of the axis of rotation of an ellipsoidal body within itself and in space. Among matters of interest discussed will be found the behaviour of celts, the self-turning of a falling cat, with kinematograph views, the diabolo, the Brennan mono-rail, and Schlick's gyroscopic device for steadying ships.

While criticism is misplaced, the writer would suggest that those diagrams, such as Fig. 20, in which bent arrows are intended to show a direction of rotation round an axis indicated by a line, are, as drawn, ambiguous, for it is impossible to tell whether the arrow is intended to be in front of or behind the line. If one or other were broken through the meaning would be evident, as it is, for instance, in Fig. 18, where the arrow is clearly in front of a material axle.

C. V. BOYS.

MAGIC SQUARES.

Easy Methods of Constructing the Various Types of Magic Squares and Magic Cubes, with Symmetric Designs founded Thereon. By Dr. John Willis. Pp. 256. (Bradford and London: Percy Lund, Humphries and Co., Ltd., 1909.)

A MAGIC square is an example of a problem which is a particular case of another which from its enunciation may be subjected to mathematical analysis. The n^2 cells of a square of order n may be supposed occupied, each of them, by one or more numbers in such wise that the sums of the numbers in the n rows and in the n columns have given values varying from row to row and from column to column. The enumeration of such squares, or more generally of such rectangles, has been made the subject of mathematical investigation employing algebraic symmetric functions and the allied differential operators, and complete success has resulted. The absolute magnitude of the numbers appearing in the cells may be restricted, and any number of the cells may be empty; no additional difficulties present themselves. Other problems of enumeration of the magic square kind, of which the simplest is known as the Latin square, first examined by Euler, and by others up to the time of Cayley, have also in recent years completely yielded to the same calculus of symmetric functions. In all these cases row and column properties are dealt with, but directly we introduce what may be termed diagonal properties the analysis fails to overcome the great difficulties which are thereby imported into the problems. The problem of the magic square involves restrictions and limitations of the general problem above mentioned which render it impossible of complete treatment by any known method of analysis. The condition that the first n^2 natural numbers must appear one, and only one, in each cell, is, to begin with, of a most difficult character, and is made more so by the importation of the diagonal conditions. Many kinds of magic squares, moreover, involve additional properties connected with broken diagonals, nuclear squares, symmetrically placed cells, &c., which mathematically are of a most arduous nature. It thence arises that though many mathematicians of repute from the earliest times have studied the subject, they have devoted their labours mainly to observational and tentative methods of actually constructing different classes of these squares, and have seldom seriously attempted the enumeration.

Dr. Willis has put together in this work all the best-known methods of constructing the various types, and he gives a good idea of the magnitude of the numbers that may be reached when attempt at enumeration is made. There is one magic square of order 3, and 880 of order 4; beyond this huge numbers may be expected. As an illustration he takes the case of the "square of eight in magic quarters" (chapter viii.), and in forming an estimate he takes as unit the number of different squares which could be printed in a year; if this could be done at the rate of a million per second, by keeping the press at work day and night without ceasing during $365\frac{1}{4}$ days; his conclusion, "at a very moderate estimate," is that 150,000 years would be required. A particular kind of pernuclear square of order 20 is similarly shown to have a number of forms approximately given by 2953 followed by 135 zeros.

Chapter x., on magic cubes and geometric designs, takes the reader somewhat out of the beaten track, and will be found particularly interesting. In introducing the subject of magic designs, he says:—

"By making use of magic cubes in which the horizontal squares are magic . . . we may form a mosaic design which is magic in the sense that the n horizontal squares, from which the design is formed, may be found by inspection of the number of tesseræ of n different colours contained in each of the n^2 squares of which the complete design consists."

The author gives five examples of these beautiful patterns printed in colours. Anyone who will take the pains to master the method explained will find himself able to add to these to an unlimited extent, and probably possessed of the power of evolving new principles of mosaic design.

The late Prof. Sylvester was enthusiastic about mosaic designs based on mathematical principles, and one of his "anallagmatic squares," carried out in marble, was for many years in the hall of the United Service Club.

This book will be useful to the numerous persons who find the subject an amusement and recreation. The mathematical equipment required for its comprehension is limited to the multiplication table. The book is well and appropriately printed, and the different types used for both letters and numbers are of much assistance to the reader.

P. A. M.

PHYSICAL CHEMISTRY.

Grundriss der allgemeinen Chemie. By Wilhelm Ostwald. Vierte, völlig umgearbeitete Auflage. Pp. ix+661. (Leipzig: W. Engelmann, 1909.) Price 20 marks.

TWENTY years have passed since the appearance of the original edition of "Ostwald's "Grundriss," in which the principles of modern physical chemistry were first competently placed before the general scientific public. From time to time new editions have appeared, but comparatively little change was made in the original form, the lines of development of physical chemistry having been determined by the work of van 't Hoff, Arrhenius, Nernst, and the author at a period immediately preceding the composition of the book.

The fourth edition, which is now before us, has in many respects been profoundly modified. The discovery of radio-activity and the investigation of gaseous ions give a new point of departure for chemical research and theorisation, and this the author has fully recognised in the present volume. It says much for his open-mindedness that he now relinquishes definitely and explicitly his former position that the existence of atoms and molecules received no cogent experimental proof from chemical or physical science. In his preface he writes:—

"Even the most cautious experimental man of science is now justified in speaking of the atomistic nature of extended matter—on the one hand by the isolation and enumeration of the gaseous ions, the crowning-point of the excellent and persevering work of J. J. Thomson; and on the other by the correspondence of the Brownian movements with the demands of the kinetic theory which has been shown to exist by a number of investigators, finally and most completely by J. Perrin."

With the further remark of the author that this, for him, new point of view should be first properly introduced in the chapters devoted to the results of these researches, one may be disposed to agree, in view of the real pedagogic danger of allowing the student to believe that the stoichiometric laws can only be valid owing to the existence of atoms, instead of being, as they are, generalisations from experiment, and independent of any hypothesis as to the constitution of matter. The author has, therefore, made only a subsidiary use of the atomic hypothesis in the earlier part of the work.

The volume is now subdivided into the following books:—i., substances; ii., stoichiometry; iii., chemical thermodynamics; iv., electrochemistry; v., microchemistry; vi., photochemistry; vii., chemical affinity. Chemical kinetics and equilibrium receive treatment in book iii., colloidal solutions in book v., and radioactivity in book vi.

The author has made a deliberate attempt to meet the criticism that former editions of the book were too difficult for the ordinary scientific reader. The extreme compression and logical treatment aimed at certainly required an amount of concentration beyond that at the disposal of the student when he began the study of physical chemistry. It may be said at once that the author has been very largely successful in his endeavour to adapt the subject to the comprehension of those to whom the book would be most useful. It is not even yet easy reading—it is doubtful if any thorough text-book of physical chemistry *can* be easy reading—but no intelligent advanced student of chemistry can neglect to peruse and ponder it if he wishes to be abreast of the latest developments of the theoretical side of his science in their actual and in their potential aspects. We learn with pleasure that an English translation of this important work is in course of preparation.

THE CHEMISTRY OF DRUGS.

(1) *Grundriss der Pharmakochemie.* By Dr. O. A. Oesterle. Pp. xii+562. (Berlin: Gebr. Borntraeger, 1909.) Price 17.50 marks.

(2) *Southall's Organic Materia Medica. A Handbook treating of the more important of the Animal and Vegetable Drugs made use of in Medicine, including the whole of those contained in the British Pharmacopoeia.* By J. Barclay. Seventh edition. Revised and enlarged by E. W. Mann. Pp. xx+376. (London: J. and A. Churchill, 1909.) Price 7s. 6d. net.

(1) DURING the past quarter of a century a steadily increasing amount of attention has been devoted to the study of crude drugs. The investigations of these have proceeded largely upon botanical lines, many researches having been published on the morphology and anatomy of vegetable drugs and the microscopical characters of their powders. The authors of modern text-books of pharmacognosy have, in most instances, confined themselves almost entirely to dealing with their subject from this point of view, and have been very niggardly in the treatment of the history, commerce, and chemistry of drugs. Great strides have, however, been made in the chemical investigation of the constituents of vegetable as well as animal drugs. The constitution of many has been satisfactorily elucidated, and not a few have been synthetically prepared. The literature of these investigations is, unfortunately, scattered in various journals and special publications, and every teacher of pharmacognosy will have experienced the difficulty of, as well as the necessity for, collecting such information, notwithstanding the useful works of Brühl, Pictet, van Rijn, Schmidt, Dekker, and others.

Prof. Oesterle's work appears, therefore, most opportunely. He deals with those crude organised vegetable drugs the constitution of the constituents of which has been more or less completely ascertained, but has excluded the resins and oleo-resins, as these have recently been exhaustively treated by his colleague, Prof. Tschirch. The individual drugs are grouped according to their characteristic constituents, a rational arrangement, since allied constituents commonly have similar therapeutic action, and it is for this that drugs are employed. The important constituents alone are considered, but they are considered very fully. The manner in which their constitution may be demonstrated, the successive stages in their decomposition, and the synthesis of the substance itself or of a characteristic decomposition-product are fully explained, though perhaps here and there speculation is somewhat in evidence. To the section of alkaloidal drugs 159 pages are devoted, to aromatic drugs 247, to glucosidal 46, to colouring matters 64, and to tannoids 12. Hence the second section has the lion's share, which, perhaps, is scarcely in accordance with its importance from the therapeutical point of view. To the constituents of opium 33 pages are devoted, to those of cinchona bark 19, while the consideration of menthone alone occupies 7.

Hydrastine may be selected as an example of the manner in which the constituents are treated. First the steps are shown by which hydrastine, by exhaustive methylation, is converted into hydrastonic and hemipinic acids, the constitutional formulæ, occupying three pages, being given; next the production of hydrastinine and opianic acid from hydrastine, and the conversion of hydrastinine into oxyhydrastinine and hydrastininic acid are shown together with the production from the latter of hydrastic acid and methylamine; then the action of caustic alkali upon hydrastinine resulting in the formation of hydrohydrastinine and oxyhydrastinine is explained, and finally the synthesis of hydrohydrastinine from piperonal and acetalamine.

A slight feeling of regret may be expressed that the author has confined himself to vegetable drugs, as those of animal origin contain several important constituents which have been isolated and examined.

Prof. Oesterle's work will be heartily welcomed by all who are interested in the constituents of drugs. It forms a unique contribution to scientific pharmacognosy, and will undoubtedly stimulate others to labour in a similar field.

(2) The fact that this work has now reached its seventh edition is sufficient testimony of the estimation in which it has been held, and the new issue, revised by Mr. Mann, who is well known for his contributions to the chemistry of drugs, will doubtless enjoy a similar popularity.

The general arrangement of the subject-matter remains the same, but increased attention has rightly been given to the chemical constituents of drugs, which have been dealt with, on the whole, in a very satisfactory manner, although here and there, as, for instance, the cyanogenetic glucosides of cherry-laurel leaves, wild cherry bark, &c., they have not been brought quite up to date. So far as the utility of the work from the point of view of the student is concerned, there are certainly two or three weak points. In the first place, the restriction of the description of official drugs to the characters given in the British Pharmacopœia has involved the omission of much that is important as well as interesting. Official descriptions of drugs are necessarily brief, and mucn that the student should observe and know concerning them is omitted. Details of the production, collection, preparation for the market, commerce, history, &c., are but meagre. Considerable help might have been afforded by a few judiciously selected illustrations, but these the author considers undesirable.

The large number of drugs dealt with renders the book extremely valuable for reference, but the defects alluded to militate against its efficiency as an educational work for students. HENRY G. GREENISH.

MAGNETO- AND ELECTRIC-OPTICS.

(1) *Magneto- und Elektro-optik.* By Dr. Woldemar Voigt. Pp. xiv+396. (Leipzig: B. G. Teubner, 1908.) Price 14 marks.

(2) *Cours de Physique.* Cinquième Partie. Électroptique. Ondes Hertziennes. By Prof. H. Bouasse. Pp. 426. (Paris: Delagrave, n.d.) Price 14 francs.

(1) THIS is a work on one of the most fascinating branches of modern science by one of those who have done most towards its development. To all students of physics the volume is to be specially recommended as giving an admirable account of a subject which has the most intimate bearing on present theories of the constitution of matter; to those who are themselves working in the same field the name of the author will be sufficient to indicate that the book is indispensable.

The subject dealt with is not the electromagnetic theory of light in general, but, in Prof. Voigt's own words, "that special branch of optics which deals with the action of a magnetic or an electric field on the optical properties of bodies." The study of this special branch of optics may be said to have begun in 1845 with Faraday's experimental demonstration that the plane of polarisation of a beam of polarised light is rotated by the action of a magnetic field having its lines of force parallel to the direction in which the light is travelling. Since that date an enormous amount of attention has been given to the phenomena due to the action on light of a magnetic or an electric field. In 1876 Kerr succeeded in detecting the rotation of the plane of polarisation when light is reflected normally from the surface of a ferromagnetic metal in a strong magnetic field. In 1896 Zeemann showed that the periods of free vibration of the light emitted by a flowing gas are changed by the direct action of a magnetic field, and that there is a corresponding action on an absorbing medium. In 1898 Voigt himself showed that a body in a magnetic field becomes doubly refractive in the direction perpendicular to the lines of force, in the same manner as a uniaxial crystal perpendicular to its axis. In the section of electro-optics, the advances made are less marked. Kerr's demonstration that an isotropic insulating substance becomes doubly refractive in the direction perpendicular to the lines of electric force may be taken as fundamental. An army of workers has followed along the main lines thus indicated, and to-day the mere marshalling of the known facts of observation is a task of no small difficulty, while there are many points of which theory yet fails to give any convincing explanation.

Prof. Voigt's book is founded on lectures given by him at Göttingen University The material thus available, however, has clearly been greatly extended and amplified, with results which may be regarded as exceptionally satisfactory. Thus the elementary and fundamental facts of observation, as well as all the more important experimental appliances and apparatus, are very fully and clearly described, while, on the other hand, a large amount of detail as to the latest developments, both in experiment and theory, is included. In a branch of knowledge so necessarily subject to modification under the influence of new ideas, it is usually to be expected that a volume will be already almost antiquated by the date of its publication, but one of the chief claims of the present work to attention is the extent of the information given as to the most recent work.

The first two chapters are devoted to setting forth the fundamental observations and the principal experimental methods and developments in connection with the Faraday effect and the Zeeman effect. The two chapters following, covering some 120 pages, are concerned with the explanation of these observations on the electron theory. The chief feature of Voigt's own work is the establishment of a simple connection between the emission and absorption phenomena and the rotatory effect of the magnetic field, and the development of the theory here given is founded on the series of papers published by the author between 1898 and 1902 in the *Annalen der Physik.* The theory is, however, here further extended, and includes, in chapter v., a discussion of Becquerel's more recent experiments on crystals of compounds of the rare earths.

The remaining chapters are devoted to the discussion of the "magnetic" Kerr effect, and the consideration of the fundamental phenomena of electro-optics. In the field of electro-optics the experimental difficulties have rendered progress slow. Insulation breaks down under very high voltages, and conduction is never entirely absent, and more refined methods of observation are necessary before the indications of theory can be verified. The subject is, however, of great theoretical interest and importance, and the publication of the present work will no doubt do much in stimulating further research.

(2) The general plan of the "Cours de Physique," of which the present volume is the fifth part, is somewhat unusual. The volumes previously issued bear the titles:—(1) "Mécanique Physique"; (2) "Thermodynamique—Théorie des Ions"; (3) "Électricité et Magnétisme"; (4) "Optique. Étude des Instruments," the part here considered being devoted to the general discussion of electromagnetic radiations, including Hertzian waves. Part vi. is to be entitled "Étude des Symétries"; from the references in the present volume we gather that this might best be translated "Crystallography." We are by no means clear that the arrangement thus outlined is satisfactory. In the volume before us especially, the inclusion of the discussion of Hertzian waves, though entirely logical and perfectly defensible on theoretical grounds, seems to us unfortunate. The questions involved are essentially practical and of special interest to the electrician, and the early chapters devoted to

their treatment form a section quite distinct from the remainder of the volume.

At the same time, it must be remembered that the whole work is one written for the student, and from this point of view it may be maintained that the logical arrangement is to be preferred. The usefulness of such an extended general treatise on physics is, however, far from being limited to the purposes of a university course, and the convenience of the older student who needs his theory for its application to practice might well have received more consideration.

It is to be remarked also that Prof. Bouasse's "Cours de Physique" is essentially a treatise on mathematical physics. The author takes a keen interest in the most recent developments in physical science from the theoretical point of view, but it is not to him that we should turn for information as to experimental work.

This premised, it may be said that the work is one which should command attention. Prof. Bouasse has the faculty of presenting his mathematics in a clear and attractive form, and his theoretical discussion of practical points often presents novelties of value to the practical experimenter.

The first chapter is devoted to the discussion of Maxwell's equations of the electromagnetic field. It is unfortunate that so much reference to vol. iii. of the work should be necessary, but, nevertheless, the matter is presented with admirable clearness, and the student has no cause to complain of the author's dictum:—

"The reader cannot spend too much time on this first chapter; if he understands it well, all the rest of the volume will appear clear to him. If he fails to understand it—*nous ne saurions trop lui conseiller d'abandonner la théorie électromagnetique de la lumière.*"

Then follows the section of some seventy pages on Hertzian waves and their application in wireless telegraphy. The treatment is of interest; it includes an account of the general theory and a mathematical discussion of various practical questions, especially the propagation of a disturbance along a wire; but it is necessarily incomplete, and would be of more value in a volume not so specially devoted to optical theory.

The main part of the work is that devoted to the discussion of double refraction and of polarised light. The theory is directly based on that of the propagation of electromagnetic waves in an anisotropic medium; from this is deduced the equation of the wave surface and the construction of Fresnel. This leads up to a sufficiently full treatment of the phenomena connected with double refraction as dealt with in any modern treatise on physical optics; as elsewhere, the mathematical presentment has many original and attractive features.

In the succeeding chapters reflection and refraction, dispersion and absorption are fully discussed from the standpoint of the electromagnetic theory. A somewhat brief treatment of the electron theory leads to the consideration of the Zeemann effect, and the phenomena of emission, phosphorescence and fluorescence, &c., while the concluding chapter deals with the thermodynamics of space, including such topics as Poynting's experiments on radiation pressure and the discussion of Stefan's law.

As has been sufficiently indicated, the whole of the section of physical optics here dealt with is treated as a deduction from the equations of the electromagnetic field. This may be a simplification from the point of view of theory, but we are inclined to think that to the student it may give an air of unreality to a subject which, above all others, is based on the most complete and exact experimental data.

OUR BOOK SHELF.

On the Poison of Venomous Snakes and the Methods of preventing Death from their Bite. Reprinted papers by the late Sir Joseph Fayrer, Sir Lauder Brunton, and Major Leonard Rogers. Pp. iii+174. (London: Macmillan and Co., Ltd., 1909.) Price 2*s*. 6*d*. net.

THIS publication consists of a re-issue in book form of six papers reprinted from the Proceedings of the Royal Society. The first four papers deal with the physiological action of snake venoms. They were first published more than thirty years ago, and then represented important advances in knowledge. They cannot, however, be expected to reflect the present-day knowledge of the action of snake venoms. The fifth paper, belonging to the same period, deals with chemical methods of destroying the activity of cobra poison, such as by chloride of gold or of mercury. The last paper, which was published in 1904, and is the only one of the series in which the last-named author cooperated, deals with the experimental results of the treatment of snake-bite by free exposure of the wound and local application of potassium permanganate.

To be of practical service in the treatment of snake-bite, any remedial measure must be rapidly available and easily applicable. To meet these conditions, one of the authors devised a special instrument consisting of a small lancet-shaped blade to expose the wound made by the serpent's bite, this blade being set in a short wooden handle, which is hollowed so as to form a receptacle for sufficient permanganate of potash. Experiments were made on rabbits and cats to test the value of the method and instrument. The results, especially in the latter animals, were encouraging, in so much as it was found that death could be prevented from a dose of venom considerably larger than that which was sufficient to kill a control animal. At the same time, it may be pointed out that the conditions of these experiments do not represent adequately the conditions obtaining in an ordinary case of snake-bite. The efficacy of the antidotal action of potassium permanganate depends solely upon how far the venom can before absorption be destroyed by intimate contact with the permanganate. In the authors' experiments the venom was injected into the subcutaneous tissues, in which case it was relatively easy to ensure contact of the venom with the antidote, whereas in a case of snake-bite the venom is injected usually into deeper tissues, when it is much more difficult to bring the permanganate into contact with the venom. It is thus probable that these experimental results ascribe to this method of treatment a value higher than would be found to attend it in practice.

While from its simplicity and cheapness this method of treating snake-bite ought not to be lost sight of, it probably does not represent the ideal attainment, which is by local application and general administration of an antivenomous serum, and further efforts ought to be made in the direction of obtaining such serums of high antidotal properties. If dried, an antivenomous serum retains its neutralising power for a long period, and it possesses this great advantage over a mere chemical antidote, that it can also antagonise venom which has been absorbed, and may thus be of service for a longer time after injection of the venom.

Bathy-orographical Map of Africa. 1–8,400,000. *Bathy-orographical Map of Asia.* 1–9,300,000. (Edinburgh: W. and A. K. Johnston, Ltd.) Price 12*s.* each.

We must congratulate Messrs. W. and A. K. Johnston on these excellent additions to their series of orographical maps. The elevations in Africa show 10,000, 5000, 2000, and 1000 feet and below sea-level. The general effect is satisfactory, though the very deep green is, we think, somewhat unpleasing. The 10,000-feet contour shows the higher elevations of the Atlas, Abyssinia, the Lakes Plateau and the Drakensbergen, but the tint is indistinguishable by a class. It would, however, have probably made the map more useful if the 8000-feet line had been selected, as the highest points are not of great importance for an educational map except in the region of the great lakes. As it is, the mountainous areas do not indicate their special character.

The other contours selected show the formation of Africa well. The sea depths shown are 100, 1000, 2000, and 3000 fathoms. It is to be regretted that the same contours have not been chosen to represent both the land and sea, as the plateau character of Africa would have been brought out with much greater effect.

Both in Africa and Asia, physical names have been very fully shown. As they cannot be read by a class, it is a pity that they have not been printed faintly in blue, like the initial letters of towns. The mass of black lettering largely spoils the graphic character of the maps.

Actual mistakes are few, though one may be noted—in the north-east of Abyssinia the area below sea-level has been coloured as more than 1000 feet.

The map of Asia is more effective than that of Africa, possibly owing to the selection of the contours. The 10,000-feet affords a means of comparison with Africa, but it should, if possible, have been printed the same depth; then the 15,000- and 20,000-feet lines would, with suitable graduation, have illustrated the character of the Tibet Plateau. At present minute and close examination is necessary to distinguish the features of the North-West Frontier. The lower elevations are much better shown. The 100, 3000, and 6000 feet bring out well the great river valleys and depressions of Asia.

In spite of these defects, the maps are likely to prove more useful for schools than any that have previously been published of these continents.

Publications of the Research Defence Society. March, 1908, to March, 1909. Selected by the Committee. Pp. xv+216. (London: Macmillan and Co., Ltd., 1909.) Price 2*s.* 6*d.* net.

The Research Defence Society was founded on January 27, 1908, "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." The president is the Earl of Cromer, himself a champion in the cause of kindness to animals; the committee is a strong one, its members representing all branches of science, and also including many theologians and laymen, and in March of this year the membership of the Society numbered more than 2250.

This first volume of publications contains the president's address at the inaugural meeting, a review of the Home Office Report for 1907 on, and some facts as to the administration of the Act regulating, experiments on animals, and several essays (also published separately in pamphlet form) by well-known experts dealing with the knowledge that has been derived from experiments on animals, and the saving of human life therefrom. Prof. Cushny shows that the nature of the action and therapeutic use of all drugs of recent introduction, and the potency of the preparations of many of the older drugs (*e.g.* digitalis and ergot), have been elucidated solely by experiments on animals, the value of diphtheria antitoxin and of serum treatment in epidemic cerebro-spinal meningitis (spotted fever) is discussed by Dr. Courtauld and Dr. Robb respectively, Sir David Bruce writes on the extinction of Malta fever, and Dr. Bashford's article in Nature on recent advances in knowledge of cancer is reprinted. The evidence of Lord Justice Fletcher Moulton before the Royal Commission on Vivisection is given *in extenso*, and is a powerful vindication from the ethical side of the right to employ experiments on animals for the benefit of mankind.

If the standard of its publications be maintained at the level of those contained in this volume, the Society will be doing excellent work in the cause of experimental research.

R. T. H.

Milk Testing. A Simple Practical Handbook for Dairy Farmers, Estate Agents, Creamery Managers, Milk Distributors, and Consumers. By C. W. Walker-Tisdale. (Northallerton: W. R. Smithson.) Price 1*s.* net.

The author of this little book is already favourably known by his early publications, jointly with Mr. T. R. Robinson, on butter-making and soft cheese-making. He holds an important position in the dairy world, and, as general manager of the Wensleydale Pure Milk Society, knows at first hand all the difficulties that beset the dairyman. The result is an admirable little volume, sound in regard to analytical methods, and direct in its appeal to the man for whom it is intended. It is more than a mere collection of methods, and includes discussions of such cognate subjects as the use of preservatives. Occasionally a request is heard in certain quarters that a preservative should be allowed in milk, but our author will have none of it, and advises the dairyman to keep clear of them all, even of a certain preservative offered for sale, "guaranteed to contain no boron or boric acid, and claimed to be undetectable by chemical analysis"! Quite apart from considerations of the general health of the community, the author shows that the dairyman himself would suffer, since foreign milk would invariably be imported if preservatives were allowed.

E. J. R.

The Journal of the Cooper Research Laboratory. Edited by Walter E. Collinge, Director. (Berkhamsted: The Cooper Research Laboratory, 1909.)

The fact that the principal of a large and well-known firm like Messrs. Cooper should start a research laboratory and publish a journal is a satisfactory proof of the widespread interest now being taken in science by all who have to do with agricultural and horticultural matters. The special province of the firm—treatment of insect and fungoid pests—certainly borders more closely than usual on pure science, and no doubt a trained staff would have been wanted in any case. But here we have something more. The laboratory, we are told, "is in no sense a financial venture or business concern." Its functions are to answer inquiries from farmers, fruit-growers, and gardeners as to preventive and remedial treatment for diseases of plants and parasitic diseases of animals, to investigate life-histories of various insects, parasites, &c., and generally to advise on subjects relating to economic biology, agricultural chemistry, and bacteriology.

The articles in the journal are mainly summaries of work done elsewhere rather than accounts of original work; perhaps this was only to be expected from an almost new laboratory. Mr. Collinge deals with the use of lime, with special reference to its influence on plant diseases like potato-scab and finger-and-toe fungus; he has also collected a good deal of scattered work on the woolly aphis. Mr. Barlow deals on similar lines with the effect on plants of copper salts used as fungicides. The summaries themselves call for no special comment, but the journal as a whole is well got up. We shall be interested to see how Sir Richard Cooper's experiment works—whether the laboratory can maintain the detached position essential for the publication of scientific work, or whether, as has happened elsewhere, it becomes merged in the purely commercial side.

Cambridge County Geographies: Somerset. By Francis A. Knight, assisted by Louie M. (Knight) Dutton. Pp. xi+192. (Cambridge: University Press, 1909.) Price 1s. 6*d*.

THE characteristics of the series to which this volume belongs were enumerated in our issue for May 13 (vol. lxxx., p. 305), and much of what was written on that occasion applies to the present book. The authors' interpretation of the scope of geography is wide enough to include a history of the county, its antiquities—ecclesiastical, military, and domestic—its administration and roll of honour. Like previous volumes in the series it is well illustrated, brightly written, and generally attractive.

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.*]

Difference between Longitudinal and Transversal Zeeman Effects in Helium Lines.

IT is easily shown on the theory of electrons that the amount of separation of the outer components of a transversal Zeeman triplet must be slightly different from that in a longitudinal doublet. Some time ago I showed that the transversal separation in weak magnetic fields does not strictly follow the linear relation with the magnetising force, but, owing to an indirect method of measurement, the exact amount of the separation could not be measured with accuracy. By measuring the longitudinal effect of helium lines with an echelon spectroscope of thirty-five plates, each of 1 cm. thickness, made by Hilger, I found that doublets can be distinctly separated in a field of 180 gauss, when the right- and left-handed circularly polarised light is linearly polarised in mutually perpendicular directions, by interposing Fresnel's rhomb in the course of the beam. Taking a number of points at intervals of about 300 gauss from $H=0$ to $H=2000$, and ten to thirteen points from $H=2000$ to $H=14,000$, I found that for the three lines $\lambda\lambda=6678$, 5876, 5016, the relation between the amount of separation $\delta\lambda$ and the strength of the field H is exactly linear, so that $\delta\lambda/H=$constant also in weak fields. In these experiments it was necessary to gauge the strength of the field accurately for each point before and after each micrometric measurement by means of a small coil. The values of e/m were found to be for

$\lambda=6678$	$e/m=1\cdot86\times10^7$
$=5876$ (D_3)	$=1\cdot68\times10^7$
$=5016$	$=1\cdot80\times10^7$

The separation of the satellite of D_3 is complex, but there is one component which gives the same value of e/m as D_3.

With the transversal effect the ratio $\delta\lambda/H$ is not constant in weak fields. With D_3, the curve representing the relation between H and $\delta\lambda$ is such that it increases very slowly to $H=800$, then rapidly to an inflexion point in $H=1700$, makes a bend, and from $H=2000$ follows an accurately straight course up to $H=14,000$, which is the strongest field used in the present experiment. In the latter part of the curve $d(\delta\lambda)/dH=$constant, which is smaller for the transversal than for the longitudinal effect, so that the curves representing these effects cross each other in $H=1200$ and $H=10,900$. The initial part of the curve for the transversal effect shows a striking resemblance to that of magnetisation in ferromagnetic substances. The satellite accompanying D_3 shows remarkably complex separation, as shown by Lohmann, but there are two components which take a similar course to the principal line D_3. The lines are already separated before reaching the inflexion point above mentioned, so that the method which I used in my former experiments, is confined only to weak fields. With the line 6678, the initial course of the curve for transversal effect is similar to that of D_3, but the inflexion point is reached in a higher field $H=2700$, and the curve becomes a straight line from $H=3600$ upwards. The curve for longitudinal effect lies entirely above that for the transversal, and $d(\delta\lambda)/dH$ in strong fields is greater for the former than for the latter.

The usual calculation of e/m is made on the supposition that $\delta\lambda/H=$constant, which is strictly obeyed in the longitudinal, but not in the transversal, effect; the discrepancy in the value of e/m calculated from longitudinal and transversal effects is at once explained. The initial course of the curve can be accounted for by Voigt's theory, but the appearance of the inflexion point before attaining the straight course presents some difficulty. The resemblance of the curve of transversal effect to that of magnetisation seems to have an important bearing on the exposition of the theory, which would explain these characteristic features. The extension of these experiments to stronger fields and with different elements is being undertaken.

H. NAGAOKA.

Physical Institute, University of Tokyo, July 16.

Natural Selection and Plant Evolution.

THE letter from Mr. James B. Johnston in NATURE of August 5 touches on many important points, which cannot be fully dealt with in a letter of reasonable length.

In his opening sentence the writer, speaking of chapter xii. in "Darwin and Modern Science," says that "there, perhaps for the first time, the evidence of the fossils with regard to the influence of natural selection has been fairly tackled"; I may point out that the chapter cited really relates mainly to evolution, and especially phylogeny; only the last section refers to natural selection, a subject on which, from the nature of the case, the fossil record can throw comparatively little light.

I cannot think that, on the main question, there can be any very fundamental difference between the writer's views and my own, for he says:—"In the case of the Tertiary mammals the action of natural selection can be very clearly demonstrated in numberless cases." Mr. Johnston cannot seriously mean that he accepts natural selection for animals and rejects it for plants. The question is simply one of evidence. As I have myself pointed out, the direct evidence for the derivation of one species from another is at present less satisfactory in the plant than in the animal record ("Darwin and Modern Science," p. 204); on this point we may hope for new light from further research, though, as regards the efficacy of natural selection (an essentially different question), I doubt if palæontological evidence will ever be really decisive.

My point in speaking of the evolution of the pollen-tube and seed was to show that such characters are *adaptive*, a view to which Mr. Johnston is not likely to object. In the present position of biological science evidence of adaptation is commonly accepted as presumptive evidence of the action of natural selection.

The question whether a belief in the efficacy of natural selection can be regarded as "barring out all design from the world in which we live" is not one that can be discussed here. Mr. Johnston will find this subject admirably treated, from a theologian's point of view, in Mr. Waggett's contribution (chapter xxiv.) to "Darwin and Modern Science."

The question of the antiquity of land-plants is of great interest. Assuming, for the sake of argument, that the highly organised lycopods and fern-like plants described by Prof. Potonié as Upper Silurian (" Die Silur und die Culm-flora des Harzes Geb.," *Abhandl. d. k. Preuss. Geolog. Landesanstalt*, Heft 36, 1901) were really of that age, it would appear certain that land-plants must then have already passed through a very long course of evolution. No one is likely, in these days, to suppose that Bothrodendron and Sphenopteridium were specially created. The doctrine of mutation (of which Mr. Johnston appears to be an adherent) does not materially help in hurrying up the process of evolution, for, as Prof. de Vries himself says, "Mutations do not necessarily produce greater changes than fluctuations" ("Darwin and Modern Science," p. 73).

The problem confronts us, and its solution must simply await further evidence. D. H. Scott.

Oakley, Hants.

The Perseids of 1909.

The weather, fortunately, took a very favourable turn on August 3, and observations have been obtained nearly every night since, though moonlight has rather seriously interfered with the work and obliterated many small meteors. Up to August 9, and including that date, the display of Perseids was decidedly poor, and quite disappointed expectation. On August 7 and 9, particularly, there appeared to be very few meteors, but the moon was shining rather strongly in the east.

On August 8 there were several brilliant Perseids observed. At 10 p.m. a fine, long-pathed meteor shot from Camelopardalus across ι Draconis towards ζ Ursæ Majoris. At 10.8 p.m. another Perseid, equal in brightness to Jupiter, passed from χ to between β and η Draconis. At 10.34 p.m. a third shot exactly from α Cygni to close to β Cygni. These meteors left streaks, and, in combination with a few other paths recorded on the same night, indicated a radiant at $41^\circ + 57^\circ$.

The shower will probably arrive at its most abundant phase on August 11 or 12 this year, so that the meteors already reported are merely the vanguard of the approaching main group. W. F. Denning.

Bristol, August 10.

The Ringing of House-bells without Apparent Cause.

Kindly allow me space for a few remarks upon Sir Oliver Lodge's theory, put forth in Nature of July 22 (p. 98), to the effect that "the bells get charged with electricity (atmospheric), and are attracted to a neighbouring wall or pipe, and then released suddenly by a spark." Now, while it is conceivable that a bell might be rung under certain conditions in this manner, during the progress of a thunderstorm or display of sheet-lightning, and granting that ordinary non-electric bells have been rung and wires fused when a house has been struck by the electric current during such storms, still, this theory is inadequate to explain those cases of mysterious bell-ringing on record, and for one reason, among others, that these ringings, often violent and prolonged, have been extended over a term of several weeks or months, and have constantly taken place when no storms or strong electrical conditions were apparent, and when every effort was being made to ascertain the cause.

I speak from personal experience of a case which occurred in my house when resident in the south. For a period of two months there were constant ringings—often violent, the bell lashing to and fro—of the indoor bells, without apparent cause. In the case of one bell the wires were cut, but still it rang. The utmost endeavours were made to solve the mystery, but it defied all our efforts. There were no rats, the house having been made rat-proof, nor did we see one rodent during our stay. The wires were carefully traced and examined. Pendulums were affixed to all the bells to detect slight motion, and they were strongly illuminated by a powerful light and a watch kept, sometimes all through the night. The chief offender among the bells was one communicating with a private room. The wire from this ran, high up near the ceiling, upon the varnished paper, except where it passed through a wall, which it did through a half-inch pipe. It was impossible for a rat or mouse to touch it all along its course. This bell rang repeatedly from early morn to late at night. The room was thoroughly searched and secured—the shutters put up and barred and the door locked. Still the bell rang, and defied all our efforts to elucidate the mystery. On one occasion, when the whole household was together in another room, some little distance away, one of them said, "I wonder if it will ring to-night?" The words were scarcely spoken before the bell rang out, first faintly, then so violently that the bell lashed from side to side. All ran out and saw it swaying. I can state that during the whole period we had no thunderstorm, it being winter, and the ringings were so frequent that it would have needed scores of storms and abnormal electrical conditions to produce them, even if these had been the cause. This theory is ingenious, but one doubts whether Sir Oliver advances it seriously. Whatever is the cause of these mysterious ringings, it is patent to anyone having had experience of them, or knowing the cases on record, that it is not electricity, atmospheric or other. C. L. Tweedale.

Weston Vicarage, Otley, Yorks, August 6.

Variation in Relative Intensity of Helium Lines

It has long been an open question whether the spectra of gases were subject to any general law of intensity variation such as the Wien-Paschen displacement law for incandescent solids. Reasoning from Kirchhoff's law, it is frequently assumed that the Wien-Paschen function must be an envelope to the radiation spectrum of any gas, at least for certain selected lines. Pflüger's work with the mercury lamp (*Ann. Ph.*, July, 1908) indicated some such variation in relative intensity, but the energy (temperature) effect was obscured by the effect of varying vapour density. The latter is known to be large, so that the existence of the former was not proven.

We have recently taken up this question, using a pair of helium lamps containing very pure gas at 5 mm. pressure, and found *no variation* whatever when the intensity was varied by a factor of eighteen. The method was to hold one of this pair of lamps constant at a moderate current (5 milliamperes per mm.^{2}), while the intensity of the other was varied from 0·15 to 2·70 times this value. Spectrophotometric settings were made on the brightest red line (λ 668) and the bright blue line λ 447. The uncertainty in the ratios of high/low intensities was less than 2 per cent. in both red and blue; the observed difference in these ratios between red and blue was less than 1 per cent. The red and blue lines then increase in the same proportion over a wide range of intensity.

According to the Wien-Paschen function, an incandescent body should, for an increase in total radiation of 18 fold, increase in temperature 2·06 fold. If this increase is from 1500° to 3090°, then λ 668 would increase in that range 1721 fold, and λ 447 would increase 66,850 fold in intensity, so that the blue increases 38·8 times as much as the red, whereas for helium we found no difference so great as 1 per cent. P. G. Nutting.
Orin Tugman.

Department of Commerce and Labour, Bureau of Standards, Washington.

Kohlrausch's "Physical Measurements."

I should like, through the medium of Nature, to direct attention to an erratum in Kohlrausch's "Physical Measurements" (third English edition, Churchill, 1894), p. 434, table 8. The value for $k(s=2{\cdot}0)$ is given as 0·458, its true value being 0·457(1). Other editions, English or German, not being at hand, I do not know whether the mistake is repeated or not. As this occurs in a very useful table in a universally used reference work, it should be of interest to a number of your readers.

E. W. Nelson.

The Laboratory, Citadel Hill, Plymouth, August 2.

THE BRITISH EXPLOSIVES INDUSTRY.[1]

A VALUABLE addition to the literature on explosives has been published under the auspices of the seventh International Congress of Applied Chemistry by its explosives section, with Mr. Brayler Hodgetts as editor. It owes its inception to Mr. Oscar Guttmann, to whom the publishers pay a well-deserved tribute for his able assistance and the facilities he has afforded them by placing his unique and valuable library at their disposal.

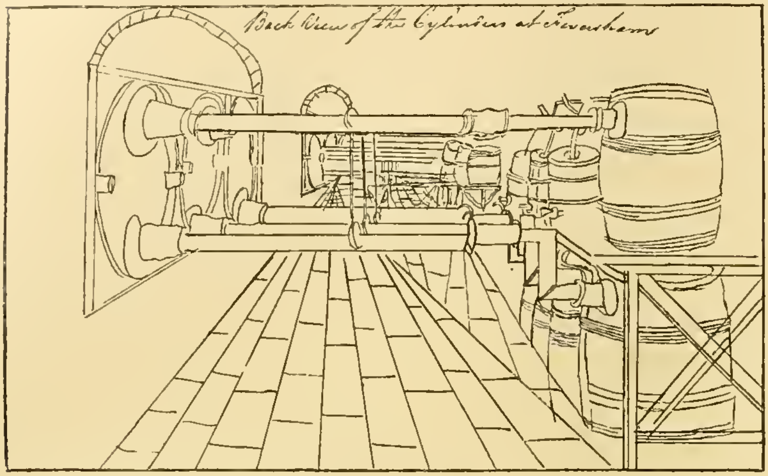

FIG. 1.—Charcoal Chambers in 1798. Back View. Reduced from "The Rise and Progress of the British Explosives Industry."

All who have been associated with the compilation of the work are to be highly congratulated on having produced a volume which will certainly fulfil the hope expressed by Captain Tulloch in his preface, that it will "in years to come be looked upon as a work of reference connecting the past with the future," for all will agree with him, after perusing it, that "it is the only work of the kind containing so complete a history of the manufacture of explosives in this country."

The book is divided into two main sections, historical and descriptive. In the former are articles devoted to each of the principal explosives, and such related subjects as percussion caps, safety fuses, and fireworks, contributed by writers specially competent to deal with each. It is impossible to single out any one article for comment, but the contributions of Mr. G. W. Macdonald on the literature relating to researches on gunpowder, nitroglycerine, and nitrocellulose, with the full references to the original papers, will prove of considerable value.

Outside of what may be regarded as the purely scientific or technical articles, that on legislation, contributed by the editor, is of great interest. Although prior to 1860 there had been many Acts placing restrictions on manufacture and storage, the supervision was very lax, leading to great carelessness in the manufacture and handling of such dangerous substances. Colonel Moody's report on the disastrous explosion of powder magazines on the river-bank at Erith in 1864 (from which report some startling extracts are given) fully emphasised the necessity for more stringent regulations, and led in October of that year to the appointment of Colonel Boxer to "inspect and examine any mill, magazine or place" in which any kind of explosive was manufactured or kept. Later, a further disaster at Birmingham, by which fifty-three lives were lost, resulted in the appointment of permanent inspectors on the recommendation of the late Colonel Sir V. D. Majendie, K.C.B., who, as chief inspector, became so well known to the public at the time of the Fenian outrages. The Explosives Act of 1875 was the final outcome of these disasters, an Act which has proved of the greatest value through the tactful administration of the inspectors and the conscientious manner in which its provisions have been observed by the industry.

Special mention must be made of the bibliography and of the chronology. It is claimed for the former that it gives a complete list of the books on explosives published in England, whilst the chronology covers the period 1242–1700, and is a remarkably complete work reflecting the greatest credit on those responsible for its compilation. The licences granted and the restrictions imposed for the sale of the ingredients of powder and for its manufacture are often extremely quaint and of great interest. This chronology should appeal to the antiquarian equally with the student of applied science.

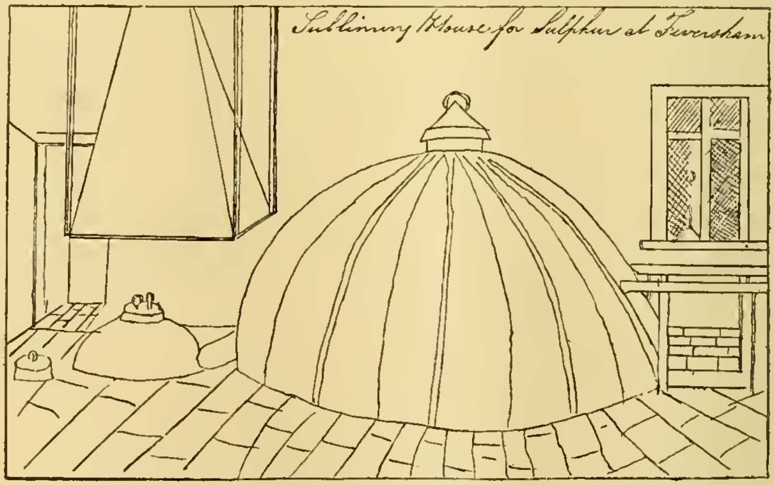

FIG 2.—Sulphur Subliming Chamber in 1798. Side View. Reduced from "The Rise and Progress of the British Explosives Industry."

In the second section of the book, devoted to description of existing factories, the information as to development, specialities of manufacture, organisation, &c., is very complete. Space only permits of reference to the articles dealing with Government

[1] "The Rise and Progress of the British Explosives Industry," Published under the Auspices of the Seventh International Congress of Applied Chemistry by its Explosives Section. Pp. xiv+418. (London: Whittaker and Co., 1909.) Price 15s. net.

establishments, in each case written by the superintendent—the Royal Laboratory, Woolwich, by Colonel Sir Hilaro Barlow; the Royal Gunpowder Factory, Waltham Abbey, by Colonel Sir Frederic Nathan; and the recently re-constituted Research Department at Woolwich, by Major H. Mansell. The history and development of these important Government establishments will prove of general interest. The Royal Laboratory alone must be prepared to manufacture at short notice some 3000 articles of approved design for war purposes. An interesting comparison of the cost of shells may be quoted. In 1849 the finished shell for 8-inch smooth-bore guns alarmed the authorities. It was *11s. 3½d.* The modern 12-inch shell costs about *29l.* when completed!

One extract may be permitted from Colonel Jocelyn's article on military fireworks. "In the Mathematical Society of London a rule existed which imposed a fine of sixpence on any member who should let off fireworks in the place of meeting." This but reflects the playfulness of the times when Pepys and his friends enjoyed pelting each other and "the people over the way" with fireworks.

The book is illustrated with some fine portraits of those who have been prominently associated with the industry, and a number of old illustrations of powder-making processes, which greatly add to the value of the work. Those selected for reproduction are of more general interest than others relating to powder manufacture itself. The recovery of by-products from the carbonisation of wood, as shown in the first illustration (Fig. 1), cannot fail to be of interest to chemists, as will also the sulphur-refining plant (Fig. 2) with its retort, fume-hood, and condensing chamber.

J. S. S. B.

DANISH RESEARCHES ON THE EEL AND THE PLAICE.[1]

THE "Kommission for Havundersøgelser," the official body entrusted with the execution of Denmark's share in the international exploration of the sea, devotes a considerable portion of its resources in endeavouring to solve certain important problems connected with the natural history of the eel and the plaice. These investigations are producing very definite results.

Two papers recently contributed by Dr. Johs. Schmidt to the "Meddelelser" of this commission considerably advance our knowledge of the metamorphosis and distribution of the larvæ of the eel and other murænoids. Since the publication of Dr. Schmidt's notable treatise of 1906, in which the distribution of the larvæ of the eel in the Atlantic, west of Europe, was described in detail for the first time, a large quantity of new material has been collected by means of the Danish research steamer *Thor*.

The new captures included more than 500 larvæ of the common eel, 300 of which were in different stages of metamorphosis. The material previously dealt with (in the treatise of 1906) consisted of 265 specimens, only eight of which showed an advance on the leptocephalus stage. Taking the captures of 1905 and 1906 together, the following is a list of the leptocephali of murænoids so far taken by the *Thor*:—Leptocephalus of eel, 790; of Synaphobranchus (deep-sea eel), 126; of the conger, 32; other leptocephali belonging to four unknown species, 12.

Confining our attention to the common eel, it may be said that these new researches throw light on obscure points, amend former statements, and fill up several gaps. The more important new facts may be briefly summarised as follows:—

(1) In May all the leptocephali were in stage 1; in September they were mostly in various stages of metamorphosis. This implies that the propagation of the eel is limited in the main to a certain portion of the year, as is the case with most other fishes.

(2) In September the later stages were found further towards the shore than the earlier stages. This indicates shoreward migration during metamorphosis.

(3) It was found that both leptocephali and glass eels were larger in the southern than in the northern part of the area of distribution.

(4) Whereas in the treatise of 1906 calculations of the shrinkage of the larvæ during metamorphosis were based on fragmentary material, belonging to different regions and different years' groups, it is now possible to say definitely that the diminution in length involved in the retrogressive metamorphosis amounts to 1 cm. This average is based on a large number of measurements of leptocephali and glass eels *from the same region, and belonging to the same year's group.* Further, weighings of leptocephali and glass eels prove for the first time that the metamorphosis involves an actual loss of substance, the dry-weight of glass eels being only one-third of that of leptocephali.

(5) There is good evidence that the larvæ execute diurnal vertical movements in the sea, coming nearer the surface at night than during the day.

(6) There are places where the larvæ of the eel are the commonest fish, just as we find in the case of the different species of gadoids, each of which (as we know from Dr. Schmidt's own investigations) chooses its own conditions of depth, salinity, and temperature for spawning purposes. Thus the specific trait shows itself in the selection of spawning habitat, as well as in anatomical and physiological peculiarities.

The first and final chapters of this weird and fascinating history have yet to be written. Neither the eggs nor the spawning adults have been found, though there is good reason to believe that the former are bathypelagic, *i.e.* floating at considerable depths, as is the case with other murænoids, Argentines, and other deep-sea fishes. The discovery of these things can only be a matter of time and resources. Ships and men are not lacking, apparently.

In regard to other murænoids, the recent investigations show that the conger is a more southern form than the eel. Its larvæ do not range further north than Rockall, whereas the leptocephali of the eel extend to the latitude of the Færöes. The larvæ of the conger do not occur over such great depths as those of the eel. They show the same inshore movement during metamorphosis, there being a close connection between depth and pre-anal length.

The larvæ of the deep-sea eel (*Synaphobranchus pinnatus*) were never taken so near the surface as the leptocephali of the common eel, never higher in the water than 100 metres. In the case of this species there is nothing to suggest shorewards migration. During metamorphosis the larvæ sink to the bottom in deep water, where fully-developed eels of this species were caught in large numbers over a wide area of the north-east Atlantic.

Of the other leptocephali (four kinds) it is impossible to say at present to what species they belong,

[1] Meddelelser fra Kommissionen for Havundersøgelser. Serie Fiskeri. Bind iii., Nos. 1, 3. 5, and 6.
No. 1. C. G. Joh. Petersen: On the Larval and Post-larval Stages of some Pleuronectidæ (Zeugopterus, Arnoglossus, Solea). With two plates.
No. 3. Johs. Schmidt: Remarks on the Metamorphosis and Distribution of the Larvæ of the Eel (*Anguilla vulgaris*, Turt.). With one plate and one chart.
No. 5. A. C. Johansen: Contributions to the Biology of the Plaice, with special regard to the Danish Plaice Fishery. iv. Is the Plaice Indigenous to the True Baltic? With Two text-figures.
No. 6. Johs. Schmidt: On the Occurrence of Leptocephali (Larval Murænoids) in the Atlantic W. of Europe. With two plates and one chart.

and it may be some time before this can be stated, owing to the difficulty of capturing the slippery and swift-moving adults. It will be necessary to have these for comparison with the leptocephali (*e.g.* to count the vertebræ). From the small numbers of these leptocephali captured, it is practically certain that their breeding-places or "nurseries" are considerably to the south of the Bay of Biscay.

Leptocephalus hyoproroïdes is particularly interesting, because it is the only species which it has been possible to trace back to the not fully-grown pre-leptocephalus stage, which, it is significant to observe, is also pelagic, like the later stages.

Much praise is due to those concerned in the production of the three beautiful plates of photographs which illustrate these two papers. One plate (in No. 3) shows seven stages (typical size) in the metamorphosis of the common eel. These figures are a great improvement on the photographs of the same series of stages published in Dr. Schmidt's original treatise; they are larger, and were taken from specimens in a much better state of preservation, so that they display the characters of the larvæ, especially the glassy transparency, more faithfully. The same remark applies to the plates illustrating No. 6. One of these shows seven stages in the *growth* of the pre-leptocephalus into the leptocephalus of "hyoproroïdes."

Leptocephalus latus. Slightly less than three times natural size.

Dr. A. C. Johansen, in No. 5, makes a very important original contribution to the much vexed question, "Is the plaice indigenous to the true Baltic?" For a long time, neither eggs, pelagic larvæ, nor early bottom stages of the plaice could be found in the true Baltic, and Dr. Petersen, the chief Danish scientific expert on sea fisheries, considered that the large stock of this fish in these waters must be entirely derived by immigration from the Belts and southern Kattegat. He thought that they must begin to immigrate when about one year old. As time went on, however, the capture of large numbers of eggs in the cold saline bottom water of the Baltic, and of *occasional* pelagic larvæ and bottom fry, seemed to indicate that this extreme view might require modification. It seemed unlikely, however, that the eggs could develop in the cold water at that depth, and the fact that the number of pelagic fry obtained were extremely few in comparison with the numbers of eggs and adults lent support to this view. But is was not impossible that the stock of plaice was partly, if not mainly, indigenous, being an "accumulated stock" grown up slowly by means of small additions from year to year. This problem had been the subject of continual investigation and discussion by German and Danish investigators under the international scheme, with, so far, inconclusive results. It seemed even probable that a third alternative might be the right explanation, viz. that the fry had not been looked for in the right places with the proper appliances. This seems to have been the case. Dr. Johansen, in the present paper, records the capture in the true Baltic of large quantities of yearling plaice "for the first time in such numbers as to compete with each of the older annual series." He also found that pelagic fry of this species were plentiful everywhere in the water between Falster and Bornholm. Other convincing evidence of the plaice being indigenous to the true Baltic is also brought forward, it being shown that the average size of plaice of a given age and the average size at first maturity are much smaller in the Baltic than in the Belts and southern Kattegat. This could hardly be the case if any considerable immigration from the latter regions took place. More light on this question may reasonably be expected from marking experiments in the future. The few experiments of this kind which have so far been made in this region have not yielded conclusive results.

In No. 1, Dr. C. G. Joh. Petersen gives the results of an exhaustive study of the diagnostic characters of Arnoglossus, Zeugopterus, and Solea in the larval and post-larval stages. These results (which need not be detailed here) are quite new. The author also discusses in a critical manner all previous observations in regard to these species and stages. Dr. Petersen is the greatest living authority on the later development of the Pleuronectidæ, and this paper and his other papers dealing with the subject are of standard importance, and indispensable to the investigator.

THE POSITION OF SCIENCE TEACHING IN PUBLIC SCHOOLS.

THE Board of Education has issued as an "Educational Pamphlet" a report on science teaching in public schools. The material for this report, made at the instance of the Association of Public School Science Masters, has been collected and edited by Mr. O. H. Latter, of Charterhouse, and the pamphlet is both instructive and amusing. The ground covered by the report is to some extent the same as in another report recently made by a committee of the British Association on the sequence of science studies in secondary schools; but a comparison of the two lists of questions sent out will show that Mr. Latter's investigation deals more particularly with equipment and finance. On the other hand, the field of inquiry was restricted to the class of school represented on the Association.

Of the seventy-one schools to which the circular was sent, twenty-four made no response, and one sent a definite refusal. It is doubtless annoying to be asked twice in the course of a year to fill up forms which require minute particulars, perhaps not ready to hand, and it is possible—in fact a study of one of the appendices makes it probable—that some of the information has been supplied without meticulous verification of the details.

If we put schools into three science classes, (*a*) those born scientific, (*b*) those that achieve science, (*c*) those that have science thrust upon them, it will be found that only (*b*) and (*c*) are represented in Mr. Latter's report. Class (*b*) supplies all the most valuable information, and it is to be hoped that it will be found useful by the governors of the third class, now a very small one.

The opening pages of the pamphlet are retrospective and historical. Darwin's experiences at Shrewsbury are given, including the public rebuke administered by the headmaster for time wasted on chemistry. This uncompromising attitude gave place later to faint encouragement. There are still to be found those whose memory of Prof. Pepper's popular lectures supplies their ideal of a school science course. The first public school to achieve science was Rugby, and Canon Wilson's reminiscences are perhaps the most interesting pages of the whole pamphlet. He was appointed science master by Temple in 1859, and taught at first in the cloakroom of the Town Hall. A small chemical laboratory with six benches was built in 1860, and here he received a visit from Babbage, brought by Temple to look at one of the first spectroscopes. In due time the Rugby science master became headmaster of Clifton, and it was here that the next real advance was made. Prof. Worthington's "Physical Laboratory Practice, First Course," has been "the model on which nearly all the existing schemes of elementary physical work have been based."

In addition to Rugby and Clifton, the scientific histories of Cheltenham and Charterhouse are briefly related, the experiences of these schools being taken as typical of what has happened at other places. Again, to quote the words of the report, "The mere historical statement conveys very little idea of the conditions under which much of the earlier teaching was conducted. In most schools the idea underlying the new work was to impart a modicum of gentlemanly information concerning natural phenomena and such special branches of science as were attracting public attention and receiving some notice in the daily press."

Among the external influences which have helped to establish the position of science, the increasing importance attached to it in university examinations is regarded as the chief factor. The recent changes in the army examinations have led to an increase in the accommodation and the teaching staff. A well-deserved tribute is paid to the influence of Profs. Armstrong and Miall in the direction of reformed methods of teaching.

To turn from past history to present conditions, it may be said briefly that the result of the inquiry is in the main satisfactory. Governing bodies appear to recognise the claims and importance of science in the most practical manner, and in nearly every instance where laboratories are inadequate new ones are being built. No hint of insufficient funds appears to have been given in any of the replies. The financial question is fully dealt with. It is inevitable that science should cost more than any other subject. Apparatus and materials must be supplied and continually renewed. Gas, water, and electricity must be consumed. In addition to masters' salaries, assistants, trained or untrained, must be paid for. In the latter respect there appears to be a deficiency. "A large number of those responsible for school service have not yet realised the value and importance of employing at least one expert attendant."

In a few cases it has been possible to estimate the cost of the science teaching per boy per hour, including everything except masters' salaries, and the average is just under 3*d*. This may be regarded as a reasonable standard in schools where the science buildings form one block in which apparatus and attendance can be shared by different class-rooms. The schools which have put off the building of specially designed laboratories until the eleventh hour are fortunate in being able to make use of experience gained by those who have borne the burden and heat of the day. We are still feeling our way, but we understand much better than we did ten years ago what is indispensable and what is superfluous in a school science building. The methods of meeting the expenses of the science teaching are very various. Some schools charge an extra fee. In others the entire cost is met by the general funds of the school without any extra charge except in cases of culpable negligence. This, no doubt, is the ideal system, and ought to obtain wherever science is compulsory. On the other hand, when there has been no raising of the general fees to meet special expenditure incurred on behalf of a few, it is not unreasonable that those few should be asked to contribute. The important points in this connection appear to be, first, that no boy should be debarred from taking up science on grounds of expense, and, secondly, that no cheapening of the science course should be effected by lowering the salaries of the staff. Economies of this kind have been known, and have been accompanied by a lowering of the standard.

To turn now to the arrangement of classes and the sequence of studies, it seems that dissatisfaction with present circumstances appears to be infrequent. It may be taken, therefore, that the average conditions are not very far wrong. Mr. Latter finds that the average ratio of masters (in all subjects) to boys is 1 to 14·5, that one out of every nine masters is engaged solely in teaching science, and, allowing for help given by mathematical masters and others, the ratio of science masters to boys is about 1 to 70. These are important facts, and should be carefully considered by school authorities who are in doubt as to their curriculum.

One of the questions asked was, "Are science classes arranged in sets according to attainment in science or according to aggregate in all subjects?" Here is a practical problem of great difficulty. It is complicated by the lack of uniformity among preparatory schools and in public school scholarship examinations in their recognition of science. Thus a clever boy coming to a public school with a scholarship but without any training in science may find himself placed with boys who have already been at the school for one or two years and have passed through its elementary scientific course. The plan of rearranging an entire school of 500 according to attainment in science alone is, of course, impracticable, and in schools where the forms are grouped in blocks, subdivision of a block for science purposes can only be possible when the proportion of masters to boys does not fall below the average already stated. In some cases the classification for science is the same as that for mathematics, and this plan is commended to the consideration of preparatory schoolmasters as well as to those who teach elementary physics at public schools.

The sequence of subjects has already been dealt with in another report. Mr. Latter urges the claims of botany and zoology with some force, and publishes in an appendix six different schedules of science work, which will doubtless be valuable and suggestive to teachers. In fact, the report should be read by all public-school governors and teachers, pastors and masters.

THE EGYPTIAN LAND SURVEY.[1]

THIS interesting volume forms a worthy termination to a piece of work of considerable interest and of immediate practical importance, the construction of the great land map of Egypt.

The fertile valley of the Nile has been a densely populated and closely cultivated tract from the earliest dawn of civilisation; so far back as 2000 B.C. methods of boundary delimitation and area computation are recorded as being in use, methods which, with modifications and improvements only at rare intervals, have lasted down to quite recent times. Seeing the intimate connection of the system of land tenure with the daily life of the people, we might be surprised to find that, up to ten years ago, there was in existence no general land map. It is, however, quite possible for a complex and orderly scheme of land-holding to coexist with an entire absence of maps—our own islands could be adduced as an example of this; in fact, it is not in general until required for fiscal purposes, *i.e.* for some form of land taxation, that a complete cadastre, or accurate large-scale map, is demanded.

In Egypt, when the present Survey Department was constituted in 1898, following upon a survey of State lands begun in 1892, it was found that though vast sums had been expended upon spasmodic efforts at map-making, no work of a permanent nature had been done and for all practical purposes most of the money so spent might as profitably have been thrown into the Nile. Thus, for example, during the ten years from 1878 to 1888 an elaborate cadastre of part of five provinces was made, but being based upon no system of triangulation or other accurate fixation of points, and being carried through so that no part of the work was really self-contained and complete, the whole was well-nigh valueless. In this way about 400,000*l.* was spent. If we cared to calculate the sums similarly wasted on previous abortive attempts we could doubtless exhibit a very handsome total, driving home the lesson that in map-making inaccurate and inefficient work spells, not only trouble and delay, but a large, direct waste of public money.

In 1898, however, this waste, so far as Egypt is concerned, came to an end; a standing survey department was established; the idea that the mapping of a region is a temporary business, which can be completed in a definite period and then set aside as finished—a delusion still found lingering in certain quarters—was discarded, and the whole work was started upon sound and permanent lines. The result of this wise procedure is that the administration now possesses a map of the cultivated area, upon a uniform scale of 1/2500, a possession of enormous value to the agricultural development of the country, without which it would be almost impossible equitably to collect the revenue due under the great water-supply schemes now in existence and likely to be undertaken in the future.

In general, we may fairly say that the account of a cadastral survey would not be of any appreciable interest except to the professional surveyor. In the case of Egypt, however, this limitation by no means holds, and many portions of the present volume, especially the descriptions of the old land measures and the methods of arriving at the areas of holdings, will be found attractive to the general reader. To the surveyor this graphic summary of modern map-making in the land generally accounted the birth-place of his science cannot fail to prove enthralling. There is possibly no country where exactly the same conditions are to be found as those obtaining in the Nile valley, but there is much in this volume applicable to the survey of any closely populated, flat district. Anyone who has the planning of such work, or who is in any way concerned with its execution, owes a debt of gratitude to Capt. Lyons and his staff for the trouble they have taken to place on record the fruits of their accumulated experience.

E. H. H.

[1] "The Cadastral Survey of Egypt, 1892–1907." By Capt. H. G. Lyons. Pp. viii+421. (Cairo: National Printing Dept., 1908.) Price 400 milliemes.

NOTES.

DR. A. BREINL, who has worked in connection with the Liverpool School of Tropical Medicine for the past five years, has been appointed director of the newly founded School of Tropical Medicine in Western Australia.

PROF. WILHELM VALENTINER has resigned the directorship of the Astronomical Institute of the grand ducal Observatory of Heidelberg. This institution is now merged with the Astrophysical Institute, under the general direction of Prof. Max Wolf.

LIEUT.-COLONEL ALLAN CUNNINGHAM, R.E., announces the verification of a Mersenne's number (the lowest as yet unverified) to be *composite*, viz.

$$2^{71}-1=228479.10334355636337793.$$

The nature of the large factor has not been determined.

THE death is announced in *Science* of Prof. S. W. Johnson, emeritus professor of agricultural chemistry in Yale University, where he held a professorship for fifty-three years. He had been a member of the National Academy of Sciences since 1866, had served as a past-president of the American Chemical Society, and was eminent for his contributions to agricultural chemistry.

THE Tuberculosis Exhibition which was held at the Art Gallery, Whitechapel, with great success (see NATURE, July 8, p. 48)—more than 70,000 people visiting it—has been moved to the Imperial International Exhibition (White City), Shepherd's Bush, and was opened there on Friday, August 6, by Lord Balfour of Burleigh. We understand that the organisers have already enough invitations to take the exhibition to the various districts of London and the provincial cities to keep it occupied for quite a year.

THE Cracow Academy of Sciences has awarded the Nicolas Copernic prize, amounting to 1000 crowns, to M. Jean Krassowski, of Cracow, for his treatment of the question, "A l'aide de la méthode de M. A. Schuster, examiner la question si les périodes des variations des latitudes, indiquées par MM. Chandler, Kimura, &c., sont réelles ou non." The Constantin Simon prize, of 900 crowns, for a work in the Polish language on mathematics or physics, has been adjudicated to M. Stanislas Zaremba, for his book "Exposé des premiers Principes de la Théorie des Nombres entiers."

THE British Museum (Natural History) has obtained from Mr. C. H. Sternberg a series of remains of the large dinosaurian Trachodon, from the Laramie Cretaceous formation of Wyoming, of which an account was published in our last number. They have just been placed on exhibition in the gallery of fossil reptiles in a case near the remains of Iguanodon, with which it is interesting to compare them. Besides portions of skulls, jaws, teeth, and limb-bones, there are also fragments of the remarkable skin-impressions which have been described by Prof. Osborn.

It may be remembered that the late Mr. Harry Barnato left by will the sum of 250,000*l.* for the purpose of founding some charity in the nature of a hospital, or kindred institution, in commemoration of his brother, Mr. Barney Barnato, and his nephew, Mr. Woolf Joel, both of whom died before him. After full and careful consideration of the merits of the many schemes put before them for the disposal of the money, the trustees have now decided upon applying it to the building and endowment of an institution for the reception of cancer patients. With the view of increasing the potentialities of the bequest, the new institution will be administered, except as regards its finance, in connection with the Middlesex Hospital, and the trustees have procured a suitable site in Nassau Street, adjoining this hospital's special cancer wards. The trustees, with Prince Francis of Teck, Lord Cheylesmore, Sir John Purcell, K.C.B., and Mr. Felix Davis, will form the committee which has been entrusted with the task of putting in train and carrying out this project.

The Rev. F. St. John Thackeray, vicar of Mapledurham, gives in the *Spectator* of April 7 a few interesting stanzas from Tennyson's works to show the poet's appreciation of scientific truth. Tennyson and Darwin were born in the same year, and they did not meet until 1868, but many years previously the poet wrote the words, "So careful of the type she seems, So careless of the single life." Here, it is held, there is a suggestion of the principle of natural selection; and in other poems written before Darwin's work appeared there are anticipatory expressions upon the development of living organisms from simple to more complex forms "Till at last arose the man." Mr. Thackeray points out that Lord Tennyson says in his notes in the Eversley edition, "My father brought 'Evolution' into poetry. Ever since his Cambridge days he believed in it." It must not be forgotten, however, that the idea of evolution, as opposed to the doctrine of special creation, has been under discussion for quite twenty-four centuries. Greek philosophers, with their natural curiosity, considered the problem in detail; and six hundred years before the commencement of our era the idea of the marine origin of life was put forward by Thales. But recognition of the process of evolution is quite a different matter from the discovery of the cause. So far as we read Tennyson's lines we find in them no clear anticipation of Darwin's views as to variation and natural selection being the prime factors of organic evolution. Mr. Thackeray's letter shows that Tennyson was familiar with the general principle of development, but it provides little evidence that he anticipated the principle formulated by Darwin.

An interesting piece of antiquarian work has just been completed by the Essex Field Club by means of a grant from the Essex County Council. It appears that in the time of Charles I. so much of this country had become "afforested" that the inhabitants of those districts subject to forest law found the conditions so burdensome that relief was applied for and sanctioned by the King, who authorised the restoration of the boundaries of all the forests to what they had been in the twentieth year of the reign of James I. This Act was passed in 1640, and in compliance therewith a court of inquiry was held at Stratford in 1641 in order to fix the boundaries of the Waltham Forest, an area comprising the forests known subsequently as Hainault and Epping. The Perambulation resulting from this "inquisition" set forth very explicitly the limits accepted by the commissioners. In defining these boundaries, natural features and the main (Roman) Colchester road were adopted for the western, northern, and southern limits respectively, but on the eastern side, where no well-defined natural or artificial features existed, certain stones, named and dated, were put up. In 1894 these long-forgotten boundary stones were re-discovered and identified by Prof. Meldola, who published a paper about them in the *Essex Naturalist* in 1895. The stones had been badly treated in later times, as several had been uprooted, and were found in ditches near their original sites. Last year the matter was formally brought under the notice of the Essex County Council, which body authorised the re-erection of the stones by the club at a cost not exceeding 100*l.* The work has now been completed, and a meeting of the club and of representatives of the County Council went over the district on July 31. Out of eight stones seven have been identified with certainty, and the site of the eighth has also been marked. The stones have been set in solid concrete beds, and an appropriately inscribed tablet let into the foundation of each. The Essex Field Club is to be congratulated in having rescued from complete oblivion this chapter in the history of a district the greater part of which is rapidly becoming covered with the bricks and mortar of the modern builder. The forest in 1641 began "at the Bridge of Stratford called the Bow."

We learn from the *Revue scientifique* that an International Congress on Radiology is to be held in Brussels in 1910.

It is stated that the Museum of Natural and Physical Science at Barcelona was destroyed during the riots in that city on July 28.

We have received the first number of a journal published at Skagen under the title of *Fiskerhøiskolens Beretning*, and devoted to the schools which have recently been established in various parts of the country for instruction during the winter in all matters connected with fisheries.

Imitation in monkeys forms the subject of an article by Mr. M. E. Haggerty in the August number of the *Century Magazine*. The monkeys experimented upon exhibited five phases of imitative behaviour, summarised as (1) simple arrest of attention; (2) following; (3) reaction to locality; (4) reaction to an object; and (5) exact repetition in detail of an observed action. By No. 1 is meant the watching by one monkey of the action of others, or, in other words, "looking," while No. 2, or "following," indicates a higher grade of mental action, and so on through the series.

According to the report for 1907–8, the collections in the Transvaal Museum are increasing so rapidly that the accommodation afforded by the present building is altogether inadequate, this being notably the case with the mounted specimens of large mammals, of which a considerable number was added during the year under review. In the study collections the congestion is even worse, and as these include a great number of rare, and in certain instances unique, specimens, the urgent need of extension is evident.

The Borough of Maidstone has issued an excellent and well-illustrated guide to the local museum and art-gallery, with a history of Chillington Manor House, in which the natural-history collections are preserved. Special attention is devoted in the museum to the local fauna, both recent and extinct, notices of various groups of which are given by local naturalists and geologists. The illustrations include photographs of the type-specimen of *Chelone benstedi*, a local Chalk chelonian now in the British Museum, and of part of the cranium of *Odontopteryx toliapica* from the London Clay of Sheppey, preserved in the Maidstone collection, the only known specimen of that remarkable bird except the type.

The all-importance of selection to breeders and, in perhaps a somewhat smaller degree, to plant-growers (where hybridisation comes more largely into play), is universally admitted, but difficulties arise in practice when, as is generally the case, it is desired to improve more than a single characteristic of the animal or plant under experiment. As an aid in overcoming these difficulties, Messrs. Pearl and Surface, in the July number of the *American Naturalist*, suggest the adoption of a system of "selection index numbers," the idea of which is to combine in a single numerical expression the values of a series of important characteristics, all of which a breeder may be desirous of improving simultaneously. The analytical expression of this idea is discussed in the article, with illustrations drawn from maize and poultry raising, and it is thus shown that the index numbers form a valuable adjunct to the score-card in judging stock.

Two notes on the feathers of kalij pheasants (Gennæus) are communicated by Prof. A. Ghigi to vol. xii. of the *Rendiconto* of the Royal Academy of Sciences of the Institute of Bologna, the first of these relating to a case of mutation in *Gennaeus swinhoei*, while the second is devoted to the development of the secondary sexual characters in *G. argentatus* and certain other birds. In the case of Swinhoe's kalij, certain marked variations from the normal type made their appearance in the feathers of a bird born in captivity, and as these cannot be attributed to hybridism, they are regarded as an instance of true mutation. In the second note the variations from the normal type of colouring and pattern produced in the feathers of the silver-pheasant and its hybrids by accelerated and retarded development are described and figured, and their bearing on the production of secondary sexual characters discussed.

From among a number of articles on natural history and geological subjects forming the second part of the fourth volume of *Aus der Natur*, we select for notice one by Prof. O. Jaekel on a new "find" of Devonian vertebrates between Cassel and Marburg, which has already yielded some very interesting remains, and is likely to produce many more in the near future. From this deposit, which is especially rich in armoured "placoderms," remains of no fewer than sixty different species of fish and fish-like vertebrates have been obtained, mostly in a wonderfully fine state of preservation, five or six of these belonging to forms previously known only by small portions of the armour. The author gives a restoration of the external form of Coccosteus, based on the new material, and differing very widely from the one in Dr. Smith Woodward's "Catalogue of Fossil Fishes." As now restored, the creature has four paired fins, a low but long dorsal fin, with a gap above the interval between the paired fins, and a somewhat similar ventral fin, continued along part of the long, whip-like tail, this long, slender tail being hypothetically added from evidence supplied by Dr. Traquair. In conclusion, Dr. Jaekel remarks that the most noteworthy feature in the new deposit is the occurrence of the remains of a number of forms of placoderms in one spot, whereas in other places only a few such are found in association. It indicates, in the author's opinion, a kind of "explosive development."

We have often been surprised at the curiously unscientific, but unfortunately very common, use of the term "ovum" by medical writers to designate a human embryo which has developed very far beyond the unicellular condition to which alone the term ought to be applied. We believe that a certain section of the medical profession is apt to question the importance of preliminary scientific education, but the short time spent by the medical student over his elementary biology would not be wasted even if it did no more than give him some idea of accurate terminology. The immediate occasion for these remarks is afforded by a paper by Maximilian Herzog in a recent number of the *American Journal of Anatomy* (vol. ix., No. 3), in which the author describes a very young human embryo, closely resembling that known as "Peters' ovum." Our information as to the early stages in the development of man is, from the nature of the case, so extremely meagre that any fresh light on the subject will be welcomed by embryologists. The embryo in question is regarded as representing the earliest stage of normal human development hitherto known, perhaps from one to two weeks after fertilisation.

The Bulletin of the Liverpool School of Tropical Medicine, of which the first number has just been issued, contains correspondence relating to malaria and mosquito reduction at Ismailia and Helouan. At Ismailia the expense of the anti-malaria measures has averaged 18,000 francs per annum. In 1903 malaria cost the Suez Canal Company 38,200 francs; in 1908 this item dropped to 16,800 francs.

We have received the second number of the *Eugenics Review* (i., No. 2, July), published quarterly by the Eugenics Education Society. The contents include editorial notes and reviews of books, and articles by Sir Francis Galton, Mr. John Russell, Miss A. H. P. Kirby, and others. The review cannot fail to be both interesting and instructive to all those who have the welfare of the race at heart.

Nicolle and Adil-Bey in 1902 reported that the infective particles of cattle-plague virus would pass through the Chamberland porcelain filter "F," and their results were confirmed by Yersin. E. H. Ruediger states (*Philippine Journal of Science*, iv., 1909, No. 1, p. 37) that he was not able to verify these results, and in a second series of experiments, using four different filter candles, confirms his previous work, no filter candle having been found to allow the cattle-plague virus to pass through.

It is a usual custom in pharmacological work to state the dosage of drugs as so much per kilogram of body-weight of animal or man, the subject of experiment or treatment. Prof. Benjamin Moore points out in the *Bio-chemical Journal* (iv., Nos. 5, 6, and 7, July) that this method of stating dosage is inaccurate, the dose of a drug for two individuals of different size, apart from peculiar idiosyncrasies, being proportional, not to their weights, but to their *body surfaces*, in other words, to the two-thirds powers of their weights. Thus an adult of 150 lb. weight cannot be given fifteen times the dose for an infant of 10 lb., but much more nearly a dose only six times as much. It may be that it is this principle which limits the value of some drugs. Thus atoxyl will cure trypanosome infections in mice and rats, but in cattle, horses, and man it is much less effectual. A rat of 140 grams weight can be safely given 0·02 gram of atoxyl. If the dose were proportionate to the body-weight, a man ought to be able to tolerate 10 grams, but, as a matter of fact, about 1 gram is the maximum safe dose, which is in close correspondence to the two-thirds powers of the ratio of weights (1/500).

The progress of forestry in the University of Cambridge is briefly summarised in the second annual report of the forestry committee issued recently. It is announced that Mr. H. J. Elwes has made an offer to provide 1000*l.* towards the erection of a building to serve as a museum and a laboratory, where special attention would be devoted to the study of home-grown timbers. The reader in forestry, Dr. A. Henry, has taken steps to test the suitability of the western larch, *Larix occidentalis*, a native of North-west America, for planting as a forest tree in the British Isles and Europe; the canker disease of the common larch is being made the subject of systematic experimental investigation by Mr. E. R. Burdon.

Horticultural and general botanical articles form one of the leading features of the *Country Home*. The August number contains a contribution by Mr. G. C. Nuttall on plant aspects and plant names, in which, by means of a few examples and clever illustrations, the author shows the reasonableness of popular floral names; it is suggested that the subject is a suitable one for investigating during a holiday. A practical article on tomato culture is provided by Mr. F. W. G. Blyth, where again the excellent reproductions from photographs are conspicuous, and Mr. W. L. Térasse gives advice on the intensive cultivation of strawberries. The monthly calendar and special instructions for the month's work in garden and greenhouse add to the value of the publication.

Owing to loss of the paper for printing, the early numbers of the *Philippine Journal of Science* for the current year have been delayed. The first botanical number opens with a contribution, by Dr. E. B. Copeland, on the ferns of the Malay-Asiatic region. Largely in connection with the identification of specimens from the Philippines, Dr. Copeland has acquired a knowledge of the ferns of the Malay Archipelago, which has induced him to present a fern flora of this region. This first part refers to ten families, from the Ophioglossaceæ and Marattiaceæ to the Cyatheaceæ. Keys and short diagnoses are given for each family, genus, and species. The most striking innovation is the reduction of the genera Alsophila and Hemitelia to Cyathea. Cyathea thus becomes a genus of about 400 species, of which one-fourth occur in the region under consideration; Dicksonia and Balantium are retained. Under Marattiaceæ a fifth genus is provided by the author's monotypic genus Macroglossum, and Kaulfussia is lost under the synonym Christensenia.

Mr. W. J. Bean contributes to the current number of the *Kew Bulletin* (No. 6) a note regarding the effect of the past winter on trees and shrubs in Kew Gardens, with special reference to plants of recent introduction. It is pointed out that alternations between cold and unseasonable warmth were more potent than the actual intensity or duration of cold, and, incidentally, it is noted that plants growing in low, damp situations were killed, while specimens situated on drier ground survived. A considerable number of recently introduced Chinese plants, including *Davidia involucrata* and *Ailanthus Vilmorinii*, came successfully through the ordeal, and the author gives a list of rhododendrons from north India that may be considered hardy. Bamboos suffered greatly, with the exception of *Arundinaria nitida* and *A. fastuosa*. Other shrubs that proved hardy are *Erica stricta, Cistus laurifolius, Genista virgata,* and *Vaccinium padifolium.*

The Bulletin of the College of Agriculture, Tokyo Imperial University, Japan, vol. viii., 1909, No. 2, contains a paper by S. Kusano on the cytology of *Synchytrium puerariae* and *S. decipiens*, parasitic fungi belonging to the phycomycetes, with bibliography, and illustrated with several excellent plates; a description of a new species of moth belonging to the genus Latirostrum, by T. Miyake; and a revision of Japanese Arctianæ, insects injurious to farm crops and fruit and forest trees, by the same author, with descriptions of some new species.

A series of Bulletins, Nos. 141–4, issued from the Colorado Agricultural College, deal with various phases of market-garden work. No. 142 discusses general problems such as tillage, manuring, &c., in the light of local experience, and lays stress on the conditions which must be fulfilled in Colorado if success is to be attained. Among them is the necessity for "shade" crops, *i.e.* for crops grown with the view of shading the ground from the sun's heat, or, in winter, of reducing the loss of heat by radiation, and thus of keeping the soil temperature more uniform. Another effect of a "shade" crop in summer is to diminish loss of water by evaporation. The other bulletins deal with special crops—grapes, cabbages, and celery.

Some of the most important agricultural problems of Cape Colony are associated with water supply, and that this fact is recognised is abundantly proved by the number of articles devoted to it in the Agricultural Journal of the Colony. The Karoo is a dry region, and at the same time possesses a very rich soil; this combination is not unusual, and can be paralleled in the dry belt of British Columbia, of parts of the United States, and elsewhere. Its productiveness is limited by the water supply, and recourse is had to various methods for conserving and increasing the amount of moisture in the soil. Special methods of cultivation are found to diminish loss of water by evaporation, and dams are built to store rain-water, which can then be used for irrigation. Attention is also being directed to the effect of forests on water supply.

The *Bulletin de la Société d'Encouragement pour l'Industrie nationale* (vol. iii., No. 3) recently published a long and interesting article by M. Hitier on agriculture in Russia. The various regions are described, and a good account is given of the black soils, the steppes, and other well-marked types of soil. Analyses are quoted showing the presence in black soils of 0·5 per cent. of nitrogen, 7 per cent. of organic matter, and distinct quantities of carbonates, along with sufficient potash and phosphates; the area covered by these wonderfully fertile soils is considerably larger than that of France. The natural conditions are eminently favourable for agricultural development, but the economic conditions, especially the collective ownership of land and the power of the Mir, are regarded as great obstacles, and the author does not consider any advance possible until these artificial hindrances are removed.

The movements of the deeper waters of the Skagerack form the subject of an interesting paper by Dr. O. Pettersson which is published as No. 47 of the *Publications* *de Circonstance* of the Conseil Permanent International pour l'Exploration de la Mer. Dr. Pettersson finds that in the underlying deep waters there is a tidal oscillation which can have daily, monthly and annual periods. These oscillations produce variations in the temperature and salinity of the sea at certain depths, and their investigation becomes of great commercial importance owing to their action in determining the coming and the migration of the herring shoals. The great annual oscillation of the coastal water in the Norwegian sea shows amplitudes of more than 100 m., and the corresponding expansion of the coastal waters of the surface to the westward, in the summer months, was found by Hjort and Nansen to cover an area more than 100 miles broad.

THE fourth report on earthquakes in Jamaica, by Mr. Maxwell Hall, contains a catalogue of shocks recorded since the commencement of the weather service in 1880, and some interesting particulars regarding the fracture of cables by the earthquake of January 14, 1907. The cable to Colon was broken four miles south of Bull Bay, and to the south of the break the cable was so deeply buried in mud that it parted in the attempt to raise it. A more extensive break took place at twenty miles further south, where the cable had been dragged from west to east, and the fractured ends were fully a mile apart, and further south the cable was again buried in mud and had to be abandoned. Captain Morrell, of the repairing ship *Henry Holmes*, reports that the two ends of the cable fitted together perfectly, the cable was in perfect condition, there were no signs of erosion, and the wires were broken clean as by a tremendous strain, which he considers to have been produced by a landslide from the direction of the shallow water to the deeper. Mr. Hall points out that the soundings indicate a gradient of 740 fathoms in five miles, or about 1 in 6, on the average, from the California bank, but where the great break occurred the sea-bed is apparently level or nearly so; consequently, he considers, the dragging of the cable for a mile or so to the east, and the parting of the ends to the same extent, could only have been produced by a great chasm opening in the bed of the sea to the east of the great break.

THE first part of the "Bergens Museums Aarbog" for the current year records an important discovery at Jaederen of a house of the Middle Iron age. It consisted of a single oblong room, the roof resting on beams set upright, distinct marks of which were found in the clay floor, and the interior being filled with remains of the birch-bark roofing. The fireplace was a paved depression in the centre, but fires had been made also in other parts of the apartment. The antiquities discovered were, on the whole, disappointing, consisting mainly of earthenware pots and grindstones, of which illustrations are given in the report. This discovery is notable, because this is the first house of this type which has been found in Norway; but in Sweden they are well known in Gotland, Oland, and Uppland, and they seem to have been noticed in Finland.

PROF. JUNE DOWNEY contributes an article on muscle reading to the July number of the *Psychological Review*. By muscle reading is meant that well-known communication between one person, the guide, and another, the subject, by means of involuntary movements of the guide, when his attention is riveted in a given direction. The writer contends that concentration of the guide's attention not only induces free involuntary movements, but also leads to more complex forms of "automatic" activity. For instance, although the guide's attention may be momentarily distracted, his involuntary movements persist unaltered. Or, again, despite his concentrated attention in a given direction, his movements may have reference to a preceding test instead of to the present one. Unfortunately, the scant experimental data given in the present paper and her defects of experimental method make it difficult to accept with confidence any of the writer's interesting conclusions.

DURING a stay at the Sonnblick Observatory (3106 metres) in July, 1908, Dr. A. Wagner, of the Austrian Meteorological Office, made some interesting observations on cloud elements, the results of which are published in the *Sitzungsberichte* of the Vienna Academy for December last. The author deals with the water contents, both in the gaseous form, as shown by the hair hygrometer, and in its fluid form in drops or ice-crystals, also with the size of the drops. During thick fog the humidity was generally more than 100 per cent., and only sank below that amount when the sun became visible through the fog. The mean of the measurements of the fluid contents of the clouds was about 2 grams per cubic metre; the greatest value was 4·84 grams, and the smallest 0·12 gram. The total of the fluid and gaseous contents varied between 9·98 grams and 4·17 grams per cubic metre; the fluid contents were always less than the gaseous. Visibility was found to be inversely proportional to the fluid contents; its dependence on the size of the drops could not be determined, owing to the few measurements made of the latter. The mean diameter of the drops, determined by the optical method, was 33 μ, but only eighteen such observations were made, on three days.

THE July number of the Journal of the Röntgen Society contains a paper by Dr. G. H. Rodman on the historical collection of sixty-three Röntgen-ray tubes which has been got together by the society, and is now in the possession of the authorities of the Victoria and Albert Museum at South Kensington, and will in a short time be installed in two show-cases in the museum. The paper is well illustrated by photographs of the tubes, and will be of great use to those who are unable to pay a visit to the museum to inspect the tubes themselves.

A VALUABLE report by Dr. H. Happel on the present position of our knowledge of the properties of the monatomic gases is to be found in the *Physikalische Zeitschrift* for July 15. The author, after giving an account of the theoretical advances made by Sutherland and by Reinganum on the assumption of hard spherical molecules, refers to the older work of Maxwell and Boltzmann, based on the molecules repelling each other according to the inverse fifth power of their distance apart. He shows that the experimental work done during recent years on the viscosity, heat conduction, and diffusion of the simpler gases does not provide more than general support for any of these theories, and that there is great need of further investigation of these properties over very wide limits of temperature. The theory of the gas-liquid state and the theory of binary mixtures as stated by van der Waals have, in Dr. Happel's opinion, proved valuable weapons in the hands of those who, like Ramsay, Travers, Dewar, and Kamerlingh-Onnes, have been engaged in investigating the thermal properties of the monatomic gases and of mixtures of them.

A PAPER on refrigerating installations, with special reference to the arrangements necessary when narrow limits of temperature are required, was read by Mr. Robert Balfour at a meeting of the Institute of Marine

Engineers held at the White City on July 24. The author's references to the difficulties of dealing with beef are particularly interesting. Beef is much more difficult to keep in condition during a voyage than mutton. The temperature must never be low enough to produce solidification; such would cause the substance of the meat to burst, and on thawing the meat would have a flabby appearance, which would depreciate its value, although perfectly wholesome as food. The temperature should be maintained as nearly as possible at 29·5° F. The animals must not be excited immediately preceding slaughter, or have any sprained joints which would produce decomposition of the joint oil. The atmospheric conditions must not be thundery or sultry at the time of slaughter, or the air heavily charged with moisture, and scrupulous cleanliness must be observed throughout. Indeed, the ideal conditions for the slaughter-house should be those of the operating theatre of a modern hospital. An article in *Engineering* for July 30 states that there has not hitherto been much success in the bringing of chilled beef from Australia, but an experiment is now being made with a large consignment, and will be watched with interest.

In the recently issued report of the proceedings of the International Committee of Weights and Measures at its meeting held in March last, the following points are of interest. Investigations made at the bureau of the committee at Sèvres have shown that when water at temperatures between 6° C. and 8° C. is saturated with air, the density of the water is diminished by about three parts in a million. Vols. xiv. and xv. of the *Travaux et Mémoires* of the committee, which are expected to be published shortly, will include the researches of M. Chappuis on the above subject, and also an account of the experiments conducted by MM. Benoît, Fabry and Perot with respect to the length of the metre in terms of wave-lengths of light. The former volume will also contain three important memoirs on the mass of a cubic decimetre of water. The committee announces the adhesion of Chili and Uruguay to the metric convention, and expresses much satisfaction with the proposal of our Colonial Office to distribute copies of the convention to all the British colonies and dependencies. The report includes two appendices by M. Guillaume. The first is a supplement to his paper entitled "Récents Progrès du Système métrique," which was presented to the general conference of weights and measures in 1907, and the second gives an account of the present state of the question of standard end-measures of length. It would appear from the latter paper that Airy's method for determining the lengths of end-bars, which had almost fallen into desuetude, has recently been employed at the International Bureau with considerable success.

The issue of the *Chemist and Druggist* for July 31 celebrates fittingly the attainment of our contemporary's jubilee. The occasion of the annual summer issue of the magazine has been taken to publish a history of the growth of the periodical from its modest beginning in 1859 to the important technical journal it has since become. The contents of this jubilee issue remind us that the *Chemist and Druggist* has for many years given prominence to the scientific aspects of pharmacology, and has insisted consistently upon the value of a knowledge of pure science if scientific principles are to be followed successfully in technical processes. The present issue contains, in addition, an exhaustive account of the proceedings at the annual meeting of the British Pharmaceutical Conference, held at Newcastle-on-Tyne towards the end of last month.

A list of the lectures arranged for the session 1909–10 in connection with the extension section of the Manchester Microscopical Society has reached us. The purpose of this section is to bring scientific knowledge, in a popular form, before societies unable to pay large fees to professional lecturers. The lectures are given gratuitously by members of the society, and all fees paid for lectures are devoted to the working expenses of the section. In addition to lectures, the honorary secretary is willing to arrange practical demonstrations in microscopy, microscopical exhibitions, and the mounting of microscopic objects, in connection with the work of natural history societies in the neighbourhood of Manchester. It is noteworthy that there are about sixty lectures from which to choose. The honorary secretary is Mr. R. Howarth, 90 George Street, Cheetham Hill, Manchester.

OUR ASTRONOMICAL COLUMN.

Observations of Saturn's Rings.—It will be remembered that on the occasion of the disappearance of Saturn's rings in 1907, Prof. Barnard, and other observers, found that even when the rings were at minimum visibility there still remained bright condensations on either side of the planet. These, Prof. Barnard suggested, were possibly due to the sunlight sifting through and being reflected from the particles comprising the crape ring.

Observations made during 1908 tend to confirm this hypothesis, for, when seen very obliquely, the crape ring appeared much brighter than when seen at such times that the rings are more open, thus showing that the particles are probably but sparsely disposed, and would permit of such transmission and reflection of sunlight as was suggested. The relative apparent brightnesses of the inner and outer bright rings as seen at different epochs also change, for during 1908, when the foreshortening of the rings was great, the outer ring appeared to be the brighter. Prof. Barnard suggests that if we could look normally at the surface of the rings the outer one would be relatively dark, and the crape ring, perhaps, invisible. Although careful search was made for it, Prof. Barnard was unable to detect any trace of the outer dark ring discovered at Mount Revard, and subsequently observed at Geneva and Greenwich (Monthly Notices [R.A.S.], vol. lxix., No. 8, p. 621).

The Relative Atmospheric Efficiency of Telescopes.—In a letter to No. 411 of the *Observatory* Mr. R. T. A. Innes directs attention to the subject of the relative efficiency of telescopes of different apertures as compared with the theoretical efficiencies. By tabulating the results obtained by Burnham, with various apertures, he shows that if the efficiency of the 36-inch Lick refractor be taken as 1·0, that of the 6-inch refractor used by Burnham is, relatively, 2·5, the efficiency per inch of aperture apparently decreasing regularly as the aperture increases.

This phenomenon is attributed by Mr. Innes to atmospheric interference; with a large instrument it is more difficult to find a night with perfect definition, and it is only on such nights that close doubles, at the limit of the observer's vision and the telescope's power, can be observed.

The Motion of the Pole.—No. 4344 of the *Astronomische Nachrichten* contains a paper by Mr. H. Kimura discussing the polar motion and the z component during the period 1890·0–1908·5. The investigation of the fourteen-months' period shows that it changed rather quickly, being 436 days in 1893, 442 days (maximum) in 1897, and 427 days in 1907. No such abrupt change of amplitude accompanied this change of period.

The new discussion is opposed to the previous theory that the annual period varies quickly while the fourteen-months' period remains nearly constant, the opposite appearing to be the case; but, as Mr. Kimura points out, the problem is a complicated one, in which many variables are inherent, and will have to wait for further observations and study before any definite conclusions are arrived at. Special attention must be given to the effect of latitude, and it may be found that the slow variation of the z component, especially in phase, is not unconnected with the sixty, or seventy-five, year period of the annual term which was announced by Dr. Chandler.

REPORTS OF OBSERVATORIES.—Mr. Hough's report of the work done at the Cape Observatory during the year 1908 cannot be summarised effectively in a brief note, but one or two points may be especially recorded. The Victoria telescope was in use on 165 nights to secure 601 stellar spectra for line-of-sight determinations; the solar parallax programme having been completed in May, the spectrograph was dismounted, repaired, and adjusted, and is now employed in the determination of the radial velocities of 365 stars between declination 30° N. and the south pole. The value obtained for the parallax was $8{\cdot}800'' \pm 0{\cdot}006''$. The astrographic telescope was employed in taking proper-motion and parallax plates of some of Prof. Kapteyn's "selected areas."

In the report of the Paris Observatory for 1908 M. Baillaud outlines the re-organised programme of the observatory work. Among other things, we note that the small equatorial *coudé* is to be employed, by M. Hamy, for the study of sun-spot spectra.

SOLAR RESEARCH.—In the August number of the *Observatory* Mr. A. A. Buss discusses, at some length, the possible purport of the results obtained in recent solar research, dealing principally with appearance of the D_3 line of helium. In concluding, he states that he has, on a number of occasions in recent years, seen immense "dark" hydrogen clouds projected on the dark background of the sun's surroundings; this phenomenon he attributes to the projection of the clouds against the slight luminosity of the sun's hydrogen corona.

A BRILLIANT METEOR.—Observing at Marseilles on June 26, M. Borrelly saw a splendid meteor, which appeared at 14h. 0m. 56s. (Marseilles M.T.), and illuminated the whole of the sky for some three seconds. The light was extraordinary, and the meteor travelled from Pegasus to the Dolphin, above ϵ Pegasi, in a N.E. direction (*Astronomische Nachrichten*, No. 4339).

PHYSIOLOGY AT THE BRITISH MEDICAL ASSOCIATION.

THE chief points of general scientific interest in the proceedings of the British Medical Association at Belfast are to be found in the communications read in the sections of anatomy and physiology, bacteriology and pathology, on July 28–30. The following account is practically limited to a brief summary of Prof. Sherrington's presidential address to the section of anatomy and physiology, entitled "The Deep Afferents—their Distribution and Function."

In contrast with our considerable knowledge of the surface afferents, our knowledge of the deep afferents is relatively slight. The deep afferent system may be subdivided into a visceral and a muscular portion, using the latter term in a somewhat wide sense.

From one point of view the visceral portion may be regarded as superficial with reference to the lining membrane of the alimentary canal and respiratory passages, but practically this fact may be neglected. The consciousness of the body is normally almost entirely confined to the external surface. When we take food, it normally disappears from our ken after its passage through the fauces, and consequently if we were guided only by our own consciousness we might doubt the likelihood of the existence of visceral afferents associated with sensation. Yet numerous examples of dim visceral sensations, especially gastric ones, might be adduced. For example, after drinking hot fluids a characteristic gastric sensation is produced. Under pathological conditions numerous visceral sensations may be obtained. The explanation and localisation of the latter form a fruitful field, in the investigation of which physiologists, anatomists, and clinicians might usefully combine. Further, it has long been recognised that afferent nerves are not necessarily associated with sensation. Numerous examples of this fact will be given in the course of this account.

The mouth and nasal cavities form an intermediate field between the external surface of the body supplied by the superficial afferents, and the remainder of the alimentary canal and the respiratory passages supplied by the deep visceral afferents. In this region the nature of the effective stimuli alters. Whereas mechanical and physical stimuli are specially effective when applied to the external surface, chemical stimuli, both gustatory and olfactory, become specially effective in the intermediate zone both in the direction of yielding sensations and of inducing reflexes.

Prof. Sherrington next passed from the consideration of this intermediate field to that of the deep visceral afferents proper. Formerly, gastric and intestinal movements and digestion were believed to be controlled by mechanical and chemical stimuli affecting afferent visceral nerves. More recently a deeper insight into the mechanism controlling gastric and intestinal movements and digestion has revealed a number of difficulties which militate against the acceptance of the older views. For example, the intestinal movements, both the simple pendular and the more powerful and less frequent peristaltic movements, take place in an isolated loop of intestine after section of all the nerves passing to the loop. In this case there cannot only be no conscious reaction, but even no true reflex act. Further, the removal of the abdominal sympathetic in the dog does not cause any obvious alteration in digestion or intestinal movements. Under such conditions the regulation of movements and digestion is controlled by the intrinsic nerve mechanism of the alimentary canal, namely, Auerbach's and Meissner's plexuses.

A very interesting phase of recent physiology is the suggestion by Bayliss and Starling of a mode of chemical regulation other than that through the nervous system. They have extracted from certain organs substances called hormones, which are capable of exciting the activity of correlated organs. One of the best known of these is secretin. Bayliss and Starling showed that secretin is effective after severance of nervous connections, and have thus rendered doubtful Pawlow's view that the co-adjustment of organs is mainly nervous in origin. Other examples of hormones are a substance extracted from the cardiac end of the stomach, which acts on the pyloric end, and carbon dioxide, which may be regarded as the hormone affecting the bulbar respiratory centre.

Prof. Sherrington next passed to a subject of great theoretical and practical interest, namely, visceral pain. This subject has long formed a field of controversy, largely on account of the obvious difficulties in the way of its investigation. The observations which have been made on visceral pain are best dealt with in historical sequence.

Haller, one of the earliest investigators of this subject, distinguished parts which feel from those which do not feel. He included the viscera, tendons, and blood-vessels amongst the non-feeling parts. His results were largely obtained by investigation of the human subject, using interrogation of the patient as the test. He also experimented on animals. The methods of stimulation used in the latter cases were extreme in character, and consequently throw no light on the results which might be obtained by the use of more normal and adequate stimuli. Johannes Müller held views diametrically opposed to those of Haller. He maintained that the viscera are sensitive.

Amongst later observers, Head almost takes visceral pain for granted, and, following Ross, develops the idea of "referred pain." Lennander's papers are the most recent on this subject. As the result of experiments on man, he comes to the conclusion that the abdominal and thoracic viscera do not feel. The parietal peritoneum is also insensitive, but the subserous layer of the peritoneum is highly sensitive even under normal conditions. When slightly inflamed the subserous layer becomes hypersensitive.

Meltzer's results are opposed to those of Lennander. From a large series of experiments, chiefly on the dog, but also on man, he comes to the conclusion that stimulation of the liver and intestines elicits reactions that indicate pain. After a short period of exposure to the air, the viscera appear to become hypersensitive, slight stimuli producing well-marked reactions.

On considering the results obtained by these observers, it is difficult to imagine that the powerful vaso-motor reactions obtainable by stimulation of the abdominal sympathetic are not associated with sensation. The distinct reflex contraction of the abdominal muscles resulting from stimulation of the abdominal sympathetic is another reaction which it is difficult to believe is not associated with sensation. The latter phenomenon has a two-fold interest. In the first place, it is the basis of a well-known clinical symptom, the rigid belly wall, and, secondly, it represents a form of tonic contraction not directly inducible by artificial stimuli.

On examining critically Haller's, and to a less extent Lennander's paper, we are struck by the fact that the stimuli used are unnatural in character. It is not likely that the viscera are equally responsive to all forms of mechanical stimuli. Twisting, stretching, or squeezing the wall of the intestine from the outside may be ineffective, because the nerve endings in these organs are adjusted for stimuli of another kind. In the case of the bile duct and of the ureters a twist produces no vaso-motor effect, but distension by injection produces a well-marked rise of blood pressure.

The "referred visceral pain" was discussed next. Dr. J. Mackenzie denies that a viscus is ever directly painful, the pain felt being essentially a "referred one." For example, in pleurisy the lungs and parietal pleura are insensitive. While agreeing with Lennander in the view that the subserous layer of the pleura is sensitive, Mackenzie holds that the pain of pleurisy is mainly a referred pain due to cramp of the muscles of the thoracic wall. Mackenzie gives the following theory as to the mechanism of the different forms of "referred pain." He holds that stimulation of afferent visceral nerves by some influence increases the excitability of afferent centres in the cord connected with corresponding areas of skin. The pain is consequently referred to these cutaneous areas, and is only indirectly the result of stimulation of deep visceral afferents.

Head gives a somewhat different explanation. Impressed by the fact that inflammation of spinal ganglia produces herpes zoster, he was led to believe that afferent visceral fibres in their passage through the same ganglia as certain afferent cutaneous nerves can affect the adjoining cells connected with the latter and thus produce "referred cutaneous pain." This view is opposed to Müller's law, and was finally given up by Head. He ultimately transferred the seat of the nervous mechanism from the ganglia to deeper centres in the cord. The segments of the cord connected with "referred pain" do not correspond with the segments of the spinal axis as indicated by the ganglia. Head suggests that the "referred pain" areas correspond with the primitive phylogenetic segments of the cord. He leaves the mechanism of overflow unexplained. A remarkable fact is that the area of skin affected by referred pain is a mere patch or couple of patches, not a segment, but nevertheless more or less segmentally arranged.

The deep visceral afferents from the heart are not only those which have been most fully investigated experimentally, but also form an intermediate group between the pure visceral deep afferents and those of somatic or muscular origin. The chief afferent nerve of the heart is the depressor, and the receptive field for its stimulation is its nerve terminations in the wall of the aorta. The most adequate stimulus is distension of the walls of that vessel. The result of stimulation is a lowering of blood pressure due to a diminution of vascular tone. The nature of this tone, like that of voluntary muscles, is still obscure. It is doubtful whether stimulation of the depressor gives rise to pain directly. The areas of "referred pain" given by Mackenzie are not cranial, as we should expect, since the vagus is a cranial nerve, but mainly lie in the chest wall. Tender spots, however, are also found on the head.

Prof. Sherrington then gave a brief survey of deep non-visceral or muscular afferents. Since the work on this subject is largely due to himself, and since he has elsewhere stated his views more fully, it would not serve any good purpose to try to epitomise this part of his paper.

The paper was followed by an interesting discussion, in which Prof. J. S. Macdonald, Dr. Graham Brown, and others took part. The discussion chiefly referred to the nature and functions of the terminations of the deep afferent muscular nerves. A number of other papers of anatomical and physiological interest were also read by the following:—Prof. Dixon (Dublin), the development of the achondroplasic skeleton; Prof. Anderson (Galway); Dr. Dickey (Belfast), the cervical pleura; Dr. Johnston (Dublin), the intercostal nerves; Drs. Goodall and Earle (London), the structure of the pancreas in relation to its functions; Dr. Maclean (Liverpool), phosphatides in the light of modern research; Prof. B. Moore (Liverpool), the chemistry of hæmolysis; Dr. S. Spicer, some points in the mechanics of respiration; Prof. Thompson, the development of the fœtal heart; Dr. Leonard Hill, F.R.S., the influence of inhalations of oxygen on the onset of muscular exhaustion; Dr. Rutherford, some points in connection with the anatomy of the cranium of the fish; Dr. Waterston, some instruments used in anthropometry.

RECENT IMPROVEMENTS IN THE INTERNAL-COMBUSTION ENGINE.[1]

II.

WE have already explained how important in the economical development of the internal-combustion engine is an accurate and precise knowledge of the physical properties of the working medium. The two chief features of which a knowledge is required are the calorific value of the explosive mixture and the relation between the specific heat and temperature of the ignited gases. The calorific value has been carefully ascertained for most of the gases commonly used, but the specific-heat relation is still a matter of unfortunate uncertainty. At the Leicester meeting of the British Association in 1907, under the sectional presidency of Prof. Silvanus P. Thompson, the desirability of clearing up the doubts that surrounded this subject was so keenly felt that an important committee was appointed for "the investigation of gaseous explosions, with special reference to temperature." An account of the findings of this committee was published in NATURE of June 24 last. From our present point of view the important result of the committee's work is expressed in the following extract from its report:—"Recent researches on the properties of the gases at high temperatures have definitely shown that the assumption of constant specific heat is erroneous, and have given sufficient information about the magnitude of the error to show that it is of material importance. . . . The closer approximation to the real cycle which is made by taking account of the actual properties of the working fluid, though it leads to some complication of formulæ, gives compensating advantages of real practical value." This bears out, also, a remark made by the late Prof. Zeuner[2] to the effect that "at any rate there must be dropped from the theory of the internal-combustion motors the former assumption of the constancy of the specific heats of the products of combustion." A curve connecting the specific heat at constant volume (C_v) of the mixture of gases, formed by the explosion of one part of coal gas in nine parts of air, with temperature centigrade (θ), which was considered to be accurate within 5 per cent., was included in the committee's report. A formula which fits this curve closely is

$$C_v = 0{\cdot}172 + 0{\cdot}075 \frac{\theta}{1000},$$

and although the constant in the second term on the right-hand side of this equation can only be looked upon as a first estimate, however carefully chosen, the equation does, probably, represent the high-water mark in our present-day knowledge, and from it can be deduced the limiting theoretical efficiency of engine cycles in which such a working medium is employed.

It is well known that on the basis of a constant specific heat the ideal efficiency (η) can be found from the following equation,

$$\eta = 1 - \left(\frac{1}{r}\right)^{\gamma-1},$$

where r is the ratio of compression and γ is the ratio of the specific heats. This relation applies with equal truth

[1] Continued from p 172.

[2] "Technical Thermodynamics," by Prof. Zeuner.

whether the cycle followed is (1) the constant-volume cycle, (2) the constant-pressure cycle, or (3) the constant-temperature cycle, an important discovery attributed to Profs. Unwin and Callendar. The problem now arises to re-calculate the thermal efficiency (η) for a working medium of which the specific heat is *not* constant. Most of the important internal-combustion engines operate on the constant-volume cycle, and if we re-calculate the equation to suit this case, making the necessary approximations to secure a workable result of sufficient accuracy, and using the above linear law based on the British Association Committee's figures for specific heats, we find that the new efficiency equals

$$\eta\left\{1-\frac{1}{4000}\left(\overline{1-\eta}\,.\,T_2+T_0\right)\right\},$$

where T_2 is the maximum absolute temperature (centigrade) in the cycle, T_0 the suction temperature, whilst η is the value obtained from the equation

$$\eta=1-\left(\frac{1}{r}\right)^{\gamma-1},$$

using here the value of γ corresponding to the *absolute zero of temperature*. The value of T_0 is practically independent of the compression, and in round figures suitable to this calculation may be written down as 400. The value of T_2 for a given richness of mixture will depend upon the degree of compression before ignition, and can be calculated therefrom. In this way a new expression for the real thermal efficiency can be obtained in terms, not of T_2, but of r, and the following table shows a few comparative figures worked out in this way. The figures for the "air-standard" efficiency are also given by way of comparison.

Thermal Efficiency.

Ratio of compression	"Air standard"	Real thermal efficiency (approximate figures)
4	0·43	0·30
10	0·60	0·45

Ratio, air/gas = 9/1.

It will be seen that in each case the real efficiency is about a quarter less than the "air-standard" efficiency.

This discrepancy sufficiently explains why those associated with the design and building of gas engines have expressed their dissatisfaction with the "air standard" of efficiency. The adoption of the "air standard" has led to the setting up as an ideal, to be aimed at and striven after, of a series of figures which it now appears are about one-third above the thermal efficiencies theoretically possible, and it is not surprising that engine builders, who from their practical work realised that there must be something wrong with the theory as then put forward, should have objected. It is not too much to say that had the engine builders to depend in the past solely on scientific guidance as the mainspring of their investigations, there would have been far less progress made than has been effected by the system of trial and error. Even now the state of knowledge as to gaseous specific heats is so uncertain that no accurate quantitative theory of the thermodynamics of the internal-combustion engine can be laid down. The writer has, however, endeavoured to show here and elsewhere how the problem may be investigated symbolically, and so prepared for expression in numerical form as soon as the thermal properties of the gases are actually known.

Mr. Dugald Clerk, in his 1907 paper[1] before the Institution of Civil Engineers, made some estimates of real efficiencies based on theoretical maximum temperatures of 1600° C. and 1000° C., and his results are given below.

	Ideal efficiencies		
r	If maximum temperature of cycle 1600° C.	If maximum temperature of cycle 1000° C.	On air standard
2	0·195	0·200	0·242
3	0·286	0·293	0·356
4	0·354	0·356	0·426
5	0·384	0·394	0·475
7	0·439	0·443	0·541

It was apparently contemplated that these figures might be used in comparison with engine performances in which the *real* maximum temperatures were also 1600° C. and 1000° C. This, however, would be open to several objections. As an instance, take the case of an engine which by improved design was made capable of giving for the same mixture and the same compression ratio a higher maximum temperature and pressure. Such an effect might be produced, let us say, by decreasing the ratio of cooling surface to volume through an alteration in the amount of pocketing. This new engine, on the basis of comparison with an ideal cycle having an identical maximum temperature, would probably show little, if any, improvement in relative efficiency over the old engine. Such a result would tend to defeat the purpose for which comparisons with ideal cycles are made. It would seem to the author that the better way would be to compare both old and new engines with an ideal cycle having a maximum temperature corresponding to the known richness of the mixture, its calorific value, and the ratio of compression.

A factor that has affected most advantageously the recent progress of the internal-combustion engine is the great improvement that has taken place in engine indicators. The old moving lever design, although thoroughly serviceable for most steam engines and for many slow-moving internal-combustion engines, has been found entirely untrustworthy with modern high-speed internal-combustion engines. A new form of instrument has been devised in which the recording lever is a beam of light, which, having no inertia, has no time-lag. This vitally important improvement in the indicators was due, in the first instance, to the prescience of Prof. Perry,[1] and in its later stages to the experimental skill of Profs. Callendar and Hopkinson. The writer has recently calculated out the case of an indicator of which the free periodic time of oscillation was 1/300 sec., and has shown that explosions occurring even in so short a time as 1/200 sec. could be adequately followed and recorded. We believe that this oscillation period represents about the sensitiveness of one of the reflecting indicators used by Prof. Hopkinson at Cambridge, and the calculation serves to show how accurately the new instruments can be made to follow extremely rapid explosions.

It would be useless to base any deductions on the records given by one of the old type of instruments in such a sharp explosion as this. Errors of as much as 5 per cent. are now known to have occurred in the measurements of horse-power made by the old instruments. On the other hand, it cannot be denied that the older type was a great deal easier to handle, and that it could be used by comparatively untrained persons. The new reflecting kind, despite its accuracy of measurement to within 1 per cent. of the power, is rarely seen in workshops, and the measure of "indicated horse-power" has been very commonly abandoned in favour of the measurement of "brake horse-power" both in the case of large and small engines. In the case of the numerous small high-speed petrol engines, the practice of actually measuring brake horse-power is often replaced by the use of a rating formula giving a "nominal" horse-power. It seems at first sight extraordinary that there should be a reversion to the old unscientific "N.H.P.," but, despite their apparent similarity, the "N.H.P." of the old days of the steam engine and boiler, and the "rating H.P." of the modern petrol engine, are really based on very different considerations, and, as there appears to be every likelihood that the latter will be constantly revised with the aid of the best scientific advice possible, there is little real foundation for any scientific objection to it. The pioneer work done by Prof. Callendar in promoting this advance cannot be too gratefully acknowledged. Others have also worked at the problem since, and a considerable "output" of rating formulæ has resulted. That in most common use is $\text{H.P.}=\frac{D^2.N}{2\cdot5}$, where D is cylinder diameter in inches and N is the number of cylinders. This formula was put forward with the authority of the Royal Automobile Club, and experience has shown that in the great majority of cases it gives wonderfully good results. It may even be doubted whether any of the far more complicated

[1] Proc. I.C.E., vol. clxix., p. 145.

[1] "The Steam Engine," by Prof. Perry, p. 117.

formulæ since brought forward give a more accurate measurement. It is, of course, not fitted for use with racing motors, in which everything in design is sacrificed to piston speed, high mean pressure, and a sufficient endurance to last through a few races. For an engine having 4-inch cylinders the Royal Automobile Club formula gives a rating of 25·6 horse-power, which is about the brake horse-power that a normal engine of this size would yield when driven at a normal speed. Racing motors of this size have, however, given almost, if not quite, 100 horse-power, and even if it were possible to do so it is a question whether it is worth while to search out a formula which would embrace such divergent practice and conditions of operation. The Royal Automobile Club formula corresponds to combining a piston speed of 1000 feet per sec. with a mean pressure of 67·2 lb. per square inch. Before it can be revised a complete series of careful experiments on engines of sizes ranging from 2 inches to 10 inches should be carried out.

In the succeeding article the writer proposes to discuss details of the recent mechanical improvement of the internal-combustion engine in relation to the theoretical investigations already discussed.

H. E. WIMPERIS.

CONFERENCE OF ENGINEERS AND SHIPBUILDERS AT GLASGOW.

A JOINT summer meeting of the members of the Institution of Engineers and Shipbuilders in Scotland and of the North-east Coast Institution of Engineers and Shipbuilders was held in Glasgow on August 4, 5, and 6. It is of interest to note that, although a large number of works and shipbuilding yards was thrown open to visitors, no works in which Admiralty work is under construction were included. This arises from the firms concerned paying respect to the wishes of the Admiralty that as much secrecy as possible should be observed regarding the details and progress of Government work. Wednesday and Thursday mornings were reserved for the reading and discussion of papers, of which we give brief extracts.

Sir Andrew Noble contributed some notes on the history of propellants. Perhaps the easiest way of showing the striking difference between the old gunpowders and some of the modern propellants is to quote two tables given by the author. As both the units of heat and the quantity of gas vary considerably, depending on the pressure under which the propellant is exploded, the author has taken the transformation approximately at the pressures at which the propellants are generally used in guns.

Older Propellants.

	Pebble	R.L.G.	F.G.	Mining powder	Spanish powder
Volumes of gas	278	274	263	360	234
Units of heat	721	726	738	517	767
Comparative energy	200,438	198,924	194 094	186,120	179,478

Modern Propellants.

	Cordite, Mark I.	Italian ballistite	M.D. cordite	Norwegian 167	Nitro-cellulose	Norwegian 165
Volumes of gas ...	875·5	810·5	913·5	899 9	934·0	909·9
Units of heat ...	1246·0	1305·0	1030·0	1005 5	924·0	935·5
Comparative energy	1,090,873	1,057,703	940,905	904,850	863,016	851,212

It will be seen from the tables that the comparative energies of the modern explosives are more than four times as great as those of the older propellants.

As regards the serious question of erosion, in the case of very large guns it is important to remember that, while the surface of the bore subject to the more violent erosion increases approximately as the calibre or a little more, the charge of the propellant required to give to similar projectiles the same maximum velocity increases as the cube of the calibre. Consequently, unless special arrangements as to the projectile are made, or other means adopted, the life of the largest guns before re-lining must be short when compared with that of smaller guns. Attention should be given to the best method of reducing erosion when very large charges are used, either by lowering the temperature of explosion or possibly by introducing some cooling agent with the charge.

The author has tested the capacity for erosion of several explosives, and has found these to vary considerably, but all give similar results with varied charges. Thus the erosion due to one three-quarter charge was less than that of a full charge, but two three-quarter charges gave more erosion than one full charge. Two half charges gave less, but three half charges gave more, erosion than one full charge. These experiments controvert the statement which has been made frequently that the erosion due to four three-quarter charges, as also that due to sixteen half charges, are equivalent to the erosion due to one full charge.

A paper on the trials and performances of the S.S. *Otaki*, by Engineer-Commander W. McK. Wisnom, R.N., is of interest in view of this vessel being the first merchant vessel fitted with a combination of reciprocating and turbine machinery. The *Otaki* was built by Messrs. Denny, of Dumbarton, and delivered in November, 1908. She has since completed a voyage to New Zealand and back, and is virtually a sister ship to the twin-screw vessels *Orari* and *Opawa*, fitted with reciprocating engines and constructed by the same builders. All three vessels belong to the New Zealand Shipping Company.

The only important differences in the vessels consist in an increase in length of the *Otaki* of 4 feet 6 inches to make up for the loss in cargo capacity due to three shaft tunnels instead of two, and also the modified design of the stern and stern post in the same ship. The boiler installations in the three vessels are identical. The engines of the *Otaki* consist of two sets of ordinary triple-expansion reciprocating engines driving wing propellers, and a low-pressure turbine driving a central propeller. In ordinary ahead working the reciprocating engines exhaust into the turbine, and change valves are fitted so that the reciprocating engines can also exhaust direct to the condensers.

At the trials on the measured mile at Skelmorlie the *Orari* attained a mean speed of 14·6 knots; the *Otaki*, under the same conditions, attained a mean speed of more than 15 knots for a total water consumption per hour of 6 per cent. less than that of the *Orari*. The total water consumption per hour in the *Otaki* at 14·6 knots was 17 per cent. less than in the *Orari* at the same speed.

On the run from the Clyde to Liverpool, with the vessel partly loaded, on November 21 and 22, 1908, at about half power, the coal consumption was about 1·387 lb. per horse-power per hour for all purposes. Scotch coal was used, having a heating value of about 7500 centigrade units.

As regards the performance of the *Otaki* on service, the coal consumption on the voyage from Liverpool to Teneriffe was 11 per cent. less than the mean for the sister vessels *Orari* and *Opawa* under similar conditions and at practically the same speed. For the round voyage, at the same speed, the coal consumption of the *Otaki* is about 8 per cent. less than that of her sister ships. The engines of the *Otaki* made a non-stop run from Teneriffe to New Zealand, a distance of 11,669 miles as logged, which is probably the longest continuous run yet made by a marine turbine. The turbine worked perfectly satisfactorily throughout the whole round voyage.

The New Zealand Shipping Company is to be congratulated in allowing this experiment to be made, and also for its courtesy in rendering available the very full information contained in the paper regarding the performances of their vessels.

PAPERS ON REPTILES AND FISHES.

A NEW species of leathery, or leather-back, turtle from the Miocene of Maryland is described by Mr. W. Palmer in No. 1669 of the Proceedings of the U.S. National Museum under the name of *Psephophorus calvertensis*, this being the first representative of the genus, which was previously known from the Tertiaries of Europe and Egypt, hitherto recorded from American deposits. It is, however, pointed out that certain dermal armour from the Zeuglodont Limestone of North America, figured by Müller in his work on Zeuglodon, probably belongs to the same genus.

In No. 1681 of the same publication Dr. L. Stejneger gives the name *Mesopeltis longifrenis* to a snake from

Panama, which appears to have been previously undescribed.

The first part of the second volume of the Memoirs of the Indian Museum is devoted to the initial portion of a report, by Dr. N. Annandale, on the fishes taken by the Bengal fisheries steamer *Golden Crown*; this section, which is illustrated with five plates, dealing with the skates, rays, and sawfishes. In the group of sting-rays and butterfly-rays, new species of the genera Trygon and Urogymnus are described and named, while in the torpedo-rays, in addition to a new species of Narcine, Dr. Annandale proposes the unclassical term "Bengalichthys" for a ray distinguished from Astrape by its thickened and fleshy disc, rudimentary pectoral fins, and degenerate eyes.

A second new genus of rays, Dactylobatus, has recently been proposed by Messrs. B. A. Bean and A. C. Weed in No. 1682 of the Proceedings of the U.S. National Museum for a species of which two examples were taken off South Carolina nearly a quarter of a century ago. The generic name refers to the presence of a finger-like process jutting from the middle of each pectoral fin, which, together with the subcircular form of the disc, distinguishes this handsomely spotted species from the typical rays of the genus Raia.

In No. 1677 of the publication last quoted Messrs. D. S. Jordan and J. O. Snyder describe, under the name of *Coregonus oregonius*, a new "white-fish" from the McKenzie River, Oregon, where it is locally known as the "chisel-mouth Jack." It is an active, predaceous fish about 18 inches in length, which takes the fly readily.

To the June number of the *Zoologist* Mr. R. Elmhirst, superintendent of the Marine Biological Station at Millport, communicates a note on whelks as cod-food. Cod, it is well known, feed chiefly on crustaceans, but two cases are on record where large numbers of whelks were taken from the stomachs of these fishes. Now, although these molluscs, generally with the operculums cut off, are frequently used as bait in cod-fishing, the number of whelks with their operculums in the two instances mentioned indicates that these had not been taken on lines, but devoured in the course of natural feeding. The author is of opinion that cod seize whelks when the foot is protruded, and swallow this part alone, rejecting the shell and its contents by means of a vigorous shake.

In the same issue Mr. L. E. Adams gives some additional notes on the flying-fish problem, in the course of which it is suggested that the discrepancy between the accounts of different observers with regard to the occurrence of wing-vibration may be due to the "personal equation" in the matter of vision-power.

PRIMITIVE DIPROTODONTS.

AT last, it seems, the true position of Plagiaulax, of the Dorsetshire Purbeck, described by Hugh Falconer in 1857, has been more or less definitely determined, and this by means of its early Tertiary American relative Ptilodus, of which remains, in a much more satisfactory condition than any hitherto known, have recently been discovered in Montana. These are described by Mr. J. W. Gidley in No. 1689 (vol. xxxvi., pp. 611–26) of the U.S. National Museum Proceedings under the name of *P. gracilis*. Of late years Plagiaulax and Ptilodus, together with a number of more or less nearly allied types, collectively forming the Multituberculata or Allotheria, have been tentatively associated with the Metatheria on account of a presumed resemblance of their cheek-teeth to those of the platypus. A study of the skull, pelvis, and limb-bones of the American genus has, however, convinced Mr. Gidley that this is wrong, and that the Plagiaulacidæ (together with the other Multituberculata) are really marsupials. The unequal development of the fore and hind limbs, the characters of the incisors, the form of the palate, and the position of the cheek-teeth indicate, in his opinion, a close, although not ancestral, relationship with the diprotodont marsupials.

This is practically a confirmation of the original view of Falconer, who regarded Plagiaulax as related to Hypsiprymnodon (Potorus). Cope (who was followed by Mr. Lydekker on p. 195 of the fifth volume of the "Catalogue of Fossil Mammalia in the British Museum") endorsed, in a somewhat modified manner, this opinion, regarding the Multituberculata as primitive diprotodonts presenting some very specialised features. In the course of his investigation Mr. Gidley has been led to conclude that Bolodon of the English Purbeck is inseparable from Plagiaulax, while the American Chirox is identical with Ptilodus.

The dental formula of Ptilodus is $i.\frac{1}{1}$, $c.\frac{1}{0}$, $p.\frac{4}{2}$, $m.\frac{2}{2}$ The lower jaw is attached obliquely to the skull in such a manner that its condyle is raised above the line of the cheek-teeth (thereby doing away with an objection raised by Owen against the herbivorous nature of Plagiaulax), and the greater portion of the large cutting lower premolar does not, in consequence, bite against the upper cheek-teeth, which extend considerably in advance of the same. Mr. Gidley's views, especially if the Triassic Microlestes (a name which it has recently been proposed to replace by Thomasia) belong to the same group as Plagiaulax, will considerably modify opinion with regard to the origin and radiation of the diprotodonts.

PROBLEMS OF AVIATION.

THE interim report of the Advisory Committee for Aëronautics, which, in his recent speech in the House of Commons, Mr. Haldane promised shortly, has now been published (Cd. 4711). It will be remembered that the duty of the committee is to advise on questions submitted to it by the Government departments to which the work of constructing and experimenting with aëroplanes and dirigibles has been entrusted. This work necessitates, in some cases, experimental research at the National Physical Laboratory. The committee is intended generally to advance the applications of the science of aëronautics by such means as may seem best. It has arranged already for a series of reports as to the present state of knowledge on the questions which will have to be considered. These reports are to include papers on the following subjects:—Mr. A. Mallock, on general questions to be studied; Dr. T. E. Stanton, on recent researches on the forces on plane surfaces in a uniform current of air; Sir G. Greenhill, on stability and on the screw propeller; Dr. W. N. Shaw, on wind structure, dealing especially with the phenomena of gusts, and on the variation of wind velocity with height; Mr. F. W. Lanchester, on petrol motors for aëronautical purposes; Dr. W. Rosenhain, on light alloys; and the secretary (Mr. F. J. Selby), on existing knowledge on the subject of the accumulation of electrostatic charges on balloons, and the precautions to be adopted to avoid the dangers arising therefrom.

To make it possible to decide what work should be undertaken first at the National Physical Laboratory, the committee drew up a list of desirable experiments as follows:—

I.—*General Questions in Aërodynamics.*

(1) Determination of the vertical and horizontal components of the force on inclined planes in a horizontal current of air, especially for small angles of inclination to the current.

(2) Determination of surface friction on plates exposed to a current of air.

(3) Centre of pressure for inclined planes.

(4) Distribution of pressure on inclined planes.

(5) Pressure components, distribution of pressure and centre of pressure for curved surfaces of various forms.

(6) Resistance to motion of bodies of different shapes; long and short cylinders, &c.

(7) Combinations of planes; effect on pressure components of various arrangements of two or more planes.

II.—*Questions Especially Relating to Aëroplanes.*

(8) Resistance components for aëroplane models.

(9) Resistance of struts and connections.

(10) Resistance of different stabilising planes, both horizontal and vertical.

(11) Problems connected with stability:—(i.) mathematical investigation of stability; (ii.) the stability of aëro curves of different section and of different plan (Turnbull's experiments); (iii.) effect of stabilising planes and investiga-

tion of questions as to their size and position; (iv.) effect of rudder action; (v.) effect of gusts of wind; (vi.) investigations as to stability of models for different dispositions of weight, &c.

(12) Materials for aëroplane construction.

(13) Consideration of different forms of aëroplane, monoplane, biplane, &c.

(14) Other forms of heavier-than-air machines, helicopters, &c.

III.—*Propeller Experiments.*

(15) Efficiency and the effect on the efficiency of variations in blade area, pitch, and slip.

(16) Positions relative to the machine.

IV.—*Motors.*

(17) Efficiency.

(18) Trustworthiness and steadiness.

(19) Materials of construction.

(20) Design.

V.—*Questions Especially Relating to Airships.*

(21) Materials of construction, strength, &c.:—(i.) alloys, wood, bamboo, &c.; (ii.) balloon fabrics; (iii.) wires, cords.

(22) Production of hydrogen.

(23) Gas-tightness of fabrics.

(24) Detection of leakage.

(25) Air resistance to ships of different form; experiments on models:—(i.) effect of shape of ends; (ii.) effect of length; (iii.) variation with speed; (iv.) distribution of pressure as affecting stability, strength in construction, position of propellers, fins, &c.; (v.) total resistance of models rigged to represent different balloons.

(26) Questions as to stability of airships in different positions.

(27) Stabilising and steering appliances, fins, rudders, &c.; form and position.

(28) General design.

(29) Navigation of airships. Mooring, &c.

(30) Efficiency and position of propellers for airships.

(31) Motors for airship work.

VI.—*Meteorology.*

(32) General information relating to variations of wind velocity and phenomena connected with gusts of wind.

(33) Relative variation in speed and direction of the wind at different heights above the earth's surface.

(34) Vertical movements in the air.

(35) Rotary movements in the air.

(36) Electrical phenomena.

(37) Formation of clouds, snow, hail, &c.

Eventually the committee decided that the following researches should be undertaken at once:—

(*a*) Experiments on air resistance and on air friction as outlined in (1) to (7) above, and including experiments on models of airships and aëroplanes, resistances of wires and connecting stays, &c.

(*b*) Motor tests.

(*c*) Propeller experiments.

(*d*) Tests for gas-tightness of materials suitable for dirigibles.

(*e*) Experiments on the behaviour of different materials with reference to the accumulation of electrostatic charge, and generally as to means of protecting airships from the effect of electrical discharges.

The interim report points out that additions to the existing buildings at the National Physical Laboratory have been found necessary to provide space for part of the experimental work, while a special building is also being provided for the whirling table referred to below. The equipment which is now being installed comprises the following:—

(i.) A wind channel 4 feet square and about 20 feet long, with a fan giving a draught of 40 feet per second, special arrangements being made to obtain a uniform flow. This will be employed for the determination of the air-pressure components on plane and curved surfaces, for the resistance of models of airships and aëroplanes, and for observations on the centre of pressure, frictional resistance, stability, &c.

(ii.) A whirling table of about 70 feet diameter. For this a special building is being erected; the table itself is under construction in the laboratory. It will be employed for a repetition of Dines's and Langley's experiments, as well as for propeller tests, which are urgently called for.

(iii.) Two wind towers for experiments in the open. These will enable some of the air-channel experiments to be repeated on a larger scale in the natural wind, and will, it is hoped, afford valuable information as to the varying conditions which obtain in practice.

(iv.) Apparatus for efficiency tests on high-speed motors up to 50 horse-power.

In addition, certain machine tools, &c., are being provided for workshop use.

The evidences provided by the interim report of the activity of the committee are gratifying in view of the activity being displayed in other countries in practical aviation. We notice that, on August 7, M. Sommer added another triumph to France in this province of aëronautics. M. Sommer beat the world's record for length of time in the air by flying at Châlons for 2h. 27m. 15s. The record was previously that of Mr. Wilbur Wright, who, on December 31 last, remained in the air at Le Mans for 2h. 20m. 23s.

THE MAGNETIC OBSERVATORIES OF THE U.S. COAST AND GEODETIC SURVEY.[1]

A LIBERAL addition made in 1899 to the funds available for magnetic work by the U.S. Coast and Geodetic Survey enabled a great extension to be made in the direction of magnetic observatories. Previously to that date the only magnetographs run by the Survey were an old Brooke instrument, first set up in 1860 at Key West, and an Adie instrument installed in 1882 at Los Angeles, and subsequently in use elsewhere. These two instruments are still in use, the Brooke in modified form at Vieques, the Adie at Cheltenham (fourteen miles south-east of Washington, D.C.), the central station of the Survey. Cheltenham also possesses a new set of Eschenhagen instruments, and similar instruments were also obtained for Baldwin, Sitka, and Honolulu. The curves from the five observatories are tabulated at a central office, and the volumes containing the earliest years' results have recently appeared. The material is dealt with after a uniform plan. Each volume discusses the buildings and instruments, and enumerates the base-line and scale-value changes. It is interesting to learn that the experience at Cheltenham "is decidedly favourable to the old Adie type, on account of its greater stability and the less frequent adjustments required." Another instrumental point of interest relates to the temperature coefficients of the horizontal force instruments. That of the Adie instrument appears exceptionally large for an instrument of its type, but it is less than half the average value for the four Eschenhagen instruments, and only one of the latter is worse than the Brooke in this respect. When a rise of 1° C. in temperature produces the same effect in the trace as a fall of 17 γ in the force—as seems to be the case at Honolulu—satisfactory elimination of temperature effects must be troublesome. If the cause lies in the quartz-fibre suspension, a substitute should be sought for.

The greater part of each volume is devoted to the hourly readings from the curves. Declination and horizontal intensity results are given for all the stations, but vertical intensity results only for Cheltenham. Mean hourly values are deduced for each month, first from all the days, and, secondly, from the ten least disturbed days. The latter form the basis of the regular diurnal inequalities given for each month. Inequalities are calculated for the northerly and easterly components as well as for declination and horizontal intensity, and at Cheltenham for dip as well as for vertical intensity. Under the heading "Daily Range of Declination" we have tables of values

[1] Results of Observations made at the Coast and Geodetic Survey Magnetic Observatories, Cheltenham, Maryland, 1901–4 pp. 206; Baldwin, Kansas, 1901–4, pp. 138; Sitka, Alaska, 1902–4, pp. 129; near Honolulu, Hawaii, 1902–4, pp. 130; and Vieques, Porto Rico, 1903–4, pp. 70. By Daniel L. Hazard, Computer, Division of Terrestrial Magnetism. (Washington: Government Printing Office, 1909.)

of the maximum and minimum for each day, and their times of occurrence, to the nearest minute; but the actual *range* is not given explicitly. The space allowed to the date is unnecessarily large, and it would probably be found possible to add the daily range without unduly crowding the figures. This would be a welcome addition.

An interesting feature is a list of the disturbed days, classified 1 to 4 according to the intensity. The highest figure, 4, is reserved for one or two exceptional disturbances, being applied at one or two stations only to October 30–31, 1903. Copies are also given, except in the case of Baldwin, of the curves from a considerable number of the disturbed days, the same selection being made for all the stations. This is likely to prove a valuable feature. Its value, however, is somewhat lessened by the fact that the curves are shown on a considerably reduced scale. Comparisons requiring high accuracy in the time must suffer. The fact that local time is employed is also somewhat of an obstacle to inter-comparisons. The disturbed curves are all from Eschenhagen instruments, which record all the elements on one sheet. This brings before the eye all that was happening simultaneously in the several elements. This is a distinct advantage in the study of disturbances, provided the different curves can be kept distinct. Sitka, owing to its higher latitude, is exposed to larger magnetic storms than the other stations, and the clearness of a good many of the curves reproduced suffers from crossing and confusion of the declination and horizontal force traces. October 30–31, 1903, was naturally an outstanding case of this; but on that occasion there was, besides, great loss of trace, the movements being so rapid that no clear record appeared on the photographic paper. The sensitiveness of the horizontal force instrument at Sitka was reduced towards the end of 1904 to about 1 mm. $=3\gamma$, as compared to an average of about 1 mm. $=1\cdot8\gamma$ in 1902 and 1903. The sensitiveness that used to be aimed at in temperate Europe is 1 mm. $=5\gamma$, and we cannot but think that the reduction of sensitiveness in Sitka might with advantage go a good deal further than it has yet gone. Though not quite so easily effected, a reduction in the sensitiveness of the declination instrument at Sitka might also be advantageous, at least for a study of the larger features of magnetic storms. The device of two mirrors adopted in the magnetographs to avoid loss of trace is an alleviation if the movements are slow, but if, as is frequently the case, the movements are not merely large but rapid, this device may only aggravate the confusion of trace.

The volumes contain a great mass of facts, clearly printed, presented in a readily intelligible form. Having put their hand to the plough, it is to be hoped that those responsible for the work of the Coast and Geodetic Survey will not turn back until simultaneous records have been obtained for at least one sun-spot cycle at all the stations.

C. CHREE.

RECENT ADVANCES IN OUR KNOWLEDGE OF SILICON AND OF ITS RELATIONS TO ORGANISED STRUCTURES.[1]

NOT only is silicon widely diffused in nature in the many forms of its oxide, but it also constitutes between one-third and one-fourth of the original and non-sedimentary rocks—of which the solid crust of the earth largely consists—in these cases being chemically combined with oxygen and various metals, forming natural *silicates*. The subjoined table gives a necessarily very rough estimate of the relative proportions in which the chief constituents are present.

THE EARTH'S CRUST.

Approximate average Composition of non-sedimentary Rocks.

Oxygen	about	47	per cent.
Silicon	,,	28	,,
Aluminium	,,	8	,,
Iron	,,	7	,,
Calcium and magnesium ...	,,	6	,,
Alkali metals	,,	4	,,

[1] From a discourse delivered at the Royal Institution on Friday, May 28, by Prof. J. Emerson Reynolds, F.R.S.

The crust of the earth is, in fact, a vast assemblage of silicon compounds, and the products of their disintegration under the influence of water and other agents are the various forms of clay, sand, and chalk which constitute so large a portion of the earth's surface.

The solid crust of the earth is actually known to us for but a very few miles down—thirty at most—our deepest mines being mere scratchings on its surface; but, so far as known, practically all its constituents are fully oxidised, and this is probably true at much greater depths. During æons past oxygen has been absorbed as the earth cooled down, and the product is the crust on which we live.[1] It is probable that the proportion of oxygen diminishes away from the surface until it disappears almost wholly. What of the deeper depths? Are the comparatively light elements arranged more or less in the order of density? Are we to suppose that silicon and some carbon, aluminium, calcium, the elements chiefly comprising the crust, are those nearer the surface, and iron, copper, and the heavier metals nearer the centre?

Until recently we knew little more than that the earth is some 8000 miles in diameter, that its mean density is 5·6–5·7, and that its relatively thin outer skin, or crust, has approximately the composition already described. By a very skilful use of earthquake observations Mr. R. D. Oldham has, however, lately[2] given us something like a glimpse within the ball, and concludes from his observations that about five-sixths of the earth's radius includes fairly *homogeneous* material, and that the remaining sixth at the centre consists of substances of much higher density. Assuming this to be even roughly true, we conclude that silicon forms probably as great a proportion of this large mass of the earth—whether in the free state or in the forms of silicides—as it does of the crust.

Having thus magnified the office of the important element of which I wish to speak to you, I shall pass to my next point, which is how the element can be separated from quartz or other forms of the oxide, for it is never met with unless combined with oxygen in any of the rocks known to us.

I have already mentioned that quartz is a dioxide of the element—in fact it is the only known oxide—hence if we remove this oxygen we should obtain free silicon. This is not a very difficult matter, as it is only necessary to heat a mixture of finely powdered quartz with just the right proportion of metallic magnesium. The metal combines with the oxygen of the quartz, and forms therewith an oxide of magnesium, while silicon remains. If the material be heated in a glass vessel the moment of actual reduction is marked by a bright glow, which proceeds throughout the mass. When the product is thrown into diluted acid the magnesium oxide is dissolved, and nearly pure silicon is obtained as a soft, dark-brown powder, which is not soluble in the acid. This is not crystalline, but if it be heated in an electric furnace it fuses, and on cooling forms the dark crystalline substance on the table, which, as you see, resembles pretty closely the graphitic form of carbon, though its density is rather greater (2·6, graphite being 2·3).

Silicon Analogues of Carbon Compounds.

The points of physical resemblance between silicon and carbon are of small importance compared with the much deeper-rooted resemblance in chemical habits which exists between the two elements. This is expressed in the periodic table of the elements as in the following diagram:—

$$\begin{array}{ccccccc} Na=23, & Mg=24, & Al=27, & \mathbf{Si}=28, & P=31, & S=32, & Cl=35\cdot5 \\ Li=7, & Be=9, & B=11, & \mathbf{C}=12, & N=14, & O=16, & F=19 \end{array}$$

where silicon is represented as the middle term of a period of seven elements of increasing atomic weights, just as carbon is the middle term of the previous period. The fact is, these two electro-negative or non-metallic elements play leading parts in the great drama of nature, silicon

[1] An interesting calculation has been made by Mr. Gerald Stoney, from which it appears that a stratum only 9 feet in depth of the surface of the earth contains as much oxygen as the whole of our present atmosphere. (See *Phil. Mag.*, 1800, p. 566.)

[2] R. D. Oldham, "Constitution of the Interior of the Earth." (Quarterly Journal of the Geological Society, vol. lxii., 1906, pp. 456–75.)

dominating that which has to do with dead matter, while carbon is the great organ-building and maintaining element of all living things. While each carries on the work to which it is best suited under existing terrestrial conditions, they both go about it in somewhat similar ways, and each one shows a tendency to overstep the border line and perform the other's part. This tendency is for various reasons much more marked in the case of carbon, but I hope to show you presently that silicon is by no means out of touch with living things, and, further, that it exhibits capacities which render it a potential element of life under other conditions of our planet, but more especially at a much higher level of temperature.

I do not propose to dwell in much detail on the remarkable parallelism of some silicon and carbon compounds, but must refer shortly to a few of them, and the oxides naturally come first.

The lecturer then described silicon oxide, chloride, bromide, chloroform, &c., with the analogous carbon compounds, and continued:—Both silicon and carbon form gaseous compounds with hydrogen of similar composition:—

$$CH_4 \text{ and } SiH_4.$$

Neither of these hydrides can be obtained by direct union of the respective elements, though they are easily obtained by indirect means, with the details of which I need not trouble you. Both are colourless gases, as you see. The carbon hydride, or marsh gas, is combustible, but requires to have its temperature raised considerably before it takes fire in air, and its flame is only slightly luminous. It produces on complete oxidation water vapour and carbon dioxide gas. The analogous silicon hydride takes fire much more easily in air, and when not quite pure is even spontaneously combustible under ordinary conditions, and it burns, producing water vapour and solid silicon dioxide.

"*Silico-organic Chemistry.*"

Now, just as marsh gas may be regarded as the starting point of that great branch of science which is usually spoken of as organic chemistry, so the analogous hydride of silicon is the primary compound from which many substances, which are often termed silico-organic compounds, can be derived by various means, and these were discovered in the course of the classical researches of Friedel, Crafts, Ladenburg, and others.

I wish to avoid using many chemical formulæ, which probably would convey but little meaning to some of those whom I address; it will suffice merely to indicate the *lines* on which investigations have proceeded in this direction.

In the older work of Friedel, Crafts, and Ladenburg, they produced complex substances by the substitution of various radicles (always carbon groups), for one atom of hydrogen in SiH_4, and ultimately replaced another atom of hydrogen by the OH or hydroxyl group. The substances so formed were silicon *alcohols*, which may be represented in the following manner, A, B, and C being used to indicate the different complex replacing radicles:—

$$\mathrm{Si}\begin{cases}\mathrm{H}\\ \mathrm{H}\\ \mathrm{H}\\ \mathrm{H}\end{cases} \qquad \mathrm{Si}\begin{cases}\mathrm{A}\\ \mathrm{H}\\ \mathrm{H}\\ \mathrm{OH}\end{cases} \qquad \mathrm{Si}\begin{cases}\mathrm{B}\\ \mathrm{H}\\ \mathrm{H}\\ \mathrm{OH}\end{cases} \qquad \mathrm{Si}\begin{cases}\mathrm{C}\\ \mathrm{H}\\ \mathrm{H}\\ \mathrm{OH}\end{cases}$$

In this way silicon alcohols were built up which proved to be analogous to well-known carbon alcohols, and afforded analogous acids, &c., on oxidation. These discoveries laid the foundations of a silico-organic chemistry, and have been further extended in later years. For example, it has been found possible to pursue the analogy with known carbon compounds in the direction of replacing all the hydrogen in silicon hydride by different radicles, and these changes, which can be effected in successive stages, may be represented in harmony with those just given:—

$$\mathrm{Si}\begin{cases}\mathrm{A}\\ \mathrm{H}\\ \mathrm{H}\\ \mathrm{OH}\end{cases} \qquad \mathrm{Si}\begin{cases}\mathrm{A}\\ \mathrm{B}\\ \mathrm{H}\\ \mathrm{OH}\end{cases} \qquad \mathrm{Si}\begin{cases}\mathrm{A}\\ \mathrm{B}\\ \mathrm{C}\\ \mathrm{OH}\end{cases}$$

The two last of these are *asymmetric*, since all four radicles are different. Consequently, they should exist in two isomeric modifications if really analogous to known carbon compounds of the same order, and each form should be capable of acting differently on polarised light.[1] Dr. F. Stanley Kipping, who has specially investigated this kind of substitution with much success, finds that the analogy between these asymmetric silicon and carbon compounds is complete in regard to optical activity as to other general characters.

Silicon Compounds including Nitrogen.

This was all good so far as it went, but some highly important information was still wanting. As you know well, the various compounds including carbon and *nitrogen* play by far the most important parts in building up organised structures under the influence of vital energy, but in the silicon series we were almost wholly ignorant of the existence of such compounds until within recent years, when I undertook definitely to investigate this branch of the subject.

All that was known at the period of which I speak was that silicon forms a white nitride of uncertain composition when strongly heated in an atmosphere of nitrogen gas, and that when silicon chloride is brought in contact with ammonia and similar substances violent action occurs, but the nature of the products formed was not known owing to special practical difficulties in separating them.

The first step taken was to examine the action of silicon halides (*i.e.* chloride, bromide, &c.) on substances free from oxygen, but rich in nitrogen. The earliest of these worked with were thiocarbamides, but in all these cases the silicon halide merely united with the nitrogen compound as a whole, in some instances producing very curious substances, of which the one with allyl-thiocarbamide,

$$(C_3H_5.H_3N_2CS)_8SiBr_4,$$

is a good example. This is a liquid which flows so slowly at ordinary temperature that it requires nearly a month in order to fall from the top of its containing tube and find its level at the bottom. Several similar substances have been obtained and examined, and their products of decomposition studied, but they do not belong to the class of which I was really in search.

It would weary you to give the details of scientific prospecting which one has to go through in order to attain definite results in a new line of work like this; suffice it to say that success attended the efforts at last, and a finely crystallised and perfectly defined compound was obtained in which silicon is wholly in direct chemical combination with nitrogen, and a specimen of that substance I now show you. Its composition is represented by the expression

$$Si(NHPh)_4,$$

where Ph stands for the phenyl group, and its name is silicophenylamide.

This substance when heated undergoes some important changes, which resemble rather closely similar changes that can be effected in analogous compounds of carbon with nitrogen. Thus it first affords a *guanidine*,

$$\mathrm{Si}\begin{cases}\mathrm{NHPh}\\ \mathrm{=NPh}\\ \mathrm{NHPh}\end{cases},$$

analogous to the well-known carbon guanidine, and further a di-imide, $Si(NPh)_2$, which only needs the addition of a molecule of water to convert it into a silicon *urea*, $SiO(NHPh)_2$. Many other substances have been produced similar to silicophenylamide, and they afford analogous products to these just mentioned; but these have been fully described elsewhere, and need not be dealt with here.

Silicon in Relation to Organised Structures.

The general results of these researches are that we now know a considerable number of silicon compounds including nitrogen, which resemble those of carbon with nitrogen, both in composition and in the general nature

[1] These changes are represented above as having been effected through the silicon alcohols in order to avoid complicating the general statement; other compounds have, in fact, been found more convenient for the purpose.

of the changes in which they can take part. Some of these carbon analogues are closely related to those which are concerned in building up organised structures of plants and animals.

All theories of life assume that its phenomena are inseparably associated with certain complex combinations of the elements carbon, nitrogen, hydrogen, and oxygen, with the occasional aid of sulphur and phosphorus. These are the elements of that protoplasm which is the physical basis of life, and by their interplay they form the unstable and complicated groupings of which that remarkable material is composed. All the phenomena we call vital are associated with the change of some protoplasm, and the oxidation of carbon and hydrogen; but it is quite open to question whether the connection of life with the elements first specified is inevitable. We can conceive the existence of similar groupings of other analogous elements forming other protoplasms capable of existing within much greater ranges of temperature than any plants or animals now known to us have to withstand. For example, we can imagine a high-temperature protoplasm in which silicon takes the place of carbon, sulphur of oxygen, and phosphorus of nitrogen, either wholly or in part. In fact, protoplasm, so far as we know it in purest form,

FIG. 1.

always contains some sulphur, and often a little phosphorus, representing a very partial substitution of the kind in question.

In view of our newer knowledge there is, therefore, nothing very far-fetched in supposing that under suitable conditions a plant or an animal organism may be able to construct from silicon compounds, ultimately derived from the soil, something akin to silicon protoplasm for use in its structures.

You will now ask me whether there is any evidence that anything of this kind actually occurs in nature. I think there is, although I admit that the evidence is not very varied so far as we yet know.

First, as to the *vegetable* kingdom. It is well known that many plants take up silicon in some form from the soil, and use it in ways which my botanical friends tell me they do not at present understand. Silicon is present in the straw of cereals, such as wheat, oats, &c., and in most of the Gramineæ. It was supposed that the stiffness of the straw was secured by a siliceous varnish, but this view is not now in favour, as it has been found possible to remove silica from the straw by careful treatment without diminishing its rigidity. It is also present in the leaves of some palms, for my friend, Dr. Hugo Müller, in the course of his extensive researches on the sugars present in certain palm leaves, has been much troubled by the presence in the extract from the leaves of siliceous compounds of unknown nature. Again, a well-known substance called "tabasheer," consisting largely of hydrated silica, including some organic matter, is obtained at the nodes of some bamboos. What purpose silicon serves in these plants, which seem to have special need for it, we do not know, but the subject appears to be well worth closer examination than it has yet received at the hands of plant physiologists.

I have on the table some good specimens of tabasheer, and can show some portions on the screen which have been rendered nearly transparent by soaking in benzene, and under these conditions exhibit traces of structure.

Next, as to the *animal* kingdom. The most satisfactory evidence that we can at present offer as to the organ-building capacity of silicon comes, curiously enough, from some of the simpler organisms of the animal kingdom, but the only group the short remaining time at my disposal permits me to notice is that of the *sponges*.

You know that these curious forms of undoubted animal life live in sea-water, and are usually anchored to rocks. The sea contains a very minute proportion of silica in solution, and the sponge has the power of appropriating very considerable quantities in the course of its life and as a part of its normal food supply. What does it do with this silica? It appears to use it in cell production, and from the cell evolves the beautiful and minute siliceous spicules which are so abundant throughout the structure of many of the sponges.

FIG. 2.

I have here some photographs of these spicules which I have had taken, and shall throw them on the screen. Two of the best of them have been made from microscopic specimens kindly lent to me by Prof. Dendy, who has made a special study of these spicules and of their modes of growth. One of these slides is reproduced in the engraving (Fig. 1).

These structures do not represent mere incrustations, but rather definite growths from the cell protoplasm, and are themselves in the nature of cells of characteristic forms. Prof. Dendy informs me that these spicules in certain cases become surrounded by a horny substance and seem to die, as if by cutting off the supply of energy as well as growing material.

In some of the larger sponges, as in the beautiful *Euplectella aspergillum*, or "Venus' flower basket," represented in Fig. 2, the siliceous material constitutes the greater part of the sponge, as the soft portion resembles a somewhat gelatinous coating from which the exquisite siliceous structure is developed.

To sum up, then, I have shown that silicon can easily take the place of carbon in many nitrogen compounds, as well as in others not including nitrogen. It therefore seems to me that we hazard no very violent hypothesis in supposing that the silicon which enters the sponge in its food, probably as an alkaline silicate, is in the marvellous animal laboratory made to take the place of a portion of the carbon of the protoplasm from which the spicules are ultimately developed.

The hypothesis is at any rate suggestive, and I hope enough has been said to commend it to your consideration, for there seems to be no doubt that silicon is capable of playing a larger part as an "organic element" than we hitherto had reason to suppose.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The appointments to chairs of chemistry in the Technical High School at Breslau were announced by mistake in last week's Nature (p. 180) as referring to the Technical High School at Munich.

The governors of the South-Western Polytechnic Institute, Chelsea, have appointed Mr. W. Campbell Houston to be head of the department of mechanical engineering in succession to Mr. W. W. F. Pullen, appointed to the inspectorate of the Board of Education. For the past six years Mr. Houston has been the assistant professor of engineering in the Heriot Watt College, previous to which he was chief assistant to Prof. Watkinson at the Glasgow and West of Scotland Technical College.

The Board of Education has issued a memorandum directing attention to changes in certain syllabuses of examination for 1910 affecting students engaged in engineering and building trades. The changes affect the syllabuses in practical plane and solid geometry, practical mathematics, and applied mechanics, and aim at bringing the distribution of the subject-matter of instruction and of examination more fully into line with the prevailing requirements in these subjects in relation to the building and engineering trades.

Attention has been directed recently in these columns to the serious efforts being made in several directions to secure the efficient education of children in elementary schools during the years of ordinary school life, and to provide for their further instruction in continuation schools after they have begun to work for their living. In our issue for July 8 (vol. lxxxi., p. 50) the question of child employment and evening continuation schools was considered, and in Nature of August 5 (vol. lxxxi., p. 172) the recently published report of the Consultative Committee of the Board of Education on attendance, compulsory or otherwise, at continuation schools was reviewed. The most recent evidence of this desire to improve our system of elementary education is the Parliamentary paper (Cd. 4791) containing the report of the Inter-Departmental Committee on Partial Exemption from School Attendance. The committee was appointed (i.) To inquire into and report upon the extent to which existing enactments relating to partial exemption from compulsory school attendance are taken advantage of in urban and rural areas in England and Wales; the occupations in which children so exempted are employed, and the effect of such occupation upon the general education and industrial training of the children. (ii.) To consider the practical effects of legislation providing for the abolition or restriction of half-time employment upon industries and wage-earning, and upon educational organisation and expenditure. (iii.) To report whether, and to what extent, in view of these considerations, it is desirable to amend the law by raising the age at which partial exemption from attendance at public elementary schools is to be permitted, or by raising the *minimum* age for total exemption concurrently with affording facilities for partial exemption. The committee examined fifty-two witnesses, including representatives of chambers of commerce and agriculture, of associations of employers and of trades unions, officials of the Home Office, of the Board of Education, and of local authorities, members of the Consultative Committee of the Board of Education, certifying factory surgeons, teachers, farmers, and others whose opinions seemed likely to be of value. After an exhaustive inquiry the committee recommends:—(*a*) that all partial exemption be abolished from a date not earlier than January 1, 1911; (*b*) that, at the same time, total exemption under the age of thirteen be abolished; (*c*) that the attendance certificate for total exemption be abolished; (*d*) that total exemption at the age of thirteen be granted only for the purposes of beneficial or necessary employment; (*e*) that the ordinary condition for total exemption be due attendance at a continuation class, but (*f*) that, subject to the approval of the Board of Education, an authority may adopt as an alternative condition the passing of a standard not lower than Standard VI.; (*g*) that nothing in any legislation shall affect any children who, at the date on which it comes into operation, are partially or totally exempt from attendance at school under the by-laws previously in force; (*h*) that in the application of the Factory Act to England and Wales the provisions of sections 68–72 shall cease to be operative.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, July 26.—M. Émile Picard in the chair.—Methods for collecting and preserving the gases from fumaroles, springs, or volcanic soil: Armand **Gautier**. The methods suggested are described in detail, and diagrams are given. The gases are transferred, after drying, to a vacuous tube, the latter being sealed by fusion on the spot. The amount of steam accompanying the gas is also determined.—The law of fixed dissociation pressures: Henry **Le Chatelier**. A discussion of the effect of porosity on the application of the phase rule to dissociation phenomena.—The transcendental singularities of inverse functions of integral functions: Pierre **Boutroux**.—Uniform analytical functions with discontinuous singularities: Arnaud **Denjoy**.—Study of the thrust of the air on a surface: A. **Rateau**. The apparatus used allows of the simultaneous measurement of the vertical and horizontal components of the thrust separately. Curves are given showing the experimental results for certain plane and curved surfaces.—The ultra-violet band spectrum of phosphorus: A. **de Gramont** and C. **de Watteville**. The results are given in tabular form, showing a comparison of the flame and spark spectra.—The ratio between uranium and radium in radio-active minerals: Mlle. **Gleditsch**. The results published by the author in an earlier paper not being in accord with those of other workers on the same subject, the analytical method employed has been subjected to a critical examination, but without causing any appreciable change in the figures obtained. There does not seem to be any constant ratio between uranium and radium in different radio-active minerals. This conclusion necessitates a modification in the views held as to the mechanism of the transformation of uranium into radium.—The action of gravity on the induced activity of radium: Louis **Wertenstein**.—A method of registering the length of the path of the α rays, and on a peculiarity of this path: B. **Szilard**. A layer of the radio-active material was placed horizontally, and a glass plate carrying a layer of zinc sulphide, and backed with a sensitised plate, is fixed at an angle with this layer. The range of the α rays found in this way was always about 2 mm. less than that given by the ionisation method.—The decomposition of water by the ultra-violet rays: Miroslaw **Kernbaum**. The ultra-violet rays decompose water in a similar manner to the β rays of radium, hydrogen and hydrogen peroxide being produced.—The disengagement of the radium emanation: H. **Herchfinkel**. The hydrates of iron and uranium carry down nearly the whole of a radium salt in solution, and the precipitates, when dry, give off a large proportion of the emanation.—Ionisation by chemical methods: Léon **Bloch**. A criticism of notes recently published by Reboul and by Broglie and Brizard.—The ionisation of paraffin at different temperatures: Tcheslas **Bidlobjeski**.—The conditions of stability of the Poulsen arc: C. **Tissot**.—A new method of analysis by curves of miscibility; its application to oils used for food: E. **Louïse**. Various proportions of the oil under examination are mixed with pure acetone, and the temperature of complete miscibility noted. The percentage of oil plotted against the temperature of miscibility gives a curve characteristic for the oil.—The allotropic states of phosphorus: Pierre **Jolibois**. Ordinary red phosphorus is an unstable condition. By heating alone to 360° C., or in presence of a catalyst above 250° C., a new stable modification of phosphorus is obtained, termed by the author pyromorphic phosphorus, characterised by its density, 2·37. Red phosphorus melts at 724° C.—The hydrates of thorium chloride and bromide: Ed. **Chauvenet**.—Some double sulphates: M. **Barre**.—Some derivatives of 1:2:4-butanetriol: M. **Pariselle**. The derivatives described include oxyhydrofurfurane, bromobutylene oxide, and 1:4-dibromo-2-butanol.—The formation of gold deposits: L. **de Launay**.

—Biological observations of the Tonkin india-rubber tree: M. **Eberhardt** and M. **Dubard**.—A new parasitic entophyte of one of the Coleoptera: L. **Léger** and E. **Hesse**. —The genital stolon of the compound Ascidians; its evolution in the course of partial regression: Antoine **Pizon**. —Study of the toxic powers of the strophantines according to the method of administration: J. **Pédebidou**.—The paralysing influence exercised by certain acids on alcoholic fermentation: Mlle. M. **Rozenband**. The results, given in tabular form, show the concentration up to which no prejudicial effect is produced, and the concentration at which fermentation is completely stopped. —The action of the ultra-violet rays upon the acetic fermentation of wine: Victor **Henri** and Joseph **Schnitzler**. The ultra-violet rays from a quartz mercury vapour lamp completely arrested the acetic fermentation after thirty minutes' exposure, a smaller exposure causing the action to slow down.—The hydrolysis by diastase of the α- and β-methyl-*d*-glucosides: H. **Bierry**.—Researches on the electric charge of textile substances plunged into water or into electrolytic solutions: J. Larguier **des Bancels**.—The variation of some diastases during the metamorphosis in *Limnophilus flavicornis*: Xavier **Roques**.—The tectonic relations of the internal pre-Alps with the Helvetic strata of the Morcles and the Diablerets: Maurice **Lugeon**.—The neogenic continental formations in the Hautes-Plaines, Algeria: A. **Joly**.—An oscillation of the sea noted on June 15, 1909, in the port of Marseilles: Louis **Fabry**. This oscillation had an amplitude of 40 cm. to 80 cm., and appears to be connected with a sudden rise of 2 mm. in the height of the barometer.—Some earthquake shocks felt at Yunnan: Ch. **Dupont**.

August 2.—M. Bouquet de la Grye in the chair.—Is the virulence of the trypanosomes of mammals modified after passage through cold-blooded vertebrates? A. **Laveran** and A. **Pettit**. When blood rich in *T. lewisi* or *T. evansi* is injected into the peritoneal cavity of a snake (*Tropidonotus natrix*) the trypanosomes pass rapidly into the snake's blood, and live there several days, although their number rapidly diminishes. Some days after the disappearance of the organisms from the blood the latter remains infectious. No definite proof of the modification of the virulence of the trypanosome by passage through the snake has been obtained.—The figure and mass of the planet Uranus, deduced from the motions of the two interior satellites: Œsten **Bergstrand**. The calculations are based exclusively on observations made at the Lick Observatory. The flattening of Uranus is probably of the order of one-twentieth, corresponding to a period of rotation of thirteen hours. The mean density of Uranus is 0·16 that of the earth.—The elasticity of the terrestrial globe: Ch. **Lallemand**. A discussion of the measurements made at Potsdam by Dr. Hecker.—The variation of the magnetic double refraction of aromatic compounds. Surfused bodies and substances in the vitreous state: A. **Cotton** and H. **Mouton**. The variation of the magnetic double refraction of nitrobenzene and salol with temperature was found to be linear.—The magnetic properties of carbon and organic compounds: P. **Pascal**.—The latent heat of fusion and the specific heat of propionic acid: G. **Massol** and M. A. **Faucon**. Direct measurements of the latent heat of fusion gave 23·35 cal. per gram by one method and 19·07 cal. by another. Indirect methods based on the formulæ of van 't Hoff and de Forcrand gave 26·7 and 30·5 cal. respectively. The causes of this discrepancy are discussed.—Some ethylene amido-derivatives: G. **Busignies**. A description of a series of ethylene derivatives obtained by the action of the Grignard reagent upon alkyldiamidobenzophenones.—Remarks on the nuclear evolution in the Ascomycetes: A. **Guilliermond**.—The growth of Fucus: P. **Hariot**. Observations of the rate of growth.—Contribution to the study of sterilisation by the ultra-violet rays. Application to the butter industry: MM. **Dornic** and **Daire**. The water used in washing butter made from Pasteurised cream is treated with ultra-violet rays from a quartz mercury vapour lamp, and partially sterilised. A comparison of two samples of butter made from the same Pasteurised cream showed that the one washed with ordinary water was rancid after eight days, whilst the sample washed with the treated water was fresh after the lapse of a month.—The existence of carbonophosphates in milk. Their precipitation by Pasteurisation: A. **Barillé**.—The action of the pancreatic juice on glycogen, starch, and its components: Mme. Z. **Gruzewska** and M. **Bierry**.—The examination of plants for raffinose, and on its presence in two leguminous seeds, *Erythrina fusca* and *Entada scandens*: Em. **Bourquelot** and M. **Bridel**.—The slight penetration of the ultra-violet rays through liquids containing colloidal substances: J. **Courmont** and Th. **Nogier**. Owing to the opacity of solutions containing colloidal substances to the ultra-violet rays, the practical difficulties in the way of sterilising such liquids as beer or cultures of organisms are very great.—The action of ultra-violet light on the toxin of tetanus: Mlle. P. **Cernovodeanu** and M. Victor **Henri**. —The relation between phenol eliminated in the urine and epilepsy: J. T. **Florence** and P. **Clément**.—The geological history and the tectonic of the Atlas of eastern Numidia (Algeria): J. Dareste **de la Chavanne**.

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THURSDAY, AUGUST 19, 1909.

OILS, FATS, AND WAXES.

Chemical Technology and Analysis of Oils, Fats, and Waxes. By Dr. J. Lewkowitsch. Fourth edition, entirely re-written and enlarged. 3 vols. Vol. i., pp. xx+542; vol. ii., pp. xi+816; vol. iii., pp. viii+406. (London: Macmillan and Co., Ltd., 1909.) Price 2*l.* 10*s.*

THE third edition of this work was reviewed in these columns about five years ago (vol. lxx., p. 502). It is therefore unnecessary again to describe the plan of the book in any detail. In the broad outlines it remains unaltered, though there are changes in the arrangement, and considerable additions.

Much has been done, and much written, in this branch of technology since 1904; wherefore the author has found it necessary to expand the work into three volumes. Broadly speaking, the first volume describes the general chemical constitution of oils, fats, and waxes, and the usual physical and chemical methods adopted in examining them; vol. ii. treats of the individual natural products; and the third volume is devoted to the various groups of manufactured articles, such as edible oils, oxidised oils, candles, soaps, and glycerin. Some new sections, dealing with emulsified oils, the fatty-acid industry, and wax technology, have been added to this part of the work; and more space than formerly has been allotted to the description of manufacturing operations.

Apparently no pains have been spared in making the book as complete and as modern as possible. So far as the reviewer can judge by testing the information here and there, no recent work of importance on the theoretical and scientific side has been overlooked. Thus Bömer's process for the identification of pure glycerides is summarised, and a description is given of the "direct" method for isolating and determining glycerol recently proposed by Shukoff and Schestakoff. Valenta's suggested method of quantitatively separating aromatic hydrocarbon oils from those of the aliphatic series by extraction with dimethylsulphate is dealt with at some length; and an account is also given of the criticisms of the process by subsequent workers.

On the technological side an interesting development is mentioned which may prove of some importance in the candle industry. A large quantity of liquid oleic acid occurs as a by-product, and one of the standing problems of the industry has been to find some mode of converting this liquid acid into its solid homologue, stearic acid, thereby rendering it available as a material for candle-making. Many suggestions have been made, and many patents obtained, with this object in view; but no great success has hitherto attended these efforts—at least, on a manufacturing scale. It seems, however, that an application of Sabatier and Senderens' classical researches upon the "reduction" of organic compounds by means of finely-divided nickel may mark a new stage in the matter. Several investigators have proposed such an application, and Dr. Lewkowitsch states that, by a systematic study of the Sabatier and Senderens reaction, he has recently succeeded in converting oleic acid into practically the full quantity of stearic acid theoretically obtainable from it. What, however, is not quite clear is whether the translation from laboratory experiments to factory practice has been successfully accomplished. Details are withheld.

The author gives a tabulation of oils, fats, and waxes based upon the magnitude of the iodine values. He looks upon this as the most convenient classification for practical purposes. Probably it is; but there are, as would be expected, some inconsistencies and overlapping of groups in this arrangement. Thus certain of the non-drying oils have a greater iodine value than some of the drying and semi-drying oils. But as every chemist dealing with diverse varieties of oils and fats probably constructs some such table for himself, it will be useful to have a fairly complete tabulation of critically-selected values for general reference, even though it is not an ideal basis of classification.

Turning for a moment to commercial matters, most people know that we import large quantities of butter into this country, but many may be surprised to learn that lard is imported to the value, roughly, of five millions annually, and another million pounds' worth, our author calculates, is made at home. The section of the book devoted to this important fat has been increased considerably. Some of the statements made in the earlier editions have had to be modified—notably as regards the range of iodine values—but this was only to be expected, in view of altered circumstances of production. The author discusses at some length the difficult problem of detecting small admixtures of beef-fat with lard. Tables are quoted showing the melting-points of the crystals which deposit from solutions in ether of lard and beef-fat, respectively. The beef-fat crystals have much the lower melting-point. It seems, however, to have escaped the author's notice that the crystals obtained from a mixture of beef-fat and lard have also a lower melting-point than those from lard alone. Used with discretion, such as the author wisely inculcates in other matters, the importance of this fact in solving the problem is obvious.

In dealing with the adulteration of butter the author stigmatises as futile the attempt to prove "that an admixture of beef-fat or lard has taken place if only low titration-numbers for the insoluble volatile acids are found." Undoubtedly such an attempt is futile. It is so obviously futile as to raise a shrewd suspicion that there has been a misunderstanding somewhere.

In some minor matters we do not always see eye to eye with the author. For example, he unduly minimises the value of the specific gravity indications in the examination of butter-fat. His objection is that the test "would hardly lead to the detection of smaller quantities of an adulterant than 30 per cent." In a sense, that is true; but it is also true, in a sense, of every other single criterion which could be applied.

These, however, are small points. Summing up one's impressions of the book as a whole, they are that it well maintains its place in the front rank of works devoted to the study of oils, fats, and waxes. To the chemical technologist it is practically indispensable.

C. SIMMONDS.

A CYTOLOGICAL TREATISE.

Plasma und Zelle. Erster Abtheilung. By Prof. Martin Heidenhain. Erste Lieferung, Die Grundlagen des mikroscopischen Anatomie, die Kerne, die Centren, und die Granulalehre. Pp. viii+500. (Jena: Gustav Fischer, 1907.) Price 20 marks.

THIS somewhat bulky volume is the first instalment of Prof. Martin Heidenhain's treatise on "Plasma und Zelle" which is to form a part of Bardeleben's great work on human anatomy.

The method which the author has adopted is perhaps not the ideal one, but it must be remembered that the science of cytology is young, and its vigorous development has manifested itself in the growth of an enormous amount of details which some day will become connected up so as to make a coherent organism, despite the fact that at the present time the different sections seem to be somewhat isolated. The features which in one group appear to be of fundamental importance may elude recognition in, and perhaps be really absent from, others; and thus that logical connection so dear to the minds of many is difficult, and at present often impossible, to trace. Probably for some time to come the trees will be more apparent than the wood. Prof. Heidenhain has chiefly worked on the cells of a few vertebrate animals, and it must be confessed that throughout the somewhat lengthy treatment of his subject this point of view is rather strongly reflected. There is hypothesis in plenty, together with much really acute analysis, but one cannot repress the feeling that the chastening influence of the protozoan nucleus is rather conspicuous by its absence.

The treatment is frankly morphological, and upon a somewhat narrow range of very detailed observation of comparatively few forms a theoretical superstructure of doubtful stability has been erected. Some cytologists, at any rate, will criticise one of the earlier pronouncements (p. 3) in the book, to the effect that discussion (Erörterung) of biochemical structure forms no part of the province of scientific morphology, and that the latter must take the former as granted. Surely the trend of modern morphology is in the direction of discontent with such a position. Some of us, at any rate, believe that form and structure are merely the expression of biochemical constitution, and it is just this latter problem that we want to attack.

Prof. Heidenhain postulates "units of living substance" as the essential elements of an organism. The cells are regarded as a special case of the aggregation of these living units. In this he is practically following those who regard the cell as by no means the real unit of the organism, and unquestionably this is a tenable position; but, nevertheless, the cell, despite its complex organisation, represents actually the lowest rank in the polity of the multicellular organism out of which the organism itself is built up; nor is the case really different in syncytial bodies. The quarrel with the cell from this point of view is perhaps partly due to the fact that we have not been clear as to what we mean by an organism. A human society is made up of the individuals which compose it; we are justified in regarding them as the ultimate constituents of such a social organism and we cannot usefully push our analysis further back, for they form the lowest units which propagate themselves and differentiate into the complex structure of which the society is composed. Of course, we are aware that each one can be resolved still further into tissues and cells, but these things do not come into the scheme of the social organism as such. The same holds good when we get still lower in the scale. The cells plainly continue to be the units of which the *corpus* is built up—until we get to the unicellular organisms. In the latter we find a more elaborate differentiation than is characteristic of the metazoan or metaphytan cell, but in essentials it seems to be the same. The protoplasm and the nucleus still are requisite to maintain it as a going concern, and reproduction by fission or otherwise is always connected with the distribution of a combination of both to each of the offspring. This is strikingly shown in some forms in which a nucleus as such is perhaps absent, and only the stuff of which the nucleus is made is present in a more or less distributed condition in the cell.

But although we may not agree with the author in his belittlement of the cell, many will assent to his conclusion that it has been made too prominent as the "be all and end all" of the living body. The organism is higher than its parts, and itself determines what form it shall take—or, to put it more plainly, the reactions that are due to the relations subsisting between one part of the organism and another, or between it and its environment, are of such a kind as to influence the fashion of development of the new cells and new tissues.

Prof. Heidenhain's position with regard to the cell is clearly stated on p. 81, where he says that

"it is not the cell which is the bearer of life, but life is inherent in every living particle, down to the smallest molecular group which can be called alive. The cell is rather only a special apparatus which itself is made up of living material."

The crux of the matter obviously lies in the meaning we attach to the word "living."

Many pages are devoted to cell organs, such as centrosomes, and to a very lengthy discussion of Altmann's so-called "granular theory." We confess that much of the space thus allocated seems to us to be hardly well utilised; and although it is not fair finally to criticise a work of which only the first part has appeared, it appears to us that a more real service to cytology would have been rendered if Prof. Heidenhain had focussed the information which is so rapidly accumulating as the result of the study of the lower forms of life upon the problems presented by the higher types.

But he has, at all events, laid those who are interested in cytological development under a debt of gratitude by the exhaustive treatment he has accorded to those topics which he decided to discuss.

MARINE PROPELLERS.

The Screw Propeller: and other Competing Instruments for Marine Propulsion. By A. E. Seaton. Pp. xii+255. (London: Charles Griffin and Co., Ltd., 1909.) Price 12*s.* 6*d.* net.

THE author of this book is well known, both as a practising marine engineer and as an author. His "Manual of Marine Engineering" has long served as a text-book, and has passed through many editions. It was natural, therefore, that the announcement of a work by Mr. Seaton dealing with marine propellers should awaken interest over a wide circle of readers, more especially as the problem of propeller design has not yet received a complete solution. As Mr. Seaton says, "even in modern times . . . . our best men do sometimes fail to achieve success," although there are now available the results of much experimental and theoretical investigation on the subject. After seventy years' continuous work it still remains true that when novel types of ships or unprecedented speeds have to be attempted, although use may have been made of all available data, and the best advice taken, full success is not always or at once achieved. On the contrary, considerable gains in efficiency are frequently attained by a process of "trial and error," out of which comes a final selection of the propeller forms and dimensions best suited to novel conditions.

Such a confession may be thought discreditable; indeed, it is sometimes so treated by critics who have not themselves had occasion to undertake responsibility for ship and propeller designs; but it represents the facts of the case, and the explanation is not far to seek. When a problem has been unsuccessfully attacked by men like Rankine and William Froude, amongst those who have finished their work, and by men like R. E. Froude, Cotterill, Greenhill, and D. W. Taylor, who are still alive and interested in finding solutions, it may be presumed that the problem involves considerable difficulties. When one considers the almost endless variety of the conditions involved in ship propulsion, the failure to reach a complete solution of the problem need not cause astonishment, and it is reasonable to anticipate that we shall have to be content for some time to come, if not permanently, with partial solutions chiefly based on experimental investigations, and on careful scientific analyses of the results.

Mr. Seaton definitely states in his preface that the

"object of the present work is to amplify and extend what [had been given] in skeleton or in rudimentary form" (in his "Manual of Marine Engineering") in the shape of rules for guidance in the practical work of designing propellers. These rules are said to have been "generally based on scientific reasons and always capable of giving results agreeable with the best and most successful practice": and it is claimed that by means of successive improvements "they have become generally applicable to the design of a screw for an Atlantic liner or a torpedo boat." It is added that "the more abstruse and highly mathematical investigations connected with the theory of the resistance of ships and propellers have been left to be studied in the text-books and . . . . valuable papers" of various authors.

More or less empirical rules such as Mr. Seaton proposes no doubt have a certain value as representing his own practice and deductions from his study of published results of steamship trials, but it cannot be admitted that such rules can be depended upon absolutely when new conditions have to be faced. If it were true that the best results could be ensured by the use of any known rules in the designs of screws over the wide range from "an Atlantic liner to a torpedo boat," difficulties such as have been mentioned would disappear, and the work of the naval architect would become easy of performance. The occurrence of these difficulties demonstrates the imperfection of existing rules.

Turning to the general scheme of the book, it may be said that the section dealing with the history of marine propellers is both interesting and valuable. Bourne's book, giving the early history of the screw propeller, is not now generally accessible, and Mr. Seaton's summary will be found useful for reference. Paddle wheels, screws, and hydraulic (or jet) propellers are treated separately, their principles of action are explained, rules being given for their practical design. One chapter is devoted to an explanation, in popular language, of the modern theory of the resistance of water to the motion of ships, but readers desiring full information on the subject will necessarily have to turn to other sources, as Mr. Seaton only attempts a brief sketch. Naturally, screw propellers claim most attention, their various forms, numbers and positions are described; and the effects of changes in numbers, shape, and proportions of blades are also discussed at some length. Much information has been collected and collated respecting experimental trials made with screw propellers, but it seems doubtful whether the large amount of space devoted to trials made by the Admiralty and other experimentalists in the early period of screw propulsion might not have been better utilised, seeing that these trials were made on ships the forms, proportions, and speeds of which in no way represent present practice, while many important conditions affecting results are not definitely known. An antiquarian interest attaches to them, and from their consideration certain useful deductions may be, and, indeed, have been, made; but radical differences exist between conditions prevailing thirty or forty years ago and those of the present day, and the devotion of much time to this subject, when better and later information is available, is not desirable. The chapters dealing with the geometry of the screw and materials used in the construction of the screw propeller are excellent.

The book is well produced and illustrated. It has an excellent index, and as a work of reference will be found of service to all interested in the propulsion of ships.

STUDIES ON IMMUNITY.

Studies on Immunity. By Prof. Robert Muir, in collaboration with Drs. Carl H. Browning, Alexander R. Ferguson, and William B. M. Martin. Pp. xi+216. (London: Henry Frowde, and Hodder and Stoughton, 1909.) Price 7s. 6d. net.

THIS book contains a record of original work on the theory of immunity carried out during the past six years by Prof. Muir, of Glasgow University, in collaboration with his colleagues, Dr. Browning, Dr. Ferguson, and Dr. Martin. Eleven original papers, all of which have already appeared in various scientific journals, are incorporated in the present volume, but, by judicious alterations and additions, the author has endeavoured to knit the subject-matter of these papers into one continuous whole, so that the volume serves as a connected account of the particular immunity processes (hæmolysis and opsonic action) with which the author deals.

A work which treats in strictly scientific fashion of questions so difficult and complicated as those of hæmolysis and opsonic action must of necessity appeal only to the expert, and it is unfortunate that Prof. Muir has not seen fit to bring the subject up to date by the inclusion of references to papers which have appeared since the publication of the authors' original researches. Had he done so, the book would have appealed far more forcibly to the present-day worker, who, one may presume, has been for some time familiar with these highly important researches of Prof. Muir and his collaborators.

The volume opens with an interesting chapter on the properties of hæmolytic sera generally, and the technique usually employed in the investigation of hæmolytic phenomena. There follow chapters on the mode of union of the immune body with the red corpuscle, and the relation of this union to complement action. With regard to this latter question, Prof. Muir finds himself in agreement with Bordet, whose view is that there is no direct union of immune body with complement, as Ehrlich supposed, but that the complement unites with the cell receptor, which has, so to speak, been sensitised by the immune body. "A complementophile group in the amboceptor is not proved, and the use of the term 'amboceptor' does not appear to be justified." Certain interesting filtration experiments performed by Prof. Muir and his colleagues showed very convincingly that at 37° C. a direct union of immune body with complement was highly improbable. The question of complementoids is discussed in great detail, and the author believes that Ehrlich's views with regard to these bodies have been completely confirmed.

Some interesting researches are described showing that complement may act as an agglutinin. Thus, if a certain amount of immune body (obtained by immunising an animal with the red cells of the ox) be added to ox corpuscles in the presence of ox complement, scarcely any lysis occurs, but marked agglutination of the red cells takes place. If guinea-pig's complement is employed, lysis, of course, occurs, and if the ox serum be now added, the stromata flocculate as before. Like complement, this agglutinating body in ox serum is thermolabile, and acts only in cooperation with immune body. Whether this agglutinating complement and the ordinary lytic complement are one and the same, further research must determine.

Anti-immune bodies and anti-complements are treated at great length, and a considerable amount of space is devoted to the question of the deviation of complement, a process which forms the basis of numerous diagnostic methods of great practical importance. The delicacy of this reaction is compared with that of the precipitin method as a test for the presence of protein of human origin.

The concluding chapters of the book deal with the authors' experiments on the opsonic action of normal and immune sera. In view of their finding that the opsonic action of a normal serum could be almost entirely removed by saturating it with sensitised red cells or other combinations which absorb complement, they came to the conclusion that the opsonins of normal serum belong to the group of complements. This view, which attributes to complement an entirely novel property of acting alone, and takes no account of the presence of normal amboceptors, has not met with general acceptance, and a considerable amount of evidence has accumulated in the last two years, showing that in normal serum, as well as in immune serum, amboceptors cooperate with complement to produce an opsonic effect. One cannot yet say, however, that the question whether the opsonic action of normal sera is strictly analogous to that of immune sera is definitely settled, and in the last chapter of the book Prof. Muir brings forward evidence that in some cases normal bactericidal action may differ from that which takes place through the medium of an artificial immune body. Normal bactericidal action may, in fact, follow from the direct union of complement with the bacterium, and not necessarily from an indirect union through the medium of a natural amboceptor. All workers interested in these questions will find Prof. Muir's book worthy of careful perusal.

THE SCIENCE OF EDUCATION.

Psychologie de l'Enfant et Pédagogie expérimentale. By Dr. Ed. Claparède. Second edition. Pp. viii+283. (Geneva: Librairie Kundig, 1909.) Price 3·50 francs.

THE second appearance of Dr. Claparède's book in a greatly enlarged form is an excellent indication of the interest which has been aroused by the effort of recent years to give a scientific basis to the practice of education. If further evidence were wanted, it will be found in the opening chapter, which gives a brief account of the development of the movement and of the literature of the subject. Child-study societies and child-study journals have an almost world-wide currency—from Japan in the Far East to California in the Far West. No doubt there is more zeal than science in much of the published work, but the critic is already at work, and we may hope that science will follow in his wake.

Dr. Claparède is a psychologist, and the interest of the book is mainly psychological. As a justification for the subtitle he makes certain pedagogic deductions, not, however, as tentative hypotheses upon which experimental inquiry may be founded, but rather as so many statements of fact. This seems unfortunate, and students of education who take up the book in the hope of deriving guidance and inspiration in their own class-room investigations will surely feel some disappointment. The dogmatic spirit in which the author treats certain fundamental issues is not reassuring. He finds, for example, that the prime motive power in the mental development of the young, is their inborn tendency to play and to imitate. Groos's interpretation of play is, in the main, accepted, and we are led into a strongly-worded plea for "attractiveness" as the sole principle in educational practice. The plea is backed up with the "best opinion," and ends thus:—

"It is true that certain scholastic successes may be obtained by the opposite method. But see later what the effect upon the victims is! Worked out at school, they are left without initiative, and the power of energetic action. They never become men because they have never been children."

This sweeping generalisation applies avowedly to the whole school system. Not a word of evidence is put forward in its support, though probably few of the readers of the book would regard it as a self-evident proposition. It is not a satisfactory method of laying the foundations of a science of education.

The author is more successful as an exponent of child-psychology pure and simple. He gives a brief summary of the various sources of our knowledge, and his chapter on mental development is a useful introduction to current views on the subject of play, imitation, and interest from the standpoint of biology. The student who is anxious to learn something of actual methods of research will find references to special monographs in the bibliographies appended to each chapter. It is only when he treats the subject of fatigue that the author himself gives detailed accounts of experimental methods the value of which readers can test for themselves. The curves which are given in the text of earlier chapters, showing the variations in suggestibility &c., at different ages, embody results of investigations the character and significance of which are not in any way discussed. Perhaps in a later edition the author may find it possible to strike out what is mere dogmatism, and enlarge upon those parts of his book which deal with scientific inquiry. The value of the book might in this way be greatly increased.

J. A. GREEN.

BOOKS OF REFERENCE IN ORGANIC CHEMISTRY.

(1) *Analyse und Konstitutionsermittelung organischer Verbindungen.* By Dr. Hans Meyer. Second enlarged edition. Pp. xxxii+1003. (Berlin: J. Springer, 1909.) Price 28 marks.

(2) *V. v. Richter's Chemie der Kohlenstoffverbindungen oder organische Chemie.* By Dr. R. Anschütz and Dr. G. Schroeter. Erster Band, Die Chemie der Fettkörper. Pp. xx+793. (Bonn: F. Cohen, 1909.) Price 18 marks.

(1) THE study of structure may be looked upon as the basis of all investigation in organic chemistry. It is the fundamental distinction between this and other branches of the science.

Whilst physical chemistry is chiefly concerned with the mechanism of reactions, inorganic chemistry with the conditions determining the formation of compounds, organic chemistry is mainly directed to synthetic processes, for which a knowledge of structure is essential. It is as an aid to this knowledge that Dr. Meyer's book has been written. That it has found favour with chemists and is regarded as a valuable addition to chemical literature is shown by the fact that within a few years of its first appearance the publication of a new and enlarged edition has been called for.

The volume before us has reached the respectable bulk of one thousand pages. The chief addendum is the second part, on the determination of the parent substance, containing chapters on oxidation, reduction, and alkaline fusion; many new methods have also been introduced, and older and less trustworthy ones discarded.

The book is too well known to need anything in the way of general description. It contains methods of elementary analysis, methods for determining molecular weights, for ascertaining qualitatively and quantitatively the presence of certain groups, and for breaking up the molecule into simpler fragments. One may look in vain for any serious omissions. On the other hand, the great variety of methods and the long lists of references are rather bewildering, and constitute, perhaps, the chief defect of the book. There has been, apparently, no attempt at critical examination. Every method and every modification of it seems to have found a place. The reader is left to make his own choice and to draw on his own experience.

We would take as an illustration the well-known method of Zeisel. The original and obsolete form of apparatus is described and pictured in detail, together with modifications by Benedikt and by the author (the latter being described as the simplest and most convenient), whilst the method of Perkin, generally adopted in this country, is only indicated by a reference along with five others.

We would not press this criticism too far. It is better to have too much information than too little, and if the reader has not the luck to discover at once the most suitable process, he will hit upon it in the end if he only perseveres.

It is needless to point out that the compilation of so much detail must have entailed immense labour, and has been carried out with painstaking German thoroughness. The book is well printed and illustrated, and should serve as a standard work of reference in the library of an organic laboratory.

(2) Twenty-five years ago Richter's "Organic Chemistry" appeared as a small companion volume to the one on inorganic chemistry. Since then each succeeding edition has steadily increased in bulk. A few years ago it was issued in two parts, and now it has been found necessary to enlarge the *format*. Nothing could illustrate more forcibly the growth of this branch of chemistry.

Whatever may have been the original purpose of the book, it has long ceased to be a text-book for students. One shudders at the thought of a student attempting to commit to memory such a mass of detailed information as is compressed into this volume It has developed into a portable book of reference, and as such is eminently useful and trustworthy for filling up gaps in one's knowledge as occasion requires.

Whilst deprecating the use of books of this type as class text-books, we do not share the feeling expressed by some that the bulk of new facts accumulated year by year in organic chemistry have little or no value, or that the motives which lead to their production are unworthy. The worst that can be said of multiplying compounds is that, without adding anything to the complexity of the subject, they fill in, as it were, the missing blocks in the picture puzzle, and merely complete what was anticipated; and as to the motives of those who produce them it may be pointed out that much of the research work of the compound-making type is done by young chemists as an exercise in that kind of skilful manipulation which counts for so much in every branch of chemical investigation, and for which organic chemistry seems so exceptionally well fitted.

J. B. C.

THREE FISH-FAUNAS.

(1) *Catalogue of the Fresh-water Fishes of Africa in the British Museum (Natural History).* Vol. i. By G. A. Boulenger. Pp. xi+373; illustrated. (London: Printed by Order of the Trustees; sold by Longmans, Green and Co., and others, 1909.) Price 32*s.* 6*d.*

(2) *The Fishes of Illinois.* By S. A. Forbes and R. E. Richardson, Nat. Hist. Survey of Illinois. Vol. iii., Ichthyology. Pp. cxxxi+387; plates, maps to accompany above, pp. 103. (Illinois, n.d.)

(3) *Andrew Garrett's Fische der Südsee.* Part viii. By A. C. L. Günther, Hamburg, Journ. Museum Godeffroy, vol. xvi. Pp. iv+261–388; plates, 141–160. (Hamburg: L. Friederichsen and Co., 1909.) Price 60 marks.

(1) THE zoological survey of the Nile, undertaken by the Egyptian Government during the administration of Lord Cromer, and the explorations of the great Central African lakes, initiated in that country, together with those of the Congo, carried out by the Belgian authorities, have resulted in an enormous expansion of the collection of African freshwater fishes preserved in the Natural History branch of the British Museum. That collection, moreover, as we are informed in the introduction to the first of the three works forming the subject of the present notice, contains a very large proportion of the type-specimens of the many new species which have been described as the result of the aforesaid explorations. It was, therefore, from all points of view highly desirable that a descriptive catalogue of this vast collection should be published, as such a work will serve as a basis for the discussion of the many points relating to the distribution and origin of the African fish-fauna, and likewise as a book of reference for workers in Africa itself, from which it can readily be ascertained whether specimens belong to already described species.

Mr. Boulenger, to instance only his volume on those of the Congo, published by the Government of the Congo Free State, has already devoted much study to African fresh-water fishes, and for this reason, coupled with his official position at the Museum, he was obviously the man to undertake the laborious task of writing this catalogue, which, it is considered probable, will run to three volumes.

The present volume, at all events to others than ichthyological specialists, will probably prove the most interesting of the three, as it includes some of the most distinctive and aberrant types of the African fish-fauna. To many naturalists it will be of special interest to learn that a shark (*Carcharias zambesiensis*) inhabits the Zambesi at a distance of 120 miles from its mouth, and also that a saw-fish ascends this and probably other African rivers to a considerable distance. Of the characteristic and peculiar Ethiopian types, two of the most remarkable are the bichirs (Polypterus) and Calamoichthys, the sole survivors of the fringe-finned ganoids, and the mud-fish (Protopterus). No fewer than ten species of bichir are now recognised, although the allied genus is still represented by a single known member; and there are two kinds of mud-fish.

Next in point of interest to these ancient types are the remarkable fishes forming the exclusively Ethiopian family Mormyridæ, many of the members of which display such extraordinary vagaries in the matter of beak-development—a development which has suggested for the group the not inappropriate name of elephant-fishes. Of these strange fishes eleven generic types are now admitted, some of which, such as Mormyrops (with thirteen), include a large number of species. It may be hoped that before long the author will take an opportunity of giving us his views as to the origin of this family, which, if determinable, will add considerably to our knowledge of th origin and relationships of the African fauna generally.

The other important family treated in this volume is the Characinidæ, which has a distribution similar to that of the Lepidosirenidæ, being common to Africa and Central and South America. The number of African genera admitted in the volume before us is twenty. The characinids, like the lepidosirenids, have been frequently quoted as affording evidence in favour of a land connection between Africa and America, but before it can be decided whether they are of any value in lending support to that theory, it is essential that their past history should be known.

Although we have not much to say in the way of criticism, it may be mentioned that *Elops saurus* (p. 25) has recently been shown by Mr. C. T. Regan to occur only on the American side of the Atlantic, and that there are now three African species of the genus, viz. *senegalensis*, *machnata*, and *lacerta*, the last of which is alone admitted in Mr. Boulenger's volume as a valid species. Then, again, family rank might well be granted to the genus Chanos. On the other hand, it is satisfactory to find that the author has recognised the correctness of Dr. Gill's removal of the Kneriidæ from among the Haplomi, and their transference to the neighbourhood of the Cromeriidæ. Finally, it may be pointed out that in the definition of the Cladistia the item "nostrils on upper surface of snout" is true of all the fringe-finned group, while in the definition of the Teleostei the statement that the supports of paired fins are dermal bones, and not endoskeletal elements, surely seems to stand in need of revision.

The volume is illustrated with a number of text-figures, for the most part of excellent execution, although some of these—apparently on account of the figures having been photographed from lithographs—are not printed so clearly as is desirable.

Mr. Boulenger and the trustees are to be congratulated on the issue of this valuable volume.

(2) Turning to the fishes of Illinois, it has first to be mentioned that the account of these by Messrs. Forbes and Richardson occupies a volume of cxxxi+387 pages of text, this being accompanied by an atlas showing the distribution of each species in the State. We learn from the introduction that the collections and field observations upon which this elaborate monograph are based were commenced so long ago as 1876, and continued, at somewhat irregular intervals, down to 1903. The establishment of a biological station in 1894 on the Illinois River at Havana first rendered it practicable to introduce exact methods of study and observation, such as had previously been impossible, and at the same time enabled the field-work to be conducted with greater regularity and continuity. The quantitative method of investigation, which yielded such good results in the case of the plankton, proved equally successful when applied to ichthyology.

In addition to numerous uncoloured illustrations in the form of both plates and text-figures, the volume contains a large number of coloured plates of Illinois fishes, which are admirable examples of modern colour-printing, and present life-like portraits of the species they portray. The monograph may, indeed, be regarded as a first-rate specimen of the thoroughness and completeness with which biological work is nowadays carried on in the United States, and of the excellent style in which the results are presented to the public.

The volume commences with an elaborate account of the topography and hydrography of Illinois, which is divided into a north-western unglaciated area, the areas of the Iowan and Illinoisian drift, the area of the Wisconsin drift, and the unglaciated southern area. This is followed by an equally full account of the river-systems of the State, after which we are furnished with notes on the fisheries of Illinois. All this occupies what may be termed the introductory portion of the volume, paged in Roman numerals, while the remainder is devoted to systematic work.

A total of 150 different species of fishes are recognised in Illinois. In the absence of geographical barriers to their dispersal, the causes influencing their distribution appear to be climatic, geological, and ecological. Geological limitations are indicated in the southern portion of the State by the fact that the area covered by the Illinoisian lower glaciation is inhabited by a certain number of species to the exclusion of others. An interesting fact in distribution is afforded by the existence "of a marked difference in preference of situation between nearly related species inhabiting the same area, the effect of which is to break the force of a competition between these species such as would prevail if they were similarly distributed ecologically as well as geographically. Closely related species are, as a consequence, often found much less frequently associated in their common territory than either is with widely unlike species of the same geographical range."

The Illinois fishes include the remarkable spoon-beaked sturgeon (Polyodon), locally known as paddle-fish, and now valued both for its flesh and as a source of caviare; and likewise true sturgeons, referable to the typical genus, and to the two exclusively American genera Scaphirhynchus and Parascaphirhynchus. The most interesting of these is the white sturgeon (*P. albus*), which appears to be a very rare species, represented only by about one specimen out of every three hundred examples of the common shovel-nosed *S. platyrhynchus*. Gar-pike and bow-fins form other exclusively American types among the Illinois fauna, and a large number of the genera of "white fish" are likewise solely American. The European perch is, however, represented by a nearly related species, and the same is the case with the bream; but one of the pikes of Illinois is inseparable from the well-known British fish. The authors of this monograph are to be congratulated on having made such an important contribution to the geographical study of fishes.

(3) Congratulations are likewise due to Dr. Günther on the completion of his famous work on the fishes of the South Seas collected for the founders of the Godeffroy Museum at Hamburg. This museum, we may remind our readers, was established by the Messrs. Godeffroy, the well-known Hamburg merchants, for the reception of the natural specimens collected by the officers of their vessels, and Dr. Günther accepted the task of describing the fishes, on the condition, we believe, that a selection of specimens, including all types, should be given to the British Museum. The portions of the work previously published were issued between 1873 and 1881, but for financial reasons the publication came to an end in the latter year. Now, through the generosity of Dr. W. Martin von Godeffroy, the means of completing the work have been provided, and Dr. Günther has, fortunately, been enabled to bring his long-delayed task to a successful conclusion. It should be added that a number of coloured illustrations of the Godeffroy fish collection were prepared by Andrew Garrett, and from these some of the beautifully coloured plates accompanying the present volume have been reproduced.

Since the issue of the preceding part of the work great advances have been made in our knowledge of the fishes of the South Seas, more especially as regards those of the Sandwich and certain other islands; and to correlate this new work with the material in hand required a large amount of investigation. Fortunately, this work could be most effectively done at the British Museum, where a large series of the Godeffroy fishes are preserved, and where also large collections of fishes from the Indian Ocean are available for comparison with those from the South Seas. The result of these investigations and comparisons has been to produce order and certainty where uncertainty and chaos—as regards the identification of species and the determination of their synonymy—previously prevailed to no inconsiderable extent.

Littoral forms of fish-life occupy a considerable portion of the part now before us, although a section is devoted to flying-fish and other pelagic types; but the deep-sea fishes do not come within the purview of the work. Coral-fishes, or coral-wrasses, of the family Labridæ, are treated in the commencement of the present part, and the brilliant hues and remarkable colour-patterns of these gorgeous fishes are most admirably rendered in the accompanying plates. Our sole regret is that the author appears to have made no attempt to explain the mutual relationships and special purpose of these varied markings. Ichthyologists will greatly appreciate the author's careful revision of the large number of species of flying fishes inhabiting the South Seas; but students of the habits of animals will perhaps regret that Dr. Günther has maintained a cautious reserve with regard to the manner in which these fishes perform their aërial flight. Both the "aëroplane" and the "vibration" theories are mentioned, with references, but the author does not give even a suggestion as to which he considers to be the more probable explanation.

With the bare mention that no new species are described, we repeat our congratulations to Dr. Günther on the completion of his long-deferred task.

R. L.

OUR BOOK SHELF.

Further Advances in Physiology. Edited by Leonard Hill, F.R.S. Pp. vii+440. (London: E. Arnold, 1909.) Price 15*s.* net.

THIS is the second volume of original articles issued under the editorship of Mr. Leonard Hill. The first appeared about three years ago, and was reviewed in NATURE, May 3, 1906. That the publishers have seen fit to issue a second volume is an indication that the first was a success. The present volume treats of a number of interesting and important questions which have recently been subjects of research among physiologists, and the senior student is thus provided with a summary of the latest views which otherwise it would have been impossible for him to have obtained without much labour and exploration in many journals. The idea of the book is thus excellent; one's only fear is that in the presentation of a good deal of controversial matter even the best of students may sometimes lose himself and wish there was more agreement among physiological workers. In some of the articles more attention is paid to points of difference than to points of agreement, and general conclusions to help the reader in the maze are not always forthcoming. On the other hand, from the point of view of the researcher, the descriptions given of recent work are too fragmentary in some cases to be of any real help, though perhaps this may be wise, for anything which tempts the original worker to neglect reading the actual writings of his predecessors on the same road is to be deprecated.

The articles contained in the book are the following:—Prof. B. Moore opens with a consideraton of the equilibrium of colloid and crystalloid in living cells; Mr. M. Flack comes next with an article on the heart, in which, *inter alia*, he discusses the *pros* and *cons.* of the myogenic and neurogenic theories; Dr. T. Lewis deals with pulse records in relation to the events of the human cardiac cycle; the editor advances his heterodox views on the part played by blood-pressure on such phenomena as lymph production and secretion; Dr. A. Keith contributes an anatomico-physiological article on the mechanism of respiration; and Dr. M. S. Pembrey an extremely useful essay on the physiology of muscular work; the problems of growth and regeneration of nerve, and the nature of the nerve impulse, are then considered by Dr. N. Alcock; Dr. J. S. Bolton treats of cortical localisation, and Marie's views on Broca's aphasia are described; and the volume concludes with an article by Mr. M. Greenwood on visual adaptation and colour vision.

The mere enumeration of the subjects treated indicates the wide-reaching interest of the book, and the names of the authors are a sufficient guarantee that the work is well done.

Weltsprache und Wissenschaft. Gedanken über die Einführung der internationalen Hilfsprache in die Wissenschaft. By L. Couturat, O. Jespersen, R. Lorenz, W. Ostwald, L. Pfaundler. Pp. iv+83. (Jena: Gustav Fischer, 1909.) Price 1 mark.

THAT an international language for scientific communication is desirable no one will question; that an artificial language will ever be generally adopted for such a purpose is more than doubtful. If success in this direction is to be attained, it will probably be on the lines indicated in the present pamphlet, which is a kind of unofficial manifesto of the "Délégation pour l'adoption d'une langue auxiliaire internationale" appointed in 1900. A commission including scientific and linguistic experts of different nationalities is more likely to devise an acceptable language than any individual, who of necessity suffers from the prejudice of his mother-tongue and a comparatively limited knowledge of the requirements of the new medium. After seven years' deliberation, the international delegation has adopted most of the principles of Esperanto, but with great modifications in detail.

For Europeans and Americans the fundamental requisites of a common artificial language are:—(1) a simple phonology and alphabet, only such sounds being admitted as are in actual use amongst all the principal European peoples (exclusion of English *w* and *th*, German modified vowels, French nasals); (2) a vocabulary composed, as far as may be, of words comprehensible at sight to cultivated Europeans; (3) as little grammar as possible. These principles are generally followed in the new lauguage "Ilo," the Slavonic peculiarities of Esperanto (*e.g.* the circumflexed consonants and absurd terminal j's) being carefully avoided. The vocabulary has a distinctly Romanic appearance, and grammar is reduced to small proportions, which might with advantage be smaller still. Word-formation from stems by means of prefixes and suffixes is systematic, but needlessly complicated. Why should we, for example, have the prefix *bo-* to indicate relationship by marriage? "Father-in-law"=*bopatro* is not a necessary word; "wife's father" or "husband's father" is equally simple and more definite. Again, to use *-isto* for "professional" and *-ero* for "amateur" is making a rather superfluous distinction. It may be convenient occasionally to distinguish between *fotografisto* and *fotografero*, but in the case of, say, *dentisto* and *dentero* the necessity is not so obvious.

Notwithstanding its shortcomings, "Ilo" is a great advance on its predecessors, and men of science who are interested in the general scheme may be cordially invited to join the "Uniono di l'amiki di la linguo internaciona." But for the general adoption of the language much enthusiasm will be needed, and it is rather disquieting to read in a specimen sentence:—"Omna entuziasmo posedas per su la tendenco, ne klarigar, sed trublar l'okulo di l'intelekto."

Einführung in die Lehre vom Bau und den Verrichtungen des Nervensystems. By Prof. Ludwig Edinger. Pp. iii+190. (Leipzig: F. C. W. Vogel, 1909.) Price 6 marks.

This is an excellent work consisting of fifteen lectures on the various parts of the central nervous system. Dr. Edinger has a very pleasant way of introducing information concerning the functions of the nervous structures as he describes them, a feature which makes his works much more readable than those which give merely geographical descriptions of the parts under consideration. Another feature of the present work is that it keeps the reader constantly informed respecting the comparative anatomy and evolutionary antiquity of the particular structure he is studying.

The book consists of 190 pages, but there are probably less than 100 pages of letterpress owing to the generous way in which it is illustrated. There are no fewer than 161 diagrams, in addition to a plate showing the development of the Neencephalon over the Palæencephalon. The diagrams are so clear and helpful to the student that a mere smattering of knowledge of the German language is probably all that is necessary for the book to be a useful addition to his library.

The first chapter, on methods of investigation of the nervous system, is largely historical; the second is devoted to the study of the histological elements; while the third is a charming combination and correlation of the histology, physiology, embryology and comparative anatomy of the nervous system as a whole. The author then presents a general survey of the brain and spinal cord, and subsequently discusses the various tracts of the spinal cord and traces them from their origin to their termination. Then follow chapters on the pons, cerebellum, mesencephalon, basal ganglia and connections of the optic nerve. The last four chapters are devoted to the various portions of the cerebrum, the corpus striatum, connections of the olfactory nerve, the internal capsule, &c.

On p. 61 there are two diagrams of the root distribution of cutaneous sensation (front and back views) which, so far as our memory serves us, are not in accordance with the findings of Head, Starr or Thorburn, and we are inclined to think that Edinger's diagrams are incorrect.

The addition of an index to the book would greatly enhance its value.

Annuaire astronomique de l'Observatoire royal de Belgique, 1909. Published under the direction of G. Lecointe. Pp. vii+347+258. (Brussels: Hayez.)

Of the numerous publications of the Brussels Observatory, none is, perhaps, more generally useful than this "Annuaire," and we know of no other annual which excels it in general usefulness. All the usual tables, ephemerides, &c., relating to the sun, moon, planets, comets, and stars are contained in the first part, which is followed by explanations as to how to use the tables, and a long list of the names and positions of the principal observatories of the world. A very useful and explicit statement of the legal time used in various countries is clearly illustrated by a folding map, particoloured to show the countries which have so far adopted "universal" time and those which have not; the date line is shown in detail too.

Other parts of the "Annuaire" deal with surveying problems—there are some useful formulæ and forms for amateur surveyors—the form of the earth and the more recent work in astronomy. 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.*]

Mining Administration in India.

In view of the recent attacks made in the London *Mining Journal* on Mining Administration in India, and also, both directly and indirectly, on the director of the Geological Survey, we have deemed it advisable to send you the following extracts, one of which is taken from the *Mining Journal* of June 26, p. 801, and the other from the published evidence given by Sir Thomas Holland before the Royal Commission upon Decentralisation, and published in Blue-book Cd. 4369 (vol. x. of Minutes of Evidence, p. 47):—

From the *Mining Journal* of June 26, p. 801, leading article, headed "Mining Administration in British India."	Evidence of Sir Thomas Holland, director, Geological Survey of India, published in Blue-book Cd. 4369, being vol. x. of the Minutes of Evidence taken before the Royal Commission upon Decentralisation in India, p. 47:—
"We cannot close our observations on the evidence tendered to the Commission without noting the light thrown by the report on the sincerity of Sir Thomas Holland's attempt to suggest that we had imputed corruption to Government officials in India. As an argument against the establishment of a separate Provincial Survey, the director of the Geological Survey said:—	Question No. 43455: "Is not an officer who has to deal with mining concessions in any part of the world subject to great temptation?"
"'If I transferred an officer, say, to Burma, or any province beyond my control, and he was the officer who governed the granting of mining concessions, I have not the slightest doubt that within a year, if he had only ordinary intelligence, he would discover that his salary *would*[1] be only a fraction of his income.' We do not remember even to have seen the chief of what is professedly a scientific body so frankly confess his distrust of his colleagues' honesty and professional pride."	"Yes; if I transferred an officer, say to Burma, or to any province beyond my control, and he was the officer who governed the granting of mining concessions, I have not the slightest doubt that within a year, if he had ordinary intelligence, he would discover that his salary *need*[1] be only a fraction of his income."

By changing one word in quoting the Blue-book, the *Mining Journal* has altered the whole meaning of the remarks made by the director. In view of the comments made, it is for the *Mining Journal* to prove that this misquotation is accidental. Having regard to the claim of the *Mining Journal* that it "circulates all over the world," the writer of the article must know that it will be read by many to whom the Blue-books are not accessible, for no assistance has been given by a reference to the particular volume in which the director's evidence is recorded. As the inaccurate quotation has already received a start of some weeks before reaching us in India, we shall be glad if, by publishing this letter, you will assist in preventing any further dissemination of a grossly unjust insinuation.

With this sample before them, we can safely leave your readers to estimate the value of the attacks on the Indian administration recently made in the *Mining Journal.*

Needless to add, the relation between us and Sir Thomas Holland is one of perfect and mutual confidence.

We have been unable to communicate with three of our

[1] The italics are ours.

colleagues, who are at present absent in the field, but we are convinced that if they had the opportunity they would join with us in appending their signatures to this letter.

T. H. D. La Touche, H. H. Hayden (Superintendents, Geological Survey of India).

P. N. Datta, E. Vredenburg, L. L. Fermor, G. E. Pilgrim, G. H. Tipper, H. Walker, K. A. K. Hallowes, G. de P. Cotter, J. J. A. Page, H. C. Jones, A. M. Heron, M. Stuart, N. D. Daru (Assistant Superintendents, Geological Survey of India).

W. A. K. Christie (Chemist, Geological Survey of India).

Geological Survey of India, Calcutta.

An Optical Phenomenon.

In reference to the query of "V. P." in Nature of June 3 (p. 398), under the above title, I describe a simple experiment which will, in all probability, lead to an easy explanation.

Allow sunlight to fall upon a vessel filled with water to a depth of a few inches. If the bottom be white, so much the better. A bath-tub is excellent. Now draw a finger through the water so as to produce a wake, in which are to be seen the familiar "dimples" characteristic of vortex motion. Then, on the bottom will be observed, corresponding to each dimple, a black shadow with a brilliant edge, just the same sort of appearance, in fact, as that described by your correspondent. The same, by the way, may be observed in shallow brooks.

The explanation in this case is not difficult. A very small central portion forms a concave lens, the enfeebled illumination of which on the bottom is negligible. The portion surrounding this and extending as far as the plane water-surface acts somewhat after the manner of a convex lens, concentrating the light passing through it into a more or less sharply defined ring, a "focal ring," so to speak, as contrasted with a "focal point." The diameter of this ring would approximate that of the whole dimple. By far the greater part of the light falling upon the area of the dimple is collected here, and, consequently, the field within appears black aided by contrast. It is easy to see that an essential is the relative smallness of the concave part of the dimple, as is borne out by failure to obtain the phenomenon on a large scale by stirring water in a beaker.

Now, following up this experiment and considering window-panes, one would expect to find there flaws of a dimpled nature, or else of a corresponding heterogeneity of refractive index. The former I have found to be the case, especially surrounding air-bubbles, as is easily to be detected by the touch in many cases. The formation of these flaws could be accounted for by the contraction of the air during cooling in process of manufacture. Moreover, in this instance, the bubble itself, forming the concave lens, need not always be small, since it is usually of a focal length far shorter than that of the surrounding portions of the pane.

Flaws of this type are rarer than those of an opposite or protruding type, which, of course, produce patterns with a white centre. L. G. Hoxton.

University of Virginia, July 26.

A Question of Percentages

In reply to the letter on the "Calculation of Percentages" in Nature of August 5, may I venture the opinion that the only common-sense method of finding the percentage of marks gained by a student in a series of examinations is to add together all the marks obtained by the student, and find what percentage this total is of the maximum possible?

By this method the more difficult papers, which have a greater number of marks allotted to them, retain an important proportion in the result, whereas the elementary papers, which are worth only a few marks, have only a small influence on the final percentage.

If one were to calculate the percentage for each paper, and then average these percentages, this would manifestly be the same as giving the same number (*i.e.* 100) of marks for each paper. This would necessitate equal difficulty in each paper set. Lewis Whalley.

39 Clarendon Street, Keighley, Yorks, August 13.

In Nature of August 5 Mr. Cunningham appeals to mathematical readers for information on the question of averaging three results, viz.:—

$$37/50+50/50+71/100,$$

either giving

$$(37+50+71)/200=79/100$$

or

$$(2\times37+2\times50+71)/300=81\tfrac{2}{3}/100.$$

Though I am not a mathematician, but a chemist, I trust I can give the required answer.

The way of averaging depends on the weight of the single results. By the latter way of calculating, the third result affects the average with twice the weight of the former way. Equal weights for each result require equal denominators. Taking for a very simple instance the problem of averaging between 20/100 and 40/100, which is obviously 30/100, the first way of averaging, as proposed by Mr. Cunningham, would permit a calculation like this (20/100 being $=2/10=1/5$, &c.):—

$$2/10+40/100=42/110 \text{ or } 1/5+40/100=41/105,$$

or (40/100 being $=400/1000=4000/10,000$)

$$1/5+400/1000=401/1005 \text{ or } 1/5+4000/10,000=4001/10,005.$$

These results, I believe, will explain better than many words the essential point of this question.

Breslau, Parkstr. 13. R. Abegg.

Kohlrausch's "Physical Measurements."

Replying to the letter of Mr. Nelson in Nature of August 12, the value given for the k in question in the ninth German edition of "Kohlrausch's Lehrbuch der praktischen Physik" (1901) is 0·457. But it must be borne in mind that this value is deduced on the assumption that the specific gravity of the brass weights is 8·4, and seeing that the specific gravity of various samples of "brass" varies not inconsiderably, it is immaterial whether one uses 0·457 or 0·458 for the correction factor. The rounded value, 0·46, is near enough for most purposes, and that is the one given in the tables of Landolt-Birnstein. For accurate work the specific gravity of the weights must be determined in any case, and the value of k calculated for these particular weights.

G. Rudorf.

"Ivor," Cranley Gardens, Muswell Hill, London, N., August 12.

A Kinematical Illusion.

The following experiment is easily tried, and throws, I think, some light on a certain type of illusions.

A small cogwheel from an old American clock is the only apparatus required. Holding the axle in the finger and thumb of the right hand, give it a twirling motion, say counter-clockwise. Let the teeth of the wheel click gently against a small card, or the finger-nail of the left hand. On looking at the wheel the spokes appear to revolve counter-clockwise (as they do) and the teeth to revolve in the reverse direction. C. S. Jackson.

25 Nightingale Place, Woolwich.

RÖNTGEN RAYS IN THE DIAGNOSIS OF DISEASE.

Great development has taken place in the last few years in the application of Röntgen rays to the diagnosis of disease. At first it was only possible to show the shadows cast by bones and by dense foreign bodies, usually metallic bodies. With improvement in apparatus and in method, the art of radiography has advanced in such a way that it is now possible to show, not only the outlines of the bones, but minute details of their structure, and, more than this, a considerable amount of detail can now be shown in the soft parts of the limbs. While at first surgeons alone found X-ray diagnosis useful, as in the diagnosis of fractures, dislocations, and foreign bodies, the physicians have gradually been able to take advantage of the useful properties of the Röntgen rays, and, indeed, the physicians commenced the use of this method of diagnosis very early, since it was found that the heart and aorta cast a fairly distinct shadow. Before long it was shown that certain diseases of the lungs were also recognisable, and still later some of the other organs, notably the kidneys and the liver, were added to the list of organs which were accessible to Röntgen-ray diagnosis. At the present time, not only these various organs, but the entire length of the alimentary canal can be revealed and explored. Opacity to Röntgen rays is almost entirely a function of density. Of the substances which enter into the construction of the human frame, the least dense is air. The healthy lungs have their spongy tissue filled with air, and they are, therefore, the most transradiant organs of the body. The lungs are contained in the thin-walled chest, so that there is very little substance to interfere with their transradiancy. In examining the chest upon the fluorescent screen, it is seen that the act of deep inspiration increases the transradiancy of the lungs, the shadows cast by the ribs being shown up in greater contrast than during expiration. This is exactly what would be expected, since the spongy tissue of the lungs becomes blown up and filled with air during the act of inspiration. The heart and aorta are far denser organs, and they are shown up in strong relief against the background of the air-containing lungs. It is, therefore, quite easy to estimate the size, shape, and position of the heart and aorta.

It must be remembered that the shadow cast upon the fluorescent screen (or obtained by photography upon a photographic plate) is greater than the actual size of the organ. For some purposes it is important to obtain an accurate measure of the true size of the heart. In this case the X-ray tube—which nowadays is always enclosed in an opaque box or shield—is so arranged that there is only a small opening through which the X-rays can emerge and penetrate the patient's body. The apparatus is arranged so that the X-ray tube can be moved to any position in its own plane. If the tube be moved around the margins of the heart, and these margins be marked out upon the glass which covers the front of the fluorescent screen, an outline of the heart is obtained upon the glass, and represents the true projection of the heart in the plane of the fluorescent screen, and for practical purposes this may usually be regarded as representing the true size of the heart. The pulsations of the heart and of the aorta can be studied minutely upon the fluorescent screen.

Coming now to the lungs, it will be clear that any tumour or condensed area in the lungs will be shown up in relief against the air-containing healthy lung tissue. In this way the consolidation due to phthisis is shown even in the earliest stages of the disease. For instance, there may be slight diminution of transradiancy near the apex of one lung. On deep inspiration the whole of the lung becomes more transradiant, showing up the impaired apex in stronger contrast. There are other signs observable on the fluorescent screen in phthisis; thus the range of movement of the diaphragm is much restricted. In more advanced phthisis the congested areas are shown as dark shadows, and in very advanced disease where there are cavities in the lung these cavities are frequently visible as lighter areas with irregular outlines surrounded by a darker area of congested lung. Other diseases of the chest, tumours in the glands, cysts, &c., are shown against the light background of the healthy lungs.

When there is fluid accumulated in the pleural cavity, *i.e.* between the chest wall and the lungs, it is necessary to examine the patient in the upright position in order to obtain the effect of gravity in causing the fluid to take up a position at the base of the chest. Fluid in the chest is very opaque when compared with the transradiancy of the lungs. When fluid begins to collect in the chest it is found at the most dependent part of the chest, where the diaphragm is attached to the chest wall. As the fluid accumulates, the opaque area increases upwards, its upper limit forming a curved line concave upward, the direction of which is from the middle line of the body upward and outward. The greater the quantity of fluid, the higher and the steeper does the position of this line become, but with increasing accumulation of fluid the lung itself, which is floated up upon the fluid, becomes more and more compressed, and, therefore, less and less transradiant, so that the line which separates the liquid from the lung becomes more and more ill-defined, and finally disappears altogether, the whole of this half of the chest becoming uniformly opaque, since the lung itself has become so greatly compressed that it no longer contains any appreciable quantity of air. As the fluid accumulates, it is observed that the heart becomes displaced further and further to the opposite side of the chest.

The foregoing description refers to cases in which there is an accumulation of liquid only, but in other cases (known as hydropneumothorax) not only is there a collection of liquid in the pleural cavity, but there is also free air in this cavity. In this case the appearances are fundamentally altered, for there is now a sharply-defined horizontal line of demarcation between the liquid and the air. The lung itself is collapsed, and usually occupies a small space close against the middle line of the body. The heart is displaced to the opposite side of the chest. We have here the physical conditions of a liquid contained in a vessel and placed in air. On tilting the patient, the liquid is at once seen to flow in a direction which enables its upper surface again to become horizontal. If the movements of the patient are fairly rapid, waves are produced in the liquid, and this is still better seen if the patient shake himself or be shaken. It frequently happens that the heart beats against the liquid and sends a regular series of waves along the surface of the liquid. Hitherto, in forming their opinion as to the nature of diseases of the chest, physicians have been dependent upon the information derived from the application of percussion and auscultation, and although very accurate information can in many cases be obtained by these methods, a Röntgen-ray examination is still of great importance in confirming the conclusions obtained from the other clinical methods of examination, and in supplementing information thus obtained. Thus in phthisis the degree and extent of the affected lung is shown with far greater accuracy by the Röntgen-ray method than by the methods of percussion and auscultation, and in many cases pulmonary lesions which are quite unrecognisable by percussion and auscultation may be clearly shown upon the fluorescent screen. In other cases the Röntgen-ray examination leads to a diagnosis entirely different from that obtained by percussion and auscultation.

In the examination of the abdomen, the conditions are very different from those which prevail in the case of the chest. There is usually no air in the abdominal cavity except such as may be contained in the stomach or in the large intestine. Consequently, the only structures which stand out in strong relief are the bones, viz. those of the vertebral column, the hip bones, and the lower ribs. There is a way, however, in which the conditions in the abdomen may be made more to resemble those found in the chest. Air may be forced into the large intestine, and its passage along the course of the intestine followed on the fluorescent screen. The air forms a very definite band of relatively high transradiancy. The size, shape, and position of all parts of the large intestine can usually be traced out by this means. The presence of air has a further advantage in that the solid organs of the abdomen stand out in sharp relief against the light background formed by the air-containing large intestine. Thus the lower edge of the liver is shown up as a well-defined margin; the upper margin of the liver is always obvious, as its domed surface lies in contact with the diaphragm on the right side, and has the base of the right lung immediately above it. On viewing the patient's back (especially if he lie prone on a couch with a loosely filled air-pillow under the abdomen, the X-ray tube being contained in a box under the couch), the shadows of the kidneys are shown one on each side of the vertebral column, and their movements up and down with respiration are easily observed. Should either kidney contain a calculus (stone), this is shown on the fluorescent screen, and it is seen to move with the kidney on respiration.

In a large proportion of cases in which there are symptoms suggesting the presence of a calculus, the Röntgen-ray examination shows that no calculus is, in fact, present. On the other hand, cases are by no means uncommon in which one or more calculi are found by the Röntgen-ray examination, when the clinical examination had led to an entirely different diagnosis. In these cases the calculi may be removed by the surgeon, and the patient cured.

There is another, an indirect, method of studying the digestive canal. For this method we are indebted to Prof. Rieder, of Munich, who discovered that large doses of bismuth salts may be given to patients without fear of ill effects. The salt used by Rieder in the first instance was the sub-nitrate. Unfortunately, several cases occurred in America in which the administration of large doses of sub-nitrate of bismuth was followed by fatal results, and we now know that this result was due to the formation of nitrous acid in the stomach, probably through the action of bacteria The carbonate of bismuth is now commonly used, and it is a perfectly inert and harmless substance. Two ounces is the dose usually employed, though three or four ounces may be given at a time. It is important to use a pure preparation, for the presence of arsenic or selenium as an impurity becomes an important source of danger where large doses are used.

By placing the patient upright in front of the X-ray tube, and trans-illuminating him in an oblique direction, the course of the food-pipe is revealed, occupying a clear space in front of the vertebral column. If the patient be now given an emulsion containing about two ounces of carbonate of bismuth to drink, the course of this drink from the mouth to the stomach can be observed upon the fluorescent screen, as the bismuth-containing fluid throws a very opaque shadow. Any obstruction in the food-pipe, or any deviation in its course, at once becomes apparent. The bismuth having passed through the food-pipe, it is now seen in the stomach occupying the most dependent part of that organ. The opening in front of the X-ray tube-box is now closed down to a small size, and this part of the stomach is examined in detail. The regular contractions by means of which the contents of the stomach are expelled into the small intestine may now be observed, and any irregularity in the shape of the stomach or obstruction at its orifice is clearly shown.

Some hours later the course of the bismuth meal may be clearly traced in its path through the large intestine, and here again the exact size, shape, and position of all parts of the large intestine is shown in strong relief through the opaque mass of bismuth with which the fæcal masses are mixed. These bismuth meals thus constitute a most valuable diagnostic method, and pathological conditions, the recognition of which is of extreme importance, are frequently shown in a manner more certain than is to be obtained by any other means of diagnosis.

One of the newest books dealing with the Röntgen-ray method of diagnosis as applied to diseases of the chest is that of Dr. Hans Arnsperger.[1] Improved apparatus and improved methods have led to so rapid an advance in this branch of study that few physicians have been able to keep pace with it. The literature is already large, and is rapidly extending. Dr. Arnsperger has given a full review of the literature, and has made a full and laborious exposition of the subject. He has lost no opportunity of discussing the application of the Röntgen-ray method to the elucidation of contentious problems in physiology and pathology. It is true some of the physiological views expressed by those who have studied the Röntgen-ray appearances do not tally with the results of physiological experiment; still, many important practical questions are discussed in a useful manner.

Dr. Arnsperger is careful to lay emphasis on the importance of using the Röntgen-ray method in conjunction with other clinical methods of diagnosis, for it is rarely safe to rely on a Röntgen-ray examination unassisted by a knowledge of the clinical history of the case. It is true that in a case of phthisis (for instance) the extent and distribution of the disease may be shown with great accuracy on the fluorescent screen or on a photographic plate, but in other cases the Röntgen-ray picture is capable of various interpretations, and the most useful information will be derived from the Röntgen-ray examination if the clinical aspects of the case are fully known. Dr. Arnsperger points out the advantages of the fluorescent-screen examination as compared with the examination of skiagrams. Screen examinations enable observations to be made of the living processes in the body, the movements of respiration, the beating of the heart, the pulsation in the aorta, the peristaltic contractions of the stomach, and so on. Skiagrams are chiefly useful in enabling permanent records to be obtained of the appearances described. In some cases, however, the skiagram shows more detail than is to be seen on the more coarse-grained fluorescent screen, and this applies particularly to the quiescent parts of the body, notably the bones and joints. Dr. Arnsperger's book contains twenty-seven plates, upon which fifty-two photographs are reproduced by the half-tone process. It is unfortunate that no known process of reproducing photographs in print represents successfully all the detail which the original negatives show.

A. C. J.

THE CYANAMIDE INDUSTRY OF FRANCE.[2]

In 1895 Frank and Caro laid the foundations of an important industry by discovering that barium or calcium carbide absorbs nitrogen at a temperature of 800°, and is converted into a cyanamide. They expressed the change by the following equation:—

$$CaC_2 + 2N_2 = CaCN_2 + C.$$

The cyanamide thus produced is a useful nitrogenous manure of the same class as ammonium sulphate, but has the further advantage of adding a calcium compound to the soil.

[1] "Die Röntgenuntersuchung der Brustorgane und ihre Ergebnisse für Physiologie und Pathologie." By Dr. Hans Arnsperger. Pp. 263+27 plates. (Leipzig: F. C. W. Vogel, 1909.) Price 12 marks

[2] A paper by M. Pluvinage in the Bulletin de la Société d'Encouragement pour l'Industrie Nationale, No. 3, vol. iii.

Cyanamide is made in France at the village of Notre Dame de Briançon, near to Montiers (Savoie). Abundant water-power is available, and is, of course, an essential condition for the success of the industry. At the power station there are now three turbines of 2200 h.p., but provision is made for more when necessary; these produce a three-phase current of 15,000 volts, which is conducted a distance of 11 km. to the factory. There it is transformed; part is used for making calcium carbide, and part for making cyanamide. The calcium carbide obtained has a purity of 80·5 per cent., estimated with sufficient accuracy by measuring the volume of gas evolved on treatment with water. Nitrogen is prepared by Linde's method. Liquid air is fractionated, and the vapours made to pass through a column, where they meet with liquid air, and then, higher up, with liquid nitrogen; in these circumstances, the percentage of oxygen in the issuing vapours is reduced to 7, and then finally to zero.

The calcium carbide is broken up and placed in an electric furnace, about 300 kilos. forming the charge. It is raised to a high temperature in presence of a stream of nitrogen; the operation may last from eighteen to fifty-six hours. The resulting hard mass is then reduced to a fine powder. The daily production is at present 10 tons, but this output could readily be doubled. It is estimated that 2 tons of carbide can be produced per kilowatt per year, and that 2 tons of carbide combine with 500 kilos. of nitrogen. Two grades of cyanamide are sold—one containing 15 per cent. of nitrogen, *i.e.* the quantity present in nitrate of soda, the other containing 20 per cent., the quantity present in sulphate of ammonia. The latter grade also contains 20 per cent. of lime, 7 to 8 per cent. of silica, oxides of iron and aluminium, and 14 per cent. of free carbon, to which the dark colour is due.

When added to the soil, it is rapidly decomposed by bacteria to form calcium carbonate and ammonia thus:—

$$CaCN_2+3H_2O=CaCO_3+2NH_3.$$

The ammonia is then nitrified and taken up by plants.

Direct field trials to ascertain its manurial value were first made in 1901 by Gerlach and Wagner, and have since been repeated in other countries. All experiments prove its value, and show that it is comparable in its effects with sulphate of ammonia. It should be applied before sowing, and may be mixed with basic slag or potassic manures, but not with superphosphates. The dressing recommended is 150 kilos. to 250 kilos. per hectare, or $2\frac{3}{4}$ cwts. to $4\frac{1}{2}$ cwts. per acre, the smaller dressing for cereals, the higher for potatoes and beets. In England it would not be customary to use for these crops more than half the above quantities of "artificial" nitrogenous manures.

THE "PREHISTORIC HORSE" OF BISHOP'S STORTFORD.

A COMPLETE skeleton of a horse was recently found during excavations at Bishop's Stortford. As this skeleton lay in an extended position some six feet below the surface in a deposit which had apparently never previously been disturbed by man, it is conceivable that it belongs to a wild variety which inhabited England in prehistoric times. The Rev. Dr. Irving first thought the skeleton might belong to Hipparion (*Standard*, May 24), but he eventually came to the conclusion that it is the remains of a horse of the Neolithic or Bronze age.

Unfortunately, it seems to be impossible to determine the age of the deposit in which the skeleton was found. The examination of the skull, teeth and limbs indicates that the Bishop's Stortford horse differs from all the known wild horses of the Pleistocene period—from, *e.g.*, the small, stout horse of the "elephant" bed at Brighton; the small, slender-limbed horse of the Oreston Cavern, believed by Owen to be an ass or a zebra; the Prejvalsky-like diluvial horse of Remagen; and the coarse-limbed horse of Westeregeln. On the other hand, the horse described by Dr. Irving and figured in the *Illustrated London News* (June 5) closely resembles a variety from Walthamstow believed to be of Neolithic or Bronze age. This Walthamstow horse was probably a blend of a "forest" and a "steppe" variety in which the broad-browed forest ancestors were dominant. The limb bones indicate that the Bishop's Stortford horse measured from 14 to 14·2 hands (56 to 58 inches) at the withers—several inches more than the Walthamstow horses represented in the British Museum.

It is generally assumed that the horse did not live under domestication in Britain until the end of the Bronze or the beginning of the Iron age, and that the native British horses up to the coming of Cæsar were too small to carry men. The Bishop's Stortford horse was, however, as large and powerful as the Galloways used in border raids. Should the Bishop's Stortford horse be proved to be of Neolithic or Bronze age, we may have to modify our views as to the size of the horses in the possession of the ancient Britons. For an opportunity of examining the skull and limb bones of the Bishop's Stortford horse, I am indebted to the Rev. Dr. Irving.

J. C. EWART.

METEOROLOGICAL STUDIES AT THE BLUE HILL OBSERVATORY.[1]

(1) THIS is an account of the methods employed and the results obtained at St. Louis. Seventy-seven ascensions were made, and in most cases good traces were obtained. The funds were supplied partly by grants from the Exposition Company and from the Hodgkins fund of the Smithsonian Institution, and the remainder by Prof. Rotch.

A very large proportion of the balloons were found, a proportion looked upon with envy by those engaged in similar work in England, and this occurred notwithstanding the fact that they were mostly sent up in the evening to escape the chance of solar radiation.

A full description of the method of working and of calibrating the instruments is given, and every care seems to have been taken to secure accuracy in the results; but it is incorrect to say that the only method of making the registration yet devised is that of writing on a smoked metal surface. The plan of scratching on an electro-plated but unpolished silver surface has answered excellently in England, and Mr. Field's plan of using glass silvered lightly by the ordinary solution seems to be quite satisfactory.

The results from each ascent are published in full, and it appears that about half the ascents afforded records up to 10 kilometres in height. The general conclusion is in striking agreement with that obtained

[1] (1) "Exploration of the Air with Ballons-sondes at St. Louis and with Kites at Blue Hill." By H. Helm Clayton and S. P. Fergusson. Pp. 92; 11 plates. (Cambridge, Mass.: The Observatory, 1909.)
"Annals of the Astronomical Observatory of Harvard College." Vol. lxviii., part i., Observations and Investigations made at the Blue Hill Meteorological Observatory, Massachusetts, U.S.A., under the direction of A. Lawrence Rotch.
(2) "Annals of the Astronomical Observatory of Harvard College." Vol. lviii., part iii., Observations and Investigations made at Blue Hill Meteorological Observatory, Massachusetts, U.S.A., in the year 1905, under the direction of A. Lawrence Rotch. Pp. 147–228; 2 plates. (Cambridge, Mass.: The Observatory, 1908.)

on the Continent and in England, excepting that the minimum temperatures are somewhat lower there than on this side of the Atlantic. This is probably on account of the lower latitude. The gradients for the various seasons are given, but the distribution of the ascents is not wide enough to make these figures of much value. Thus the value of the upper part of the gradient for the spring is obtained from ascents on sixteen consecutive days in the spring of 1906, and we have no ground for assuming that these sixteen days represent the average spring conditions.

There is also a discussion of the results obtained from the kite ascents at Blue Hill. The values of the pressure, of the departures from the normal of the temperature, of the humidity, and of the direction and strength of the wind at different heights are plotted for the various segments of cyclones and anticyclones, and the curves and tables are well worth careful study.

(2) In addition to the ordinary observations and to those made by means of kites during the year, there is a general summary for the period 1901–5, and a table of mean temperature for the twenty years 1886–1905. Although the great difference of climate on the eastern and western sides of the Atlantic is well known, one cannot help feeling surprise on being reminded by a publication of this sort how great the difference is. Thus at Blue Hill, in latitude 42° 12′ 44″ N., a latitude further south than any part of France, and, be it remarked, closer to the Gulf Stream than many parts of England are to the Atlantic, we find that, on the average, the ponds are covered with ice from the end of November to the end of March, while in England, 10° further north, few people under twenty-five years are able to skate, owing to the almost total absence of opportunity during recent years. The difference is, of course, due to the prevailing westerly winds, which bring the temperature of the Atlantic to western Europe and the continental temperature of North America to the Atlantic coast of Canada and the United States.

There is also a very interesting account of the meteorology of total solar eclipses by Mr. H. Helm Clayton. In the brief space of a review it is not possible to refer to this in detail, but the tables give a collection of the changes that have been observed on various occasions. The temperature effect is perfectly plain, and is shown to vary with the intensity of the natural solar radiation at the time and place. It is pointed out how difficult it is with the other elements to separate the changes due to the eclipse from the casual and diurnal changes that are going on at the same time, but it appears to be proved that the barometer and hygrometer are influenced.

The shadow bands of the eclipse are discussed by Prof. Rotch, who comes to the conclusion that they are produced by rays from the narrow crescent of light passing through strata of different refractive index, the motion being due to the wind.

AUGUST METEORIC SHOWER.

ON August 10 the sky was watched for $1\frac{3}{4}$ hours, but only 19 meteors were noticed, of which 12 were Perseids. The shower seemed disappointingly feeble.

On August 11 it became evident that the display had greatly intensified. In $2\frac{3}{4}$ hours before midnight 73 meteors were counted, and they were nearly all Perseids from 46° + 58°. Very few large ones were seen; in fact, the meteors were generally small, and the display could not be regarded as a very conspicuous one. The sky became rather foggy towards midnight, and many small meteors must have been hidden. The vapour increased, and next morning after sunrise there was a thick autumn-like fog, which was not dispersed until the sun had risen high.

On August 12 the atmosphere was beautifully clear when night came in, but meteors appeared to be scarcely so numerous as on preceding night. They were, however, of astonishing brilliancy, and made the shower a very attractive and notable one. In all 65 meteors were counted between 9h. and 12h. 52m., but clouds partially veiled the sky after 11h. and obscured many which would otherwise have been seen. Relatively to the total number counted, I have never, within a long experience, remarked such an abundance of fine, flashing meteors. Their long, graceful flights and highly luminous trails added to the interesting and striking nature of the spectacle. A fireball at 9.42 gave a lightning-like flash, and must have presented its best effect to observers at London and in the eastern counties. The following were the recorded paths of a few of the most brilliant objects :—

Aug. 12 h. m.		Mag.		Apparent path ° ° ° °
9 42	...	3 × ♀	...	5 + 27 to 357 + 15
9 42	...	♃	...	330 + 19 ,, $320\frac{1}{2}$ + 4
9 51	...	> 1	...	7 + 53 ,, 343 + $40\frac{1}{2}$
10 4	..	♃	...	$302\frac{1}{2}$ + 37 ,, 291 + 22
10 4	...	1	...	302 + 8 ,, 292 − 8
10 4	...	♃	...	265 + 1 ,, 259 − 15
10 18	...	♃	...	$352\frac{1}{2}$ + 24 ,, 340 + $3\frac{1}{2}$
10 14	...	1	...	17 + 37 ,, $12\frac{1}{2}$ + 30
10 19	...	♃	...	349 + 51 ,, $318\frac{1}{2}$ + 34
10 37	...	> 1	...	$342\frac{1}{2}$ + 25 ,, $326\frac{1}{2}$ + 6
10 43	...	> 1	...	358 + 62 ,, 332 + 51
10 46	...	♃	...	349 + 31 ,, 331 + 9
10 49	...	> 1	...	18 + 20 ,, 12 + 1

These were all Perseids, and duplicate observations would be valuable as furnishing data for the computation of the real paths. The very clear summer weather has recently offered an almost unique opportunity for studying the progress of the shower during its approach to the maximum.

The finest meteor which appeared during the display was recorded on August 12 at 9h. 42m. It lit up the sky like a flash of lightning, and left a streak which remained visible for several minutes. The fireball was observed at Bristol by the writer, and also by the following :—Observers at Greenwich; Dr. W. J. S. Lockyer, London; Howard E. Goodson, S. Kensington; H. Wilkie, Bognor; R. Langton Cole, Havant; J. S. Sowerby, Tatsfield, Surrey; T. K. Jenkins, Blaina; George Powell, Aberdare. The meteor was a magnificent specimen of the Perseids, and was quite noteworthy, even during a shower which consisted of unusually brilliant members. Its radiant point was at about 47° + 58°, and it passed over the earth from above a point ten miles W. of Ipswich to a point about 15 miles E. of Croydon. Its height was from 87 to 53 miles, length of path 68 miles, and velocity about 35 miles per second. The observations from Hayling Island, Bristol, and S. Kensington are in excellent agreement. The streak was generated in the latter portion of the flight. As viewed from Bristol, the nucleus brightened several times, and just where the outbursts had occurred the streak exhibited sections which were intensely luminous. From Hayling Island this streak lay 4 degrees under α and δ Cassiopeia, and during the short interval it remained in sight it assumed a serpentine form and drifted two or three degrees to the westwards.

The following are particulars of four brilliant meteors recently seen and estimated = ♃ :—

Date	Aug. 8	Aug. 10	Aug. 11	Aug. 12
G.M.T.	10.8	11.15	9.57	10.19
Height at first	94 m.	87 m.	103 m.	78 m.
,, end	65 ,,	52 ,,	48 ,,	52 ,,
Length of path	58 ,,	62 ,,	110 ,,	52 ,,
Velocity per sec.	48 ,,	40 ,,	—	30 ,,
Radiant	41+57	43+56	43+58	47+58

On August 13 the watch was continued, but the Perseid shower had greatly declined. About 25 meteors were recorded in about 2 hours before 11h. 45m. (when clouds came over), and of these 11 only were Perseids.

On August 14, observing for a similar interval, 19 meteors were counted, including 7 Perseids. The principal minor shower seen at Bristol recently was at 302°+22° in Vulpecula, and the same radiant was well marked in 1908, both in July and August.

W. F. DENNING.

NOTES.

ON Monday, August 16, an exhibition of manuscripts, portraits, medals, books, and natural history specimens illustrative of Darwin's life and work was opened to the public in the central hall of the Natural History branch of the British Museum. Although most of the special portion of the exhibits is displayed in one of the bays on the right side of the hall, a table-case, containing illustrations of the fertilisation of plants by insects and other animals, and a second devoted to insectivorous plants, have been placed in the middle of the hall. In addition to these, several of the permanent cases in the hall, such as those illustrating melanism, albinism, adaptation to natural surroundings, and the breeds of domesticated pigeons, are included in the exhibition. In order that the public may properly appreciate and understand the exhibition, an excellent little guide-book has been published, at the price of sixpence, in which, in addition to a brief but comprehensive biography of Darwin, and a photograph of the Darwin statue in the museum, will be found clear explanations of the leading features of the more important exhibits. These exhibits, apart from the two botanical cases, form a total of no fewer than 251, and certainly make a most instructive and interesting display. In the compilation of the guide-book it would have been better had the author avoided the use of words of the type of "exoskeleton," which are certainly not understood by the general public. As regards the specimens displayed, we must refer our readers to the guide, or, better still, to the exhibition itself.

THE fourth International Congress of Aëronautics will be held at Nancy on September 18–24.

MR. H. E. HARRISON, principal of Faraday House, and a fellow of several scientific societies, died on August 12 at fifty years of age.

CAPTAIN H. E. PUREY CUST, R.N., assistant hydrographer of the Navy, has been appointed hydrographer in succession to Rear-Admiral A. M. Field, F.R.S., whose term of office in that appointment has expired.

REUTER messages from Tokio report that a severe earthquake was felt at 3.30 p.m. on August 15 throughout Central Japan. Much damage was done to the important commercial city of Nagoya, which was practically destroyed by the earthquake that visited the district in 1891. Considerable damage is stated to have been done in part of the Shiga Prefecture.

WE learn from the *Times* that on August 12 the Italian balloon *Albatross*, manned by Lieut. Mina and Signor Piacenza, and starting from Turin, reached the height of 38,715 feet, at which point one of the two aëronauts opened the valve. The highest altitude previously attained in a manned balloon was 35,500 feet, reached by Berson and Süring on July 31, 1901. The new record is equivalent to an altitude of 7·3 miles, and shows the great heights which can be attained when improved means of respiration are employed.

WE record with regret the death, on August 14, of Mr. William F. Stanley at eighty-one years of age. Mr. Stanley was well known as a maker of scientific instruments; in 1856 he invented the first simple open stereoscope, and later he designed and manufactured scientific instruments for the use of various Government departments. He was the author of several text-books, and in 1895 he published "Notes on the Nebular Theory in Relation to Stellar, Solar, Planetary, Cometary, and Geological Phenomena," the book being reviewed in the issue of NATURE for November 14, 1895 (vol. liii., p. 25). In addition to other beneficent acts, Mr. Stanley erected and equipped at Norwood the Stanley Technical Trade Schools, where boys are educated on thoroughly practical lines. The schools have been endowed adequately, and are for the future to be administered by the Charity Commissioners.

As has been already announced, the ninety-second annual meeting of the Société helvétique des Sciences naturelles will be held this year at Lausanne on September 5–8. The business of the meeting will be conducted in six sections, as follows:—section of physics and mathematics, president, Prof. H. Dufour; chemical section, president, Prof. H. Brunner; section of geology and geography, president, Prof. Lugeon; agronomic section, president, Prof. E. Chuard; botanical section, president, Prof. E. Wilczek; and the section of zoology and physiology, president, Prof. E. Bugnion. On September 6 two lectures will be delivered, one by Prof. S. Finsterwalder on aërodynamics in aviation, and the other by M. Auguste Forel on comparative psychology, determinism, and the theory of memory. Three lectures will be delivered on September 8 at Vevey, as follows:—M. Fritz Sarasin, on the history of the animal life of Ceylon; M. Raoul Gautier, on some recent important results furnished by astronomical photography; and M. Martin Rikli, on the natural history of Greenland. Full particulars of the meeting may be obtained from the general secretary, Prof. Paul L. Mercanton, the University, Lausanne.

To *Annotationes Zoologicae Japanenses*, vol. vii., part ii., Dr. N. Annandale, of the Indian Museum, communicates a paper on Japanese freshwater sponges, in which an apparently new species is described. Of the five known Japanese species, three are widely distributed and the other two peculiar to Japan.

THE combined July and August issue of *Naturen* contains an important paper, by Messrs. Bjon Helland-Hansen and Fridtjof Nansen, on annual fluctuations in the mean temperature of the sea on the Scandinavian coast and their influence on the climate, agriculture, and fisheries of Norway. The paper is illustrated with a large number of temperature-charts.

IN the August number of the *Irish Naturalist* Mr. C. B. Moffat suggests that one reason why certain species of birds construct covered nests is to enable them to rear a larger number of nestlings than would otherwise be possible. The author supports this theory by mentioning that out of the eight species of Irish birds which make domed nests, six lay larger clutches of eggs than birds which are content with open nests.

The August number of *British Birds* contains reproductions from eight very remarkable photographs of a water-rail taken by Miss E. L. Turner. Some of these exhibit the bird in the act of removing its young from the nest; but whether this action represents a normal or an abnormal trait remains to be decided. To have obtained these beautiful photographs of such a shy and wary bird as the water-rail is a great triumph for the artist. We may also refer to a note by Mr. F. J. Stubbs, in which attention is directed to the fact that on certain Yorkshire grouse-moors there is no heather or heath, the place of which is taken by crowberry, and that on such grounds the birds, so far as can be ascertained, are free from disease.

We have to welcome a new biological serial, the Transactions of the Royal Society of South Africa, of which we have received the first part of vol. i., comprising 319 pages of text and twenty-four plates. Among the more important articles, reference may be made to Mr. R. B. Newton's report on Cretaceous shells from Zululand. Many of these are identical with or nearly allied to South Indian Cretaceous forms, especially those from the Trichinopoli group; and it is specially interesting to note that some of these indicate a connection between the Cretaceous fauna of Trichinopoli and Angola. This suggests that the great tropical land-barrier shown in Neumayr's map of the Jurassic epoch had become partially broken up by Cretaceous times. Another important communication is the first part of Dr. L. Péringuey's descriptive catalogue of South African Coleoptera, dealing with the family Meloidæ.

Owing to a severe outbreak of a fungal disease in the mulberry nurseries near Srinagar, connected with the silk industry in Kashmir, Dr. E. J. Butler was deputed by the Indian Government to investigate the matter. The results of his investigation are published in the Memoirs of the Department of Agriculture in India (vol. ii., No. 8). The disease was traced to *Coryneum mori*, a fungus of the Melanconiales, previously recorded only from Japan. The fungus is a wound parasite which found its opportunity after a severe frost; it was also discovered on mulberry trees outside the nursery, and on a jungle tree, *Celtis caucasicum*. Reference is also made to three other fungi: *Septogloeum mori*, producing leaf-spot; *Phyllactinia corylea*, a mildew; and the bracket-fungus *Polyporus hispidus*—none of which, however, were doing much damage.

The curious instances of polymorphism in the flower which occur in the orchid Cycnoches are described by Mr. R. A. Rolfe in the *Kew Bulletin* (No. 6), where he provides a revision of the genus. The production of flowers so different in appearance puzzled Lindley and other botanists until the solution was found in the dissimilarity between staminate and pistillate types. Nine species are recorded for which both types are known, and in six cases only the staminate flowers have been definitely identified. Two sections of the genus are recognised; in the Eucycnoches the difference lies chiefly in the column and attached sexual organs; in the Heteranthæ the distinction is more marked, as the staminate flowers are smaller, sometimes different in colour, and the lip is reduced to a small disc margined with clavate teeth.

Investigations on abstruse points in plant morphology have within recent years engaged the attention of several Austrian botanists. Two papers appear in the *Bulletin International* (1907), the official publication of the Académie des Sciences de l'Empereur François Joseph I., Prague. Miss M. Doubek contributes a discussion of the much-debated nature of the tendrils in the Cucurbitaceæ. An explanation is constructed on the hypothesis of adnation by different axes. The least complex examples—they cannot be described as simple—are furnished by Luffa and Cucurbita, but the author also offers solutions of the more difficult cases provided by Bryonia, Cyclanthera, and other genera. The second paper, communicated by Dr. B. Nemec, deals with regeneration in the unifoliate plant *Streptocarpus Wendlandii*. Some of his experiments were made with irregularly regular specimens bearing two well-developed cotyledons.

The arrangement of the botanical garden of the Johns Hopkins University, which is described in the University Circular (No. 217), shows some novel features. The garden, which is being established primarily as an aid to botanical research and instruction, is divided into four sections. Two are planned for the cultivation of typical forms illustrating vegetative and reproductive organs. The third is devoted to plant relationship, as exemplified by species, genus, &c., extending to systems of classification for which Engler's system is selected for complete exposition. The fourth section contains two divisions, one for economic, the other for cultivated plants. The latter should be quite the most interesting feature in the garden. The three genera Dianthus, Rosa, and Chrysanthemum are chosen as types to indicate the origin and natural relationship of horticultural races. Cultivated roses are arranged under fifteen sections, and in addition eight groups of hybrids are illustrated.

A pamphlet published by the Hawaiian Sugar-planters' Association as Bulletin No. 9 of the division of pathology and physiology is devoted to an investigation by Messrs. L. Lewton-Brain and Noël Deerr of the bacterial flora of Hawaiian sugars. Sugar agar was the most satisfactory medium, as, for some reason undetermined, it was impossible to get a good gelatin preparation. Another difficulty was presented by what the authors term a "weed-bacillus" that produced its spores within twenty-four hours, and so escaped sterilisation. The practical object was to isolate and identify types of bacteria with the view of studying their action on moist sugars. Five different types were distinguished by the shape of the individuals or of the colonies formed in different media; their general action is to reduce the sucrose and form invert sugar, gum, or other products in sugars containing 1 per cent. or more of moisture.

The Purdue University Agricultural Experiment Station has issued a pamphlet (Circular No. 15) on the growth of onions, an important crop in northern Indiana to which many hundreds of acres are annually devoted. The methods adopted on the large scale are described at length, and suggestions are offered for improvement; curing and marketing are also dealt with. Another pamphlet deals on similar lines with the Indiana cantaloup industry. In Bulletin No. 134 Messrs. Hunziker and Spitzer discuss methods for the estimation of fat in unsweetened evaporated milk. Since the introduction by the Act of Congress, 1906, of the new pure food standards requiring a definite minimum per cent. of fat and solids in evaporated milk, the product from numerous milk-condensing factories has been found below standard, rendering them liable to prosecution by Government and State authorities. It was known that no fat was removed by the firms in question, and the authors show that the fault lies in the method of analysis, the ordinary Babcock method failing to show all the fat in evaporated milk. A suitable method, giving correct results, is described.

THE introduction of labour-saving machinery on the farm has been one of the principal features of the modern revolution in agriculture, and has been rendered necessary by the difficulty of getting sufficient help. Few contrivances are more interesting than the milking machine. Rubber funnels are fitted on to the teats and connected by stout tubing to a milk-can; the pressure is diminished by a pump to about half an atmosphere when the milk begins to flow. A lengthy test has been made at the Wisconsin Agricultural Experiment Station, and is recorded in Bulletin No. 173. The machine worked more quickly and more cheaply than a man; it yielded a cleaner milk, which therefore kept better, and, finally, was shown to have no injurious effect on the udders or the general health of the animals. The machine, of course, requires proper attention and careful driving to get the best results, but proved decidedly economical in herds of thirty cows or more. There are already signs that the agricultural labourer of the next generation will be, in the main, an engineer.

WE have received from Mr. Stewart J. McCall, Director of Agriculture, Nyasaland, an interesting pamphlet on the growth of cotton in America. The four types dealt with are (1) Sea Island cotton, a small high-quality crop, forming less than 1 per cent. of the total American crop, but very important by reason of its quality; (2) upland cotton, short staple, the principal variety in commerce; (3) upland cotton, long staple, which has only been introduced within the last few years, and is almost exclusively confined to the rich bottom lands of the Mississippi; (4) Egyptian cotton, introduced to supply the manufacturers' demand for a lustrous cotton, well adapted for mercerisation. The pamphlet is written for the African cotton grower, and great stress is laid on the necessity for keeping out of Africa the cotton weevil, which has done incalculable harm in America, and made cotton cultivation impossible in some places. Mr. McCall suggests that all seed imported from America should pass through a Government Department for examination and treatment. The question of distributing insect and fungoid pests by artificial means has to be considered seriously. Unfortunately, our administrators are often insufficiently in touch with scientific problems to realise that a small pest which could at little expense be kept out of a country may do great damage once it is introduced.

THE mixed population of Manila, which includes almost all races of mankind in varying degrees of purity, has afforded to Mr. R. B. Bean an unrivalled opportunity of studying the different types of human ears, and formulating, for the first time, a morphological classification of the same. His results, which are published in the first number of vol. iv. of the *Philippine Journal of Science*, cannot fail to be of great interest to anthropologists. Names, such as Malay, Negroid, Cro-Magnon, Alpine, &c., are given to these various types of ears, which are characteristic of definite physical types of men, although it does not necessarily follow that they are also distinctive of all members of the races whose names they bear. The Alpine ear is, for example, the ear of the fat man. In the Philippines the author finds that ears not of European origin are morphologically older than those of European type, and from these data he draws certain conclusions as to the evolution of the modern Filipinos.

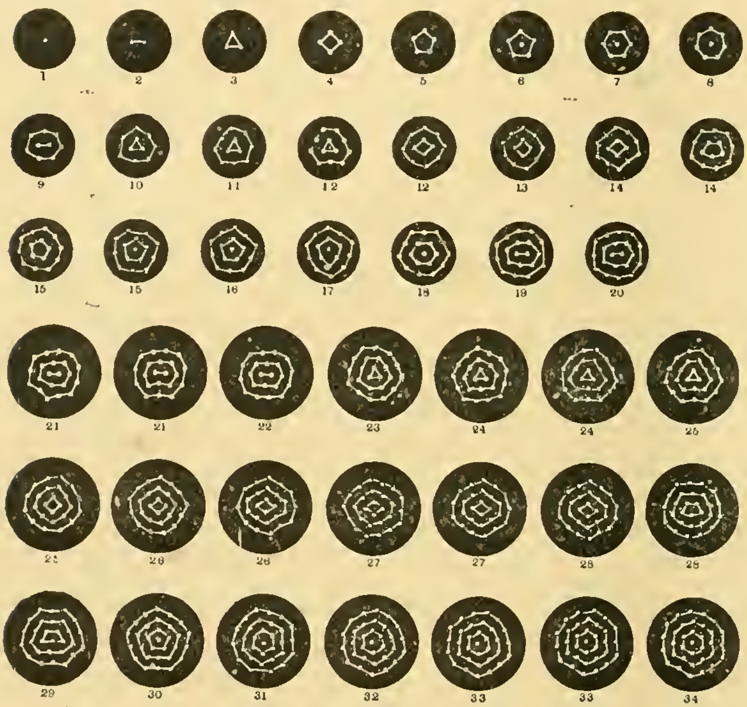
DR. F. ERK, director of the Bavarian Meteorological Service, has contributed to part i., vol. iii., of "Beiträge zur Physik der freien Atmosphäre" an interesting paper on the relations of the upper inversion of temperature to the areas of high and low atmospheric pressure. The author, who has the experience of a critical examination of daily weather conditions during the last twenty-five years, assumes, from the labours of recent investigators, that the relatively high temperatures of the region of the upper inversion (the "stratosphere") arise from the absorption of radiation, not from the surface of the earth, but from strata of some 4000 metres in height. He discusses at considerable length the effects of the descending air in the high-pressure areas of the upper regions and of the advance of the low-pressure systems towards the stratosphere, and shows how a registering balloon on entering the stratosphere must first meet with a rapid increase, and afterwards with a gradual decrease, of temperature. Photograms of the curves obtained during ascents at Hamburg and Munich on the same day and with similar instruments exhibit these phenomena very clearly, and show the desirability of the more frequent publication of results in this way instead of tabular statements only.

A NEW recording rain gauge made by Messrs. Negretti and Zambra, which the makers have named the hyetograph, is now procurable, and supplies a much-needed want. Meteorologists have looked forward to the time when a simple register should be obtainable of the duration and amount of rainfall day by day. The instrument has the advantage of great simplicity, and it is scarcely possible for it to get out of order. The only movable parts are the clock drum, the float, and the pen lever. The hyetograph practically gives equal results with the necessarily more expensive Halliwell's patent rain gauge, of which Messrs. Negretti and Zambra are also the makers. The funnel is 8 inches in diameter. The float has the capacity for measuring 4½ inches of rain, which is the maximum amount likely to occur in one day in almost any locality in Great Britain. The spindle attached to the float has a number of pins or projections, and these engage successively with a lever arranged so that when the pen reaches the top of the chart, wound round the clock drum, the lever disengages with the pin or projection and falls by its own weight on to the next lower pin, which is so placed as to allow the pen to fall to zero on the chart. The whole of the working parts are protected by a stout galvanised iron cover, and the water collected is removed by a hand-started syphon. The hyetograph complete, with 100 special charts, costs 6*l*. 15*s*.

THE "Report of a Magnetic Survey of South Africa," upon which Prof. J. C. Beattie, of Cape Town, and coadjutors have been engaged, with the aid of Royal Society and colonial grants, for a series of years, has now been published by the Royal Society at the price of 20*s*. net. It forms a quarto volume with numerous maps and plates, uniform with Rücker and Thorpe's Survey of the British Islands. Copies may be obtained from the Cambridge University Press Warehouse.

WE learn from the *Amateur Photographer* that Messrs. Aldis Bros., of Birmingham, have perfected a periscope lens which enables the observer to see completely round the horizon without movement of either himself or the lens. It consists of a ring of glass with an outer curved surface, while the inner surface, which is inclined and plane in one direction, serves to reflect the light that enters the system down the axis of the vertical tube that carries the lens at its upper part. A reflecting prism enables a horizontal eye-piece to be used. The lens has already been approved by the Admiralty for use in the conning towers of submarines. A photograph taken by it gives a well-defined annular picture of the view as seen in every direction around it.

WE have received a copy of a paper, by Mr. Louis Derr, on a photographic study of Mayer's floating magnets (Proceedings of the American Academy of Arts and Sciences, vol. xliv., No. 19, May). Although it is now recognised that inferences made in regard to the structure of matter from the exact behaviour of such floating systems must be received with caution, yet the groupings obtained are so suggestive that any fresh study of them is of interest. Mr. Derr has endeavoured to obtain a



Photographs of systems of floating magnets.

much more complete series, which he has photographed in order to show the progression from one form to another more clearly than can be done by tables. The magnets were clear $\frac{1}{4}$-inch steel balls, floated on freshly filtered mercury, as described by Prof. R. W. Wood, but initially magnetised by placing them one by one between the poles of an electromagnet. In the plate (part of which we reproduce) the balls as photographed have been connected together afterwards by lines, in order to bring out more obviously to the eye the formation in concentric groups. Many of the forms differ from those calculated by Sir J. J. Thomson; since the stability depends upon the exact law of force between the magnets—and in the experiments this is different from the law assumed in the calculations—the divergence is not to be wondered at.

THE May number of the Bulletin of the Bureau of Standards contains a description of a new method of determining the focal length of a converging lens system, by Mr. Irwin G. Priest. The method depends on the measurement of the diameter of one of the circular rings of the Fabry-Perot interferometer when seen through the lens by reflected homogeneous light. If viewed without the intervention of the lens, the ring system is localised at infinity, and with the lens a real image will be formed in the focal plane of the lens. The outer edges of the rings are sharp, and admit of accurate measurement of diameters by means of a micrometer. From two measurements of the diameters of the same ring with different distances between the interference plates, the focal length of the lens can be found with an accuracy of about half per cent., and if with the interference plates a fixed distance apart the constant of the apparatus be determined once for all, a single measurement of the diameter of a ring is all that is necessary.

THE four numbers of the Journal of the Royal Society of Arts issued in July contain the Cantor lectures on the public supply of electric power delivered by Mr. G. L. Addenbrooke before the society in January and February last. After describing with great clearness the present position of affairs, the lecturer points out in what directions we may reasonably look for improvements in the future. Whatever the improvements in prime movers, he believes that electrical power will still be the most suitable for factories. This power will, when gas engines and producers have been rendered more suitable and trustworthy, be produced by internal-combustion engines of the four- or six-cylinder type. He considers that the time now required to obtain a provisional order in the case of a power scheme should be greatly reduced, and wishes to direct the attention of legislators to the importance of facilitating the supply of cheap electric power.

NONE of the formulæ in common use connecting the pressure and temperature of saturated steam can be regarded as satisfactory. Any empirical formula should cover the whole range, give a fair representation of those experimental results which probably approximate most closely to the true relation, and should be easy of calculation. Mr. S. Godbeer, in an article in *Engineering* for August 6, presents a new formula which should be useful. For various reasons, a table given by Holborn in 1908, ranging from 0° to 205° C., together with experiments by Cailletet covering a range up to the critical temperature, have been used as data. A few irregularities have been corrected, and the formula is as follows:—

$$\log p = \frac{1319\,(t+226)\,(t+2299)^2}{192028\,(t+808)\,(t+329)} - 30\cdot203,$$

where p is the pressure in millimetres of mercury and t is the temperature centigrade. If pressure and temperature curves be drawn for the experiments of Cailletet, Battelli, and Knipp, it becomes evident that there is a sudden disturbance in the general trend of the curve between 240° and 270° C., and the author suggests that further experiments in this region of temperature would be interesting.

METAL-CUTTING by means of oxygen is now finding a place among engineering operations, and several interesting applications are given in *Engineering* for August 6. The instrument used consists of an oxy-hydrogen, oxy-coal-gas, or oxy-acetylene mixed blowpipe, through which an additional stream of oxygen can be supplied at will by the operator. The object is to heat to incandescence the part on which the jet of oxygen is afterwards to play, and to keep it at that high temperature all the time the oxygen jet is operating. This method has been found to overcome entirely the older difficulties with regard to unsteady manipulation of the oxygen jet, as well as the trouble due to the presence of iron oxide. Plates and slabs of steel up to 12 inches in thickness can be cut by this method. The cut is very clean, and, in one example illustrated, where a slab of steel 8 inches thick was cut into pieces $\frac{3}{4}$ inch in width, the width of the cut was only about $\frac{1}{4}$ inch, showing the intensely local nature of the operation. Another illustration shows an armour plate being cut circular by means of a special appliance carrying a blowpipe, the thickness of the plate in this example being 9 inches. The cut surfaces are left comparatively smooth, and the cut is square down from the face of the plate, although it is possible also to make bevel cuts. All grades of steel can be operated on.

MR. H. K. LEWIS, of Gower Street, London, has sent us a copy of a catalogue of the new books and new editions added to his medical and scientific circulating library during the second quarter of this year. The list will be sent post free to any address on application.

A SECOND edition of Prof. Marcel Moye's translation of Prof. Lowell's "Mars and its Canals" has been published at the office of the *Mercure de France*, Paris. The original volume has already been reviewed in these columns, and we are glad of this opportunity of congratulating Prof. Moye on the demand for a second edition of his translation of Prof. Lowell's interesting book. The price of the translation is five francs.

SIR WILLIAM RAMSAY'S volume of "Essays, Biographical and Chemical," which was reviewed in NATURE of July 29, has been translated into German by Prof. W. Ostwald, and published by the Leipzig Akademische Verlagsgesellschaft, under the title, "Vergangenes und Künftiges aus der Chemie." The German volume includes, in addition to the essays of the original work, an autobiographical sketch by Sir William Ramsay, occupying thirty-five pages.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF MARS.—Circular 110 from the Kiel Centralstelle announces that, at 2 p.m. on August 12, M. R. Jonckheere observed a brilliant spot detach itself from the polar snows of Mars and cover the Novissima Thyle, in longitude 320°.

In No. 4340 of the *Astronomische Nachrichten* M. Jarry Desloges records some observations of Mars made at the Massegros Observatory (Lozère) during June and July.

On June 20 and 23 a dark cutting was seen in the south polar snows, in longitude about 190°, and appeared to terminate in a rounded spot, which was of a darker shade. The crevasse observed by Prof. Lowell in longitude 350° was easily seen on July 4 with a 37 cm. refractor installed on the Revard plateau, and appeared to traverse the whole length of the visible part of the snow-cap. On the same day, at 4h. 15m. a.m., a broad, bright spot was seen on the dark edge of the snow in about longitude 30°.

RE-DISCOVERY OF PERRINE'S COMET.—A telegram from the Kiel Centralstelle announces that comet Perrine was discovered by Herr Kopff at 10h. 54m. (M.T. Königstuhl) on August 12. The position of the comet at that hour was R.A.=0h. 17·1m., dec.=35° 32′ N., and the magnitude was 15·0.

Of the three ephemerides given by Herr Ristenpart, the first (T=October 27·5) gives the nearest position to the above for August 12, the ephemeris place being

R.A.=0h. 40·2m., dec. 36° 45·9′ (1910·0).

THE NUMBER OF THE STARS.—In the August number of the *Observatory* (No. 412, p. 323) Mr. Gavin Burns directs attention to the discrepancy between the Groningen and the Harvard estimates of the total number of stars, and suggests that Prof. Kapteyn's estimate is probably excessive. Tabulating the figures given by each of the two observatories, he shows that from the tenth magnitude downwards the Groningen numbers are greatly in excess of those given by Prof. Pickering; for example, the respective totals, including all stars down to the 10·5 magnitude, are 697,551 and 604,000, but if the 13·5 magnitude be included they are 14,582,551 and 6,761,000. Then there is a note in the Harvard publication which suggests that if stars to the fifteenth magnitude were included the total would be raised to about 18 million, whereas Prof. Kapteyn's estimate for magnitude 14·5 is 38 million, and for magnitude 15·5 98 million. A published investigation of the Greenwich astrographic plates shows agreement with Harvard for the fainter magnitudes, and strengthens the suggestion that the Groningen estimates are too high.

THE FAINT COMPANIONS OF PROCYON AND SIRIUS.—During last winter Prof. Barnard employed the Yerkes 40-inch refractor on many occasions in an endeavour to detect and measure Schaeberle's faint companion to Procyon, but only on a few occasions was he successful. The results, which are published in No. 4345 of the *Astronomische Nachrichten* (p. 13, August 7), show that during the last five or six years the angular motion of the companion has been about 5·2° per annum, but the distance has changed but little. The weighted means, for 1909·162, were 22·51° and 5·26″ respectively. Prof. Barnard states that the least atmospheric diffusion of the light of the large star hides the close companion, and then explains a device which he uses to obviate the adverse effect of the stray light. This is to place a hexagonal diaphragm over the 40-inch object-glass so that the angles of the hexagon lie on the periphery of the glass. This collects the stray light into six thin bright rays, and the small star can be more easily seen in the dark space between a pair of the rays.

A similar device was employed in observing the faint companion to Sirius, and the measures made during the period 1903–9 are given in the same journal. These show that the angle is decreasing, from 115·38°, for 1903·808, to 92·53°, for 1909·135, whilst the distance is increasing, the values for the corresponding epochs being 6·32″ and 8·75″ respectively.

PROF. LOWELL'S NEW 40-INCH REFLECTOR.—A brief description of the new 40-inch reflector which Messrs. Alvan Clark and Sons are just completing for Prof. Lowell appears in No. 412 of the *Observatory*. The focal length is 18 feet 4 inches, and the mirror, cast at St. Gobain, is 7 inches thick and weighs more than 900 lb. The cell is an iron ring with zinc blocks so arranged that the combined expansion is the same as that of the glass, thus obviating distortion. For planetary photography the reflector can be used as a Cassegrain of 154 feet, or 75 feet, focal length, whilst for stars and nebulæ it will be used as a Newtonian with the plate at the principal focus. In order to protect the instrument from the wind, and partially from large temperature changes, it will be mounted in a pit sunk 6 feet into the ground, over which is erected a hemispherical dome of wood and canvas. The requisite diurnal motion is to be imparted to the instrument by two electric motors, one for driving, the other for slow motion.

WATER VAPOUR IN SUN-SPOTS.—In the July number of the *Astrophysical Journal* (vol. xxx., No. 1, p. 44) Mr. W. M. Mitchell discusses the various researches which have led to the suggestion that water vapour exists in sunspots. He points out that the spectroscopic evidence is not unanimous, either for or against, and is certainly not conclusive.

The affected spot lines may be due to other substances not yet identified, and giving lines of nearly similar wavelength. Then the apparent intensification may be a subjective effect, to which the varying intensities of the water-vapour lines in the normal Fraunhofer spectrum is a contributory cause. Mr. Mitchell suggests that very fine measures of the displacement of spot lines, caused by the sun's rotation, might settle the question as to the solar origin of the apparent intensification, and concludes that, as yet, the evidence adduced by various observers in favour of the presence of water vapour is by no means satisfactory.

THE PALISA AND WOLF CELESTIAL CHARTS.—Dr. Palisa announces that the second series of Celestial Charts, prepared by Dr. Wolf and himself, is now ready, the price, if ordered from him, being 30s.; the bookseller's price is 35s. After the end of November this series will cost the purchaser 40s., wherever purchased. Dr. Palisa's address is "The Observatory, Vienna, Austria."

THE PIMA AND TLINGIT INDIANS.[1]

THE introduction to the twenty-sixth annual report of the Bureau of American Ethnology (1904–5), 1908, by the chief of the Bureau, Prof. W. H. Holmes, indicates that the staff are zealously carrying on the work of the department. The report itself contains two excellent

FIG. 1.—Pima woman making pottery: supporting vessel on loose sand.

memoirs, one on "The Pima Indians," by Frank Russell, and the other on "Social Condition, Beliefs, and Linguistic Relationship of the Tlingit Indians," by John R. Swanton.

As Mr. Russell's memoir is a monograph of the Pima, he naturally pays a good deal of attention to the arts and crafts and food supply of the people, his account being fully illustrated. The Pima keep an annual mnemonic record of events by means of notched sticks. "The year notches are exactly alike. . . . Dots or shallow circular pits and short notches are the most common symbols on the sticks. These have no distinctive meaning, and are used for recording a great variety of events," but they never make a mistake. One man who lost his stick continued his history with pencil and paper, and this "introduced a tendency to use pictorial symbols rather than merely mnemonic characters, such as are most easily incised on the surface of a stick."

With all their surplus energies expended in warfare, the young Pima men formerly lived exemplary lives as compared with the youths of the last generation. Before the Pimas came in contact with "civilisation" chastity was the rule among the young women. On reaching puberty there were several taboos, and there was "danger" in the girl that must be breathed out by songs ere she, the members of her family, and the community as a whole were exempt from the hazard of the lightning stroke and other perils. The youths marry "early and often." In the majority of cases the choice is made by the girl, who seeks to avoid an alliance with a lazy man. Polygyny was practised to some extent, but the division of labour was such that no great economic advantage resulted. There were no groups within the tribe between which marriage was prohibited. Divorce was easily effected. They often had large families, and twins were received with general rejoicing. Male children were preferred, because "they would grow up to fight the Apaches." So strong was the feeling of the Pimas against the abnormal that they tried in recent years to kill a grown man who had six toes. Under the head of "Baptism" we find the following information:—at child-naming the child was held aloft to receive the first rays of the rising sun. Beads were formerly held up to receive the first rays of sunlight, and were then placed about the child's neck.

Descent is traced in the male line, and there are five groups that may be called gentes, though they exert no influence upon marriage laws, nor do they manifest any evidences of organisation so far as ascertained. The

FIG. 2.—A Piman holding a Calendar Stick.

Pimas are governed by a head chief and by a chief for each village. These men are assisted by village councils, which do not, Mr. Russell believes, appoint any representatives to the tribal councils. The head chief is elected by the village chiefs. The tribe acted as a unit against the dreaded Apaches. The slaves taken by the Pimas were chiefly from the ranks of the Apaches or their allies; they were well treated. The Pimas held possession of the best agricultural land in their section of the south-west, and were compelled to fight for the privilege. There was no law among them observed with greater strictness than that which required purification and expiation for the deed that was at the same time the most lauded—the killing of an enemy. Numbers of myths and songs are cited. The Pimas are far less given than their pueblo neighbours to the outward show of religion. The sun was appealed to. At the present time two deities are recognised, Earth Magician and Elder Brother. They live in the east, dividing the control of the universe between them. The stars are living beings. Some declared that at death the soul passed into the body of an owl, others that after death it went to the land of the dead in the east. Again, souls are supposed to hang about and perform unpleasant pranks with the living.

There are fourteen geographical groups or tribes of the Tlingit or Koluschan, each of which had at least one winter village and a section of coast where they camped

[1] Twenty-sixth Annual Report of the Bureau of American Ethnology, to the Secretary of the Smithsonian Institution. Pp. xxxi+512; 58 plates. (Washington: Government Printing Office, 1908.)

in summer and behind which they hunted in winter. As a whole, they are divided into two exogamous phraties with matrilineal descent, one called Raven, the other usually Wolf, and in the north Eagle as well. One small group outside both phraties could marry into either. Each was subdivided into clans or consanguineal bands, which originally appear to have occupied a particular camp. The larger geographical groups contained members of both phraties, and usually numerous clans. Finally, the clans are subdivided into house groups. Each clan claimed a few distinctive carvings and names; occasionally they might be borrowed. The house names and clan names were generally distinct, and confined to their respective phratry, but a man sometimes claimed the right to the house name owned by his paternal grandfather's clan, so that names sometimes go out of the clan. Those of a man's own phratry are called "friends," those of the opposite phratry "opposites" or "my outside shell." A list is given of the relationship terms. The importance of the phratry system is indicated by the rules of etiquette and the hospitality shown towards members of the same phratry, and the performance by the opposite phratry of certain functions at birth and death.

A mourning feast is given to members of the opposite phratry, food being put into the fire for the spirit of the deceased. All property given away or destroyed at a feast was dedicated to some dead person, who then actually received its spiritual counterpart. A Tlingit employed his opposites to do everything—put up his house and pole, pierce the lips and ears of his children, and initiate them into the secret societies. The secret society dances were imported from the south, but their observance by no means reached the importance attained among the Kwakiutl and Tsimshian. Whistles were essential concomitants of these dances. The putting up of a house or pole, and the accompanying secret society performance, feasts, and distributions of property were all undertaken for the sake of dead members of a man's clan. Rivalries between opposing parties of dancers at a potlatch often resulted in serious conflict, but the host's people often prevented them by rushing between them bearing their emblem or making the call of the phratry animal. A. C. H.

RECENT PUBLICATIONS ON AGRICULTURE FROM INDIA AND CEYLON.

THE recent issues of Circulars and Agricultural Journal of the Royal Botanic Gardens, Ceylon, contain interesting papers on cotton, *Hevea brasiliensis*, and other native crops. Mr. Lock issues a concise guide to the plots on the Experiment Station, Peradeniya, which will prove useful to visitors, and will, we hope, be the forerunner of a work setting out the general results obtained in the Ceylon experiments and the conclusions to be drawn from them. Mr. Petch deals with certain abnormalities in *Hevea brasiliensis*. Nursery plants with twisted stems are frequently sent in for examination and report. The stem generally makes a complete turn at the base, either in a regular curve or a combination of curves and abruptly angular bends; in other cases there are two complete turns, and in a single instance three have been observed. It was found possible to reproduce some of these abnormalities by varying the position of the seed in the soil. The insect pests—which mainly attack the root, since the rest of the plant is to a large extent self-protected by the viscid caoutchouc-producing latex—are dealt with by Mr. E. Ernest Green. Mr. Bamber deals in one pamphlet with tapioca, describing its method of cultivation in Malacca, and in another with the cultivation of strong-growing plants to overrun and "choke" weeds in rubber plantations. The plants suggested are *Passiflora foetida* and *Mikania scandens*; *crotolaria* is also used. When growth has attained its maximum, and before the plants die down, the whole mass of material, usually 12 inches to 18 inches deep, can be rolled up like a huge carpet, leaving the surface soil quite free from weeds. Mr. Jowitt describes several of the oil-yielding grasses, and Mr. Stewart McCall puts in a plea for the more extensive cultivation of cotton. Altogether the papers are fully up to the high standard we have learnt to associate with Peradeniya.

It has already been remarked in these columns that the *Agricultural Journal of India* ranks for general excellence among the best agricultural publications in the world, and the recent numbers in no way alter the impression. The list of articles includes several dealing with improved methods of cultivating cotton and paddy, besides a well-illustrated paper on improved implements of home-make adapted to the special conditions of the native cultivator. Mr. Maxwell-Lefroy deals with Eri or castor silk, and Mr. Marsh discusses certain indirect benefits of irrigation not generally recognised. Among these are the possibility of substituting new sowings in case of accidents to advanced crops, the certainty of fodder for the cattle, which are among the worst sufferers in time of drought, and the general improvement of the people and country which inevitably results when the conditions of life become stable. The journal is issued quarterly from Pusa, and the articles are well written from a general point of view; it may be confidently recommended to all interested in Indian affairs.

Probably no publication could give a better idea of the enormous size of India, and the great diversity of conditions, than the two volumes of agricultural statistics brought out by the Government of India. The first volume deals with British India, and contains 429 folio pages of closely printed figures; the second contains the records of native States, and is smaller. Comparing the year 1906–7 with 1897–8, the earliest given in the volume, we find the following areas, in acres :—

	British India		Native States	
	1897–98	1906–07	1897–98	1906–07
Net area cropped ...	196,497,232 ...	214,026,319 ...	10,120,324 ...	14,923,731
Irrigated...	30,418,454 ...	36,653,903 ...	1,425,895 ...	1,982,668
Total food grains ... (Rice, wheat, maize, pulse, &c)	182,725,689 ...	195,117,838 ...	9,126,337 ...	13,123,691
Other food crops ... (Gardens, orchards, spice, &c.)	5,773,267 ...	7,274,340 ...	369,392 ...	561,431
Total oil seeds ...	12,566,648 ...	13,965,315 ...	603,076 ...	836,335
Cotton	8,914,996 ...	13,771,214 ...	279,758 ...	625,694
Indigo	1,366,513 ...	448,594 ...	1,731 ...	18,182

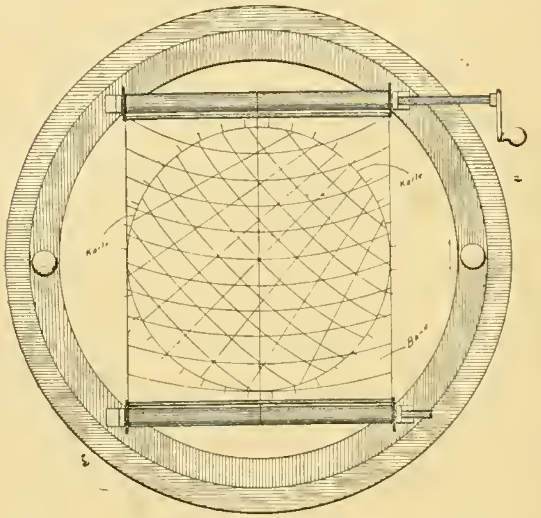
This steady, all-round increase in the area under the various crops furnishes abundant proof of the increasing prosperity of India, and must be a source of great gratification to the British administrators and advisers through whose labour it has been made possible. The one exception in the general prosperity is indigo. During the ten years the area has shrunk from more than one and a third million to less than half a million acres. The indigo planters are a highly enlightened body, and look to science to help them save the industry; their fortunes are very much involved in the contest now going on between the agricultural chemist and the synthetical organic chemist.

POSITION FINDING WITHOUT AN HORIZON.

THE Journal *Ila* of July 17—an aëronautical journal published at Frankfort—contains an article which in some respects is supplementary to that on the subject of position finding without an horizon which appeared in NATURE of July 22, or, as this article was the later in time, perhaps it would be more correct to say that it was supplementary to the one in *Ila*. The latter, which is written by Dr. Alfred Brill, relates to the reduction of observed altitudes for the purpose of finding position by means which can be quickly and readily effected in a balloon. After showing the inconvenience of the usual trigonometrical methods used on board ship, and how tiresome the use of tables must be which correlate time, latitude, declination, and altitude, he proceeds to describe his method, which is one eminently suitable and convenient, that is, where a graphic method is sufficiently accurate.

Dr. Brill employs a circular map of, say, Central Europe on transparent celluloid, the projection being one of least distortion. Before and behind this are two more sheets of celluloid, with the Sumner equal altitude circles drawn on the same projection. These sheets each have a central longitudinal azimuth line, while the map is provided with a circle of degrees round its periphery. The two Sumner sheets can be moved longitudinally on rollers like blinds, and these two and the included map may be turned in-their own planes relatively to one another, so that the azimuth line of either Sumner sheet always passing the centre point of the map may be brought to any bearing in relation to the map. Now the observation of altitude of a star at a given sidereal time having been made, a table calculated for stars of that declination and for the centre point of the map is consulted so as to ascertain what is the altitude and azimuth for the particular star at the moment of observation at the mid-point of the map. One Sumner sheet is then rolled until the line representing this altitude is over the mid-point of the map, and one is turned relatively to the other until the mid-line on the Sumner sheet is over the tabulated azimuth on the scale of degrees outside the map. Then the observer at the time of observation was somewhere on the Sumner line representing the observed altitude truly projected over the map. The corresponding observation of a second star is similarly transferred and the corresponding Sumner line on the other sheet brought into position. The observer is then at the point of intersection of the two Sumner lines of observed altitudes.

It will be seen that the device and tables are of a simple character, and that by their aid the principle of the Sumner method is applied graphically, so that the position may be



seen by inspection. The figure shows the map and one of the Sumner sheets only, the one behind not being shown to avoid confusion.
C. V. B.

ARCHÆOLOGICAL AND ETHNOGRAPHICAL EXPLORATIONS.

FULL details have now reached this country of the remarkable discovery made by Dr. D. B. Spooner, of the Indian Archæological Survey, in the neighbourhood of Peshawar. Hitherto the site of the great Stupa erected at the ancient city of Purushapura by the Kushan Emperor Kanishka, who ascended the throne about 123 A.D., to enshrine the relics of Gautama Buddha, was unknown. It was described by Hieuen Tsang and other Buddhist pilgrims from China as far the most famous and magnificent of the pagodas in India. A few years ago M. Foucher, the eminent French archæologist, suggested that it lay beneath certain tumuli in the neighbourhood of Peshawar. Excavations conducted by Dr. Spooner corroborate this identification.

The ruins are of great extent, and within the pagoda the relic chamber was reached. In it was discovered a metal casket enclosing a rock crystal reliquary. The outer casket, cylindrical in form, has a lid in the form of a lotus supporting three figures in the round, a seated Buddha in the centre, with a standing Bodhisattva on either side. Round it is an elaborate frieze in low relief of flying geese bearing wreaths in their beaks and figures of the Buddha, with a large, standing figure of the Emperor himself in the well-known attitude in which he appears on his coinage. The casket bears the signature of a Greek artist, Agesilaus, who describes himself as "superintendent engineer" of the monastery. Incidentally the casket throws much light upon the Græco-Indian art of the age, and supports the view that the Gandhara school was in a state of decadence.

The actual relics consist of three small fragments of the bones of the Buddha. The question of the ultimate disposal of these remains will excite much interest in the Buddhist world, and the Indian Government will doubtless consider the claims of the Burmese, Siamese, and Sinhalese religious foundations to share in the custody of relics which, like the alleged tooth of the Buddha at Kandy, are sure to receive the homage of millions of pilgrims drawn from the Buddhists of Eastern Asia.

The return is expected shortly of an expedition undertaken in 1907, under the auspices of the trustees of the British Museum and the council of the Royal Anthropological Institute, and conducted by Messrs. E. Torday, W. M. Hilton-Simpson, and N. H. Hardy, to examine the customs and culture of certain tribes in the Upper Congo region. The chief tribes which came under examination were the Batalela, Basonge, and, in particular, the Bakuba, the true name of which is now found to be Bashongo. The latest news showed that the explorers had reached the Loange river, and after exploring the hitherto unknown Tukongo people, they hoped to penetrate the Kasai region, and to return thence to Europe in September next. Large materials in the shape of photographs, maps, phonographic records, and ethnographical collections have already reached England, and a selection from them has recently been placed for exhibition in the Ethnographical Gallery of the British Museum.

Much information has been collected regarding the almost unknown Bashongos, one of the most remarkable tribes in Africa. They have preserved much of their tribal history and legends, and are particularly famous for their skill in weaving and wood-carving. Some portrait statues of their kings are remarkable works of art, exhibiting a degree of artistic skill hitherto unknown in Africa outside ancient Egypt. Their embroidered cloths, made of palm-leaf fibre, in the oldest and best examples, suggest a distinct resemblance to Celtic art. They possess a decayed form of totemism, and records of their remarkable rites of initiation, recently discontinued, have fortunately been recovered.

Mr. C. H. Read, of the British Museum, who is largely responsible for the organisation of this important expedition, may be congratulated on the successful collection of a mass of novel ethnographical material about these hitherto unknown races, which must throw much-needed light on the ethnology of Western and Central Africa.

THE MICROSCOPE AND ITS PRACTICAL APPLICATIONS.

AMONG scientific instruments, the microscope is at the present time one of the most extensively employed, either for commercial or scientific purposes. In nearly all branches of science it has now become a necessity, both as an essential factor in preliminary training and for advanced investigations or pure research work, while in commerce its uses are so wide and varied that it is difficult to see to what practical purposes it may not sooner or later be applied.

That this is the case may be due to many causes, and a by no means negligible factor is the simplification in construction and design that has in recent years been effected in the mechanical portions of the instrument and in its essential optical parts. In this respect, perhaps, a microscope differs from the majority of scientific instruments, as in most of the latter elaboration of construction—often, it must be admitted, quite unavoidable—is the usual rule; but for general purposes microscopes were never more simple in design than at the present time. This simplicity has not been obtained at the expense of loss of efficiency, but rather the contrary. The cost, too, has been greatly reduced, so that unless objectives and other optical parts of the highest class are required, a complete microscopic outfit may now be obtained of good quality and of high efficiency for a few pounds. The same, however, can scarcely be said if objectives of the finest quality are required, but this is rarely necessary for commercial purposes or for laboratory use unless work of a highly critical nature is to be carried out.

In our present state of knowledge it may almost be said that the science and practice of microscopic optics has reached such a stage of perfection that it is difficult to foretell in which direction the next improvement is to be looked for, much less the means by which such may be effected. Attempts have been made to increase optical efficiency, particularly by various dark-ground illumination methods, but it must be confessed with somewhat disappointing results. While such methods assist in demonstrating the presence of particles or isolated objects not easily seen, or even invisible by other means, the resolving power of the optical system is not improved. The most promising development has been in the apparatus introduced by Messrs. Carl Zeiss for use with ultra-violet light. This certainly held out a prospect of definite increase in resolving power being obtained, and in some directions has probably justified its existence. For the ordinary worker, however, the great cost of the necessary appliances, the more than usual skill required in its manipulation, the necessity of using special mounting materials, as well as the impossibility of observing any object mounted in the ordinary way on glass, has prevented its use for any but very special purposes.

For a long time a form of microscope stand, known as the Continental model, in which the instrument was supported on a foot of a horseshoe shape, practically held the field; but English makers, fortunately, to a large extent maintained their more stable method of support by means of a tripod foot. The latter not only admits of the microscope body being more conveniently swung, but also ensures that at any inclination of the body-tube the centre of gravity of the instrument is well within the triangle formed by the three points of support. With the horseshoe foot this is not the case, as the point of support is usually in such a position that at any considerable inclination the instrument is unstable, while in a horizontal position for photomicrography or projection, some Continental types are so unevenly balanced that they will not even stand alone, much less allow of the proper use of their various adjustments. This may be in part overcome by clamping the instrument down to some stable base for such special purposes, but no microscope with any pretension to be regarded as well designed should require that precaution.

The influence of this condition is now being felt very largely, and most Continental makers are either adopting a more stable method of support approximating to the English model, or are embodying the English type in their later makes of stands. In some cases a fusion of the two types appears to have been attempted, with certainly beneficial effects, but unfortunately the objections to the Continental model are still to be met with in some that have only in part realised the advantage of the English design. Continental microscopes have also long been open to the objection that their substage arrangements are altogether too cramped, and as it is only for very special purposes that a microscope is of necessity a portable instrument, the reason for this is not easily seen; certainly some more space underneath the stage, a greater range of action of the substage condenser, and considerably more freedom of movement of the mirror, would result in the production of a more convenient style of instrument.

It is extraordinary how widespread the applications of the microscope are at the present time. A recent article on its use in metallurgy and engineering, by Mr. W. Rosenhain, which appeared in these columns (vol. lxxx., p. 250), has sufficiently and clearly indicated its value in this direction. It is well enough known that in trades like brewing the microscope has played a very important part, and, in fact, it may be said that all trades which are concerned in the production or use of fluids for human consumption—at least where the work is carried out on anything approaching a large scale—are now compelled to have the service of a trained microscopist. Dairy workers, mineral-water makers, and all authorities concerned with the supply of pure water for drinking purposes, are equally interested in the question.

As indicative of how great is the interest in this direction, it may be mentioned that the Cunard Steamship Company and the White Star Line have inquired of well-known makers for instruments and complete outfits suitable for their use. The presumption is that they intend to initiate some method of microscopically examining the water supply on their vessels, constituting, in fact, a miniature Water Board to ensure that their water supply is as free from any bacterial or similar contamination as even that to be obtained in great centres of population.

As indications of some other directions in which microscopes are being utilised, it may be mentioned that chemists and druggists, paper manufacturers, makers of Portland and other cement, such as the Associated Portland Cement Company, foundrymen, printers and half-tone block makers for photographic reproduction purposes, quarrymen, linen, cotton, and silk manufacturers, and various other allied trades, are using microscopes at the present time. Petrological microscopes, in the development of the design of which great improvements have been made of late, are being applied now for testing stone and for supplying architects with exact information as to the structure and quality of the stone supplied by quarrymen, and as to the suitability of such material for building purposes.

As the result of a series of lectures given to laundrymen by Prof. Herbert Jackson, of King's College, an interesting further use of the microscope has recently arisen. Some large laundries and dyeing and cleaning establishments are now installing a microscopical outfit. The result of this may be fairly widespread, as it will now be possible, when a customer brings an article to be cleaned or otherwise dealt with, to determine its exact constitution before any effort is made to carry out the process. The result may be that an article which has been, for example, described originally to the purchaser as pure silk may at once be recognised by the laundryman as something totally different, and he may thus be saved from many unpleasant recriminations and possible legal claims by obtaining definite knowledge of the article before doing any work to it. One single thread detached from the article will usually supply all the information required, and will, in addition, often decide the best method or process that can most suitably be employed to effect the desired renovation.

There is still need, however, for much educational work in the use of the microscope, and it is much to be regretted that there appears to be no institution where systematic instruction in its various uses and possible applications can be obtained. Even an elementary course in the use of the instrument, suited to the requirements of the student, would be more than useful. Medical students and others, who may sooner or later engage in research work, are too often given the barest instruction in microscopic technique, and it is easy to see that, could they but have even a short course of instruction—which should be regarded, not merely as incidental to, but as an absolutely necessary preliminary portion of their class work—then much of the rough-and-ready usage seen in the course of laboratory work might be avoided. It seems almost absurd that a student who is taking a course in bacteriology or pathology, which at its best requires the very highest knowledge of the use of the microscope, should usually receive little or only the barest and most superficial instruction in the methods of use of the instrument. With the great increase in the number of applications of the microscope, it may become essential that means should be provided for teaching systematically the elements of the theory of microscopic optics and the methods of using the instrument and its optical parts, and it is to be hoped that at no distant time this necessity will be recognised in some institutions of higher education.

J. E. Barnard.

RECENT IMPROVEMENTS IN THE INTERNAL-COMBUSTION ENGINE.[1]

III.

We have now to consider the way in which the recent great practical improvements in the design and operation of gas engines and gas-producing plant have come about, and how they are connected with the theoretical considerations referred to in the previous articles.

Despite the multitudinous ways in which the internal-combustion engine is employed, there is a general assortment into three main groups, which may be described thus:—

(*a*) Large gas engines for gas blowing, for the generation of electric power or other power purposes, the size being usually more than 1000 horse-power.

(*b*) Smaller gas or oil engines used for workshop driving, in sizes up to about 500 horse-power.

(*c*) Petrol engines for road transport, for marine work, and for aëroplanes, the sizes being usually less than 100 horse-power.

With class (*a*) are associated pressure gas producers, frequently worked with by-product recovery plant, and schemes for the utilisation of the waste gases of coke ovens and blast furnaces. The gas engines in class (*b*) usually derive their gas from suction gas producers, which are practically always of smaller size than the 500-horse-power unit, though attempts are now being made to work with the larger units suitable to marine work. H.M.S. *Rattler* is one of the very first instances of the application of the suction gas producer to marine purposes, and it has been remarkably successful. Looming in the distance is the prospect of using suction gas producers and gas engines in smaller units for road transport, but the difficulty of finding space on the present type of motor-car for the whole of the plant is a great one. On the other hand, the considerable economy in fuel to which this development would lead is an inducement to proceed with the endeavour to overcome these difficulties.

By far the most numerous class of internal-combustion engine is that of class (*c*), which includes the thousands of motor-cars and cycles now in use in all civilised countries. The fuel used is not invariably petrol, as successful attempts have been made to run on alcohol, benzol, and the heavier elements in the paraffin series. Ordinary commercial paraffin has recently been used with extraordinary success, particularly in tropical countries, and it is even reported from Uganda that the combination there of altitude with high temperature enables paraffin to be used as a fuel in small engines without any change in the usual petrol carburettor as used in this country.

Improvements in Class (a).

The chief direct practical improvements in this class are the better proportioning of parts, so as to avoid cracking by unequal heating, and the better general design of the fly-wheel effect in conjunction with such an arrangement of cylinders as to produce a more even turning moment, and therefore less cyclic irregularity. The former is evidenced by the greater trustworthiness to-day of the big engine, and the latter is abundantly illustrated by the following extract from Messrs. Andrews and Porter's recent paper[2] before the Institution of Electrical Engineers:—

"The large gas engines at the Bruckhauser, Homecomb and Heinitz installations visited by English engineers in August last are all provided with fly-wheels to maintain a cyclic irregularity within 1/250. The two former are single tandem engines, and the latter twin tandem, but no appreciable difference in the parallel running was noticeable."

The information derived from recent experimental work on piston and wall-temperatures will probably lead to still further improvements in the mechanical design of details, as once the conditions of the heat flow are known a proper proportioning and subdivision of parts is rendered possible. The recent improved trustworthiness of operation is shared equally by the two-cycle engines (such as the Oechelhauser, Koerting, and others) and the four-cycle engines, and it is very difficult to say that either type is gaining ground at the expense of the other. By-product recovery work is becoming better understood, although there is always the difficulty that the by-products, when produced, have to be sold, and one has therefore to take into account the effect upon the market price should a largely increased output result from the extended use of such plant. The utilisation in gas engines of the waste gases of coke ovens and blast furnaces is now very usual. This is especially so in Germany and Belgium, where a great deal of work has been done in this direction; in the United States there has been a rapid increase in the adoption of this process, whilst in this country matters have moved appreciably, although, owing to the low cost of fuel in England, there is not the same economic pressure to make the change. On Tyneside an excellent plan is in operation, whereby engines running on waste gases are made to generate electric power, which is then supplied to, and paid for by, the central electric generating station. By this method of pooling the current, which, of course, cannot be economically stored, but has to be used as fast as it is produced, the complicated questions as to its utilisation are avoided.

A notable recent improvement in the ignition of gas engines of all sizes is the adoption of the electric system with either low-tension or high-tension currents. On the whole it seems likely that, as with motor-cars, the latter will in the end become the most used, though at present the low-tension system with moving contacts inside the cylinder seems to be the most popular.

Improvements in Class (b).

In both this class and class (*a*) it is noticeable that the engines designed on the Continent are more complicated in appearance than those designed here. The British desire for simplicity doubtless is, at the root, a good one. One of its most noticeable illustrations in modern life is the steam railway locomotive. As applied to the gas engine, this desire takes effect in the much simpler method of governing. The usual English plan is to govern on the "hit-and-miss" principle, that is to say, when the engine runs up to too fast a speed the cylinder for one or more cycles will get no charge of gas at all, or else (which comes to the same thing) the ignition will be cut off and no explosion take place (this, though a very simple means of governing, is wasteful in fuel). The average Continental design provides for the throttling (as in a steam engine or by varying the lift of the inlet valves) of the entering charge, so as to cause a less intense explosion. This tends towards a steadier speed, but on the other hand leads to a constant lowering of the compression ratio, and therefore to a diminished thermal efficiency and an increased rate of fuel consumption.[1] In England the difficulty of speed fluctuation, to which the adoption of the hit-and-miss principle leads, is met by increased fly-wheel effect or by dividing the power between a number of cylinders, but several well-known English makers are now governing by throttling the mixture.

The standard of achieved thermal efficiency is continually rising, although the amount of the improvement is the less easy to state on account of the very optimistic way in which certain experimental readings seem to have been taken. Much depends upon the ratio of compression, and many attempts have been made to permit of a high compression pressure without pre-ignition. This has been successfully attempted in several ways, viz. by the method of water injection, so lowering the compression temperature corresponding to a given pressure, or else by the method of supercompression, which consists of causing the in-coming charge to be at a pressure of from 5 lb. to 10 lb. above the atmosphere, so that here also a higher pressure corresponds to a lower temperature, and sometimes by the method of decreasing the proportion of hydrogen present, and so raising the temperature at which the mixture would be liable to pre-ignition. In the usual form of suction producer, the proportion of hydrogen pre-

[1] Continued from p. 203.

[2] "The Use of Large Gas Engines for Generating Electric Power." Read before the Institution of Electrical Engineers, 1909.

[1] In a specific case the reduction of the compression pressure from 170 lb. to 120 lb. led to an increase in the thermal units used per horse-power from 9500 to 11,500.

sent is usually about 20 per cent., and a method of lowering the amount which has been employed recently is to admit exhaust gases into the producer in place of the usual water supply. The CO_2 then takes the place of H_2O as an energy absorber, and the chemical composition of the resulting gas is so greatly affected that the hydrogen sinks to less than 1 per cent. Another recent improvement in the suction gas producer is the regulation of the water admitted, so that the composition of the gas may be the same, no matter whether the "draw" of the engine is vigorous or slight. Without some such device the gas tends to become "wet" at the lower loads, and the producer to "go dead." To avoid this, the water supply to the producer has to be cut off, or greatly reduced, in proportion as the governor is cutting out working strokes in the engine.

Improvements in Class (c).

These are exceedingly numerous. The most recent decided change has been the adoption of the sleeve type of valve in the Daimler engine. Despite apparent drawbacks from the theoretical point of view, it has lately undergone an extremely severe test under the officials of the Royal Automobile Club, and has emerged victorious. It is understood that a number of other manufacturers are now considering the adoption of the slide type of valve.

Another innovation is the use of air pressure to force the fuel up from low-lying tanks to the carburettor. This is claimed to be an improvement on the exhaust pressure feed, as being less likely to choke. As regards heavy oil engines, the chief improvement to be noticed is the widespread use of water injection, which is even more useful here than in a gas engine on account of the very low pre-ignition point of mixtures of oil vapour and air.

Attempts have continually been made to produce an engine working on the two-cycle principle, and there would seem to be no reason why engines of this kind should not be as practically successful as any built to operate on the four-cycle principle. One would expect that in this way a lighter engine could be built, and lightness is a great asset, particularly in the most recent use to which the internal-combustion engine has been put, viz. aëroplane work. Wonderfully light engines have already been made for this purpose. The 50 horse-power engine on the aëroplane *Silver Dart* weighs only 220 lb. without oil and water, or 4·4 lb. per horse-power. The 50 horse-power "Wolseley" V-type eight-cylinder engine, built for aëroplane work, is reported to weigh only 340 lb., or 6·8 lb. per horse-power, although the engine is fitted with a water-cooling system. The somewhat similar 80 horse-power engine fitted to Mr. Moore Brabazon's aëroplane is reported to weigh only 366 lb., or 4·6 lb. per horse-power; this is also a water-cooled engine. The possibilities of the different types of engine have lately been summarised in the technical Press[1] as follows:—

Type of engine	Weight per brake horse-power lb.	Weight of 50-brake horse-power engine lb.
Four-cylinder vertical	8	400
Eight- ,, diagonal	6	300
Diagonal, with several cylinders grouped on one crank pin ...	4	200
Rotary	3	150

From this it appears that engines amply light enough for aëroplane work have already been built, and there is not much scope left for any improvement in this direction for which the two-cycle engine would be useful, although there is still room for general improvement by the avoidance of the use in the engine parts of all heavy materials of low mechanical strength. On the other hand, the lighter the engine the better, as it means the possibility of adding additional accessories that make for constancy of operation, such as duplicate ignition, ample water-cooling arrangements, &c. The aëroplane appears to offer little chance of an "altitude stop" to permit of the engine being adjusted, and constancy of operation is therefore the one essential thing so far as the motor is concerned.

Carburettors are continually being improved, but the ideal one, which will give a constant mixture at all speeds and all loads in all weather conditions, has yet to be invented. The high-water mark as regards fuel economy that has so far been reached is the performance of the White and Poppe carburettor in the 1907 Royal Automobile Club trials of commercial vehicles. This carburettor was fitted to a Maudslay car, and showed the very high "figure of merit" of 62 gross ton miles per gallon of petrol, which is nearly twice as good as was obtained from the average car of that time. In the last two years the average has, however, risen appreciably. This, with an assumed road resistance of 50 lb. per ton, would correspond to an efficiency of power transmission between the carburettor and the road wheels of no less than 15 per cent. What the road resistance really was is not known, but now, without doubt, such road resistances ought to be accurately measured and the results applied.

[1] *Engineering*, April 16.

Conclusion.

With such a rapidly moving industry as that of the internal-combustion engine, prophesy is even more unsafe than it usually is. Writers have been bold enough to look forward to solid explosives being employed, but there one is faced with the difficulty of selecting any form of solid explosive that would have an entirely gaseous exhaust. When the gas turbine has taken practical shape, this consideration may be of less importance. Indeed, the combination of a solid explosive with a gas turbine promises this advantage, that the difficulty of the initial compression would thereby be removed. On the other hand, if we may judge by analogy with the steam turbine, provided that it were possible to keep the exhaust pressure sufficiently low, a high initial pressure would not be essential to economy. Whatever may be the outcome of the present experiments with gas turbines, or of gas producers, suitable for marine purposes on the one hand or to road transport on the other, one may be certain that the days of the external-combustion engine, the steam engine, are numbered, and that the engineers of the near future will not be satisfied with any less degree of efficiency than that which the internal-combustion engine will afford. One seems to see in the world of engineering the working of a continuous process leading to the supersession of those ideas, which, though old and tried friends, are found to produce less efficient results than those obtainable by more scientific methods. There is no reason that the writer can see to doubt the continued operation of this process during the present rivalry between the steam engine and the internal-combustion engine.

H. E. WIMPERIS.

OSMOTIC PHENOMENA AND THEIR MODERN PHYSICAL INTERPRETATION.[1]

OSMOTIC pressure is a phenomenon of such importance in the theory of solutions, and in the interpretation of all vital processes, and so much valuable work has recently been directed to its elucidation, that, although it is a somewhat thorny and difficult subject, no apology is needed for any serious attempt, however inadequate, at its explanation.

One of the earliest recorded experiments on osmotic pressure is that of the Abbé Nollet, who found that a bladder containing alcohol, when immersed in water, absorbed water so greedily as in many cases to burst the bladder. The experiment illustrates in an imperfect manner the fundamental property of all animal and vegetable membranes of allowing some substances to pass through them by osmosis more easily than others. In many cases such membranes, while freely permeable to water, are practically impermeable to certain substances in solution, and play the part of sieves in directing and controlling diffusion. It will readily be understood that results of the greatest importance to biology have been obtained by studying this property of *semipermeability*, as it is called, but the application of natural membranes to the physical study of the subject is necessarily limited on account of the difficulty of obtaining sufficiently large and perfect membranes capable of withstanding any considerable pressure.

[1] Discourse delivered at the Royal Institution on Friday, February 26, by Prof. H. L. Callendar, F.R.S.

Artificial membranes of sufficient fineness to be impermeable to such substances as sugar in solution, were first prepared by Traube by means of precipitated pellicles of substances like copper-ferrocyanide. The first quantitative measurements of osmotic pressures of considerable magnitude were made by Pfeffer with membranes of this kind deposited in the pores of earthenware pots fitted with suitable manometers for indicating the pressure developed. Pfeffer found that when a semipermeable vessel, filled with sugar solution, was immersed in water, the membrane being freely permeable to water, but not to the dissolved sugar, the solution absorbed water through the membrane by osmosis until the internal pressure reached a certain magnitude sufficient to balance the tendency to absorption. The osmotic pressure developed in the state of equilibrium was found to be proportional to the strength of the solution, and to increase with rise of temperature at the same rate as the pressure of a gas at constant volume. A few years later van 't Hoff, reviewing these experiments in the light of thermodynamics, showed that the osmotic pressure of a dilute solution should be the same as the pressure exerted by a number of molecules of gas equal to those of the dissolved substance in a space equal to the volume of the solution, that it should be the same for all solutions of equal molecular strength, and that osmotic pressure followed the well-known laws of gas-pressure in all respects. This most important generalisation was hailed as the first step to a complete kinetic theory of solution, and the osmotic pressure itself has generally been regarded as due to the bombardment of the sides of the semipermeable membrane by the particles of solute, as though they were able to move freely through the solution with velocities comparable to those of the molecules of a gas. Such a view would not now be seriously maintained, but the fascinating simplicity of the gas-pressure analogy has frequently led to the attempt to express everything in terms of the osmotic pressure, regarded simply, but inaccurately, as obeying the gaseous laws, and has done much to divert attention from other aspects of the phenomena, which, in reality, are more important and have the advantage of being more easily studied. It was very soon discovered that the gaseous laws for osmotic pressure must be restricted to very dilute solutions, and that the form of the laws was merely a consequence of the state of extreme dilution, and did not necessarily involve any physical identity between osmotic pressure and gas-pressure. Many different lines of argument might be cited to illustrate this point, but it will be sufficient to take some of the more recent experimental measurements of osmotic pressure by the direct method of the semipermeable membrane.

Morse and Frazer in 1905 succeeded in preparing ferrocyanide membranes impermeable to sugar, and capable of withstanding pressures of more than 20 atmospheres. They operated by Pfeffer's original method, allowing water to diffuse into the solution in a porous pot until the maximum pressure was developed. There are many serious experimental and manipulative difficulties which the authors carefully considered and discussed in applying this method, but they succeeded in obtaining very consistent results. As a first deduction from their investigations they considered that they had established the relation that the osmotic pressure of cane-sugar was the same as that exerted by the same number of molecules of gas at the same temperature in the volume occupied by the solvent, and not in the volume occupied by the solution. In other words, the osmotic pressure of a strong solution was greater than that given by van 't Hoff's formula for a dilute solution in proportion as the volume of the whole solution exceeded the volume of the solvent contained in it. It was a very natural extension of the gas-pressure analogy to deduct the volume occupied by the sugar molecules themselves in order to arrive at the space in which they were free to move. Unfortunately, the later and more accurate series of measurements by the same experimentalists at 0° C. and 5° C. gave nearly the same osmotic pressures as at 24° C., and would appear to show either that there is little or no increase of osmotic pressure with temperature, and that the pressures at 0° C. are much greater than those given by their extension of the gas-pressure analogy, or that one or other of the series of experiments are in error.

About the same time Lord Berkeley and E. J. Hartley undertook a series of measurements of the osmotic pressures of solutions of various kinds of sugar at 0° C. by a greatly improved experimental method, which permitted the range of pressure to be extended to upwards of 100 atmospheres. Instead of allowing the solvent to diffuse into the solution until the equilibrium pressure was reached, they applied pressure to the solution until balance was attained. The method of Lord Berkeley and Hartley possesses several obvious advantages, and it is impossible to study the original memoir without being convinced that they have really measured the actual equilibrium pressures with an order of certainty not previously attained or even approached. The pressures found were in all cases greatly in excess of those calculated from the gas-pressure of the sugar molecules in the volume occupied by the solution (according to van 't Hoff's formula for dilute solutions), or even in the restricted volume occupied by the solvent (according to Morse and Frazer's assumption).

Lord Berkeley endeavoured to represent these deviations on the gas-pressure analogy by employing a formula of the van der Waals type, with three disposable constants. Out of some fifty formulæ tested, the two most successful were those given in Table I. The constants A, a, and b were calculated to fit the three highest observations for each solution. Values calculated by the formulæ for the lower points were then compared with the observations at these points, with the results given in Table I. for cane-sugar.

TABLE I.—OSMOTIC PRESSURES OF CANE-SUGAR SOLUTIONS.

Osmotic Pressures calculated by various Formulae.

Vant 't Hoff	Morse and Frazer	Lord B. (1)	Lord B. (2)	C.	Do. observed Lord B.
35·6	53·2	68·4	67·7	67·6	67·5
27·6	37·4	45·0	43·4	43·7	44·0
19·7	24·4	27·7	25·4	26·8	26·8
11·2	13·3	14·6	12·2	14·1	14·0

Lord Berkeley's equations :—

$$(A/v - P + a/v^2)(v - b) = RT \quad . \quad . \quad . \quad (1)$$

$$(A/v + P - a/v^2)(v - b) = RT \quad . \quad . \quad . \quad (2)$$

It is at once evident that, even with three constants, the gas-pressure analogy does not represent the results satisfactorily within the limits of error of experiment. Moreover, with three constants the equation cannot be interpreted, so that the gas-pressure analogy becomes useless as a working hypothesis or as a guide to further research. On the vapour-pressure theory, to be next explained, the results are much better represented, as shown in column C, with but a single constant, and that a positive integer with a simple physical meaning.

Vapour-pressure Theory.

On the vapour-pressure theory, osmotic equilibrium depends on equality of vapour-pressure, and not on an imaginary pressure which the particles of the dissolved substance would exert if they were in the state of gas at the same volume and temperature. The vapour-pressure of any substance is a definite physical property of the substance which is always the same under the same conditions of pressure and temperature and state, and is easily measured in most cases for liquids and solutions. Equality of vapour-pressure is one of the most general, as well as the simplest, of all conditions of physical equilibrium. Ice and water can only exist together without change under atmospheric pressure at the freezing point 0° C., at which their vapour-pressures are the same. Below the freezing point the vapour-pressure of water is greater than that of ice. Either is capable of stable existence separately within certain limits, but if the two are put in communication, the vapour, being mobile, passes over from the water at higher pressure to the ice at lower pressure until equality of vapour-pressure is restored by change of temperature, or until the whole of the water is converted into ice.

In the case of ice and water, equality of vapour-pressure can also be restored by a suitable increase of pressure.

This is the well-known phenomenon of the lowering of the freezing point by pressure. By considering the equilibrium of water and vapour in a capillary tube, Lord Kelvin showed that the vapour-pressure of water, or any other liquid, was increased by pressure according to a very simple law, the ratio of the increase of vapour-pressure, dp, to the increase of pressure, dP, on the liquid being simply equal to the ratio of the densities of the vapour and liquid, or inversely as the specific volumes, v and V. This relation, which may be written $VdP=vdp$, is merely a special case of Carnot's principle, and was deduced by assuming the impossibility of perpetual motion. Assuming a similar relation to apply to ice, Poynting showed that when a mixture of ice and water was subjected to pressure, the vapour-pressure of the ice must be increased more than that of the water (since the specific volume of ice is greater than that of water). Consequently, some of the ice must pass over into water, and the temperature must fall until the vapour-pressures are again equal. The lowering of the freezing point by pressure, as observed by Lord Kelvin, and calculated by James Thomson, agrees precisely with that deduced as above from the condition of equality of vapour-pressure.

Similar considerations apply to the equilibrium between a solution and the pure solvent, or between solutions of different strengths. To take a simple case, the vapour-pressure p'' of a sugar solution is always less than the vapour-pressure p' of water at the same temperature, and the ratio p''/p' of the vapour-pressures depends simply on the concentration of the solution, diminishing regularly with increase of concentration and being independent of the temperature. If separate vessels containing solution and water are placed in communication at the same temperature by a tube through which the vapour has free passage, vapour will immediately pass over from the water to the solution in consequence of the pressure difference, and will condense in the solution. The immediate effect is to produce equality of vapour-pressure by change of temperature. This takes only a few seconds. The vapour-pressure then remains practically uniform throughout. As diffusion proceeds and the temperature is slowly equalised, the water will gradually distil over into the solution, but the process of diffusion is so infinitely slow compared with the equalising of vapour-pressure that the final attainment of equilibrium would take years unless the solution were continually stirred.

The reason why equality of vapour-pressure is so important as a condition of physical equilibrium is that the vapour is so mobile and so energetic as a carrier of energy in the form of latent heat. The first effect is generally a change of temperature, but if the temperature is kept constant there must then be a change of concentration. Thus if two parts of the same solution are maintained at different constant temperatures, the concentrations will change so as to restore equality of vapour-pressure, if possible. Thus in a tube of solution the two ends of which are maintained at different temperatures, the dissolved substance will appear to move towards the hotter end. What really happens is that the vapour, which is the mobile constituent, moves towards the colder end. If the tube is horizontal, with a free space above the liquid for the vapour, this transference will be effected with extreme rapidity. In fact, it will be practically impossible to establish an appreciable difference of temperature until the transfer is effected. If the vapour has to diffuse through the solution in a vertical column heated at the top, the process is greatly retarded, but the final effect is the same, and can be readily calculated from the relation between the vapour-pressure and the concentration.

In explaining the production of osmotic pressure as a necessary consequence of the laws of vapour-pressure, there is one difficulty which, though seldom expressed, has undoubtedly served very greatly to retard progress. How can an insignificant difference of vapour-pressure, which may not amount to so much as one-thousandth part of an atmosphere in the case of a strong sugar solution at 0° C., be regarded as the cause of an osmotic pressure exceeding 100 atmospheres, or 100,000 times as great as itself? The answer is that the equilibrium does not depend at all on the absolute magnitude of the vapour-pressure, but only on the work done for a given ratio of expansion, which is the same in the limit for a gram-molecule of any vapour at the same temperature, however small the vapour-pressure. Indirectly, the smallness of the vapour-pressure may have a great effect in retarding the attainment of equilibrium, especially if obstructive influences, such as other vapours or liquids, are present. Thus mercury at ordinary temperatures in the open air is regarded as practically non-volatile. Its vapour-pressure is less than a millionth of an atmosphere, and cannot be directly measured, though it may easily be calculated. When, however, we take mercury in a perfect vacuum, such as that of a Dewar vessel, the presence of the vapour is readily manifested by its rapid condensation on the application of liquid air in the form of a fine metallic mirror of frozen mercury. The least trace of air or other gas in the vacuum will retard the condensation excessively.

Under the conditions of an osmotic-pressure experiment we have solvent and solution in practical contact, separated only by a thin porous membrane. It will facilitate our conception of the conditions of equilibrium if we imagine the membrane to be a continuous partition pierced by a large number of very fine holes of the order of a millionth of an inch in diameter. If the holes are not wetted by the solution or the water, the liquid cannot get through unless the pressure on it exceeds 100 atmospheres, but the vapour has free passage. If the solvent and solution are under the same hydrostatic pressure the vapour-pressure of the solvent will be the greater, and the vapour will pass over into the solution. Since the surfaces are practically in contact, no appreciable difference of temperature can be maintained. If the solution is confined in a rigid envelope, so that its volume cannot increase, the capillary surfaces of the solution will rapidly bulge out as the vapour condenses on them, and the pressure on the solution will increase until condensation finally ceases, when the vapour-pressure of the solution is raised to equality with that of the pure solvent. The osmotic pressure is simply the mechanical pressure-difference which must be applied to the solution in order to increase its vapour-pressure to equality with that of the pure solvent. If any pressure in excess of this value is applied to the solution, the vapour will pass in the opposite direction, and solvent will be forced out of solution. The osmotic work required to force a gram-molecule of the solvent out of the solution is the product of the osmotic pressure P by the change of volume U of the solution per gram-molecule of solvent abstracted. In the state of equilibrium of vapour-pressure, this osmotic work PU must be equal to the work which the vapour could do by expanding from the vapour-pressure p' of the pure solvent to the vapour-pressure p'' of the solution. Neglecting minor corrections, we thus obtain the approximate relation

$$PU = R\theta \log (p'/p'').[1]$$

From this point of view the osmotic pressure of a solution is not a specific property of the solution in the same sense as the vapour-pressure, or the density, or the concentration, but is merely the mechanical pressure required under certain special conditions to produce equilibrium of vapour-pressure when neither the temperature nor the concentration are allowed to vary. One might with almost equal propriety speak of the "osmotic temperature" of a solution, meaning by that phrase the difference of temperature required to make the vapour-pressure of the solution equal to that of the pure solvent. The observation of the elevation of the boiling point of a solution above that of the pure solvent is a familiar instance of a special case of such a temperature difference. It is just as much a specific property of the solution as the osmotic pressure, and would only require a perfectly non-conducting membrane for its production. No one would regard the rise of boiling point as being the fundamental property of a solution in terms of which its other properties should be expressed. By similar reasoning osmotic pressure should not be regarded as existing *per se* in the solution, and as being the cause of the relative lowering of vapour-pressure and other phenomena. This point of view does not detract in any way from the reality and physical

[1] Obtained by integrating $UdP=vdp$. Planck, "Thermodynamik," also *Zeit. Phys. Chem.*, xli. 212, 1902, and xlii. 584, 1903.

importance of the effects of osmotic pressure when it comes into play, but it puts the phenomena in their true light as consequences of the law of vapour-pressure.

Regarded as a verification of the laws of vapour-pressure, direct measurements of the osmotic pressure are of the highest value, but there are comparatively few cases known at present in which such direct measurements are possible. In other cases the osmotic pressure, if it exists, can always be calculated from a knowledge of the vapour-pressure. For the elucidation of osmotic phenomena and many other problems in the theory of solutions we are compelled to make a systematic study of the relations of vapour-pressure. Much has been done in this direction in the past, but, owing to the difficulty of the measurements, much remains yet to do. I may, therefore, be pardoned if I allude briefly to some of the methods which I have employed for this purpose, and some of the conclusions at which I have so far arrived.

It is often a difficult matter, when the difference of vapour-pressure between a solution and the solvent is small, to measure the pressure difference directly to a sufficient degree of accuracy. A method very commonly employed, which has been brought to a high degree of accuracy by Lord Berkeley and his assistants, depends on the observation of the losses of weight of two vessels, containing solution and solvent respectively, when the same volume of air is aspirated slowly through them in succession. To secure accurate results, the air must pass very slowly. One complete observation takes about a week to perform successfully, and involves many difficult manipulations. I have endeavoured to avoid this difficulty by measuring the temperature difference in place of the pressure difference, since the temperature difference remains nearly constant, while the pressure difference tends to diminish in geometrical progression with fall of temperature. The method adopted for this purpose is that indicated in the diagram of the vapour-temperature balance. The temperatures of solution and solvent, contained in separate vessels communicating through a tap, are adjusted until, on opening communication between them, there is no flow of vapour from one to the other, as indicated by a change in the reading of a pair of thermojunctions immersed in the solvent respectively. The corresponding difference of temperature is observed, and since the vapour-pressures of the solvent are known, it is easy to calculate the required ratio or difference of the vapour-pressures of solvent and solution at the same temperature. When the vapour-pressures are very small it may be difficult to observe the change of temperature on opening the tap unless the apparatus is very carefully exhausted. A more delicate method in this case is to observe the direction and magnitude of the current of vapour from solution to solvent, or *vice versâ*, by means of the "vapour-current indicator," illustrated in the companion diagram. This consists of a delicately suspended vane, the deflections of which are read by a mirror, and will readily indicate a difference of pressure less than the thousandth part of a millionth of an atmosphere.

The vapour-current indicator is so constructed that its deflections are very accurately proportional to the pressure difference, much more so, in fact, than any form of electric galvanometer. It can also be employed for direct measurements of small differences of vapour-pressure. The chief difficulty in this case is to ensure the absence of air or other disturbing factors. A method of avoiding this difficulty is to work at atmospheric pressure, and to measure the pressure difference between two vertical columns of air saturated with the vapours of the solvent and solution respectively.[1] The temperature difference may be adjusted to balance, and is preferably measured by means of a pair of differential platinum thermometers, which permits a higher order of accuracy to be attained than the thermoelectric method.

Vapour-pressure in relation to Molecular Constitution.

The well-known law of Raoult, according to which the relative lowering of vapour-pressure of a solution is equal to the ratio of the number of molecules n of the solute to the number of molecules of solvent N in the solution, has thrown a great deal of light on the molecular state of the dissolved substance in dilute solutions, but fails notably in many cases when applied to strong solutions. In the case of homogeneous mixtures of two indifferent volatile substances, such as benzol (C_6H_6) and ethylene chloride ($C_2H_4Cl_2$), which mix in all proportions without mutual action, a slightly different but equally simple law is known to hold very accurately throughout the whole range of concentration from 0 per cent. to 100 per cent. The vapour-pressure of each ingredient is simply proportional to its molecular concentration. In other words, the ratio of the partial vapour-pressure p' of either constituent at any concentration to its vapour-pressure p_0' in the pure state at the same temperature is equal to the ratio of the number of its molecules n' in the solution to the whole number of molecules $n'+n''$ of both substances in the solution. Such is evidently the form of the simple mixture law. For substances which form compounds in the solution, or the molecules of which are associated or dissociated, this simple law is widely departed from. In a recent paper, "On Vapour-pressure and Osmotic Pressure of Strong Solutions" (Proc. R.S.A., vol. lxxx., p. 466, 1908), I have endeavoured to extend this simple relation to more complicated cases by making the obvious assumption that, if compound molecules are formed, they should be counted as single molecules of a separate substance in considering their effect on the vapour-pressure. With this proviso the vapour-pressures of strong solutions are well represented by a natural extension of the simple mixture law, and it becomes possible to investigate the nature of the compounds formed in any case. To take a simple instance, suppose that each of the n molecules of the dissolved substance combines with a molecules of the solvent, the total number of molecules of the solvent being N. The ratio of the vapour-pressure p'' of the solvent in the solution to the vapour-pressure p' of the pure solvent at the same temperature will then be the same as the ratio of the number $N-an$ of molecules of *free* solvent in the solution, to the whole number of molecules $N-an+n$ in the solution, each compound molecule being counted as a single molecule.

With the simple formula

$$p'/p''=(N-an+n)/(N-an),$$

the values of the vapour-pressure are very easily calculated from the molecular concentration n for simple integral values of the hydration factor a. The osmotic pressures are also readily deduced from the ratio of the vapour-pressures (p'/p'') by the formula

$$PU=RT\log(p'/p'').$$

The value $a=5$ fits the osmotic pressures for cane-sugar very well, as shown in the column headed C in Table I. The value $a=2$ fits Lord Berkeley's observations on dextrose equally well up to pressures of 130 atmospheres. The same value $a=5$ for cane-sugar also fits the observations on the depression of the freezing point and the rise of the boiling point, as it necessarily must, since these phenomena also depend on the vapour-pressure. The freezing-point method is the easiest for getting the ratio of the vapour pressures to compare with the formula. At the freezing point of an aqueous solution the vapour-pressure of the solution must be the same as that of ice, provided that ice separates on freezing in the pure state. The ratio of the vapour-pressure of ice to that of water at any temperature below 0° C. is easily calculated. All the best recorded results, except those of a few associating substances, give simple positive integral values of a. Even in the case of associating substances, like formic acid and acetone, the curves are of the same type, but the value of a is negative. Dissociating substances, like strong electrolytes, present greater difficulties, on account of the ionisation factor; but, allowing for the uncertainty of the ionisation data, they seem to follow satisfactorily the same law of vapour-pressure.

It appears from the form of the proposed law that the hydration factor a makes very little difference to the vapour-pressure in weak solutions, which follow Raoult's law as a limiting case, but it makes a very great difference in strong solutions, when nearly all the free water is used up, and the denominator $N-an$ is small. Thus

[1] I first showed this experiment ten years ago, in illustration of the delicacy of the apparatus, at a Friday Evening Lecture at the Royal Institution.

the depression of the freezing point of a strong solution of calcium chloride is more than five times as great as that calculated from the number of ions present in the solution. Each ion appears to appropriate no less than 9 molecules of water. The factor $a=9$ gives a very good approximation to the freezing-point curve, as far as the uncertainty of the data permit. When $N=an$, the vapour-pressure would be reduced to zero, according to the formula, but the formula ceases to apply when the vapour-pressure of the compound molecules themselves becomes equal to that of the solution. At or before this point the molecules will dissociate with the formation of lower hydrates. Many analogous phenomena are already known, and a more complete study of the vapour-pressures of strong solutions may be expected to throw additional light on the subject.

The essential point of the theory here sketched is that the equilibrium existing in a solution is one between definite chemical compounds and the solvent, giving rise to a simple vapour-pressure relation by means of which the phenomena may be studied and elucidated. There is a great deal of work to be done before such a theory can be regarded as established, but in the meantime it may serve very well as a working hypothesis for correlating experimental results and suggesting new lines of investigation. Regarded in this light, the vapour-pressure theory may serve a useful purpose, and, judging by the experimental data at present available, I think I may fairly claim to have made out a good *primâ-facie* case for the theory.

NOTE.—The vapour-current indicator is a development of the old smoke-jack. A light spiral vane with a mirror attached is suspended in a tube, which nearly fits it, by means of a quartz fibre. Joule (Proc. Phil. Soc., Manchester, vii., 35) employed a wire spiral suspended by a silk fibre for indicating air currents, but does not seem to have adapted it for purposes of exact measurement. The instrument shown in the lecture gave a deflection of 30° (500 mm. at 1 metre) for a velocity of air current 0·01 cm./sec. The sensitiveness might easily have been increased, but the above amply suffices for most purposes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

REUTER'S Agency states that the Hong Kong and Shanghai Bank has made a donation of about 4500*l.* to the Hong Kong University.

PROF. W. OSLER, F.R.S., will deliver the inaugural address of the winter session of the London School of Tropical Medicine on Tuesday, October 26.

MR. W. H. HADOW, fellow and tutor of Worcester College, Oxford, has been appointed principal of Armstrong College of Durham University at Newcastle-on-Tyne, in succession to Sir Isambard Owen, who has accepted the Vice-Chancellorship of Bristol University.

WE learn from *Science* that the College of Agriculture of the University of the Philippines, situated at Los Banos, opened on June 14 last with about sixty students. Prof. E. B. Copeland is dean and professor in botany; Prof. H. Cuzner, professor of agronomy; Prof. E. M. Ledyard, professor of zoology; and Prof. S. B. Durham, professor of animal husbandry.

A CORRESPONDENT asks us to mention that a man with a science training and degree is wanted for a vacant post in an advanced mission college in South China. The Chinese are eager to acquire the secrets of Western power, and a teacher with the science qualifications required would have a fine opportunity of assisting to make history in that great land.

WE learn from the *Pioneer Mail* that on July 14 the Governor of Madras opened a new agricultural college and research institute at Coimbatore. The building is designed both for teaching and research work. A special set of rooms is set apart for chemistry, botany, entomology, and mycology. A physical laboratory is provided, as well as ample accommodation for the Madras herbarium and a library. The cost of the new institution, including the surrounding farm, has been eight lakhs. The Governor, during the course of his remarks, said that as the demands of scientific agriculture grow and the necessity for expansion arises, the Government will not hesitate to increase the capacity of the institution.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 9.—M. Bouquet de la Grye in the chair.—The thermal effects of moistening soils: A. **Müntz** and H. **Gaudechon.** Certain dry soils, when moistened, give out an appreciable amount of heat, and it is possible that this thermal phenomenon may have an effect on the growth of plants. Measurements with different soils gave an evolution of heat varying from 0·9 to 6·6 calories per kilogram, and a systematic levigation showed that the finest particles caused nearly all the heat evolution.—Magneto-anodic phenomena: M. **Gouy.** The phenomenon described accords to a certain extent with the theory of M. Fortin, which regards the magneto-kathode rays as formed of spirals of electrons.—Discontinuous singularities of uniform analytical functions: A. **Denjoy.**—Tides and the crust and the elasticity of the terrestrial globe: Ch. **Lallemand.** The author has shown in a previous note that the principal modes of determination of the rigidity of the globe lead to different results. The theory developed in the present paper removes this anomaly.—The different species of asymmetrical intensities, observed for the magnetic components, polarised circularly, of the absorption bands of uniaxial crystals: Jean **Becquerel.**—The decomposition of carbon dioxide by the ultra-violet rays: H. **Herchefinkel.** The decomposition of carbon dioxide into oxygen and carbon monoxide by the action of the ultra-violet rays has been proved; a similar result has been obtained with the radium emanation, confirming the observations of Ramsay and Cameron.—The intervention of osmotic pressure in dyeing: M. **Rosenstiehl.**—A method for the rapid estimation of metallic aluminium: E. **Kohn-Abrest.** The metal is heated to 300° C. first in hydrogen, and then in pure hydrochloric acid gas, followed again by hydrogen. The aluminium is volatilised as chloride, and the metal determined indirectly by a determination of the chlorine.—Attempts at benzidination in the diphenyl, diphenylamine, and diphenylethane series: H. **Duval.**—The ethyl acetal of tetrolic aldehyde: P. L. **Viguer.** Dibromo butyric aldehyde was obtained by the addition of bromine to crotonaldehyde; the application of Claisen's method to this aldehyde gave, not the tetrolic aldehyde desired, but its ethyl acetal.—Some parasitic diseases of *Cinnamomum zeylanicum* of Ceylon: D. **Bois** and C. **Gerber.**—Vaccination of cattle against tuberculosis: M. **Rappin.** The bacilli used in these injections were modified by the action of sodium fluoride; it has been shown that the resistance of the animal to tuberculous infection is increased by the treatment almost to the point of immunisation.—The glucoses of the urine: F. **Landolph.** Each species of glucosuria or diabetes corresponds, in the urine, to the presence of mixtures of several kinds of sugars, and it may be supposed that these differences correspond to diseases of different organs.—The preservation and increase of digestibility of distillery pulps and of green ensilage by a rational fermentation by inoculation: J. **Crolbois.**—The suprarenal capsules and their exchanges between the blood and tissues: J. **Athanasiu** and A. **Gradinesco.** The experiments on a dog and a cat described lead to the conclusion that the death of animals deprived of the suprarenal capsules is due to the arrest of the exchanges between the blood and the tissues.—Contribution to the study of urinary indosis in diabetic subjects: H. **Labbé** and G. **Vitry.**—The variation of an oxidising enzyme during metamorphosis in *Limnophilus flavicornis*: Xavier **Roques.**

CAPE TOWN.

Royal Society of South Africa, June 16.—Dr. R. Marloth in the chair.—Some points in the morphology and biology of a new species of Haworthia: Dr. S. **Schönland.** The author gives a full description of the only species of Haworthia with strictly distichous arrangement of leaves. The leaves are to a large extent underground, the exposed parts resembling small pebbles, so that this plant may be classed amongst the so-called "mimicry-plants." The structure of the leaves is adapted to the peculiar mode of life of the plant. The truncate apex is without chlorophyll, thus forming a "window," through which light can reach, by way of the central transparent tissue, the assimilating tissue which extends to the underground basal parts of the leaves.—The absorption of water by the aërial organs of some succulents: Dr. S. **Schönland.** The author describes numerous experiments, from which he has drawn the following conclusions:—*Mesembrianthemum barbatum* and *Anacampseros flamentosa* cannot absorb any appreciable quantity of water through their aërial organs. *Crassula cymosa* can do so to a small extent, which, however, cannot be of any practical importance under natural conditions. The marginal papillæ of this species are certainly not water-absorbing organs.—Note on an abnormal seedling of *Widdringtonia cupressoides*: E. P. **Phillips**, and a brief account of the vascular system of the normal seedling: H. S. **Morris.**—Some new South African succulents, part ii.: Dr. R. **Marloth.** Among the succulents described in this paper are a few with a very peculiar structure of their leaves. Last year the author exhibited a species of Bulbine with window-leaves, pointing out that such a structure had not been observed as yet on any other plant. The very succulent, nearly egg-shaped leaves of the plant remain embedded in the ground, hence the blunt apex only becomes visible. Here the green tissue is absent, being confined to the sides of the leaf. As the sides are surrounded by soil, the light cannot reach them in the ordinary way, but only by entering through the window at the apex, illuminating the leaf from within. Since then the writer found five other species of plants with such window-leaves. They are all stemless succulents, their leaves remaining embedded in the ground, and showing only the flat or convex apex, which is entirely devoid of green tissue. Hence, as in the case of the Bulbine, the light can reach the green tissue of the leaf only through the window, illuminating the leaf from within. It is considered that this structure is principally a contrivance for the protection of the green tissue against the destructive action of too severe sunlight.

NEW SOUTH WALES.

Linnean Society, June 30.—Mr. C. Hedley, president, in the chair.—Studies on Tunicata, No. 1: H. L. **Kesteven.** One genus allied to Polyclinum and Sidnyum (Polyclinidæ), and three species referable to the genera Corella, Molgula, and Dendrodoa, from Tasmania or New South Wales, are described as new, and detailed descriptions are given of *Ciona intestinalis*, var. *sydneiensis*, Stimpson, and var. *diaphnea*, Quoy and Gaimard.—Second supplement to the "Revision of the Cicindelidæ of Australia": T. G. **Sloane.**—The hexone bases of egg-white: Dr. J. M. **Petrie** and Dr. H. G. **Chapman.** This paper deals with the separation and estimation of the hexone bases among the products of the hydrolysis of the proteins of egg-white. By the method of Kossel and Patten, arginin, histidin, and lysin were isolated and identified from egg-white digested with 25 per cent. H_2SO_4. The amounts of lysin, histidin, and arginin present in 100 gm. protein of egg-white were:—lysin, 3·19 gm.; histidin, 0·66 gm.; and lysin, 2·39 gm. Certain improvements in the method of separation are also described.—Notes on the native flora of New South Wales, part vii., eastern Monaro: R. H. **Cambage.** The general botany of the area lying chiefly to the east of Cooma and Nimitybelle is reviewed. The absence of forest growths on the Monaro plains, which are largely basaltic, is a striking feature, and it is suggested that the rigid winter climate, dry summer atmosphere, moderate rainfall (being less than 20 inches annually at Cooma), together with the basic nature of the rocks, in view of the low rainfall, all contribute to hinder the growth of large trees. Where the formation contains a high percentage of silica forest trees are found, and this is thought to be possibly owing to physical properties rather than to chemical constituents, resulting in capillarity being induced by the siliceous particles in the soil, thereby enabling it to supply moisture in dry times better than the soils formed from the basic rocks. The unexpected occurrence of a rare species of Eucalyptus, *E. pulvigera*, first discovered by Allan Cunningham nearly ninety years ago at Cox's River, and now known to occur only in three localities, was of interest. The abrupt change in the flora, where the eastern and western aspects meet on the Main Dividing Range near the head of the Kybean River, is commented upon.—Description of a new species of Eucalyptus from the Monaro district, N.S.W.: R. H. **Cambage.** This species, for which the name *Eucalyptus parvifolia* is suggested, has so far only been found near the head of the Kybean River, on eastern Monaro. It frequents the flats in company with *E. stellulata*, attaining a height of from 20 feet to 30 feet, and having a smooth gum-tree bark. Its most remarkable feature is that it retains a large percentage of the juvenile foliage until the trees are nearly full-grown, the length of these leaves being rather less than 1 inch.

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THURSDAY, AUGUST 26, 1909.

TREE-FLORA OF JAVA.

Mikrographie des Holzes der auf Java vorkommenden Baumarten. By Dr. J. W. Moll and H. H. Janssonius. Erste Lieferung (1906), pp. 368; and Zweite Lieferung (1908), pp. 369–568+160. (Leyden: E. J. Brill.) Price 6 marks each.

THIS work, like the earlier tree-flora of Java, was undertaken at the suggestion of Prof. M. Treub, director of the Botanic Garden at Buitenzorg. It will be convenient to begin by making a short reference to this earlier publication.

In the year 1888 Dr. S. H. Koorders began to collect material for a tree-flora of Java. The work connected with the compilation of this flora was carried out in a most careful and methodical manner. More than four thousand trees, many of which were in the primeval forest, were marked, and a special system of numbering the trees, and of indexes and maps, was instituted, so that each tree could be easily found again, and the rate of growth, leaf fall, &c., could be studied. In the course of naming and studying the plants for the tree-flora of Java ("Flora arborea Javanica," by S. H. Koorders and Th. Valeton), a collection of fifteen thousand specimens was made to illustrate the species dealt with in the flora.

This collection included a series of wood-specimens, which were sent in 1904 from Buitenzorg to the University of Gröningen for microscopic examination and description, and this work has been carried out, under the direction of Prof. J. W. Moll, by Herr H. H. Janssonius. The results appear in the present work, which may therefore be described as a counterpart to Koorders and Valeton's flora in the province of the anatomy of the wood. Hence a most important asset in the value of the work lies in the fact that there is no uncertainty as to the origin of the specimens. They have all been obtained from trees which have been carefully studied and determined by an expert, and, moreover, herbarium material from the same trees is to be found in the herbaria at Buitenzorg, Leyden, Berlin, &c.

In this work the authors have adopted a very orderly arrangement of the information. Under each species there are five principal headings, beneath which are given the literature, information on the material, the preparations made, the reagents used, and, lastly, under the name of micrography, a description of the structure of the wood. The section on micrography is generally subdivided into one on topography, dealing chiefly with the distribution of the tissues and elements as seen in transverse section, and another giving descriptions of the individual elements, based on a study of radial, tangential, and transverse sections, sometimes supplemented by macerated preparations. A separate paragraph is devoted to each kind of element, and gives full details of measurements, pitting, contents, &c. The section on topography is elucidated, in cases where this is advisable, by means of a diagrammatic figure showing the distribution of the vessels, wood-parenchyma, medullary rays, &c., in a portion of a transverse section. When several species of a genus are found to differ only slightly in the structure of the wood, one of them is fully described, and the description of the others is shortened by comparative treatment. Under each family, except where only one species is dealt with, there is a description of the structure of the wood, founded on that of the different species described, and an analytical key for distinguishing the species, so far as this is possible by means of the wood, is added.

Part i. contains, first (pp. 5–62), general information, including the history of the material and an exposition of the method adopted in presenting the information in the succeeding pages. The remainder of part i. (pp. 63–368) is occupied by the description of the microscopic structure of the wood in species from Dilleniaceæ to Dipterocarpaceæ. Part ii. (pp. 369–547) continues the same from Dipterocarpaceæ to Tiliaceæ, followed by the index and contents of vol. i., after which pp. 1–160 form a first instalment of vol. ii., extending from Geraniaceæ to Meliaceæ. The last page of part ii. reaches species No. 230, twenty-one families having been dealt with up to this point.

The foregoing description of this work will serve to indicate its value, which lies in the authentic nature of the specimens, the large number of species and families dealt with, the completeness of the description of the microscopic structure, and, lastly, the strict uniformity of treatment adhered to by the authors.

This book will be an important aid in the determination of wood-specimens, and the authors are to be congratulated on the efficient way in which they are carrying out a difficult and laborious task.

L. A. B.

TWO AMERICAN MATHEMATICAL BOOKS.

(1) *Plane and Spherical Trigonometry and Four-place Tables of Logarithms.* By Dr. Wm. A. Granville. Pp. xii+264+38. (London: Ginn and Co., n.d.) Price 5*s.* 6*d.*

(2) *A Course of Mathematics for Students of Engineering and Applied Science.* By Fredk. S. Woods and Fredk. H. Bailey. Vol. II. Pp. xii+410. (London: Ginn and Co., n.d.) Price 10*s.* 6*d.*

(1) THE type and diagrams in this book are models of elegance and excellence; evidently no pains have been spared in making both as clear and perfect as possible, and the logarithm tables at the end of the book add greatly to its completeness. One useful feature in them is the table of circular functions with the angles expressed in degrees and decimals of a degree, in addition to the usual table in degrees and minutes. The author also supplies a neat celluloid combined protractor and scale in a pocket attached to the cover.

In the plane trigonometry the author introduces the student to practical examples in connection with right triangles in the first chapter, but does not proceed to the solution of oblique triangles until chapter vii., after discussion of functions of the generalised angle, the addition theorems, inverse notation, and trigonometric equations, but to a certain extent teachers can choose their own order in taking these chapters.

The proof of the addition theorem is not very satisfactory. The author proves the theorems for sin $(x+y)$ and cos $(x+y)$ for *acute* angles (using a revolving line of unit length, and so denoting the sines and cosines by lengths of lines instead of ratios, which seems a pity), and then says "it is a fact, however, that these formulæ hold for angles of any magnitude, positive or negative." This he illustrates by a couple of cases. Then, in the next section, he says "it was shown" that the formulæ hold good for all angles. The proof by projection now customary in the best English books would have been much more satisfactory.

The directions for solving trigonometrical equations are not altogether satisfactory, and would lead to difficulties in the case of such an equation as $\sin 3x = \cos 4x$. This part of the subject would need amplifying. The similar instructions for proving identities, though sometimes leading to rather heavy work, would always lead to success and be useful in the last resort, though not conducive to elegance.

The solutions of triangles are well explained, and there is a good chapter on the theory and use of logarithms and their applications to nautical and other problems, but one is sorry not to see the value of the characteristic given as the distance of the highest significant figure from the unit's place, plus or minus according as it is to the left or right. It is more fundamental and easier to remember than the old-fashioned method given in the text.

This part of the book finishes with a discussion of acute angles near 0° and 90°, and a collection of miscellaneous practical examples of the usual type, followed by a useful recapitulation of formulæ, with the pages on which they are proved.

The spherical trigonometry assumes some previous knowledge on the part of the reader, as far as the properties of the polar triangle, and one or two of the more advanced formulæ are quoted without proof. The chief features of this part are a good exposition of Napier's rules for right-angled triangles, and the use of the exterior angles (α, β, γ) in all the formulæ for oblique triangles, a most excellent innovation which the reviewer has advocated for many years, but has never before seen in a text-book. By this means all formulæ become dual without any change except the interchance between a, b, c and α, β, γ. It leads, perhaps, to a preponderance of obtuse angles in the practical applications, but the author in his logarithmic work, which is most excellently exemplified, disposes of them by the simple device of putting (n) to the logarithms of negative quantities, a method often used by practical computers, but not often seen in text-books. The book concludes with applications to astronomical and other problems, well explained and illustrated by good diagrams, with a fair number of examples for the student to solve.

(2) This volume completes the authors' plan of a course of mathematics for students of engineering and physics. The first chapter discusses infinitesimals, and defines differentials of functions of a single variable. Then come chapters on integration, with applications to geometry and mechanics, followed by special methods of integration applicable to partial fractions and trigonometric functions, including the use of reduction formulæ. Chapter viii. deals with simple differential equations, with mechanical and geometric examples illustrating their importance. Chapters ix. and x. deal with solid geometry; chapter xi. with partial differentiation; chapters xii. and xiii. treat of multiple integrals and applications, with carefully drawn diagrams well illustrating the building up of such integrals, in rectangular, polar, and cylindrical coordinates. Then follows an introduction to line integrals and their connection with surface integrals (Stokes's theorem). Chapter xv. is devoted to infinite series, giving the easier tests of convergence, followed by Maclaurin's and Taylor's series and an introduction to Fourier's series, and finishing with the evaluation of indeterminate forms. Chapter xvi. contains a short treatment of complex numbers and conjugate functions. The remaining chapters are devoted to differential equations, total and partial.

The whole book is very solid reading, but the explanations are well given, and when proofs are not fully given references are made to other treatises. The intention of the authors evidently is to take the students over as much ground as possible, and introduce them to all the functions and processes which they are likely to need in their scientific work. There are numerous problems for solution throughout the book, and there is an index at the end to facilitate reference.

A. L.

ELEMENTARY PETROLOGY AND ORE FORMATION.

(1) *Rocks and Rock Minerals.* A Manual of the Elements of Petrology without the Use of the Microscope for the Geologist, Engineer, Miner, Architect, &c., or for Instruction in Colleges and Schools. By L. V. Pirsson. Fifth edition. Pp. vi+414. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1908.) Price 10s. 6d. net.

(2) *Genesis of Metallic Ores and of the Rocks which Enclose Them.* By B. Symons. Pp. xxxiii+494. (London: *The Mining Journal*, 1908.)

THE growing recognition of the economic uses of petrology and the increasing complexity of petrographic methods are rendering necessary the development of a less technical rock nomenclature for use in the field and by general geologists. No one who has acquired sufficient knowledge of petrology to determine the approximate chemical composition and qualities of a rock from a short study of a thin section is likely to discontinue the use of the microscope. The increasing number of students of mining, chemistry, engineering, and agriculture who have to study rocks, but have not much time to devote to the subject, is leading to the issue of special text-books on petrography without the microscope, and, thanks to its revelations, much can now be learnt from rocks by the examination of hand specimens.

(1) Prof. Pirsson's "Rocks and Rock Minerals" is the most advanced of the manuals of petrology without the microscope, but it may be recommended even to students who can use that instrument owing to its clear statement of the principles of petrogenesis and of the mode of occurrence of the sedimentary and

igneous rocks. It summarises the characters of the chief rock-forming minerals, and of the origin and classification of rocks, and is illustrated by an admirable series of photographs and diagrams showing the field relations of igneous rocks. The author makes a useful protest against the appropriation by geologists of popular rock names in new and technical meanings. The term granite, for example, is used in the stone trade in its correct historical and etymological sense, which is entirely different from its use in geology. This system is as inconvenient, as Prof. Pirsson points out, as if botanists had re-defined the terms bush, tree, and shrub, limiting each to a particular species. Prof. Pirsson's protest is justified, and though some American geologists are using the familiar terms in their popular meanings, this reform has probably been proposed too late.

(2) Mr. Brenton Symons's "Genesis of Metallic Ores and the Rocks which Enclose Them" is also intended to appeal to the general elementary student, and is an attempt to explain the formation of ore deposits free from unnecessary technicalities. It is a book, however, of very different standard from Prof. Pirsson's; it is written by a practical engineer, who is keenly interested in the theoretical study of mining geology, but whose knowledge of the subject is a little unequal.

The book begins with a general introduction on geological principles, followed by a section on rock metamorphism; the third part of the book deals with the ore deposits. Though the author avoids so far as possible technical scientific terms, his text is often repellent by the abundant use of such Americanisms as cavations for spaces, such reformed spellings as "lentiles" for "lenticles," and vegetal for vegetable, and mining terms of only local value. The most valuable part of the book is its collection of diagrams of ore occurrences; the instances drawn from Cornwall are the most satisfactory, for some of his diagrams and views regarding ores in other parts of the world are a little out of date. Mr. Symons takes, moreover, an extreme position as to the genesis of ores. He has a great belief in the agency of geosynclinals, by which sediments are carried down to depths where they are melted, and then forced to re-ascend as igneous rocks into overlying strata; and though he describes many ores as plutonic, he appears to regard the vast majority of ores as having been derived from the destruction of Archæan rocks and precipitated in the sea. He says, on p. 381, "It has been already observed that nearly all the ores that can come within the reach of man have been derived from the Archean strata"; from these rocks, according to Mr. Symons, the metals are removed in solution and "precipitated on the bottom of the sea by chemical reactions that were principally set up by organic matter." He has no doubt, for example, that the gold in the reefs of Nova Scotia and the copper ores of Mansfeld were deposited in the rocks of those mining fields during their deposition in the sea. His view of the origin of crystalline rocks of most ores is shown by the following quotation.

"The presence of such minute proportions in all formations is natural, since the crystalline rocks, as far as known, were originally deposited as marine strata, and, consequently, retain some part of the minerals that were precipitated during sedimentation from the oceanic waters. The proportion of these metals appears to be just the same, whether districts are metalliferous or not" (p. 363).

This extract shows that the author adopts such an extreme position in regard to the genesis of ores that his book must be read with caution.

ZOOLOGICAL PRIMERS.

(1) *Die Säugetiere Deutschlands.* By Dr. C. Hennings. Pp. 174. (Leipzig: Quelle und Meyer, 1909.) Price 1.25 marks.

(2) *Korallen und andere gesteinsbildende Tiere.* By Dr. Walther May. Pp. iii+122. (Leipzig: B. G. Teubner, 1909.) Price 1.25 marks.

(3) *Die Fortpflanzung der Tiere.* By Dr. R. Goldschmidt. Pp. iv+124. (Leipzig: B. G. Teubner, 1909.) Price 1.25 marks.

(4) *Die Stammesgeschichte unserer Haustiere.* By Prof. Dr. T. Keller. Pp. iii+114. (Leipzig: B. G. Teubner, 1909.) Price 1.25 marks.

(5) *Biology.* By Prof. R. J. Harvey Gibson. Pp. viii+120. (London: J. M. Dent and Co., 1909.) Price 1s. net.

(1) THE most useful portion of this sketch of the mammalia of Germany lies in the synoptic tables placed at the head of each order; but these can hardly be considered as complete, since they do not include any account of the subspecies, which are of the greatest interest.

A complete list prefixed to this book would have made comparisons with the fauna of other countries a much easier matter. As it is, one has to search through the index in order to discover what forms are included in this work.

(2) Dr. May is a well-known writer on the anatomy of corals, and in this little work he brings together descriptions of a heterogeneous assemblage of animals, the common feature amongst which is the property of producing a hard exoskeleton, or of contributing otherwise by their remains to the formation of strata.

The question inevitably arising out of this treatment is, What determines the difference between, say, a soft anemone and an encrusted coral? To this Dr. May has, so far as we can see, no answer. Nevertheless, his book contains a good sketch of the various hypotheses accounting for the origin and formation of coral-reefs, and for this, if for nothing else, it is welcome. The corals and lamellibranchs appear to us the best parts of the work.

(3) Dr. Goldschmidt has undertaken to compress into a hundred small pages an account of the methods of animal reproduction, with especial reference to the number of the young, their state on hatching, their habits and adaptations. The work cannot be considered as really up to date, but the treatment is interesting, and the subject is one of such importance that we regret more space could not have been allotted to it. The illustrations are better than those of any other booklet of this series we have so far seen.

(4) In an earlier and larger work, published some

three years ago, Dr. Keller advanced his views on the origin of domesticated animals. The present little work is an abstract of the larger one, and gives only the most meagre outline of the evidence on this difficult subject. The time has not yet arrived when such a work can be successfully written. We know far too little to establish conclusions on the origin of most of our familiar animals, and we can only recommend this work on a most interesting subject with considerable reserve. Prof. Ewart's work on horses appears to be unknown to the author. The book has no index.

(5) The general scheme of this primer is excellently devised. Beginning with a sketch of function, the author passes on to differentiation. The values, transformations, and elaboration of food-stuffs are next dealt with, and a special section is given to "sensitivity." The adaptations of organisms are briefly considered, and a short account of reproduction is given. The primer concludes with a sketch of the theory of natural selection. Such a concise statement of the general principles of animal and plant life should be of considerable use to teachers of elementary science.

The value of the book would have been increased by better illustrations. Many of those employed (for example, Nos. 8, 9, 18, 19, 37, 40, and 47) are so incompletely described as to lose much of their value. The figure of Padina (Fig. 2) is extremely vague. The text as a whole is what we should expect from such an experienced teacher as Prof. Harvey Gibson, and it has had the benefit of revision from his colleagues. The account of the destruction of life as illustrated by a dinner (p. 114) is perhaps open to criticism. The benefits of cultivation in increasing the number and variety of edible organisms are not pointed out. Moreover, in contrast to wild species, the individuals of cultivated ones have surely not remained "fairly constant" in numbers. Demand has in this case created supply. So far from illustrating natural selection, such an example seems to typify artificial selection. The statement about green Hydra on p. 43 goes beyond our present knowledge.

SOME NEW ELECTRICAL BOOKS.

(1) *The Bell Telephone.* The Deposition of A. G. Bell in the Suit brought by the United States to annul the Bell Patents. Pp. iv+469. (Boston: The American Bell Telephone Co., 1908.)

(2) *How Telegraphs and Telephones Work.* Explained in non-technical language by C. R. Gibson. Pp. vi+156. (London: Seeley and Co., Ltd., 1909.) Price 1*s.* 6*d.* net.

(3) *Technical Electricity.* By H. T. Davidge and R. W. Hutchinson. Second edition. Pp. xi+539. (Cambridge: University Tutorial Press, Ltd., 1909.) Price 4*s.* 6*d.*

(1) THE printing of the full deposition made by Mr. Bell in the suit brought by the United States to annul the Bell telephone patents doubtless furnishes a valuable historical record of the experiments which led to the invention of the telephone, and, since the deposition was never officially printed, the American Bell Telephone Co. has performed a useful service in the publication of this book. To any who may still be interested in the legal aspects of the case the book should also prove valuable. But for the general reader, even when specially interested in telephony, the verbatim report of a legal examination and cross-examination is a very unsatisfactory medium for conveying information. The constant repetitions, the frequent insistence on what must be regarded from the broader point of view as wholly irrelevant details, and, above all, the clumsiness of a dialogue devoid of literary merit, make very poor reading, and one is liable to be overcome with ennui before any salient points have been gleaned.

By judicious, if comprehensive, skipping, however, many facts of both scientific and general interest may be obtained from this volume, and to many the detailed descriptions of the earlier struggles and difficulties leading to an invention of enormous utility and importance will have a particular fascination. It is only to be regretted that the book was not written in consecutive narrative form, though possibly some of its value as a record might have been sacrificed thereby.

(2) That Mr. Gibson has an aptitude for the description in non-technical language of the achievements of modern technology has been amply proved by his earlier books which have been reviewed in these columns. The present small volume shares the merits of its predecessors. The very large degree to which the telegraph and telephone enter into the daily life of the community should make this book particularly useful, and it should find a large circle of readers. The book is more or less an amplification of the chapters dealing with this branch in earlier more general books. The subjects covered are telegraphy and telephony, both with wires and without; there is a short chapter on lightning, the reason for the inclusion of which "by request" does not seem clear, and three concluding chapters of a more general character on electrical units and theory. The volume is well printed and illustrated.

(3) This text-book was originally published in 1906, and the present is the third impression. Advantage has been taken of the new edition to bring some parts of the book more up to date, but the revision has not been very thorough, as reference to the chapter on lamps (in which there has been very marked progress since 1906) will show. The tungsten lamp is allotted seven lines of small print, but the osmium lamp, almost if not quite defunct, remains in possession of what we presume was its original position in the main text. The whole chapter on lamps seems to us poor; the drawing of an arc in Fig. 128 is purely imaginary, and the authors would do well to refer to Mrs. Ayrton's book before they issue their next edition; the section on flame arcs and the reference to the Bremer arc lamp lead us to the conclusion that the authors have no correct idea of the real difference between the flame and the ordinary arc.

It is perhaps somewhat unkind to take exception to such errors in what is only one chapter amongst four-and-twenty. But it is deplorable that a text-book should give incorrect or misleading information; the authors' aim "at spanning the gulf which too often divides pure theory and practical engineering" will not be realised if the student is obliged to unlearn much that they teach him when he becomes a practical engineer. We do not profess to be experts in the whole subject of electrical engineering, and cannot criticise the whole book, therefore, on the same lines as we have criticised the section on lamps; but the authors, by writing such a book, lay claim—at least so far as fundamentals are concerned—to be such experts, and if we find them at fault at one part we are led to suspect the whole.

The book covers the whole electrical field; the arrangement is that usually adopted, opening with electrostatics and magnetism, and passing on to electric currents. The diagrams and illustrations are for the most part good, but the process blocks (fortunately few) come out badly on the class of paper used. There are numerous exercises for the student to work out at the end of each chapter.

M. S.

OUR BOOK SHELF.

Gas-engine Theory and Design. By A. C. Mehrtens. Pp. v+256. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 10s. 6d. net.

THE writer of this book is an instructor in mechanical engineering in the Michigan Agricultural College. His aim, he tells us, has been to prepare a book for all who are interested in gas engines, whether students, draughtsmen, engineers, or engine operators.

This is an ambitious aim, and we may well doubt the possibility of its being carried out in such a small compass; but there can be no doubt that the cardinal virtues of simplicity and conciseness of language which any such intention must require are here presented in no usual degree. The reviewer does not remember any book hitherto written on the gas engine which presents its subject with such lucidity.

The chief entry to be made on the debit side of the account is that the extent of the field covered is far too great. It will be found, on perusing the volume, that it not only deals with the history and present position of gas-engine invention, and with the properties of the gases and fuels used, but also with such a big subject as the design of engine details and the dimensions of parts. Students usually learn their physics and machine design independently of the steam or gas engine, and a book on the gas engine which includes a great deal of what has already been studied separately is wasting space. The result in so small a book as this is that the truth and applicability of a great number of formulæ are taken for granted, which may account for the poor compliment paid to them by the author on p. 123, where he remarks:—

"A number of formulas will be given in the following paragraphs, but machinery cannot be designed by formulas alone. The author has frequently found that empirical, and other, formulas would sometimes come within 500 per cent. of the correct result."

There are also the inevitable slips of a "first edition," but they are not numerous. The author should, however, make a point in the next edition of correcting his description (on p. 33) of carbon monoxide as an unstable compound; his omission on p. 39, in the discussion of the apparent suppression of heat on explosion, of any reference to the increase of specific heats admitted on p. 25; the error in saying (on p. 44) that it is usual to increase the compression pressure in an engine which is to run on kerosene, and he should also correct the general confusion of the table on p. 167. It is difficult to understand what the author means in his description (on p. 52) of the working of the gas producer by the remark:—"The limit of the ratio of steam to coal by weight is about 1 to 40."

Although, as has been stated, the author has attempted to get too much into so small a volume, it must be acknowledged that he has produced a book at once interesting in treatment and clear in language.

La materia radiante e i raggi magnetici. By Prof. A. Righi. Pp. vii+308. (Bologna: N. Zanichelli, 1909.) Price 8 lire.

IN a recent number of NATURE a brief account was given of Righi's "magnetic rays," this being the name applied to a peculiar luminosity near the kathode of a vacuum tube, when the latter is placed in a longitudinal magnetic field. Righi supposes that this luminous column is due to electrically neutral doublets, which are not in sufficiently stable equilibrium to be looked upon as atoms or molecules, which owe, in fact, such stability as they possess to the action of the magnetic field. Several papers on this subject have been published by the author, and the main object of the present small volume is to give a connected account of the whole research. About one-third of the book is devoted to an extremely lucid and interesting summary of our present knowledge concerning the corpuscular theory of matter, written in a style which, as far as possible, is free from technical terms. The remainder, except for three short mathematical appendices, deals with the evidence for and against the existence of neutral doublets or magnetic rays. Here, while very suggestive, the experiments are not altogether convincing—this is evidently the opinion of Prof. Righi himself—but this is due in great measure to the difficult experimental conditions. While no one experiment can be said to have demonstrated the existence of magnetic rays, the results as a whole certainly tend to support the author's view. One point might have been treated more fully, viz., the conditions under which a magnetic field lowers the potential difference at the terminals of the discharge tube. Experiments are described, in some of which an increase, in others a decrease, of potential is brought about by the magnetic field, but it is not clear to what difference in the conditions this is due.

R. S. W.

Brassolidae. By Dr. H. Stichel. (Das Tierreich, 25 Lieferung.) Pp. xiv+244. (Berlin: R. Friedländer und Sohn, 1909.) Price 15 marks.

THIS is a very elaborate monograph of a comparatively small group of butterflies found only in Tropical America. They form a subfamily of the great family Nymphalidæ, and are most nearly allied to the great blue Morphidæ, but differ from them by their stouter bodies, darker colours, and the closed cell of the hind wings, which are generally ornamented with three large eye-spots on the under-surface. Their flight is crepuscular, while that of the Morphidæ (which are represented in the East Indies as well as in Tropical America), is diurnal.

In 1823, Latreille and Godart, in the second part of "Papillons" in the "Encyclopédie méthodique," were acquainted with only twenty-three species now referred to the Brassolidæ. Of these, twenty-one formed the bulk of the second section of the genus Morpho, while the remaining two species were placed in Brassolis. In Kirby's Catalogue of Diurnal Lepidoptera and Supplement (1871 and 1877) we find eight genera of Brassolidæ and fifty-four species, while Dr. Stichel now enumerates eleven genera and seventy-five species, in addition to a very considerable number of forms treated for the present as subspecies.

Dr. Stichel describes the species at great length, adding tables of the genera, species, and subspecies. The synonymy of the genera and species is very fully given, and the excellent text-illustrations include the neuration of one species of each genus, and also the markings of the wings of a large number of species, both surfaces being usually figured. Descriptions are also given of the eggs, larvæ and pupæ of the insects, as far as known at present, and the range of each species is also indicated. On pp. 3 and 4 we find general information on the habits of the butterflies, and should have liked more detail under the various species; but we presume that there was either no room, or the available information on the subject was too meagre to be worth giving, except in a general manner. W. F. K.

The Volcanic Origin of Coal and Modern Geological Theories: a Plea for Lessening Demands on Geological Time; and for Further Separating the Life Histories of the Aqueous and Volcanic Formations. By Col. A. T. Fraser (late R.E.). Pp. 21. (London: R. Banks and Sons, 1909.)

THE old Wernerians used to account for volcanic action by the supposed combustion of coal within the earth's crust, but the author of this pamphlet turns the tables upon them by making the volcanoes produce the coal! The way in which this feat is performed is as follows:—first by pointing out that in the sides of the active volcano Gedeh in Java the tuffs are seen to be well stratified, and look, *at a distance,* like old red sandstone; then the mud deposits ejected by the eruption of Tarawera in New Zealand are also stratified. Next, we have somewhat of a leap in the advance of the argument. The Java experience showed, *though coal was absent,* another way in which it (coal) might originate; namely, being rained down in a shower of bitumen alternately with sandstones, shales, &c. In support of this view we are told that a visit to "the quarries of Carrara and Parnassus" show that "marble is a volcanic rock," "ejected, accompanied by high-pressure steam, from a fissure and showered down." We must leave our author with the coal and marble, and not attempt to follow his leading among geological theories, old and new. We fear, judging from books advertised on a fly-leaf at the end of the one before us, that the author has been so much occupied with psychical research, occult powers of Eastern nations and the religions of the world, that he has not found time for even a very little elementary chemistry.

Cassell's "Nature" Copies (Wild Flowers). Aids to Nature Study, Brushwork, and Drawing. In twelve packets. (London: Cassell and Co., Ltd., n.d.) Price 6*d*. net per packet.

EACH of these packets of drawing copies contains ten examples of pictures of wild flowers executed in colours on stout plate paper. Though the best plan is to have wild flowers drawn from actual specimens, these copies may serve a useful purpose in town schools, where it is very difficult or impossible to procure the plants themselves; in any case they will add variety to the art work, and familiarise children with the beauty of common wild flowers.

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.*]

August Meteoric Shower.

I HAVE summarised in a form which may be convenient for comparison some of the results of Perseid observations this year. The differences in some cases are remarkable, and sufficiently prove that to arrive at definite conclusions respecting the character of a shower a large number of materials should be consulted and averaged. Weather conditions are dissimilar, the places of observation are not equally well situated (certain positions in towns are much affected by artificial light), and there are other causes which must introduce discordances. Though comparatively few Perseids were observed at Bristol and Meltham on August 10, they were fairly numerous at Blaina and Antwerp, and on the night of August 12, when a rich display of brilliant meteors was remarked at Bristol, there was no striking exhibition witnessed at several other places.

Results of Perseid Observations, 1909.

	Aug.	h. m. h. m.	h. m.	Meteors	Perseids
C. B. Pennington, Notts.	11	9 0–12 0	3 0	50	
Mrs. H. P. Hawkins, Brockham, Surrey	11	10 0–13 0	3 0	80	
Miss Irene Warner, Bristol	11	10 0–11 37	1 37	60	55
	12	10 0–10 30	0 30	9	6
John Hicks, Weston-super-Mare	11	9 30–10 0	0 30	30	
	12	9 30–10 30	1 0	9	
Mrs. R. M. Brook, Meltham, Huddersfield	11	10 0–11 30	1 30	54	
T. K. Jenkins, Blaina	10	10 50–12 5	1 15	30	
	11	9 48–12 10	2 22	78	
	12	9 14–10 43	1 29	12	
C. L. Brook, Meltham	9	10 25–12 15	1 35	15	10
	10	10 25–12 25	1 35	23	14
W. F. Denning, Bristol	8	9 45–11 0	1 30	12	6
	9	9 45–11 30	1 30	8	4
	10	9 15–12 0	1 45	19	12
	11	9 5–11 50	2 45	73	67
	12	9 0–12 52	2 30	65	55
	13	9 5–11 45	1 45	25	11
	14	9 0–11 50	1 45	19	7
C. Birkenstock & another observer, Antwerp	7	11 50–13 0	1 10	3	
	8	11 25–13 0	1 35	19	
	9	11 0–12 20	1 20	15	
	10	10 15–14 0	3 15	113	
	11	10 30–14 0	3 30	129	
	12	10 30–14 0	3 30	96	
Col. E. E. Markwick, Boscombe	11	10 7–11 40	1 33	40	38
Ellison Hawks, Leeds	11	10 30–dawn	—	175	
J. L. Haughton and another, Dublin	10	10 0–11 0	1 0	20	17
	11	9 0–12 0	3 0	57	48
	12	8 30–10 30	2 0	50	35
	13	9 15–10 15	1 0	19	15

Apparently few determinations of the radiant have been made, but so many values have been found for this at previous returns that further estimates are not much needed. Photographic impressions of the trails would be of essential value as giving, not only a very exact position for the radiant, but as indicating its character and the extent of its diffusion. W. F. DENNING.

The Ringing of House-bells without Apparent Cause.

UNTIL I read the two letters in NATURE of July 22 and August 12 I had no idea that the ringing of house-bells without apparent cause was so fascinating a subject, as my own experience of it has been rather prosaic. One of my bells occasionally rings when no one is in the room, but it is entirely due to bad workmanship. The strength of the spring which draws the wire back after it has been pulled is only about equal to the friction of the wires, and the result is that, though it generally draws the wire back immediately after it has been pulled, yet it sometimes fails to do so at the time; but after some time, it may be hours, owing to some change in the conditions, it succeeds in drawing back the wire, when the bell again rings when no one is touching it. The bell thus rings once when it is pulled, and a second time when the spring succeeds in drawing back the wire.

The electrical explanation of any mysterious ringings seems hopeless in any conditions, save possibly in a thunderstorm, when we remember that all the bells and wires are in good electric contact with each other, and in more or less indifferent contact at many places with pipes, walls, &c. Further, only the bell at the end of a row could be rung by electrical attraction to the opposite wall, because the bells swing parallel to the wall on which they are fixed, and considerable force is required to make them move in a direction at right angles to their free swing.

In the case referred to by Mr. C. L. Tweedale, it might have been worth while to see if the wire attached to the lively bell he mentions did not come in contact with any other wires at any part of its length. What makes me suggest this is that in one of my rooms I can tell when the front-door bell is rung by a sympathetic movement of the bell-pull in the room, due to the wires rubbing against each other at some part and the wire to the door bell pulling the wire to the room.

When one considers the class of workmanship put into bell-hanging, one need not be surprised at the vagaries of the bells. Like plumber work, it is mostly out of sight, and as the work has often to be done in very imperfect light and under cramped conditions, anything that will work is considered good enough.

JOHN AITKEN.

Ardenlea, Falkirk, August 21.

FLYING ANIMALS AND FLYING MACHINES.

UNTIL quite recently human flight was considered by the mass of mankind as so impracticable that "I can no more do that than fly" was a phrase used to denote something not to be accomplished. It is no wonder, then, that the fact that several people (probably some dozens at the present moment) have actually flown should appeal to the popular imagination, and the appeal is especially strong in such a case as M. Blériot's flight over the English Channel, although there is nothing really more formidable in a flight over water than over land. It may be of some interest to show briefly how it is that what was formerly looked on as a typical impossibility has now become a matter of everyday occurrence.

It will be a help to take first the case of such animals as have wings, and to see why it is that no creature the height of which approaches even one-quarter that of a man has been able to fly either in present or former times. In order that the wings may support the body, their movement must generate a downward current of air of which the momentum per unit of time is equivalent to the downward momentum which the body and wings would acquire in the same time under the influence of gravity. This does not necessarily involve a large expenditure of work. For instance, when a weight is attached to a parachute and is dropped from a height the speed of descent soon becomes constant, and the work done in the air by the parachute is then just equal to the product of the weight into the distance fallen. The resistance of the parachute is proportional to its area, and the speed of descent can be made as small as we please if the area is made large enough. The work, therefore, expended in a given time, that is, the power delivered to the air, is diminished in the same proportion.

Suppose now that instead of an inanimate weight an animal is suspended from the parachute by a long rope ladder. When the speed of descent is slow enough, the animal will have no difficulty in climbing the ladder at such a rate that the centre of gravity of the "system" may remain stationary in the air, and this by an expenditure of work which can be diminished indefinitely by increasing the area of the parachute.

This case is analogous to the hovering of a bird in the air without horizontal velocity during the downstroke of the wings, and as no means are here provided for restoring the wing to its primitive position the time of support is limited. The illustration suffices, however, to show that the work required in order to maintain a stationary position in the air by means of wings is equal to the work required to raise the total weight involved at the same rate as that at which it would fall were no work to be expended.

Of the total weight supported, namely, the animal and the parachute, the animal only is a source of power. Thus, while in "dynamically similar" combinations the total weight varies as the cube of the linear dimensions, the supporting area varies as the square, and the living power available varies, not as the total weight, but as the total weight less the weight of the supporting wing. It will be readily seen that if the animal can only deliver a certain amount of power per unit weight of body these conditions lead to an absolute limit to the weight of an animal which can sustain itself stationary in the air. For, suppose the total weight is $w = w_a + w_s$ (the weights, namely, of the animal and the parachute of area s), w_s must vary as $s^{\frac{3}{2}}$, and if the downward velocity is to be constant s must be proportional to w. From this it can be shown that the greatest weight an animal (incapable of climbing faster than some given speed) can have is $2b^3/3c^2$, where $b = w'/s'$ and $c = w_s'/s'^{\frac{3}{2}}$, w_s' and s' being known values of wing weight and wing area fulfilling the condition of falling with the required velocity when the total weight is w'. If we take $w_s' = w'/n$, the expression $2b^3/3c^2$ becomes $\frac{2}{3}w'n^2$.

As an example, suppose that 30 feet per minute is the limiting velocity at which an animal can continue to climb, and that the area of the parachute which will drop at the appropriate speed when the total weight of parachute and load is 1 lb. is 100 square feet, and also that the weight of the parachute alone is $\frac{1}{4}$ lb., then it appears that no animal could maintain itself stationary in the air by means of a parachute the weight of which exceeded $\frac{2}{3}(4)^2$ (or about $10\frac{1}{2}$ lb.), and the area required for this weight would be more than 1600 square feet. Thus, if no more favourable way of supporting a weight was available than the down stroke of a wing in still air, flight would be impossible for all except the very smallest animals.

As is well known, however, the vertical reaction on a slightly inclined plane moving rapidly in a horizontal direction enormously exceeds that which it would experience in dropping through still air, and although the proportionalities between the weights and the supporting area still remain, viz. $s \propto w$ and $w_s \propto s^{\frac{3}{2}}$, the actual weight which can be supported by a given area increases indefinitely as the horizontal speed increases.

If there were no such thing as air friction, the work expended in supporting a given load might also be reduced indefinitely, for the resistance to the horizontal motion (which, when the inclination of the plane is small, may be regarded as the horizontal component of the normal force) could be diminished indefinitely by decreasing the inclination.

Air friction, however, fixes a limit beyond which the inclination of the plane to the direction of motion cannot be advantageously reduced. Experiments have shown that this inclination is about 5°, and that then the ratio of the supporting force to the resistance lies between 5 and 7 (depending partly on the shape of the plane). A knowledge of the best angle of inclination and the ratio of the resistance to the force on the plane at right angles to its path afford means of determining the possible efficiency (see "Experiments on

Model Screws," R. E. Froude, F.R.S., Proc. Naval Architects, 1908).

Among birds, those which fly continuously seldom have the ratio of weight to wing area more than 1 lb. per square foot, and in many cases, such as hawks and swallows, the ratio is something like $\frac{1}{3}$ lb. per square foot; but whatever the ratio may be, so long as the animal can only give out a limited amount of power proportional to its weight, a definite limit can be assigned to the size and weight of the body which can sustain itself in flight by muscular action.

If the weight of the wing increased directly as its area such a limit would not exist. The weight of a flock of birds, for example, is limited simply by the numbers in the flock, and we only have to suppose the individuals to be connected by a light framework to convert the flock into a flying machine the wing weight of which is proportional to the wing area. To a certain extent, the biplane flying machine carries out the same idea, but in most of the existing types the weight of the connecting framework must to a great extent neutralise the reduction of weight which should accompany the reduced linear dimensions.

From what has been said it will be seen that so long as no engine was available which, with all adjuncts, such as fuel supply, framing, and wings, could raise the total weight much faster than could an animal of the weight of the engine only, there was no chance for the addition of flight to human accomplishments, and it is due to the advent of the internal-combustion engine that it is now possible to carry air-borne loads of more than 1000 lb. To carry heavy loads with a moderate wing area requires large horizontal velocities, and in such machines as have succeeded the load per square foot generally exceeds 2 lb.

The high velocity requisite is advantageous when the machine is launched and is pursuing a straight course, but it adds to the difficulties of starting and stopping, and is a restriction on manœuvring power: that is, it increases the radius of the circle in which the machine can turn. When a flying machine of weight w travels in a circle of radius r with velocity v the centrifugal force, F, is wv^2/rg, and if the plane of the circle is horizontal the upward component of the normal force on the wings is w, and hence the normal force is $(w^2+F^2)^{\frac{1}{2}}$ (nearly), and the inclination (β) of the wings to the horizontal in the direction of r is F/w.

The normal force on a straight course differs little from w. In flying in a horizontal curve, therefore, the normal force must be increased in the ratio $(w^2+F^2)^{\frac{1}{2}}/w$ if the velocity is to remain constant. To effect this the engine revolutions must be quickened and the fore and aft trim of the wings altered. In other words, it requires more power to fly in a curve than in a straight course at the same speed, although the increase is not important so long as F/w is small.

For example, if $v=50$ f.s. and $r=200$ feet, $F/w=0{\cdot}256$, the increase of power required is about 3 per cent., and $\beta=14°$. For the same radius if $v=100$ f.s., $F/w=1{\cdot}56$. The power required is 1·86 times that for the straight course, and $\beta=56°$ about.

I am not aware that any exact experiments have yet been made on the manœuvring capacity of flying machines, but the subject will have to be carefully investigated.

The three most important lines along which the development of flying machines should be pursued are those relating to intrinsic stability, ease of starting and stopping, and manœuvring capacity. It is improbable that any form is intrinsically stable at all speeds, but automatic devices may be introduced (as mentioned in my letters to NATURE of January 30 and December 24 1908) which will relieve the aëronaut of responsibility in this respect. Ease in starting and stopping implies the power of flying (at any rate, for a short time) at low velocities; while manœuvring capacity demands ready control of the angles at which the various supporting surfaces are presented to the air.

A. MALLOCK.

THE BRITISH ASSOCIATION AT WINNIPEG.

As we go to press the seventy-ninth annual meeting of the British Association is being opened at Winnipeg, under the presidency of Sir J. J. Thomson, F.R.S., whose inaugural address is reprinted below. Following our usual custom, the addresses of presidents of most of the sections will be published in future issues of NATURE, and also accounts of the scientific proceedings of the sections.

This is the fourth time the association has met outside the British Isles, the previous occasions being Montreal (1884), Toronto (1897), and South Africa (1905). The last meeting of the association in Canada was very successful, the number of members and associates present being 1362. During the twelve years that have since elapsed, great progress has been made in all branches of science, and, though the people of Western Canada do not expect to contribute a very large part to the scientific proceedings of the sections, they anticipate interest in many of the subjects to be dealt with or discussed. Much interest in the meeting has been manifested in Canada and the United States, as well as on this side of the Atlantic. It is estimated that between 400 and 500 members have gone to Winnipeg from Europe, and it is hoped that the total number of members and associates attending the meeting will be at least 1500.

Generous financial support towards the expenses of the meeting has been given by the Dominion Government, the Government of Manitoba, and the city of Winnipeg, while the western provinces and cities have agreed to defray the expenses of an excursion to the Pacific Coast of a party of about two hundred office-bearers and distinguished guests of the association.

Excursions have been arranged for Saturday, August 28, to points of interest in the vicinity of Winnipeg, including Stony Mountain and the municipal stone quarries; Lake Winnipeg, St. Andrew's Rapids, and Selkirk; the wheat fields of Manitoba; the hydro-electric plant on the Winnipeg River. Members have also the opportunity of visiting various industrial works in the city of Winnipeg.

Evening receptions will be held by the Lieutenant-Governor at Government House, and by the local executive committee. Garden-parties have been arranged for several afternoons during the meeting including those to be given at the historic Lower Fort Garry by the Commissioner of the Hudson's Bay Company, at the Provincial Agricultural College, and by the Hon. Chief Justice Howell.

INAUGURAL ADDRESS BY PROF. SIR J. J. THOMSON, M.A., LL.D., D.Sc., F.R.S., PRESIDENT OF THE ASSOCIATION.

TWENTY-FIVE years ago a great change was made in the practice of the British Association. From the foundation of our Society until 1884 its meetings had always been held in the British Isles; in that year, however, the Association met in Montreal, and a step was taken which changed us from an Insular into an Imperial Association. For this change, which now I think meets with nothing but approval, Canada is mainly responsible. Men of science welcome it for the increased opportunities it gives them of studying under the most pleasant and favourable conditions different parts of our Empire, of making new friends; such meetings as these not only promote the progress of science, but also help to strengthen the bonds which bind together the different portions of the King's Dominions.

This year, for the third time in a quarter of a century, we are meeting in Canada. As if to give us an object lesson in the growth of Empire, you in Winnipeg took the opportunity at our first meeting in Canada in 1884 to invite our members to visit Manitoba and see for themselves the development of the Province at that time. Those who were fortunate enough to be your guests then as well as now are confronted with a change which must seem to them unexampled and almost incredible. Great cities have sprung up, immense areas have been converted from prairies to prosperous farms, flourishing industries have been started, and the population has quadrupled. As the President of a scientific association I hope I may be pardoned if I point out that even the enterprise and energy of your people and the richness of your country would have been powerless to effect this change without the resources placed at their disposal by the labours of men of science.

The eminence of my predecessors in the chair at the meetings of the British Association in Canada makes my task this evening a difficult one. The meeting at Montreal was presided over by Lord Rayleigh, who, like Lord Kelvin, his colleague in the chair of Section A at that meeting, has left the lion's mark on every department of physics, and has shown that, vast as is the empire of physics, there are still men who can extend its frontiers in all of the many regions under its sway. It has been my lot to succeed Lord Rayleigh in other offices as well as this, and I know how difficult a man he is to follow.

The President of the second meeting in Canada—that held in 1897 at Toronto—was Sir John Evans, one of those men who, like Boyle, Cavendish, Darwin, Joule, and Huggins, have, from their own resources and without the aid derived from official positions or from the universities, made memorable contributions to science: such men form one of the characteristic features of British science. May we not hope that, as the knowledge of science and the interest taken in it increase, more of the large number of men of independent means in our country may be found working for the advancement of science, and thereby rendering services to the community no less valuable than the political, philanthropic, and social work at which many of them labour with so much zeal and success?

I can, however, claim to have some experience of, at any rate, one branch of Canadian science, for it has been my privilege to receive at the Cavendish Laboratory many students from your universities. Some of these have been holders of what are known as the 1851 scholarships. These scholarships are provided from the surplus of the Great Exhibition of 1851, and are placed at the disposal of most of the younger universities in the British Empire, to enable students to devote themselves for two or three years to original research in various branches of science. I have had many opportunities of seeing the work of these scholars, and I should like to put on record my opinion that there is no educational endowment in the country which has done or is doing better work.

I have had, as I said, the privilege of having as pupils students from your universities as well as from those of New Zealand, Australia, and the United States, and have thus had opportunities of comparing the effect on the best men of the educational system in force at your universities with that which prevails in the older English universities. Well, as the result, I have come to the conclusion that there is a good deal in the latter system which you have been wise not to imitate. The chief evil from which we at Cambridge suffer and which you have avoided is, I am convinced, the excessive competition for scholarships which confronts our students at almost every stage of their education. You may form some estimate of the prevalence of these scholarships if I tell you that the colleges in the University of Cambridge alone give more than 35,000*l*. a year in scholarships to undergraduates, and I suppose the case is much the same at Oxford. The result of this is that preparation for these scholarships dominates the education of the great majority of the cleverer boys who come to these universities, and indeed in some quarters it seems to be held that the chief duty of a schoolmaster, and the best test of his efficiency, is to make his boys get scholarships. The preparation for the scholarship too often means that about two years before the examination the boy begins to specialise, and from the age of sixteen does little else than the subject, be it mathematics, classics, or natural science, for which he wishes to get a scholarship; then, on entering the university, he spends three or four years studying the same subject before he takes his degree, when his real life-work ought to begin. How has this training fitted him for this work? I will take the case in which the system might perhaps be expected to show to greatest advantage, when his work is to be original research in the subject he has been studying. He has certainly acquired a very minute acquaintance with his subject—indeed, the knowledge possessed by some of the students trained under this system is quite remarkable, much greater than that of any other students I have ever met. But though he has acquired knowledge, the effect of studying one subject, and one subject only, for so long a time is too often to dull his enthusiasm for it, and he begins research with much of his early interest and keenness evaporated. Now there is hardly any quality more essential to success in research than enthusiasm. Research is difficult, laborious, often disheartening. The carefully designed apparatus refuses to work, it develops defects which may take months of patient work to rectify, the results obtained may appear inconsistent with each other and with every known law of Nature, sleepless nights and laborious days may seem only to make the confusion more confounded, and there is nothing for the student to do but to take for his motto "It's dogged as does it," and plod on, comforting himself with the assurance that when success does come, the difficulties he has overcome will increase the pleasure—one of the most exquisite men can enjoy—of getting some conception which will make all that was tangled, confused, and contradictory clear and consistent. Unless he has enthusiasm to carry him on when the prospect seems almost hopeless and the labour and strain incessant, the student may give up his task and take to easier, though less important, pursuits.

I am convinced that no greater evil can be done to a young man than to dull his enthusiasm. In a very considerable experience of students of physics beginning research, I have met with more—many more—failures from lack of enthusiasm and determination than from any lack of knowledge or of what is usually known as cleverness.

This continual harping from an early age on one subject, which is so efficient in quenching enthusiasm, is much encouraged by the practice of the colleges to give scholarships for proficiency in one subject alone. I went through a list of the scholarships awarded in the University of Cambridge last winter, and, though there were 202 of them, I could only find three cases in which it was specified that the award was made for proficiency in more than one subject.

The premature specialisation fostered by the preparation for these scholarships injures the student by depriving him of adequate literary culture, while when it extends, as it often does, to specialisation in one or two branches of science, it retards the progress of science by tending to isolate one science from another. The boundaries between the sciences are arbitrary, and tend to disappear as science progresses. The principles of one science often find most striking and suggestive illustrations in the phenomena of another. Thus, for example, the physicist finds in astronomy that effects he has observed in the laboratory are illustrated on the grand scale in the sun and stars. No better illustration of this could be given than Prof. Hale's recent discovery of the Zeeman effect in the light from sun-spots; in chemistry, too, the physicist finds in the behaviour of whole series of reactions illustrations of the great laws of thermodynamics, while if he turns to the biological sciences he is confronted by problems, mostly unsolved, of unsurpassed interest. Consider for a moment the problem presented by almost any plant—the characteristic and often exquisite detail of flower, leaf, and habit—and remember that the mechanism which controls this almost infinite complexity was once contained in a seed perhaps hardly large enough to be visible. We have here one of the most entrancing problems in chemistry and physics it is possible to conceive.

Again, the specialisation prevalent in schools often prevents students of science from acquiring sufficient knowledge of mathematics; it is true that most of those who study physics do some mathematics, but I hold that, in general, they do not do enough, and that they are not as efficient physicists as they would be if they had a wider knowledge of that subject. There seems at present a tendency in some quarters to discourage the use of mathematics in physics; indeed, one might infer, from the statements of some writers in quasi-scientific journals, that ignorance of mathematics is almost a virtue. If this is so, then surely of all the virtues this is the easiest and most prevalent.

I do not for a moment urge that the physicist should confine himself to looking at his problems from the mathematical point of view; on the contrary, I think a famous French mathematician and physicist was guilty of only slight exaggeration when he said that no discovery was really important or properly understood by its author unless and until he could explain it to the first man he met in the street.

But two points of view are better than one, and the physicist who is also a mathematician possesses a most powerful instrument for scientific research with which many of the greatest discoveries have been made; for example, electric waves were discovered by mathematics long before they were detected in the laboratory. He has also at his command a language clear, concise, and universal, and there is no better way of detecting ambiguities and discrepancies in his ideas than by trying to express them in this language. Again, it often happens that we are not able to appreciate the full significance of some physical discovery until we have subjected it to mathematical treatment, when we find that the effect we have discovered involves other effects which have not been detected, and we are able by this means to duplicate the discovery. Thus James Thomson, starting from the fact that ice floats on water, showed that it follows by mathematics that ice can be melted and water prevented from freezing by pressure. This effect, which was at that time unknown, was afterwards verified by his brother, Lord Kelvin. Multitudes of similar duplication of physical discoveries by mathematics could be quoted.

I have been pleading in the interests of physics for a greater study of mathematics by physicists. I would also plead for a greater study of physics by mathematicians in the interest of pure mathematics.

The history of pure mathematics shows that many of the most important branches of the subject have arisen from the attempts made to get a mathematical solution of a problem suggested by physics. Thus the differential calculus arose from attempts to deal with the problem of moving bodies. Fourier's theorem resulted from attempts to deal with the vibrations of strings and the conduction of heat; indeed, it would seem that the most fruitful crop of scientific ideas is produced by cross-fertilisation between the mind and some definite fact, and that the mind by itself is comparatively unproductive.

I think, if we could trace the origin of some of our most comprehensive and important scientific ideas, it would be found that they arose in the attempt to find an explanation of some apparently trivial and very special phenomenon; when once started the ideas grew to such generality and importance that their modest origin could hardly be suspected. Water vapour we know will refuse to condense into rain unless there are particles of dust to form nuclei; so an idea before taking shape seems to require a nucleus of solid fact round which it can condense.

I have ventured to urge the closer union between mathematics and physics, because I think of late years there has been some tendency for these sciences to drift apart, and that the workers in applied mathematics are relatively fewer than they were some years ago. This is no doubt due to some extent to the remarkable developments made in the last few years in experimental physics on the one hand and in the most abstract and metaphysical parts of pure mathematics on the other. The fascination of these has drawn workers to the frontiers of these regions who would otherwise have worked nearer the junction of the two. In part, too, it may be due to the fact that the problems with which the applied mathematician has to deal are exceedingly difficult, and many may have felt that the problems presented by the older physics have been worked over so often by men of the highest genius that there was but little chance of any problem which they could have any hope of solving being left.

But the newer developments of physics have opened virgin ground which has not yet been worked over, and which offers problems to the mathematician of great interest and novelty—problems which will suggest and require new methods of attack, the development of which will advance pure mathematics as well as physics.

I have alluded to the fact that pure mathematicians have been indebted to the study of concrete problems for the origination of some of their most valuable conceptions; but though no doubt pure mathematicians are in many ways very exceptional folk, yet in this respect they are very human. Most of us need to tackle some definite difficulty before our minds develop whatever powers they may possess. This is true for even the youngest of us, for our schoolboys and schoolgirls, and I think the moral to be drawn from it is that we should aim at making the education in our schools as little bookish and as practical and concrete as possible.

I once had an illustration of the power of the concrete in stimulating the mind which made a very lasting impression upon me. One of my first pupils came to me with the assurance from his previous teacher that he knew little and cared less about mathematics, and that he had no chance of obtaining a degree in that subject. For some time I thought this estimate was correct, but he happened to be enthusiastic about billiards, and when we were reading that part of mechanics which deals with the collision of elastic bodies I pointed out that many of the effects he was constantly observing were illustrations of the subject we were studying. From that time he was a changed man. He had never before regarded mathematics as anything but a means of annoying innocent undergraduates; now, when he saw what important results it could obtain, he became enthusiastic about it, developed very considerable mathematical ability, and, though he had already wasted two out of his three years at college, took a good place in the Mathematical Tripos.

It is possible to read books, to pass examinations without the higher qualities of the mind being called into play. Indeed, I doubt if there is any process in which the mind is more quiescent than in reading without interest. I might appeal to the widespread habit of reading in bed as a prevention of insomnia as a proof of this. But it is not possible for a boy to make a boat or for a girl to cook a dinner without using their brains. With practical things the difficulties have to be surmounted, the boat must be made watertight, the dinner must be cooked, while in reading there is always the hope that the difficulties which have been slurred over will not be set in the examination.

I think it was Helmholtz who said that often in the course of a research more thought and energy were spent in reducing a refractory piece of brass to order than in devising the method or planning the scheme of campaign. This constant need for thought and action gives to original research in any branch of experimental science great educational value even for those who will not become professional men of science. I have had considerable experience with students beginning research in experimental physics, and I have always been struck by the quite remarkable improvement in judgment, independence of thought and maturity produced by a year's research. Research develops qualities which are apt to atrophy when the student is preparing for examinations, and, quite apart from the addition of new knowledge to our store, is of the greatest importance as a means of education.

It is the practice in many universities to make special provision for the reception of students from other universities who wish to do original research or to study the more advanced parts of their subject, and considerable numbers of such students migrate from one university to another. I think it would be a good thing if this practice were to extend to students at an earlier stage in their career; especially should I like to see a considerable interchange of students between the universities in the Mother Country and those in the Colonies.

I am quite sure that many of our English students, especially those destined for public life, could have no more valuable experience than to spend a year in one or other of your universities, and I hope some of your students might profit by a visit to ours.

I can think of nothing more likely to lead to a better understanding of the feelings, the sympathies, and, what is not less important, the prejudices, of one country by another, than by the youths of those countries spending a part of their student life together. Undergraduates as a rule do not wear a mask either of politeness or any other material, and have probably a better knowledge of each other's opinions and points of view—in fact, know each other better than do people of riper age. To bring this communion of students about there must be cooperation between the universities throughout the Empire; there must be recognition of each other's examinations, residence, and degrees. Before this can be accomplished there must, as my friend Mr. E. B. Sargant pointed out in a lecture given at the McGill University, be cooperation and recognition between the universities in each part of the Empire. I do not mean for a moment that all universities in a country should be under one government. I am a strong believer in the individuality of universities, but I do not think this is in any way inconsistent with the policy of an open door from one university to every other in the Empire.

It has usually been the practice of the President of this Association to give some account of the progress made in the last few years in the branch of science which he has the honour to represent.

I propose this evening to follow that precedent and to attempt to give a very short account of some of the more recent developments of physics, and the new conceptions of physical processes to which they have led.

The period which has elapsed since the Association last met in Canada has been one of almost unparalleled activity in many branches of physics, and many new and unsuspected properties of matter and electricity have been discovered. The history of this period affords a remarkable illustration of the effect which may be produced by a single discovery; for it is, I think, to the discovery of the Röntgen rays that we owe the rapidity of the progress which has recently been made in physics. A striking discovery like that of the Röntgen rays acts much like the discovery of gold in a sparsely populated country; it attracts workers who come in the first place for the gold, but who may find that the country has other products, other charms, perhaps even more valuable than the gold itself. The country in which the gold was discovered in the case of the Röntgen rays was the department of physics dealing with the discharge of electricity through gases, a subject which, almost from the beginning of electrical science, had attracted a few enthusiastic workers, who felt convinced that the key to unlock the secret of electricity was to be found in a vacuum tube. Röntgen, in 1895, showed that when electricity passed through such a tube, the tube emitted rays which could pass through bodies opaque to ordinary light; which could, for example, pass through the flesh of the body and throw a shadow of the bones on a suitable screen. The fascination of this discovery attracted many workers to the subject of the discharge of electricity through gases, and led to great improvements in the instruments used in this type of research. It is not, however, to the power of probing dark places, important though this is, that the influence of Röntgen rays on the progress of science has mainly been due; it is rather because these rays make gases, and, indeed, solids and liquids, through which they pass conductors of electricity. It is true that before the discovery of these rays other methods of making gases conductors were known, but none of these was so convenient for the purposes of accurate measurement.

The study of gases exposed to Röntgen rays has revealed in such gases the presence of particles charged with electricity; some of these particles are charged with positive, others with negative electricity.

The properties of these particles have been investigated; we know the charge they carry, the speed with which they move under an electric force, the rate at which the oppositely charged ones recombine, and these investigations have thrown a new light, not only on electricity, but also on the structure of matter.

We know from these investigations that electricity, like matter, is molecular in structure, that just as a quantity of hydrogen is a collection of an immense number of small particles called molecules, so a charge of electricity is made up of a great number of small charges, each of a perfectly definite and known amount.

Helmholtz said in 1880 that in his opinion the evidence in favour of the molecular constitution of electricity was even stronger than that in favour of the molecular constitution of matter. How much stronger is that evidence now, when we have measured the charge on the unit and found it to be the same from whatever source the electricity is obtained. Nay, further, the molecular theory of matter is indebted to the molecular theory of electricity for the most accurate determination of its fundamental quantity, the number of molecules in any given quantity of an elementary substance.

The great advantage of the electrical methods for the study of the properties of matter is due to the fact that whenever a particle is electrified it is very easily identified, whereas an uncharged molecule is most elusive; and it is only when these are present in immense numbers that we are able to detect them. A very simple calculation will illustrate the difference in our power of detecting electrified and unelectrified molecules. The smallest quantity of unelectrified matter ever detected is probably that of neon, one of the inert gases of the atmosphere. Prof. Strutt has shown that the amount of neon in 1/20th of a cubic centimetre of the air at ordinary pressures can be detected by the spectroscope; Sir William Ramsay estimates that the neon in the air only amounts to one part of neon in 100,000 parts of air, so that the neon in 1/20th of a cubic centimetre of air would only occupy at atmospheric pressure a volume of half a millionth of a cubic centimetre. When stated in this form the quantity seems exceedingly small, but in this small volume there are about ten million million molecules. Now the population of the earth is estimated at about fifteen hundred millions, so that the smallest number of molecules of neon we can identify is about 7,000 times the population of the earth. In other words, if we had no better test for the existence of a man than we have for that of an unelectrified molecule we should come to the conclusion that the earth is uninhabited. Contrast this with our power of detecting electrified molecules. We can by the electrical method, even better by the cloud method of C. T. R. Wilson, detect the presence of three or four charged particles in a cubic centimetre. Rutherford has shown that we can detect the presence of a single α particle. Now the α particle is a charged atom of helium; if this atom had been uncharged we should have required more than a million million of them, instead of one, before we should have been able to detect them.

We may, I think, conclude, since electrified particles can be studied with so much greater ease than unelectrified ones, that we shall obtain a knowledge of the ultimate structure of electricity before we arrive at a corresponding degree of certainty with regard to the structure of matter.

We have already made considerable progress in the task of discovering what the structure of electricity is. We have known for some time that of one kind of electricity —the negative—and a very interesting one it is. We know that negative electricity is made up of units all of which are of the same kind; that these units are exceedingly small compared with even the smallest atom, for the mass of the unit is only 1/1700th part of the mass of an atom of hydrogen; that its radius is only 10^{-13} centimetre, and that these units, "corpuscles" as they have been called, can be obtained from all substances. The size of these corpuscles is on an altogether different scale from that of atoms; the volume of a corpuscle bears to that of the atom about the same relation as that of a speck of dust to the volume of this room. Under suitable conditions they move at enormous speeds, which approach in some instances the velocity of light.

The discovery of these corpuscles is an interesting example of the way Nature responds to the demands made upon her by mathematicians. Some years before the discovery of corpuscles it had been shown by a mathematical investigation that the mass of a body must be increased by a charge of electricity. This increase, however, is greater for small bodies than for large ones, and even bodies as small as atoms are hopelessly too large to show any appreciable effect; thus the result seemed entirely academic. After a time corpuscles were discovered, and these are so much smaller than the atom that the increase in mass due to the charge becomes not merely appreciable, but so great that, as the experiments of Kaufmann and Bucherer have shown, the whole of the mass of the corpuscle arises from its charge.

We know a great deal about negative electricity; what do we know about positive electricity? Is positive electricity molecular in structure? Is it made up into units, each unit carrying a charge equal in magnitude though opposite in sign to that carried by a corpuscle? Does, or does not, this unit differ, in size and physical properties, very widely from the corpuscle? We know that by suitable processes we can get corpuscles out of any kind of matter, and that the corpuscles will be the same from whatever source they may be derived. Is a similar thing true for positive electricity? Can we get, for example, a positive unit from oxygen of the same kind as that we get from hydrogen?

For my own part, I think the evidence is in favour of the view that we can, although the nature of the unit of positive electricity makes the proof much more difficult than for the negative unit.

In the first place we find that the positive particles—"canalstrahlen" is their technical name—discovered by our distinguished guest, Dr. Goldstein, which are found when an electric discharge passes through a highly rarefied gas, are, when the pressure is very low, the same, whatever may have been the gas in the vessel to begin with. If we pump out the gas until the pressure is too low to allow the discharge to pass, and then introduce a small quantity of gas and restart the discharge, the positive particles are the same whatever kind of gas may have been introduced.

I have, for example, put into the exhausted vessel oxygen, argon, helium, the vapour of carbon tetrachloride, none of which contain hydrogen, and found the positive particles to be the same as when hydrogen was introduced.

Some experiments made lately by Wellisch, in the Cavendish Laboratory, strongly support the view that there is a definite unit of positive electricity independent of the gas from which it is derived; these experiments were on the velocity with which positive particles move through mixed gases. If we have a mixture of methyl-iodide and hydrogen exposed to Röntgen rays, the effect of the rays on the methyl-iodide is so much greater than on the hydrogen that, even when the mixture contains only a small percentage of methyl-iodide, practically all the electricity comes from this gas, and not from the hydrogen.

Now if the positive particles were merely the residue left when a corpuscle had been abstracted from the methyl-iodide, these particles would have the dimensions of a molecule of methyl-iodide; this is very large and heavy, and would therefore move more slowly through the hydrogen molecules than the positive particles derived from hydrogen itself, which would, on this view, be of the size and weight of the light hydrogen molecules. Wellisch found that the velocities of both the positive and negative particles through the mixture were the same as the velocities through pure hydrogen, although in the one case the ions had originated from methyl-iodide and in the other from hydrogen; a similar result was obtained when carbon tetrachloride, or mercury methyl, was used instead of methyl-iodide. These and similar results lead to the conclusion that the atom of the different chemical elements contains definite units of positive as well as of negative electricity, and that the positive electricity, like the negative, is molecular in structure.

The investigations made on the unit of positive electricity show that it is of quite a different kind from the unit of negative, the mass of the negative unit is exceedingly small compared with any atom, the only positive units that up to the present have been detected are quite comparable in mass with the mass of an atom of hydrogen; in fact they seem equal to it. This makes it more difficult to be certain that the unit of positive electricity has been isolated, for we have to be on our guard against its being a much smaller body attached to the hydrogen atoms which happen to be present in the vessel. If the positive units have a much greater mass than the negative ones, they ought not to be so easily deflected by magnetic forces when moving at equal speeds; and in general the insensibility of the positive particles to the influence of a magnet is very marked, though there are cases when the positive particles are much more readily deflected, and these have been interpreted as proving the existence of positive units comparable in mass with the negative ones. I have found, however, that in these cases the positive particles are moving very slowly, and that the ease with which they are deflected is due to the smallness of the velocity and not to that of the mass. It should, however, be noted that M. Jean Becquerel has observed in the absorption spectra of some minerals, and Prof. Wood in the rotation of the plane of polarisation by sodium vapour, effects which could be explained by the presence in the substances of positive units comparable in mass with corpuscles. This, however, is not the only explanation which can be given of these effects, and at present the smallest positive electrified particles of which we have direct experimental evidence have masses comparable with that of an atom of hydrogen.

A knowledge of the mass and size of the two units of electricity, the positive and the negative, would give us the material for constructing what may be called a molecular theory of electricity, and would be a starting-point for a theory of the structure of matter; for the most natural view to take, as a provisional hypothesis, is that matter is just a collection of positive and negative units of electricity, and that the forces which hold atoms and molecules together, the properties which differentiate one kind of matter from another, all have their origin in the electrical forces exerted by positive and negative units of electricity, grouped together in different ways in the atoms of the different elements.

As it would seem that the units of positive and negative electricity are of very different sizes, we must regard matter as a mixture containing systems of very different types, one type corresponding to the small corpuscle, the other to the large positive unit.

Since the energy associated with a given charge is greater the smaller the body on which the charge is concentrated, the energy stored up in the negative corpuscles will be far greater than that stored up by the positive. The amount of energy which is stored up in ordinary matter in the form of the electrostatic potential energy of its corpuscles is, I think, not generally realised. All substances give out corpuscles, so that we may assume that each atom of a substance contains at least one corpuscle. From the size and the charge on the corpuscle, both of which are known, we find that each corpuscle has 8×10^{-7} ergs of energy; this is on the supposition that the usual expressions for the energy of a charged body hold when, as in the case of a corpuscle, the charge is reduced to one unit. Now in one gram of hydrogen there are about 6×10^{23} atoms, so if there is only one corpuscle in each atom the energy due to the corpuscles in a gram of hydrogen would be 48×10^{16} ergs, or 11×10^{9} calories. This is more than seven times the heat developed by one gram of radium, or than that developed by the burning of five tons of coal. Thus we see that even ordinary matter contains enormous stores of energy; this energy is fortunately kept fast bound by the corpuscles; if at any time an appreciable fraction were to get free the earth would explode and become a gaseous nebula.

The matter of which I have been speaking so far is the material which builds up the earth, the sun, and the stars, the matter studied by the chemist, and which he can represent by a formula; this matter occupies, however, but an insignificant fraction of the universe, it forms but minute islands in the great ocean of the æther, the substance with which the whole universe is filled.

The æther is not a fantastic creation of the speculative philosopher; it is as essential to us as the air we breathe. For we must remember that we on this earth are not living on our own resources; we are dependent from minute to minute upon what we are getting from the sun, and the gifts of the sun are conveyed to us by the æther. It is to the sun that we owe, not merely night and day, springtime and harvest, but it is the energy of the sun, stored up in coal, in waterfalls, in food, that practically does all the work of the world.

How great is the supply the sun lavishes upon us becomes clear when we consider that the heat received by the earth under a high sun and a clear sky is equivalent, according to the measurements of Langley, to about 7000 horse-power per acre. Though our engineers have not yet discovered how to utilise this enormous supply of power, they will, I have not the slightest doubt, ultimately succeed in doing so; and when coal is exhausted and our water-power inadequate, it may be that this is the source from which we shall derive the energy necessary for the world's work. When that comes about, our centres of industrial activity may perhaps be transferred to the burning deserts of the Sahara, and the value of land determined by its suitability for the reception of traps to catch sunbeams.

This energy, in the interval between its departure from the sun and its arrival at the earth, must be in the space between them. Thus this space must contain something which, like ordinary matter, can store up energy, which can carry at an enormous pace the energy associated with light and heat, and can, in addition, exert the enormous stresses necessary to keep the earth circling round the sun and the moon round the earth.

The study of this all-pervading substance is perhaps the most fascinating and important duty of the physicist.

On the electromagnetic theory of light, now universally accepted, the energy streaming to the earth travels through the æther in electric waves; thus practically the whole of the energy at our disposal has at one time or another been electrical energy. The æther must, then, be the seat of electrical and magnetic forces. We know, thanks to the genius of Clerk Maxwell, the founder and inspirer of modern electrical theory, the equations which express the relation between these forces, and although for some purposes these are all we require, yet they do not tell us very much about the nature of the æther.

The interest inspired by equations, too, in some minds is apt to be somewhat Platonic; and something more grossly mechanical—a model, for example, is felt by many to be more suggestive and manageable, and for them a more powerful instrument of research, than a purely analytical theory.

Is the æther dense or rare? Has it a structure? Is it at rest or in motion? are some of the questions which force themselves upon us.

Let us consider some of the facts known about the æther. When light falls on a body and is absorbed by it, the body is pushed forward in the direction in which the light is travelling, and if the body is free to move it is set in motion by the light. Now it is a fundamental principle of dynamics that when a body is set moving in a certain direction, or, to use the language of dynamics, acquires momentum in that direction, some other mass must lose the same amount of momentum; in other words, the amount of momentum in the universe is constant. Thus when the body is pushed forward by the light some other system must have lost the momentum the body acquires, and the only other system available is the wave of light falling on the body; hence we conclude that there must have been momentum in the wave in the direction in which it is travelling. Momentum, however, implies mass in motion. We conclude, then, that in the æther through which the wave is moving there is mass moving with the velocity of light. The experiments made on the pressure due to light enable us to calculate this mass, and we find that in a cubic kilometre of æther carrying light as intense as sunlight is at the surface of the earth, the mass moving is only about one-fifty-millionth of a milligram. We must be careful not to confuse this with the mass of a cubic kilometre of æther; it is only the mass moved when the light passes through it; the vast majority of the æther is left undisturbed by the light. Now, on the electromagnetic theory of light, a wave of light may be regarded as made up of groups of lines of electric force moving with the velocity of light; and if we take this point of view we can prove that the mass of æther per cubic centimetre carried along is proportional to the energy possessed by these lines of electric force per cubic centimetre, divided by the square of the velocity of light. But though lines of electric force carry some of the æther along with them as they move, the amount so carried, even in the strongest electric fields we can produce, is but a minute fraction of the æther in their neighbourhood.

This is proved by an experiment made by Sir Oliver Lodge in which light was made to travel through an electric field in rapid motion. If the electric field had carried the whole of the æther with it, the velocity of the light would have been increased by the velocity of the electric field. As a matter of fact, no increase whatever could be detected, though it would have been registered if it had amounted to one-thousandth part of that of the field.

The æther carried along by a wave of light must be an exceedingly small part of the volume through which the wave is spread. Parts of this volume are in motion, but by far the greater part is at rest; thus in the wave front there cannot be uniformity, at some parts the æther is moving, at others it is at rest—in other words, the wave front must be more analogous to bright specks on a dark ground than to a uniformly illuminated surface.

The place where the density of the æther carried along by an electric field rises to its highest value is close to a corpuscle, for round the corpuscles are by far the strongest electric fields of which we have any knowledge. We know the mass of the corpuscle, we know from Kaufmann's experiments that this arises entirely from the electric charge, and is therefore due to the æther carried along with the corpuscle by the lines of force attached to it.

A simple calculation shows that one-half of this mass is contained in a volume seven times that of a corpuscle. Since we know the volume of the corpuscle as well as the mass, we can calculate the density of the æther attached to the corpuscle; doing so, we find it amounts to the prodigious value of about 5×10^{10}, or about 2000 million times that of lead. Sir Oliver Lodge, by somewhat different considerations, has arrived at a value of the same order of magnitude.

Thus around the corpuscle æther must have an extravagant density: whether the density is as great as this in other places depends upon whether the æther is compressible or not. If it is compressible, then it may be condensed round the corpuscles, and there have an abnormally great density; if it is not compressible, then the density in free space cannot be less than the number I have just mentioned.

With respect to this point we must remember that the forces acting on the æther close to the corpuscle are prodigious. If the æther were, for example, an ideal gas the density of which increased in proportion to the pressure, however great the pressure might be, then if, when exposed to the pressures which exist in some directions close to the corpuscle, it had the density stated above, its density under atmospheric pressure would only be about 8×10^{-16}, or a cubic kilometre would have a mass less than a gram; so that instead of being almost incomparably denser than lead, it would be almost incomparably rarer than the lightest gas.

I do not know at present of any effect which would enable us to determine whether æther is compressible or not. And although at first sight the idea that we are immersed in a medium almost infinitely denser than lead might seem inconceivable, it is not so if we remember that in all probability matter is composed mainly of holes. We may, in fact, regard matter as possessing a bird-cage kind of structure in which the volume of the æther disturbed by the wires when the structure is moved is infinitesimal in comparison with the volume enclosed by them. If we do this, no difficulty arises from the great density of the æther; all we have to do is to increase the distance between the wires in proportion as we increase the density of the æther.

Let us now consider how much æther is carried along by ordinary matter, and what effects this might be expected to produce.

The simplest electrical system we know, an electrified sphere, has attached to it a mass of æther proportional to its potential energy, and such that if the mass were to move with the velocity of light its kinetic energy would equal the electrostatic potential energy of the particle. This result can be extended to any electrified system, and it can be shown that such a system binds a mass of the æther proportional to its potential energy. Thus a part of the mass of any system is proportional to the potential energy of the system.

The question now arises, Does this part of the mass add anything to the weight of the body? If the æther were not subject to gravitational attraction it certainly would not; and even if the æther were ponderable, we might expect that as the mass is swimming in a sea of æther it would not increase the weight of the body to which it is attached. But if it does not, then a body with a large amount of potential energy may have an appreciable amount of its mass in a form which does not increase its weight, and thus the weight of a given mass of it may be less than that of an equal mass of some substance with a smaller amount of potential energy. Thus the weights of equal masses of these substances would be different. Now, experiments with pendulums, as Newton pointed out, enable us to determine with great accuracy the weights of equal masses of different substances. Newton himself made experiments of this kind, and found that the weights of equal masses were the same for all the materials he tried. Bessel, in 1830, made some experiments on this subject which are still the most accurate we possess, and he showed that the weights of equal masses of lead, silver, iron, brass did not differ by as much as one part in 60,000.

The substances tried by Newton and Bessel did not, however, include any of those substances which possess the marvellous power of radio-activity; the discovery of these came much later, and is one of the most striking achievements of modern physics.

These radio-active substances are constantly giving out large quantities of heat, presumably at the expense of their potential energy; thus when these substances reach their final non-radio-active state their potential energy must be less than when they were radio-active. Prof. Rutherford's measurements show that the energy emitted by one gram of radium in the course of its degradation to non-radio-active forms is equal to the kinetic energy of a mass of 1/13th of a milligram moving with the velocity of light.

This energy, according to the rule I have stated, corresponds to a mass of 1/13th of a milligram of the æther, and thus a gram of radium in its radio-active state must have at least 1/13th of a milligram more of æther attached to it than when it has been degraded into the non-radio-active forms. Thus if this æther does not increase the weight of the radium, the ratio of mass to weight for radium would be greater by about one part in 13,000 than for its non-radio-active products.

I attempted several years ago to find the ratio of mass to weight for radium by swinging a little pendulum, the bob of which was made of radium. I had only a small quantity of radium, and was not, therefore, able to attain any great accuracy. I found that the difference, if any, in the ratio of the mass to weight between radium and other substances was not more than one part in 2000. Lately we have been using at the Cavendish Laboratory a pendulum the bob of which was filled with uranium oxide. We have got good reasons for supposing that uranium is a parent of radium, so that the great potential energy and large æthereal mass possessed by the radium will be also in the uranium; the experiments are not yet completed. It is, perhaps, expecting almost too much to hope that the radio-active substances may add to the great services they have already done to science by furnishing the first case in which there is some differentiation in the action of gravity.

The mass of æther bound by any system is such that if it were to move with the velocity of light its kinetic energy would be equal to the potential energy of the system. This result suggests a new view of the nature of potential energy. Potential energy is usually regarded as essentially different from kinetic energy. Potential energy depends on the configuration of the system, and can be calculated from it when we have the requisite data; kinetic energy, on the other hand, depends upon the velocity of the system. According to the principle of the conservation of energy the one form can be converted into the other at a fixed rate of exchange, so that when one unit of one kind disappears a unit of the other simultaneously appears.

Now in many cases this rule is all that we require to calculate the behaviour of the system, and the conception of potential energy is of the utmost value in making the knowledge derived from experiment and observation available for mathematical calculation. It must, however, I think, be admitted that from the purely philosophical point of view it is open to serious objection. It violates, for example, the principle of continuity. When a thing changes from a state A to a different state B, the principle of continuity requires that it must pass through a number of states intermediate between A and B, so that the transition is made gradually, and not abruptly. Now, when kinetic energy changes into potential, although there is no discontinuity in the quantity of the energy, there is in its quality, for we do not recognise any kind of energy intermediate between that due to the motion and that due to the position of the system, and some portions of energy are supposed to change *per saltum* from the kinetic to the potential form. In the case of the transition of kinetic energy into heat energy in a gas, the discontinuity has disappeared with a fuller knowledge of what the heat energy in a gas is due to. When we were ignorant of the nature of this energy, the transition from kinetic into thermal energy seemed discontinuous; but now we know that this energy is the kinetic energy of the molecules of which the gas is composed, so that there is no change in the type of energy when the kinetic energy of visible motion is transformed into the thermal energy of a gas—it is just the transference of kinetic energy from one body to another.

If we regard potential energy as the kinetic energy of portions of the æther attached to the system, then all energy is kinetic energy, due to the motion of matter or of portions of æther attached to the matter. I showed, many years ago, in my "Applications of Dynamics to Physics and Chemistry," that we could imitate the effects of the potential energy of a system by means of the kinetic energy of invisible systems connected in an appropriate manner with the main system, and that the potential energy of the visible universe may in reality be the kinetic energy of an invisible one connected up with it. We naturally suppose that this invisible universe is the luminiferous æther, that portions of the æther in rapid motion are connected with the visible systems, and that their kinetic energy is the potential energy of the systems.

We may thus regard the æther as a bank in which we may deposit energy and withdraw it at our convenience. The mass of the æther attached to the system will change as the potential energy changes, and thus the mass of a system the potential energy of which is changing cannot be constant; the fluctuations in mass under ordinary conditions are, however, so small that they cannot be detected by any means at present at our disposal. Inasmuch as the various forms of potential energy are continually being changed into heat energy, which is the kinetic energy of the molecules of matter, there is a constant tendency for the mass of a system such as the earth or the sun to diminish, and thus as time goes on for the mass of æther gripped by the material universe to become smaller and smaller; the rate at which it would diminish would, however, get slower as time went on, and there is no reason to think that it would ever get below a very large value.

Radiation of light and heat from an incandescent body like the sun involves a constant loss of mass by the body. Each unit of energy radiated carries off its quota of mass, but as the mass ejected from the sun per year is only one part in 20 billionths (1 in 2×10^{13}) of the mass of the sun, and as this diminution in mass is not necessarily accompanied by any decrease in its gravitational attraction, we cannot expect to be able to get any evidence of this effect.

As our knowledge of the properties of light has progressed, we have been driven to recognise that the æther, when transmitting light, possesses properties which, before the introduction of the electromagnetic theory, would have been thought to be peculiar to an emission theory of light and to be fatal to the theory that light consists of undulations.

Take, for example, the pressure exerted by light. This would follow as a matter of course if we supposed light to be small particles moving with great velocities, for these, if they struck against a body, would manifestly tend to push it forward, while on the undulatory theory there seemed no reason why any effect of this kind should take place.

Indeed, in 1792, this very point was regarded as a test between the theories, and Bennet made experiments to see whether or not he could find any traces of this pressure. We now know that the pressure is there, and if Bennet's instrument had been more sensitive he must have observed it. It is perhaps fortunate that Bennet had not at his command more delicate apparatus. Had he discovered the pressure of light, it would have shaken confidence in the undulatory theory and checked that magnificent work at the beginning of the last century which so greatly increased our knowledge of optics.

As another example, take the question of the distribution of energy in a wave of light. On the emission theory the energy in the light is the kinetic energy of the light particles. Thus the energy of light is made up of distinct units, the unit being the energy of one of the particles.

The idea that the energy has a structure of this kind has lately received a good deal of support. Planck, in a very remarkable series of investigations on the Thermodynamics of Radiation, pointed out that the expressions for the energy and entropy of radiant energy were of such a form as to suggest that the energy of radiation, like that of a gas on the molecular theory, was made up of distinct units, the magnitude of the unit depending on the colour of the light; and on this assumption he was able to calculate the value of the unit, and from this deduce incidentally the value of Avogadro's constant—the number of molecules in a cubic centimetre of gas at standard temperature and pressure.

This result is most interesting and important, because if it were a legitimate deduction from the Second Law of Thermodynamics, it would appear that only a particular type of mechanism for the vibrators which give out light and the absorbers which absorb it could be in accordance with that law.

If this were so, then, regarding the universe as a collection of machines all obeying the laws of dynamics, the Second Law of Thermodynamics would only be true for a particular kind of machine.

There seems, however, grave objection to this view, which I may illustrate by the case of the First Law of Thermodynamics, the principle of the Conservation of Energy. This must be true whatever be the nature of the machines which make up the universe, provided they obey the laws of dynamics, any application of the principle of the Conservation of Energy could not discriminate between one type of machine and another.

Now, the Second Law of Thermodynamics, though not a dynamical principle in as strict a sense as the law of the Conservation of Energy, is one that we should expect to hold for a collection of a large number of machines of any type, provided that we could not directly affect the individual machines, but could only observe the average effects produced by an enormous number of them. On this view, the Second Law, as well as the First, should be incapable of saying that the machines were of any particular type: so that investigations founded on thermodynamics, though the expressions they lead to may suggest—cannot, I think, be regarded as proving—the unit structure of light energy.

It would seem as if in the application of thermodynamics to radiation some additional assumption has been implicitly introduced, for these applications lead to definite relations between the energy of the light of any particular wave-length and the temperature of the luminous body.

Now a possible way of accounting for the light emitted by hot bodies is to suppose that it arises from the collisions of corpuscles with the molecules of the hot body, but it is only for one particular law of force between the corpuscles and the molecules that the distribution of energy would be the same as that deduced by the Second Law of Thermodynamics, so that in this case, as in the other, the results obtained by the application of thermodynamics to radiation would require us to suppose that the Second Law of Thermodynamics is only true for radiation when the radiation is produced by mechanism of a special type.

Quite apart, however, from considerations of thermodynamics, we should expect that the light from a luminous source should in many cases consist of parcels, possessing, at any rate to begin with, a definite amount of energy. Consider, for example, the case of a gas like sodium vapour, emitting light of a definite wave-length; we may imagine that this light, consisting of electrical waves, is emitted by systems resembling Leyden jars. The energy originally possessed by such a system will be the electrostatic energy of the charged jar. When the vibrations are started, this energy will be radiated away into space, the radiation forming a complex system, containing, if the jar has no electrical resistance, the energy stored up in the jar.

The amount of this energy will depend on the size of the jar and the quantity of electricity with which it is charged. With regard to the charge, we must remember that we are dealing with systems formed out of single molecules, so that the charge will only consist of one or two natural units of electricity, or, at all events, some small multiple of that unit, while for geometrically similar Leyden jars the energy for a given charge will be proportional to the frequency of the vibration; thus, the energy in the bundle of radiation will be proportional to the frequency of the vibration.

We may picture to ourselves the radiation as consisting of the lines of electric force which, before the vibrations were started, were held bound by the charges on the jar, and which, when the vibrations begin, are thrown into rhythmic undulations, liberated from the jar and travel through space with the velocity of light.

Now let us suppose that this system strikes against an uncharged condenser and gives it a charge of electricity, the charge on the plates of the condenser must be at least one unit of electricity, because fractions of this charge do not exist, and each unit charge will anchor a unit tube of force, which must come from the parcel of radiation falling upon it. Thus a tube in the incident light will be anchored by the condenser, and the parcel formed by this tube will be anchored and withdrawn as a whole from the pencil of light incident on the condenser. If the energy required to charge up the condenser with a unit of electricity is greater than the energy in the incident parcel, the tube will not be anchored and the light will pass over the condenser and escape from it. These principles that radiation is made up of units, and that it requires a unit possessing a definite amount of energy to excite radiation in a body on which it falls, perhaps receive their best illustration in the remarkable laws governing Secondary Röntgen radiation, recently discovered by Prof. Barkla. Prof. Barkla has found that each of the different chemical elements, when exposed to Röntgen rays, emits a definite type of secondary radiation whatever may have been the type of primary; thus lead emits one type, copper another, and so on; but these radiations are not excited at all if the primary radiation is of a softer type than the specific radiation emitted by the substance; thus the secondary radiation from lead being harder than that from copper, if copper is exposed to the secondary radiation from lead the copper will radiate, but lead will not radiate when exposed to copper. Thus, if we suppose that the energy in a unit of hard Röntgen rays is greater than that in one of soft, Barkla's results are strikingly analogous to those which would follow on the unit theory of light.

Though we have, I think, strong reasons for thinking that the energy in the light waves of definite wave-length is done up into bundles, and that these bundles, when emitted, all possess the same amount of energy, I do not think there is any reason for supposing that in any casual specimen of light of this wave-length, which may subsequent to its emission have been many times refracted or reflected, the bundles possess any definite amount of energy. For consider what must happen when a bundle is incident on a surface such as glass, when part of it is reflected and part transmitted. The bundle is divided into two portions, in each of which the energy is less than the incident bundle, and since these portions diverge and may ultimately be many thousands of miles apart, it would seem meaningless still to regard them as forming one unit. Thus the energy in the bundles of light, after they have suffered partial reflection, will not be the same as in the bundles when they were emitted. The study of the dimensions of these bundles, for example, the angle they subtend at the luminous source, is an interesting subject for investigation; experiments on interference between rays of light emerging in different directions from the luminous source would probably throw light on this point.

I now pass to a very brief consideration of one of the most important and interesting advances ever made in physics, and in which Canada, as the place of the labours of Profs. Rutherford and Soddy, has taken a conspicuous part. I mean the discovery and investigation of radio-activity. Radio-activity was brought to light by the Röntgen rays. One of the many remarkable properties of these rays is to excite phosphorescence in certain substances, including the salts of uranium, when they fall upon them. Since Röntgen rays produce phosphorescence, it occurred to Becquerel to try whether phosphorescence would produce Röntgen rays. He took some uranium salts which had been made to phosphoresce by exposure, not to Röntgen rays, but to sunlight, tested them, and found that they gave out rays possessing properties similar to Röntgen rays. Further investigation showed, however, that to get these rays it was not necessary to make the uranium phosphoresce, that the salts were just as active if they had been kept in the dark. It thus appeared that the property was due to the metal and not to the phosphorescence, and that uranium and its compounds possessed the power of giving out rays which, like Röntgen rays, affect a photographic plate, make certain minerals phosphoresce, and make gases through which they pass conductors of electricity.

Niepce de Saint-Victor had observed some years before this discovery that paper soaked in a solution of uranium nitrate affected a photographic plate, but the observation excited but little interest. The ground had not then been prepared, by the discovery of the Röntgen rays, for its reception, and it withered and was soon forgotten.

Shortly after Becquerel's discovery of uranium, Schmidt found that thorium possessed similar properties. Then M. and Mme. Curie, after a most difficult and laborious investigation, discovered two new substances, radium and polonium, possessing this property to an enormously greater extent than either thorium or uranium, and this was followed by the discovery of actinium by Debierne. Now the researches of Rutherford and others have led to the discovery of so many new radio-active substances that any attempts at christening seem to have been abandoned, and they are denoted, like policemen, by the letters of the alphabet.

Mr. Campbell has recently found that potassium, though far inferior in this respect to any of the substances I have named, emits an appreciable amount of radiation, the amount depending only on the quantity of potassium, and being the same whatever the source from which the potassium is obtained or whatever the elements with which it may be in combination.

The radiation emitted by these substances is of three types, known as α, β, and γ rays. The α rays have been shown by Rutherford to be positively electrified atoms of helium, moving with speeds which reach up to about one-tenth of the velocity of light. The β rays are negatively electrified corpuscles, moving in some cases with very nearly the velocity of light itself, while the γ rays are unelectrified, and are analogous to the Röntgen rays.

The radio-activity of uranium was shown by Crookes to arise from something mixed with the uranium, which differed sufficiently in properties from the uranium itself to enable it to be separated by chemical analysis. He took some uranium, and by chemical treatment separated it into two portions, one of which was radio-active and the other not.

Next Becquerel found that if these two portions were kept for several months, the part which was not radio-active to begin with regained radio-activity, while the part which was radio-active to begin with had lost its radio-activity. These effects and many others receive a complete explanation by the theory of radio-active change which we owe to Rutherford and Soddy.

According to this theory, the radio-active elements are not permanent, but are gradually breaking up into elements of lower atomic weight; uranium, for example, is slowly breaking up, one of the products being radium, while radium breaks up into a radio-active gas called radium emanation, the emanation into another radio-active substance, and so on, and that the radiations are a kind of swan's song emitted by the atoms when they pass from one form to another; that for example, it is when a radium atom breaks up and an atom of the emanation appears that the rays which constitute the radio-activity are produced.

Thus, on this view, the atoms of the radio-active elements are not immortal; they perish after a life the average value of which ranges from thousands of millions of years in the case of uranium to a second or so in the case of the gaseous emanation from actinium.

When the atoms pass from one state to another they give out large stores of energy; thus their descendants do not inherit the whole of their wealth of stored-up energy; the estate becomes less and less wealthy with each generation; we find, in fact, that the politician, when he imposes death duties, is but imitating a process which has been going on for ages in the case of these radio-active substances.

Many points of interest arise when we consider the rate at which the atoms of radio-active substance disappear. Rutherford has shown that whatever be the age of these atoms, the percentage of atoms which disappear in one second is always the same; another way of putting it is that the expectation of life of an atom is independent of its age—that an atom of radium one thousand years old is just as likely to live for another thousand years as one just sprung into existence.

Now this would be the case if the death of the atom were due to something from outside which struck old and young indiscriminately; in a battle, for example, the chance of being shot is the same for old and young; so that we are inclined at first to look to something coming from outside as the cause why an atom of radium, for example, suddenly changes into an atom of the emanation. But here we are met with the difficulty that no changes in the external conditions that we have as yet been able to produce have had any effect on the life of the atom; so far as we know at present, the life of a radium atom is the same at the temperature of a furnace as at that of liquid air—it is not altered by surrounding the radium by thick screens of lead or other dense materials to ward off radiation from outside, and, what to my mind is especially significant, it is the same when the radium is in the most concentrated form, when its atoms are exposed to the vigorous bombardment from the rays given off by the neighbouring atoms, as when it is in the most dilute solution, when the rays are absorbed by the water which separates one atom from another. This last result seems to me to make it somewhat improbable that we shall be able to split up the atoms of the non-radio-active elements by exposing them to the radiation from radium; if this radiation is unable to affect the unstable radio-active atoms, it is somewhat unlikely that it will be able to affect the much more stable non-radio-active elements.

The evidence we have at present is against a disturbance coming from outside breaking up the radio-active atoms, and we must therefore look to some process of decay in the atom itself; but if this is the case, how are we to reconcile it with the fact that the expectation of life of an atom does not diminish as the atom gets older? We can do this if we suppose that the atoms when they are first produced have not all the same strength of constitution, that some are more robust than others, perhaps because they contain more intrinsic energy to begin with, and will therefore have a longer life. Now if when the atoms are first produced there are some which will live for one year, some for ten, some for a thousand, and so on; and if lives of all durations, from nothing to infinity, are present in such proportion that the number of atoms which will live longer than a certain number of years decreases in a constant proportion for each additional year of life, we can easily prove that the expectation of life of an atom will be the same whatever its age may be. On this view the different atoms of a radio-active substance are not, in all respects, identical.

The energy developed by radio-active substances is exceedingly large, one gram of radium developing nearly as much energy as would be produced by burning a ton of coal. This energy is mainly in the α particles, the positively charged helium atoms which are emitted when the change in the atom takes place; if this energy were produced by electrical forces it would indicate that the helium atom had moved through a potential difference of about two million volts on its way out of the atom of radium. The source of this energy is a problem of the deepest interest; if it arises from the repulsion of similarly electrified systems exerting forces varying inversely as the square of the distance, then to get the requisite amount of energy the systems, if their charges were comparable with the charge on the α particle, could not when they start be further apart than the radius of a corpuscle, 10^{-13} cm. If we suppose that the particles do not acquire this energy at the explosion, but that before they are shot out of the radium atom they move in circles inside this atom with the speed with which they emerge, the forces required to prevent particles moving with this velocity from flying off at a tangent are so great that finite charges of electricity could only produce them at distances comparable with the radius of a corpuscle.

One method by which the requisite amount of energy could be obtained is suggested by the view to which I have already alluded—that in the atom we have electrified systems of very different types, one small, the other large; the radius of one type is comparable with 10^{-13} cm., that of the other is about 100,000 times greater. The electrostatic potential energy in the smaller bodies is enormously greater than that in the larger ones; if one of these small bodies were to explode and expand to the size of the larger ones, we should have a liberation of energy large enough to endow an α particle with the energy it possesses. Is it possible that the positive units of electricity were, to begin with, quite as small as the negative, but while in the course of ages most of these have passed from the smaller stage to the larger, there are some small ones still lingering in radio-active substances, and it is the explosion of these which liberates the energy set free during radio-active transformation?

The properties of radium have consequences of enormous importance to the geologist as well as to the physicist or chemist. In fact, the discovery of these properties has entirely altered the aspect of one of the most interesting geological problems, that of the age of the earth. Before the discovery of radium it was supposed that the supplies of heat furnished by chemical changes going on in the earth were quite insignificant, and that there was nothing to replace the heat which flows from the hot interior of the earth to the colder crust. Now when the earth first solidified it only possessed a certain amount of capital in the form of heat, and if it is continually spending this capital and not gaining any fresh heat it is evident that the process cannot have been going on for more than a certain number of years; otherwise the earth would be colder than it is. Lord Kelvin in this way estimated the age of the earth to be less than 100 million years. Though the quantity of radium in the earth is an exceedingly small fraction of the mass of the earth, only amounting, according to the determinations of Profs. Strutt and Joly, to about five grams in a cube the side of which is 100 miles, yet the amount of heat given out by this small quantity of radium is so great that it is more than enough to replace the heat which flows from the inside to the outside of the earth. This, as Rutherford has pointed out, entirely vitiates the previous method of determining the age of the earth. The fact is that the radium gives out so much heat that we do not quite know what to do with it, for if there was as much radium throughout the interior of the earth as there is in its crust, the temperature of the earth would increase much more rapidly than it does as we descend below the earth's surface. Prof. Strutt has shown that if radium behaves in the interior of the earth as it does at the surface, rocks similar to those in the earth's crust cannot extend to a depth of more than forty-five miles below the surface.

It is remarkable that Prof. Milne from the study of earthquake phenomena had previously come to the conclusion that rocks similar to those at the earth's surface only descend a short distance below the surface; he estimates this distance at about thirty miles, and concludes that at a depth greater than this the earth is fairly homogeneous.

Though the discovery of radio-activity has taken away one method of calculating the age of the earth it has supplied another.

The gas helium is given out by radio-active bodies, and since, except in beryls, it is not found in minerals which do not contain radio-active elements, it is probable that all the helium in these minerals has come from these elements. In the case of a mineral containing uranium, the parent of radium in radio-active equilibrium, with radium and its products, helium will be produced at a definite rate. Helium, however, unlike the radio-active elements, is permanent, and accumulates in the mineral; hence if we measure the amount of helium in a sample of rock and the amount produced by the sample in one year we can find the length of time the helium has been accumulating, and hence the age of the rock. This method, which is due to Prof. Strutt, may lead to determinations, not merely of the average age of the crust of the earth, but of the ages of particular rocks and the date at which the various strata were deposited; he has, for example, shown in this way that a specimen of the mineral thorianite must be more than 240 million years old.

The physiological and medical properties of the rays emitted by radium is a field of research in which enough has already been done to justify the hope that it may lead to considerable alleviation of human suffering. It seems quite definitely established that for some diseases, notably rodent ulcer, treatment with these rays has produced remarkable cures; it is imperative, lest we should be passing over a means of saving life and health, that the subject should be investigated in a much more systematic and extensive manner than there has yet been either time or material for. Radium is, however, so costly that few hospitals could afford to undertake pioneering work of this kind; fortunately, however, through the generosity of Sir Ernest Cassel and Lord Iveagh a Radium Institute, under the patronage of his Majesty the King, has been founded in London for the study of the medical properties of radium, and for the treatment of patients suffering from diseases for which radium is beneficial.

The new discoveries made in physics in the last few years, and the ideas and potentialities suggested by them, have had an effect upon the workers in that subject akin to that produced in literature by the Renaissance. Enthusiasm has been quickened, and there is a hopeful, youthful, perhaps exuberant, spirit abroad which leads men to make with confidence experiments which would have been thought fantastic twenty years ago. It has quite dispelled the pessimistic feeling, not uncommon at that time, that all the interesting things had been discovered, and all that was left was to alter a decimal or two in some physical constant. There never was any justification for this feeling, there never were any signs of an approach to finality in science. The sum of knowledge is at present, at any rate, a diverging, not a converging, series. As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, the truth of which is emphasised by every advance in science, that "Great are the Works of the Lord."

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PROF. E. RUTHERFORD, M.A., D.Sc., F.R.S., PRESIDENT OF THE SECTION.

IT is a great privilege and pleasure to address the members of this Section on the occasion of the visit of the British Association to a country with which I have had such a long and pleasant connection. I feel myself in the presence of old friends, for the greater part of what may be called my scientific life has been spent in Canada, and I owe much to this country for the unusual facilities and opportunity for research so liberally provided by one of her great Universities. Canada may well regard with pride her Universities, which have made such liberal provision for teaching and research in pure and applied science. As a physicist, I may be allowed to refer in particular to the subject with which I am most intimately connected. After seeing the splendid home for physical science recently erected by the University of Toronto, and the older but no less serviceable and admirably equipped laboratories of McGill University, one cannot but feel that Canada has recognised in a striking manner the great value attaching to teaching and research in physical science. In this, as in other branches of knowledge, Canada has made notable contributions in the past, and we may confidently anticipate that this is but an earnest of what will be accomplished in the future.

It is my intention to-day to say a few words upon the present position of the atomic theory in physical science, and to discuss briefly the various methods that have been devised to determine the values of certain fundamental atomic magnitudes. The present time seems very opportune for this purpose, for the rapid advance of physics during the last decade has not only given us a much clearer conception of the relation between electricity and matter and of the constitution of the atom, but has provided us with experimental methods of attack undreamt of a few years ago. At a time when, in the vision of the physicist, the atmosphere is dim with flying fragments of atoms, it may not be out of place to see how it has fared with the atoms themselves, and to look carefully at the atomic foundations on which the great superstructure of modern science has been raised. Every physicist and chemist cannot but be aware of the great part the atomic hypothesis plays in science to-day. The idea that matter consists of a great number of small discrete particles forms practically the basis of the explanation of all properties of matter. As an indication of the importance of this theory in the advance of science it is of interest to read over the Reports of this Association and to note how many addresses, either wholly or in part, have been devoted to a consideration of this subject. Amongst numerous examples I may instance the famous and oft-quoted lecture of Maxwell on Molecules, at Bradford in 1873; the discussion of the Kinetic Theory of Gases by Lord Kelvin, then Sir William Thomson, in Montreal in 1884; and the Presidential Address of Sir Arthur Rücker in 1901, which will be recalled by many here to-day.

It is, far from my intention to discuss, except with extreme brevity, the gradual rise and development of the atomic theory. From the point of view of modern science, the atomic theory dates from the work of Dalton about 1805, who put it forward as an explanation of the combination of elements in definite proportions. The simplicity of this explanation of the facts of chemistry led to the rapid adoption of the atomic theory as a very convenient and valuable working hypothesis. By the labour of the chemists matter was shown to be composed of a number of elementary substances which could not be further decomposed by laboratory agencies, and the relative weights of the atoms of the elements were determined. On the physical side, the mathematical development of the kinetic or dynamical theory of gases by the labours of Clausius and Clerk Maxwell enormously extended the utility of this conception. It was shown that the properties of gases could be satisfactorily explained on the assumption that a gas consisted of a great assemblage of minute particles or molecules in continuous agitation, colliding with each other and with the walls of the containing vessel. Between encounters the molecules travelled in straight lines, and the free path of the molecules between collisions was supposed to be large compared with the linear dimensions of the molecules themselves. One cannot but regard with admiration the remarkable success of this statistical theory in explaining the general properties of gases and even predicting unexpected relations. The strength and at the same time the limitations of the theory lie in the fact that it does not involve any definite conception of the nature of the molecules themselves or of the forces acting between them. The molecule, for example, may be considered as a perfectly elastic sphere or a Boscovitch centre of force, as Lord Kelvin preferred to regard it, and yet on suitable assumptions the gas would show the same general statistical properties. We are consequently unable, without the aid of special subsidiary hypotheses, to draw conclusions of value in regard to the nature of the molecules themselves.

Towards the close of the last century the ideas of the atomic theory had impregnated a very large part of the domain of physics and chemistry. The conception of atoms became more and more concrete. The atom in imagination was endowed with size and shape, and unconsciously in many cases with colour. The simplicity and utility of atomic conceptions in explaining the most diverse phenomena of physics and chemistry naturally tended to enhance the importance of the theory in the eyes of the scientific worker. There was a tendency to regard the atomic theory as one of the established facts of nature, and not as a useful working hypothesis for which it was exceedingly difficult to obtain direct and convincing evidence. There were not wanting scientific men and philosophers to point out the uncertain foundations of the theory on which so much depended. Granting how useful molecular ideas were for the explanation of experimental facts, what evidence was there that the atoms were realities and not the figments of the imagination? It must be confessed that this lack of direct evidence did not in any way detract from the strength of the belief of the great majority of scientific men in the discreteness of matter. It was not unnatural, however, that there should be a reaction in some quarters against the domination of the atomic theory in physics and in chemistry. A school of thought arose that wished to do away with the atomic theory as the basis of explanation of chemistry, and substitute as its equivalent the law of combination in definite proportions. This movement was assisted by the possibility of explaining many chemical facts on the basis of thermodynamics without the aid of any hypothesis as to the particular structure of matter. Everyone recognises the great importance of such general methods of explanation, but the trouble is that few can think, or at any rate think correctly, in terms of thermodynamics. The negation of the atomic theory has not, and does not, help us to make new discoveries. The great advantage of the atomic theory is that it provides, so to speak, a tangible and concrete idea of matter which serves at once for the explanation of a multitude of facts and is of enormous aid as a working hypothesis. For the great majority of men of science it is not sufficient to group together a number of facts on general abstract principles. What is wanted is a concrete idea, however crude it may be, of the mechanism of the phenomena. This may be a weakness of the scientific mind, but it is one that deserves our sympathetic consideration. It represents an attitude of mind that appeals, I think, very strongly to the Anglo-Saxon temperament. It has no doubt as its basis the underlying idea that the facts of nature are ultimately explicable on general dynamical principles, and that there must consequently be some type of mechanism capable of accounting for the observed facts.

It has been generally considered that a decisive proof of the atomic structure of matter was in the nature of things impossible, and that the atomic theory must of necessity remain an hypothesis unverifiable by direct methods. Recent investigations have, however, disclosed such new and powerful methods of attack that we may well ask the question whether we do not now possess more decisive evidence of its truth.

Since molecules are invisible, it might appear, for example, an impossible hope that an experiment could be devised to show that the molecules of a fluid are in that state of continuous agitation which the kinetic theory leads us to suppose. In this connection I should like to direct your attention for a short time to a most striking phenomenon known as the "Brownian movement," which has been closely studied in recent years. Quite apart from its probable explanation the phenomenon is of unusual interest. In 1827 the English botanist Brown observed by means of a microscope that minute particles like spores of plants introduced into a fluid were always in a state of continuous irregular agitation, dancing to and fro in all directions at considerable speeds. For a long time this effect, known as the Brownian movement, was ascribed to inequalities in the temperature of the solution. This was disproved by a number of subsequent investigations, and especially by those of Gouy, who showed that the movement was spontaneous and continuous, and was exhibited by very small particles of whatever kind when immersed in a fluid medium. The velocity of agitation increased with decrease of diameter of the particles and increased with temperature, and was dependent on the viscosity of the surrounding fluid. With the advent of the ultra-microscope it has been possible to follow the movements with more certainty and to experiment with much smaller particles. Exner and Zsigmondy have determined the mean velocity of particles of known diameter in various solutions, while Svedberg has devised an ingenious method of determining the mean free path and the average velocity of particles of different diameter. The experiments of Ehrenhaft in 1907 showed that the Brownian movement was not confined to liquids, but was exhibited far more markedly by small particles suspended in gases. By passing an arc discharge between silver poles he produced a fine dust of silver in the air. When examined by means of the ultra-microscope the suspended particles exhibited the characteristic Brownian movement, with the difference that the mean free path for particles of the same size was much greater in gases than in liquids.

The particles exhibit in general the character of the motion which the kinetic theory ascribes to the molecules themselves, although even the smallest particles examined have a mass which is undoubtedly very large compared with that of the molecule. The character of the Brownian movement irresistibly impresses the observer with the idea that the particles are hurled hither and thither by the action of forces resident in the solution, and that these can only arise from the continuous and ceaseless movement of the invisible molecules of which the fluid is composed. Smoluchowski and Einstein have suggested explanations which are based on the kinetic theory, and there is a fair agreement between calculation and experiment. Strong additional confirmation of this view has been supplied by the very recent experiments of Perrin (1909). He obtained an emulsion of gamboge in water which consisted of a great number of spherical particles nearly of the same size, which showed the characteristic Brownian movement. The particles settled under gravity, and when equilibrium was set up the distribution of these particles in layers at different heights was determined by counting the particles with a microscope. The number was found to diminish from the bottom of the vessel upwards according to an exponential law—*i.e.* according to the same law as the pressure of the atmosphere diminishes from the surface of the earth. In this case, however, on account of the great mass of the particles, their distribution was confined to a region only a fraction of a millimetre deep. In a particular experiment the number of particles per unit volume decreased to half in a distance of 0·038 millimetre, while the corresponding distance in our atmosphere is about 6000 metres. From measurements of the diameter and weight of each particle, Perrin found that, within the limit of experimental error, the law of distribution with height indicated that each small particle had the same average kinetic energy of movement as the molecules of the solutions in which they were suspended; in fact, the particles in suspension behaved in all respects like molecules of very high molecular weight. This is a very important result, for it indicates that the law of equipartition of energy among molecules of different masses, which is an important deduction from the kinetic theory, holds, at any rate very approximately, for a distribution of particles in a medium the masses and dimensions of which are exceedingly large compared with that of the molecules of the medium. Whatever may prove to be the exact explanation of this phenomenon, there can be little doubt that it results from the movement of the molecules of the solution, and is thus a striking if somewhat indirect proof of the general correctness of the kinetic theory of matter.

From recent work in radio-activity we may take a second illustration which is novel and far more direct. It is well known that the α rays of radium are deflected by both magnetic and electric fields. It may be concluded from this evidence that the radiation is corpuscular in character, consisting of a stream of positively charged particles projected from the radium at a very high velocity. From the measurements of the deflection of the rays in passing through magnetic and electric fields the ratio e/m of the charge carried by the particle to its mass has been determined, and the magnitude of this quantity indicates that the particle is of atomic dimensions.

Rutherford and Geiger have recently developed a direct method of showing that this radiation is, as the other evidence indicated, discontinuous, and that it is possible to detect by a special electric method the passage of a single α particle into a suitable detecting vessel. The entrance of an α particle through a small opening was marked by a sudden movement of the needle of the electrometer which was used as a measuring instrument. In this way, by counting the number of separate impulses communicated to the electrometer needle, it was possible to determine by direct counting the number of α particles expelled per second from one gram of radium. But we can go further and confirm the result by counting the number of α particles by an entirely distinct method. Sir William Crookes has shown that when the α rays are allowed to fall upon a screen of phosphorescent zinc sulphide, a number of brilliant scintillations are observed. It appears as if the impact of each α particle produced a visible flash of light where it struck the screen. Using suitable screens, the number of scintillations per second on a given area can be counted by means of a microscope. It has been shown that the number of scintillations determined in this way is equal to the number of impinging α particles when counted by the electric method. This shows that the impact of each α particle on the zinc sulphide produces a visible scintillation. There are thus two distinct methods—one electrical, the other optical—for detecting the emission of a single α particle from radium. The next question to consider is the nature of the α particle itself. The general evidence indicates that the α particle is a charged atom of helium, and this conclusion was decisively verified by Rutherford and Royds by showing that helium appeared in an exhausted space into which the α particles were fired. The helium, which is produced by radium, is due to the accumulated α particles which are so continuously expelled from it. If the rate of production of helium from radium is measured, we thus have a means of determining directly how many α particles are required to form a given volume of helium gas. This rate of production has recently been measured accurately by Sir James Dewar. He has informed me that his final measurements show that one gram of radium in radioactive equilibrium produces 0·46 cubic millimetre of helium per day, or $5{\cdot}32\times10^{-6}$ cubic millimetres per second. Now from the direct counting experiments it is known that $13{\cdot}6\times10^{10}$ α particles are shot out per second from one gram of radium in equilibrium. Consequently it requires $2{\cdot}56\times10^{19}$ α particles to form one cubic centimetre of helium gas at standard pressure and temperature.

From other lines of evidence it is known that all the α particles, from whatever source, are identical in mass and constitution. It is not, then, unreasonable to suppose that the α particle, which exists as a separate entity in its flight, can exist also as a separate entity when the α particles are collected together to form a measurable volume of helium gas, or, in other words, that the α particle on losing its charge becomes the fundamental unit or atom of helium. In the case of a monatomic gas like helium, where the atom and molecule are believed to be identical, no difficulty of deduction arises from the possible combination of two or more atoms to form a complex molecule.

We consequently conclude from these experiments that one cubic centimetre of helium at standard pressure and temperature contains $2{\cdot}56\times10^{19}$ atoms. Knowing the density of helium, it at once follows that each atom of helium has a mass of $6{\cdot}8\times10^{-24}$ grams, and that the average distance apart of the molecules in the gaseous state at standard pressure and temperature is $3{\cdot}4\times10^{-7}$ centimetres.

The above result can be confirmed in a different way. It is known that the value of e/m for the α particle is

5070 electromagnetic units. The positive charge carried by each α particle has been deduced by measuring the total charge carried by a counted number of α particles. Its value is $9 \cdot 3 \times 10^{-10}$ electrostatic units, or $3 \cdot 1 \times 10^{-20}$ electromagnetic units. Substituting this number in the value of e/m, it is seen that m, the mass of the α particle, is equal to $6 \cdot 1 \times 10^{-24}$ grams—a value in fair agreement with the number previously given.

I trust that my judgment is not prejudiced by the fact that I have taken some share in these investigations; but the experiments, taken as a whole, appear to me to give an almost direct and convincing proof of the atomic hypothesis of matter. By direct counting, the number of identical entities required to form a known volume of gas has been measured. May we not conclude that the gas is discrete in structure, and that this number represents the actual number of atoms in the gas?

We have seen that under special conditions it is possible to detect easily by an electrical method the emission of a single α particle—*i.e.* of a single charged atom of matter. This has been rendered possible by the great velocity and energy of the expelled α particle, which confers on it the power of dissociating or ionising the gas through which it passes. It is obviously only possible to detect the presence of a single atom of matter when it is endowed with some special property or properties which distinguishes it from the molecules of the gas with which it is surrounded. There is a very important and striking method, for example, of visibly differentiating between the ordinary molecules of a gas and the ions produced in the gas by various agencies. C. T. R. Wilson showed in 1897 that under certain conditions each charged ion became a centre of condensation of water vapour, so that the presence of each ion was rendered visible to the eye. Sir Joseph Thomson, H. A. Wilson, and others have employed this method to count the number of ions present and to determine the magnitude of the electric charge carried by each.

A few examples will now be given which illustrate the older methods of estimating the mass and dimensions of molecules. As soon as the idea of the discrete structure of matter had taken firm hold, it was natural that attempts should be made to estimate the degree of coarse-grainedness of matter, and to form an idea of the dimension of molecules, assuming that they have extension in space. Lord Rayleigh has directed attention to the fact that the earliest estimate of this kind was made by Thomas Young in 1805, from considerations of the theory of capillarity. Space does not allow me to consider the great variety of methods that have later been employed to form an idea of the thickness of a film of matter in which a molecular structure is discernible. This phase of the subject was always a favourite one with Lord Kelvin, who developed a number of important methods of estimating the probable dimensions of molecular structure.

The development of the kinetic theory of gases on a mathematical basis at once suggested methods of estimating the number of molecules in a cubic centimetre of any gas at normal pressure and temperature. This number, which will throughout be denoted by the symbol N, is a fundamental constant of gases; for, according to the hypothesis of Avogadro, and also on the kinetic theory, all gases at normal pressure and temperature have an identical number of molecules in unit volume. Knowing the value of N, approximate estimates can be made of the diameter of the molecule; but in our ignorance of the constitution of the molecule, the meaning of the term diameter is somewhat indefinite. It is usually considered to refer to the diameter of the sphere of action of the forces surrounding the molecule. This diameter is not necessarily the same for the molecules of all gases, so that it is preferable to consider the magnitude of the fundamental constant N. The earliest estimates based on the kinetic theory were made by Loschmidt, Johnstone Stoney, and Maxwell. From the data then at his disposal, the latter found N to be $1 \cdot 9 \times 10^{19}$. Meyer, in his "Kinetic Theory of Gases," discusses the various methods of estimating the dimensions of molecules on the theory, and concludes that the most probable estimate of N is $6 \cdot 1 \times 10^{19}$. Estimates of N based on the kinetic theory are only approximate, and in many cases serve merely to fix an inferior or superior limit to the number of the molecules. Such estimates are, however, of considerable interest and historical importance, since for a long time they served as the most trustworthy methods of forming an idea of molecular magnitudes.

A very interesting and impressive method of determining the value of N was given by Lord Rayleigh in 1899 as a deduction from his theory of the blue colour in the cloudless sky. This theory supposes that the molecules of the air scatter the waves of light incident upon them. This scattering for particles, small compared with the wave-length of light, is proportional to the fourth power of the wave-length, so that the proportion of scattered to incident light is much greater for the violet than for the red end of the spectrum, and consequently the sky which is viewed by the scattered light is of a deep blue colour. This scattering of the light in passing through the atmosphere causes alterations of brightness of stars when viewed at different altitudes, and determinations of this loss of brightness have been made experimentally. Knowing this value, the number N of molecules in unit volume can be deduced by aid of the theory. From the data thus available, Lord Rayleigh concluded that the value of N was not less than 7×10^{18}. Lord Kelvin in 1902 re-calculated the value of N on the theory by using more recent and more accurate data, and found it to be $2 \cdot 47 \times 10^{19}$. Since in the simple theory no account is taken of the additional scattering due to fine suspended particles which are undoubtedly present in the atmosphere, this method only serves to fix an inferior limit to the value of N. It is difficult to estimate with accuracy the correction to be applied for this effect, but it will be seen that the uncorrected number deduced by Lord Kelvin is not much smaller than the most probable value $2 \cdot 77 \times 10^{19}$ given later. Assuming the correctness of the theory and data employed, this would indicate that the scattering due to suspended particles in the atmosphere is only a small portion of the total scattering due to molecules of air. This is an interesting example of how an accurate knowledge of the value of N may possibly assist in forming an estimate of unknown magnitudes.

It is now necessary to consider some of the more recent and direct methods of estimating N which are based on recent additions to our scientific knowledge. The newer methods allow us to fix the value of N with much more certainty and precision than was possible a few years ago.

We have referred earlier in the paper to the investigations of Perrin on the law of distribution in a fluid of a great number of minute granules, and his proof that the granules behave like molecules of high molecular weight. The value of N can be deduced at once from the experimental results, and is found to be $3 \cdot 14 \times 10^{19}$. The method developed by Perrin is a very novel and ingenious one, and is of great importance in throwing light on the law of equipartition of energy. This new method of attack of fundamental problems will no doubt be much further developed in the future.

It has already been shown that the value $N = 2 \cdot 56 \times 10^{19}$ has been obtained by the direct method of counting the particles and determining the corresponding volume of helium produced. Another very simple method of determining N from radio-active data is based on the rate of transformation of radium. Boltwood has shown by direct experiment that radium is half transformed in 2000 years. From this it follows that initially in a gram of radium 0·346 milligram breaks up per year. Now it is known from the counting method that $3 \cdot 4 \times 10^{10}$ α particles are expelled per second from one gram of radium, and the evidence indicates that one α particle accompanies the disintegration of each atom. Consequently the number of α particles expelled per year is a measure of the number of atoms of radium present in 0·346 milligram. From this it follows that there are $3 \cdot 1 \times 10^{21}$ atoms in one gram of radium, and taking the atomic weight of radium as 226, it is simply deduced that the value of N is $3 \cdot 1 \times 10^{19}$.

The study of the properties of ionised gases in recent years has led to the development of a number of important methods of determining the charge carried by the ion, produced in gases by α rays or the rays from radio-active substances. On modern views, electricity, like matter, is supposed to be discrete in structure, and the charge carried by the hydrogen atom set free by the electrolysis of water is taken as the fundamental unit of quantity of electricity. On this view, which is supported by strong evidence, the charge carried by the hydrogen atom is the smallest unit of electricity that can be obtained, and every quantity of electricity consists of an integral multiple of this unit. The experiments of Townsend have shown that the charge carried by a gaseous ion is, in the majority of cases, the same and equal in magnitude to the charge carried by a hydrogen atom in the electrolysis of water. From measurement of the quantity of electricity required to set free one gram of hydrogen in electrolysis, it can be deduced that $Ne = 1 \cdot 29 \times 10^{10}$ electrostatic units, where N, as before, is the number of molecules of hydrogen in one cubic centimetre of gas, and e the charge carried by each ion. If e be determined experimentally, the value of N can at once be deduced from this relation.

The first direct measurement of the charge carried by the ion was made by Townsend in 1897. When a solution of sulphuric acid is electrolysed, the liberated oxygen is found in a moist atmosphere to give rise to a dense cloud composed of minute globules of water. Each of these minute drops carries a negative charge of electricity. The size of the globules, and consequently the weight, was deduced with the aid of Stokes's formula by observing the rate of fall of the cloud under gravity. The weight of the cloud was measured, and, knowing the weight of each globule, the total number of drops present was determined. Since the total charge carried by the cloud was measured, the charge e carried by each drop was deduced. The value of e, the charge carried by each drop, was found by this method to be about $3 \cdot 0 \times 10^{-10}$ electrostatic units. The corresponding value of N is about $4 \cdot 3 \times 10^{19}$.

We have already referred to the method discovered by C. T. R. Wilson of rendering each ion visible by the condensation of water upon it by a sudden expansion of the gas. The property was utilised by Sir Joseph Thomson to measure the charge e carried by each ion. When the expansion of the gas exceeds a certain value, the water condenses on both the negative and positive ions, and a dense cloud of small water-drops is seen. J. J. Thomson found $e = 3 \cdot 4 \times 10^{-10}$, H. A. Wilson $e = 3 \cdot 1 \times 10^{-10}$, and Millikan and Begeman $4 \cdot 06 \times 10^{-10}$. The corresponding values of N are 3·8, 4·2, and $3 \cdot 2 \times 10^{19}$ respectively. This method is of great interest and importance, as it provides a method of directly counting the number of ions produced in the gas. An exact determination of e by this method is, however, unfortunately beset with great experimental difficulties.

Moreau has recently measured the charge carried by the negative ions produced in flames. The values deduced for e and N were respectively $4 \cdot 3 \times 10^{-10}$ and $3 \cdot 0 \times 10^{19}$.

We have referred earlier in the paper to the work of Ehrenhaft on the Brownian movement in air shown by ultra-microscopic dust of silver. In a recent paper (1909) he has shown that each of these particles carries a positive or negative charge. The size of each particle was measured by the ultra-microscope, and also by the rate of fall under gravity. The charge carried by each particle was deduced from the measured mass of the particle, and its rate of movement in an electric field. The mean value of e was found to be $4 \cdot 6 \times 10^{-10}$, and thus N becomes $2 \cdot 74 \times 10^{19}$.

A third important method of determination of N from radio-active data was given by Rutherford and Geiger in 1908. The charge carried by each α particle expelled from radium was measured by directly determining the total charge carried by a counted number of α particles. The value of the charge on each α particle was found to be $9 \cdot 3 \times 10^{-10}$. From consideration of the general evidence, it was concluded that each α particle carries two unit positive charges, so that the value of e becomes $4 \cdot 65 \times 10^{-10}$, and of N $2 \cdot 77 \times 10^{19}$. This method is deserving of considerable confidence, as the measurements involved are direct and capable of accuracy.

The methods of determination of e, so far explained, have depended on direct experiment. This discussion would not be complete without a reference to an important determination of e from theoretical considerations by Planck. From the theory of the distribution of energy in the spectrum of a hot body, Planck found that $e = 4 \cdot 69 \times 10^{-10}$, and $N = 2 \cdot 80 \times 10^{19}$. For reasons that we cannot enter into here, this theoretical deduction must be given great weight.

When we consider the great diversity of the theories and methods which have been utilised to determine the values of the atomic constants e and N, and the probable experimental errors, the agreement among the numbers is remarkably close. This is especially the case in considering the more recent measurements by very different methods, which are far more trustworthy than the older estimates. It is difficult to fix on one determination as more deserving of confidence than another; but I may be pardoned if I place some reliance on the radio-active method previously discussed, which depends on the charge carried by the α particle. The value obtained in this way is not only in close agreement with the theoretical estimate of Planck, but is in fair agreement with the recent determinations by several other distinct methods. We may consequently conclude that the number of molecules in a cubic centimetre of any gas at standard pressure and temperature is about $2 \cdot 77 \times 10^{19}$, and that the value of the fundamental unit of quantity of electricity is about $4 \cdot 65 \times 10^{-10}$ electrostatic units. From these data it is a simple matter to deduce the mass of any atom the atomic weight of which is known, and to determine the values of a number of related atomic and molecular magnitudes.

There is now no reason to view the values of these fundamental constants with scepticism, but they may be employed with confidence in calculations to advance still further our knowledge of the constitution of atoms and molecules. There will no doubt be a great number of investigations in the future to fix the values of these important constants with the greatest possible precision; but there is every reason to believe that the values are already known with reasonable certainty, and with a degree of accuracy far greater than it was possible to attain a few years ago. The remarkable agreement in the values of e and N, based on so many different theories, of itself affords exceedingly strong evidence of the correctness of the atomic theory of matter and of electricity, for it is difficult to believe that such concordance would show itself if the atoms and their charges had no real existence.

There has been a tendency in some quarters to suppose that the development of physics in recent years has cast doubt on the validity of the atomic theory of matter. This view is quite erroneous, for it will be clear from the evidence already discussed that the recent discoveries have not only greatly strengthened the evidence in support of the theory, but have given an almost direct and convincing proof of its correctness. The chemical atom as a definite unit in the subdivision of matter is now fixed in an impregnable position in science. Leaving out of account considerations of etymology, the atom in chemistry has long been considered to refer only to the smallest unit of matter that enters into ordinary chemical combination. There is no assumption made that the atom itself is indestructible and eternal, or that methods may not ultimately be found for its subdivision into still more elementary units. The advent of the electron has shown that the atom is not the unit of smallest mass of which we have cognisance, while the study of radio-active bodies has shown that the atoms of a few elements of high atomic weight are not permanently stable, but break up spontaneously with the appearance of new types of matter. These advances in knowledge do not in any way invalidate the position of the chemical atom, but rather indicate its great importance as a subdivision of matter the properties of which should be exhaustively studied.

The proof of the existence of corpuscles or electrons with an apparent mass very small compared with that of the hydrogen atom marks an important stage in the extension of our ideas of atomic constitution. This discovery, which has exercised a profound influence on the development of modern physics, we owe mainly to the genius of the President of this Association. The existence of the electron as a distinct entity is established by similar methods and with almost the same certainty as the existence of individual α particles. While it has not yet been found possible to detect a single electron by its electrical or optical effect, and thus to count the number directly as in the case of the α particles, there seems to be no reason why this should not be accomplished by the electric method. The effect to be anticipated for a single β particle is much smaller than that due to an α particle, but not too small for measurement. In this connection it is of interest to note that Regener has observed evidence of scintillations produced by the β particles of radium falling on a screen of platinocyanide of barium, but the scintillations are too feeble to count with certainty.

Experiment has shown that the apparent mass of the electron varies with its speed, and, by comparison of theory with experiment, it has been concluded that the mass of the electron is entirely electrical in origin, and that there is no necessity to assume a material nucleus on which the electrical charge is distributed. While there can be no doubt that electrons can be released from the atom or molecule by a variety of agencies, and, when in rapid motion, can retain an independent existence, there is still much room for discussion as to the actual constitution of electrons, if such a term may be employed, and of the part they play in atomic structure. There can be little doubt that the atom is a complex system, consisting of a number of positively and negatively charged masses which are held in equilibrium mainly by electrical forces; but it is difficult to assign the relative importance of the *rôle* played by the carriers of positive and negative electricity. While negative electricity can exist as a separate entity in the electron, there is yet no decisive proof of the existence of a corresponding positive electron. It is not known how much of the mass of an atom is due to electrons or other moving charges, or whether a type of mass quite distinct from electrical mass exists. Advance in this direction must be delayed until a clearer knowledge is gained of the character and structure of positive electricity and of its relation to the negative electron.

The general experimental evidence indicates that electrons play two distinct *rôles* in the structure of the atom, one as lightly attached and easily removable satellites or outliers of the atomic system, and the other as integral constituents of the interior structure of the atom. The former, which can be easily detached or set in vibration, probably play an important part in the combination of atoms to form molecules, and in the spectra of the elements; the latter, which are held in place by much stronger forces, can only be released as a result of an atomic explosion involving the disintegration of the atom. For example, the release of an electron with slow velocity by ordinary laboratory agencies does not appear to endanger the stability of the atom, but the expulsion of a high-speed electron from a radio-active substance accompanies the transformation of the atom.

The idea that the atoms of the elements may be complex structures, made up either of lighter atoms or of the atoms of some fundamental substance, has long been familiar to science. So far no direct evidence has been obtained of the possibility of building up an atom of higher atomic weight from one of lower atomic weight, but in the case of the radio-active substances we have decisive and definite evidence that certain elements show the converse process of disintegration. It may be significant that this process has only been observed in the atoms of highest atomic weights, like those of uranium, thorium, and radium. With the exception possibly of potassium, there is no trustworthy evidence that a similar process takes place in other elements. The transformation of the atom of a radio-active substance appears to result from an atomic explosion of great intensity in which a part of the atom is expelled with great speed. In the majority of cases an α particle or atom of helium is ejected, in some cases a high-speed electron, while a few substances are transformed without the appearance of a detectable radiation. The fact that the α particles from a simple substance are all ejected with an identical and very high velocity suggests the probability that the charged helium atom before its expulsion is in rapid orbital movement in the atom. There is at present no definite evidence of the causes operative in these atomic transformations.

Since in a large number of cases the transformations of the atoms are accompanied by the expulsion of one or more charged atoms of helium, it is difficult to avoid the conclusion that the atoms of the radio-active elements are built up, in part at least, of helium atoms. It is certainly very remarkable, and may prove of great significance, that helium, which is regarded from the ordinary chemical standpoint as an inert element, plays such an important part in the constitution of the atoms of uranium, thorium, and radium.

The study of radio-activity has not only thrown great light on the character of atomic transformations, but it has also led to the development of methods for detecting the presence of almost infinitesimal quantities of radioactive matter. It has already been pointed out that two methods—one electrical, the other optical—have been devised for the detection of a single α particle. By the use of the optical or scintillation method, it is possible to count with accuracy the number of α particles when only one is expelled per minute. It is not a difficult matter, consequently, to follow the transformation of any radio-active substance in which only one atom breaks up per minute, provided that an α particle accompanies the transformation. In the case of a rapidly changing substance like the actinium emanation, which has a half period of 3·7 seconds, it is possible to detect with certainty the presence, if not of a single atom, at any rate of a few atoms, while the presence of a hundred atoms would in some cases give an inconveniently large effect. The counting of the scintillations affords an exceedingly powerful and direct quantitative method of studying the properties of radio-active substances which expel α particles. Not only is it a simple matter to count the number of α particles which are expelled in any given interval, but it is possible, for example, by suitably arranged experiments to decide whether one, two, or more α particles are expelled at the disintegration of a single atom.

The possibility of detection of a single atom of matter has opened up a new field of investigation in the study of discontinuous phenomena. For example, the experimental law of transformation of radio-active matter expresses only the average rate of transformation, but by the aid of the scintillation or electric method it is possible to determine directly by experiment the actual interval between the disintegration of successive atoms and the probability law of distribution of the α particles about the average value.

Quite apart from the importance of studying radio-active changes, the radiations from active bodies provide very valuable information as to the effects produced by high-velocity particles in traversing matter. The three types of radiation, the α, β, and γ rays, emitted from active bodies, differ widely in character and their power of penetration of matter. The α particles, for example, are completely stopped by a sheet of notepaper, while the γ rays from radium can be easily detected after traversing twenty centimetres of lead. The differences in the character of the absorption of the radiations are no doubt partly due to the difference in type of the radiation and partly due to the differences of velocity.

The character of the effects produced by the α and β particles is most simply studied in gases. The α particle has such great energy of motion that it plunges through the molecules of the gas in its path, and leaves in its train more than a hundred thousand ionised or dissociated molecules. After traversing a certain distance, the α particle suddenly loses its characteristic properties and vanishes from the ken of our observational methods. It no doubt quickly loses its high velocity, and after its charge has been neutralised becomes a wandering atom of helium. The ionisation produced by the α particle appears to consist of the liberation of one or more slow-velocity electrons from the molecule, but in the case of complex gases there is no doubt that the act of ionisation is accompanied by a chemical dissociation of the molecule itself, although it is difficult to decide whether this dissociation is a primary or secondary effect. The chemical dissociation produced by α particles opens up a wide field of investigation, on which, so far, only a beginning has been made.

The β particle differs from the α particle in its much greater power of penetration of matter, and the very small number of molecules it ionises compared with the α particle traversing the same path in the gas. It is very easily deflected from its path by encounters with the gas molecules, and there is strong evidence that, unlike the α particle, the β particle can be stopped or entrapped by a molecule when travelling at a very high speed.

When the great energy of motion of the α particle and the small amount of energy absorbed in ionising a single molecule are taken into consideration, there appears to be no doubt that the α particle, as Bragg pointed out, actually passes through the atom, or rather the sphere of action of the atom which lies in its path. There is, so to speak, no time for the atom to get out of the way of the swiftly moving α particle, but the latter must pass through the atomic system. On this view, the old dictum, no doubt true in most cases, that two bodies cannot occupy the same space, no longer holds for atoms of matter if moving at a sufficiently high speed.

There would appear to be little doubt that a careful study of the effects produced by the α or β particle in passing through matter will ultimately throw much further light on the constitution of the atom itself. Work already done shows that the character of the absorption of the radiations is intimately connected with the atomic weights of the elements and their position in the periodic table. One of the most striking effects of the passage of β rays through matter is the scattering of the β particles, *i.e.* the deflection from their rectilinear path by their encounters with the molecules. It was for some time thought that such a scattering could not be expected to occur in the case of the α particles in consequence of their much greater mass and energy of motion. The recent experiments of Geiger, however, show that the scattering of the α particles is very marked, and is so great that a small fraction of the α particles, which impinge on a screen of metal, have their velocity reversed in direction and emerge again on the same side. This scattering can be most conveniently studied by the method of scintillations. It can be shown that the deflection of the α particle from its path is quite perceptible after passing through very few atoms of matter. The conclusion is unavoidable that the atom is the seat of an intense electric field, for otherwise it would be impossible to change the direction of the particle in passing over such a minute distance as the diameter of a molecule.

In conclusion, I should like to emphasise the simplicity and directness of the methods of attack on atomic problems opened up by recent discoveries. As we have seen, not only is it a simple matter, for example, to count the number of α particles by the scintillations produced on a zinc sulphide screen, but it is possible to examine directly the deflection of an individual particle in passing through a magnetic or electric field, and to determine the deviation of each particle from a rectilinear path due to encounters with molecules of matter. We can determine directly the mass of each α particle, its charge, and its velocity, and can deduce at once the number of atoms present in a given weight of any known kind of matter. In the light of these and similar direct deductions, based on a minimum amount of assumption, the physicists have, I think, some justification for their faith that they are building on the solid rock of fact, and not, as we are often so solemnly warned by some of our scientific brethren, on the shifting sands of imaginative hypothesis.

NOTES.

A MEETING of the permanent commission of the International Association of Seismology will be held at Zermatt on August 30, under the chairmanship of Prof. Arthur Schuster, F.R.S. At this meeting reports will be presented from a number of committees, appointed at the last general meeting, which took place at The Hague in 1907, and questions of organisation will be discussed. Papers will be read by Mr. H. F. Reid, on some lessons of the Californian earthquake and a method of foretelling certain earthquakes; by Mr. Albert Heim, on the objects of earthquake investigations; and by Prof. Palazzo, on a projected seismic triangulation by means of wireless telegraphy. The Central Government of the Confederation has charged the Swiss Naturforschende Gesellschaft with the organisation of the meeting, and arrangements have been made for the accommodation of the delegates taking part in the conference, who will also be able to travel on the railway between Visp and the Gorner Grat at half fares.

ON Tuesday next, August 31, at the ordinary fortnightly meeting of the Royal Horticultural Society, Vincent Square, S.W., there will be exhibited on behalf of Prof. Sargent and the president and fellows of Harvard University, Cambridge, Mass., U.S.A., a selection of photographs illustrating the flora, fauna, and scenery of central and western China. These photographs are from the large collection taken by Mr. E. H. Wilson during his last (third) journey to China. The exhibit will be of importance to all who are interested in the recent new plant introductions from China; it is also hoped that from its varied character the selection made will appeal to a wider circle. The photographs are whole-plate size ($8\frac{1}{2} \times 6\frac{1}{2}$ inches), with liberal mounts for herbarium purposes, and all are labelled. The work of developing and printing has been done by the well-known worker in floral photography, Mr. E. J. Wallis, of Kew.

THE preliminary mineralogical and geological survey of Northern Nigeria, carried out under the auspices of the Colonial Office and the Imperial Institute, has just been completed by Dr. J. D. Falconer after five seasons' work. Valuable deposits of tinstone have been located within the Protectorate, as well as less important occurrences of gold, argentiferous galena, monazite, and numerous ores of iron. The economic results of the survey are being issued as colonial reports by Prof. Dunstan, while the scientific results will be published by Dr. Falconer in the course of the coming winter. Important observations have been made as to the age and origin of Lake Chad and the Bauchi plateau, while sufficient data have been secured for the compilation of a geological map of the Protectorate which will largely fill up the existing blank in our knowledge of the structure of this portion of the Central Sudan.

MR. ASQUITH announced in the House of Commons on August 19 that the Government has decided to recommend Parliament to make a grant of 20,000*l.* in aid of the expenses of Mr. Shackleton's expedition in Antarctic regions. Mr. Shackleton has informed a Press representative that this sum will meet all his guarantees. The total cost of the expedition is said to have been nearly 45,000*l.* Of this amount, 6000*l.* was subscribed in Australia and New Zealand, and the rest was provided by Mr. Shackleton's friends. In a letter communicating the decision of the Government to Mr. Shackleton, the Prime Minister said:—"The Government have been induced to take this course as they are much impressed both by the great value of the discoveries made in the course of your voyage and by the efficient and economical manner in which the whole of the enterprise was conducted, as is shown by the fortunate return of your entire party, and by the comparatively small total outlay incurred."

WE learn from *Science* of the death, in his eighty-third year, of Dr. R. E. C. Stearns, known for his work on the geographical distribution and variation of mollusca and for other work in natural science.

THE death is announced, in his sixty-seventh year, of Dr. Otto von Bollinger, rector of the University of Munich and professor of general pathology and pathological anatomy in the University. Prof. von Bollinger was the author of a number of medical works, among them being books on meat poisoning and on the heredity of diseases, and the "Atlas und Grundriss der pathologischen Anatomie," which appeared in 1896.

The daily papers announce that the Select Committee on the Daylight Saving Bill has adopted a report approving the principle of the proposals made, but adverse to legislation which would make the seasonal change of time obligatory. The committee has arrived at the conclusion that the principle, if applied compulsorily, would tend to cause serious dislocations in certain industries, such as agriculture and railways, where an alteration in the hours of labour would cause great confusion. The hope is expressed, however, that the principle of daylight saving will be adopted voluntarily in cases where it is found to be practicable and desirable.

The Berlin correspondent of the *Times* reports that the fifth International Dental Congress opened its proceedings there on Monday, August 23, under the presidency of Prof. O. Walkhoff, of Munich. In his opening address Prof. Walkhoff referred to the increasing recognition of the public importance of dental surgery, which no longer holds a subordinate place in the field of science. Prof. Waldeyer, director of the anatomical institute of the University of Berlin, referred to the important problems which dental surgery embraces in anatomy, physiology, pathology, and palæontology.

An "American colony" of a very interesting character has recently been installed near Guildford, in Surrey, where an attempt is being made to acclimatise the American robin (*Merula migratoria*) in England. Seventeen birds—nine cocks and eight hens—were imported last spring, and after being kept for a short time in a large open-air aviary, all, with the exception of two or three pairs, were liberated about the middle of June. They mated immediately, and began nest-building almost at once. The nests—coarse, bulky constructions—were placed in trees, with little attempt at concealment, and clutches of from four to five blue eggs, about the size of those of the thrush, were laid. Old and young, the birds now number between forty and fifty. Fears are entertained that at the approach of winter these robins, impelled by their strong migratory instinct, will leave England and become hopelessly dispersed; but those who know the nature of the birds are confident that by feeding them abundantly as cold weather draws on they can be induced to remain as permanent residents. They are cheery birds, their "Kill 'em, cure 'em, give 'em physic" being the climax of optimism.

It is matter of just reproach against our statesmen and administrators that, in devising and carrying out measures intended for the amelioration of social conditions, they are very commonly blind to the teachings of science. This point is well brought out in a striking article by Mr. E. B. Iwan-Müller in the August number of the *Fortnightly Review*. In the course of his article, which is entitled "The Cult of the Unfit," the writer argues with great effect that, judged by the standard of biological principles, much recent legislation must be condemned as ill-adapted for its purpose and likely to be harmful in its results. Socialism, he maintains, and any legislation tending in that direction, runs directly counter to all the lessons that can be derived from the contemplation of evolution by struggle and survival. "The new Trades Unionism aims at the establishment and endowment of mediocrity by the elimination of competition." The facts of parasitism and other causes of degeneration are dwelt upon, and stress is laid on the warning they convey against the policy of making the conditions of life too easy—a warning still needed, though not now delivered for the first time. Apposite quotations are given from Sir E. Ray Lankester's Romanes lecture at Oxford. While opinions may differ as to Mr. Iwan-Müller's applications, there can be no doubt that his plea for a recognition of scientific principle on the part of our public men is both reasonable and necessary.

The Pasteur Institute of Paris will receive in a few days the sum of 1,200,000*l.* which was bequeathed to it by the late M. Osiris. The Paris correspondent of the *Daily News* describes the following interesting circumstances relating to this generous gift. M. Osiris founded in 1903 a triennial prize of 4000*l.* to be bestowed on "the person who had rendered the greatest service to the human race during the three preceding years." The prize was awarded to Dr. Roux, the head of the Pasteur Institute, for the discovery of the anti-diphtheria serum, which has been the means of saving the lives of many thousand children, and the whole of the money was made over by him to the institute. M. Osiris was struck by the unselfish conduct of the man of science, and asked him one day why he had given the money to the institute. "All that I am," replied Dr. Roux, "I owe to the Pasteur Institute, for all my experiments and discoveries have been made there. Besides, the institute is very poor, for we have no income except what we make by the sale of serum, and though that brings in enough to keep the establishment going, some fresh remedy may any day be discovered, in which case I fear the institute would have to close its doors for want of funds." M. Osiris said nothing at the time, adds the *Daily News* correspondent; but at his death, which occurred a year or two afterwards, it was found that he had left the bulk of his wealth to the Pasteur Institute as a token of admiration for the scientific attainments and self-abnegation of Dr. Roux.

No. 4 of vol. i. of the ornithological publications of the Field Museum of Natural History is devoted to a catalogue of birds from British East Africa, by Mr. N. Dearborn.

In vol. vi., No. 4, of the University of Colorado Studies Prof. T. D. H. Cockerell describes and figures a skull of a ground-sloth from Colorado provisionally referred to the genus Mylodon. It differs from Paramylodon, of the Nebraskan Pliocene, by having the normal five in place of four pairs of upper cheek-teeth.

We have to acknowledge the receipt of vols. xxx. (1907) and xxxi. (1908) of *Mémoires de la Société des Naturalistes de la Nouvelle-Russie*, Odessa. In the former, Dr. A. Brauner points out that while naturalists regard the green-headed starling of Western Europe as the true *Sturnus vulgaris* of Linnæus, and class the purple-headed bird as distinct, under the name of *S. intermedius*, the latter, as occurring in Sweden, should properly be called *S. vulgaris*. Hence the English starling requires another designation.

The articles in the July number of the *National Geographic Magazine* are mostly devoted to Alaska and its products, General Greely opening the subject with an account of the economic evolution of Alaska, while Mr. T. Riggs follows with the story of marking the Alaskan boundary, and Messrs. R. H. Sargent and W. H. Osgood respectively discuss the mountains and the big game of the country. In the last of the articles referred to special attention is directed to the uncertainty still existing with regard to the number of forms of Alaskan brown bears.

We have received the monthly journals of the Meteorological Society of Japan for the first half of this year. These contain notices of recent conspicuous meteorological occurrences, and articles on climatological and other interesting subjects, among which is a discussion of the winds on the east coast of Asia, by Mr. M. Ishida, which runs through several numbers. The practice of summarising the more important articles in a European language has been discontinued; this considerably lessens the usefulness of the journals, so far as western readers are concerned.

IN the July number of the *Museums Journal*, Dr. E. Howarth records his resignation of the editorship, a position he has filled for the last eight years. When that periodical was started in 1901, early failure was predicted; but the prediction has proved altogether untrue, and the *Museums Journal* is now established on a firm, and, it is hoped, lasting base. The issue also contains Mr. Henry Balfour's presidential address, delivered at the Maidstone meeting on July 13th, in which the need for a national museum of British ethnology is strongly advocated. "What is required is a National Folk-Museum, dealing exclusively and exhaustively with the history of culture of the British nation within the historic period, and illustrating the growth of ideas and indigenous characteristics. Until such an institution is founded, there will remain a very serious *lacuna* in the list of our museums, and we shall remain open to the fire of just criticism from other countries, on the score of our almost pathetic anxiety to investigate and illustrate the ethnology of other races and peoples, while we neglect our own."

ZOOLOGICAL students are much indebted to Prof. Spengel for the publication of that very useful and interesting journal, the *Ergebnisse und Fortschritte der Zoologie*, the second part of the second volume of which has just reached us. This part contains two important memoirs of general interest. The first is a very complete and valuable *résumé* of our present knowledge of sponge spicules, by Prof. E. A. Minchin. The spicules of sponges are amongst the most beautiful and at the same time the most incomprehensible objects with which the microscopist has to deal, and a considerable amount of light has lately been thrown upon their nature and origin. Prof. Minchin himself is one of the foremost investigators in this department, which modern methods of research have raised to the level of a branch of cytology. The subject, indeed, is one which of recent years has attracted much attention, and given rise to no little controversy amongst spongologists, and specialists and non-specialists alike will be interested in Prof. Minchin's essay. The second paper in the same journal deals with the excretory organs of invertebrates, our knowledge of which has also progressed by leaps and bounds during the last few years. The author, Prof. Meisenheimer, confines himself for the present to protonephridia and typical segmental organs, drawing largely for his information upon the classical and pioneer work of Mr. Goodrich, especially with regard to solenocytes.

THE July number of the Transactions of the Royal Scottish Arboricultural Society contains a large quantity of information useful to forest owners as well as to foresters. Articles from many able pens deal with afforestation, and we need only mention the names of Lord Lovat, Mr. Munro Ferguson, Dr. Nisbet, Profs. Somerville and Schlich. The report of the Royal Commission on Afforestation from a landowner's point of view, by Sir John Stirling Maxwell, contains many useful hints. A report is given of a lecture on trees of California, by Mr. F. R. S. Balfour, delivered to the society, as well as a report of an excursion to Forglen and Hatton, made by the Aberdeen Branch of the society. The volume also contains interesting notes and queries, reviews and notices of books, and altogether it is full of information likely to be of interest to foresters. The price of the volume is 3*s*.

THE first portion of an account dealing with mitosis in higher plants, communicated by Dr. H. A. Haig, is published in the August number of *Knowledge and Scientific News*. A full description is given of methods and materials examined, so that readers, if disposed, may make their own preparations. The first chapters deal with technique and the early stages of division in the cells found near the root-apices of Hyacinthus and Allium.

THE botanists in the Philippine Islands are vigorously prosecuting their identifications of indigenous plants, in pursuance of which Dr. C. B. Robinson publishes in the first part a revision of Philippine Phyllanthineæ and Mr. E. D. Merrill contributes revisions of the families Connaraceæ and Loranthaceæ to the second part of the botanical section of the *Philippine Journal of Science* (vol. iv.). Dr. Robinson accepts the separation from Phyllanthus of Glochidion, which becomes a large genus by reason of several species established by Mr. Elmer and the author. Six genera are recognised by Mr. Merrill for the Loranthaceæ, including the segregation of Phrygilanthus and a new genus, Cleistoloranthus. The number of endemic species is inordinately great, as out of forty-three species of Loranthus—the only large genus—no fewer than thirty-six are endemic.

DR. M. RACIBORSKI contributes to the *Bulletin international de l'Académie des Sciences de Cracovie* (March) a long series of descriptions of parasitic and epiphytic fungi collected and examined in Java. A peculiar formation of the basidium was observed in Cintractia, as it is abstricted directly from the resting spore, and is at once shed; three or more septa are formed in the basidium, and each cell gives rise to a basidiospore. The group of Septobasidieæ furnishes some of the commonest epiphytes. The Javanese species are separated by the author into three genera; Ordonia is characterised by a fibrous mycelium and absence of a special hymenial layer; Mohortia has a sterile layer below the hymenium, while Septobasidium develops three distinct layers. Several of the new species fall into the families Microthyriaceæ and Sphæriaceæ.

THERE are several noteworthy points in the revision of the American group of Thibaudieæ, a section of the family Ericaceæ communicated by Mr. R. Hörold to Engler's *Botanische Jahrbücher* (vol. xlii., part iv.). It provides an independent account of a section which was required to correlate the diverse views of Hooker and Klotzch. In this respect the author follows the latter in splitting the large genus Thibaudia. The classification of the genera based on staminal characters furnishes an interesting study in the variation of this organ, which is a special characteristic of the family; modifications of apical dehiscence are indicated in a text-figure. A list of new plants includes one genus and many additions to the genera Cavendishia, Psammisia, and Thibaudia. In addition, the author sketches the main features in the geographical distribution of the genera.

WE are in receipt of several important bulletins from the Wisconsin Agricultural Experiment Station dealing with subjects of considerable agricultural interest. Messrs. Whitson and Stoddart discuss the importance of phosphates in fertility, and show that the tendency of the local system of farming has been to deplete the stock of phosphates in the soil. Some of the soils are acid, and it is pointed out that acidity and lack of available phosphates usually go hand in hand. In such cases naturally occurring calcium phosphate gives excellent crop returns, and does not require the preliminary treatment with sulphuric acid usually given; fortunately, large deposits of rock phosphate occur in Florida, and can be purchased by farmers at low prices. Two bulletins by Messrs. Russell and Hoffmann deal with bovine tuberculosis. This disease has appeared in Wisconsin, and has spread, especially in the southern parts of the State, where more than 43 per cent. of the herds are infected. The most common mode of herd infection is through the purchase of infected animals, and State regulation is strongly recommended. In another bulletin Mr. Sandsten gives the results of experiments, which are said to have been entirely satisfactory, on the improvement of Wisconsin tobacco through seed selection. The "King" system of ventilating barns and cow-sheds is described in Bulletin No. 164. Its essential feature is that fresh air is introduced by means of flues running in the walls from the bottom to the top of the barn, and thus enters the building from *above*, whilst the foul air is withdrawn by flues running from the bottom to the top of the building, and terminating outside in a ventilator. This inversion of the ordinary system is said to work well, without draught and without great loss of temperature.

Mr. E. Philippi, of Jena, justly observes that the stratified structure of rocks is one of the phenomena that remain inadequately explained on account of their very familiarity. In a paper, "Über das Problem der Schichtung und über Schichtbildung am Boden der heutigen Meere" (*Zeitsch. deutsch. geol. Gesell.*, Bd. 60, 1908, p. 346), he summarises what is already known as to the bedding of sediments in waters at some distance from a coast, and urges that the German South Polar Expedition has shown stratification to be the rule and not the exception in such materials. Globigerina ooze, for example, seems regularly to contain more terrigenous matter, and to be poorer in calcium carbonate, 30 cm. or so below its surface, and Philippi attributes this to the former greater extension of the antarctic ice, with consequent production of drift. Climatic changes are probably the normal causes of stratified structure in deep-sea deposits. Deep-sea sands are ascribed to the weathering of submarine slopes and of ridges formed of solid rock, some of which may only recently have been forced towards sea-level. As new earth-ridges rise in submarine areas, new material from them gathers in the concomitant geosynclinals. Regular changes in the character of strata may thus indicate a periodicity in crust-movement in the past.

The *Philippine Journal of Science* for December last is given up to an elaborate somatological study of the Benguet Igorots, a tribe occupying the Benguet and Lepanto-Bontoc provinces of Luzon, by Mr. R. B. Dean, of the Anatomical Laboratory, Manila. The result is that the writer is able to distinguish four groups:—Tall dolichocephalic types with long arms; small dolichocephalic with short arms; mixed mesocephalic; and brachycephalic with intermediate arm form. One example, of which an illustration is given, is of a type curiously European in appearance. The race, it is clear, has been subjected to repeated modification by the introduction of new varieties. The original type seems to have been small and dolichocephalic, with relatively short arms, conjoined with a brachycephalic element, which became mingled with the former and partially fused. Upon these people intruded a tall, dolichocephalic, long-armed race; and the process of fusion was continued uninterruptedly up to quite recent times. At present the brachycephalic race is more distinct as a type than either the tall or small dolichocephalic people, and they are also present in larger numbers. The memoir, which is fully illustrated and provided with full statistical apparatus, supplies a singularly interesting example of race fusion, and may be expected to throw much light on the ethnological history of the Philippine Islands and the cognate races of that region.

In the August number of *Man* Mr. W. G. Smith discusses the character of the eoliths said to have been found in association with remains of *Elephas meridionalis* in undisturbed beds at Dewlish in Dorsetshire. This discovery has been assumed by Dr. C. A. Windle and others to prove the existence of man in the Pliocene period. Mr. Smith shows that the evidence of the association of these eoliths with remains of the Pliocene period is more than doubtful. He has examined the remains found at Dewlish by the Rev. Osmund Fisher, and finds that one of them is an undoubted sponge of the Cephalitis order, while none of the others, in his opinion, exhibit the faintest trace of human work. The case of the flints found in the same locality by Dr. Blackmore in 1814 is similar; and an iron stain on one example suggests that it was a surface find. He sums up the question as follows:—"If bulbed flakes of undoubted human origin have been found at Dewlish (none were sent to me) with *Elephas meridionalis*, this cannot prove that the elephant and the stones are Pliocene in age; it only suggests that the elephant had survived into Palæolithic times, for the sufficient reason that Dewlish is an old and well-known locality for Palæolithic implements. It is mentioned in Evans's 'Stone Implements,' ed. i., 1872, p. 559, and ed. ii., 1897, p. 638. I have not written this and former notes on 'eoliths' in an attempt to show that a Pliocene ape-man probably never existed. It is, to me, possible that such an animal did live somewhere in pre-Glacial and Pliocene times. When the evidence—geological, osteological, and archæological—is conclusive, I shall be one of the first to accept it."

It has been shown experimentally that the incidence of β or γ rays from a radio-active substance on a dielectric increases its conductivity, and Dr. H. Greinacher, of the University of Zürich, describes, in the July number of *Le Radium*, his endeavours to detect a corresponding effect in the case of the α rays. The rays were derived from a layer of polonium, and fell on the dielectric of a condenser placed in series with an electrometer and a battery of storage cells. Although at first a considerable increase of the conductivity of the dielectric appeared to be produced when the radiation fell on it, Dr. Greinacher finally traced the effect to the improved contact between the dielectric and the electrodes of the condenser, and found no effect of the radiation on the conductivity. This he attributes to the closeness of the ions together in a solid, and the rapid re-combination of them which in consequence ensues.

The best method of determining an electrical resistance in absolute measure has hitherto been that of Lorenz, but in the Bulletin of the Bureau of Standards for May, Mr. E. B. Rosa proposes to substitute for it a method which depends on the revolution of a coil in the magnetic field due to an electric current in another fixed coil. The fixed coil consists of two portions set a little further apart than in the Helmholtz galvanometer. The revolving coil consists also of two parts wound in planes at right angles to each other. The balancing is done by means of a differential galvanometer provided with three coils. Of these, two are each in series with a part of the revolving coil, and the third is connected to the ends of the resistance to be measured, which is in series with the fixed coil. By means of this apparatus Mr. Rosa hopes to obtain an accuracy ten times that which has been obtained with the Lorenz apparatus.

We note from an article on machine-tool practice in the *Engineering Magazine* for July an interesting example of the standardisation of lathe and planer tools on a large scale. A central tool-dressing plant has been established recently at the Philadelphia Navy Yard, which supplies high-speed lathe and planer tools to all navy yards on the Atlantic coast. These tools are forged, treated, and ground to standards. Each of the various yards is equipped for re-grinding the tools until they require re-dressing, when they are returned to the central tool-dressing plant at Philadelphia for replacement by newly dressed tools. The advantages of this system are that all yards are equipped with tools of standard shapes and of uniformly high quality, and as the forging, dressing, and grinding of tools are done in large lots, substantial reductions in cost result.

The necessity for keeping records of the steam consumption in the various prime-movers in use in large factories and generating stations has given a stimulus to the development of means of measuring and recording automatically the flow of water. In the Lea water-recorder, illustrated in *Engineering* for August 13, advantage is taken of the accuracy of the Thompson V-notch, the magnitude of the angle of the notch being selected to suit the flow. The recording arrangement consists essentially of a float having a vertical rod attached to it; a rack on this rod gears with a pinion fixed to the spindle of a horizontal drum. The angle of rotation of this drum will therefore be proportional to the head of water over the notch. A spiral wire coil or screw thread is wound round the drum, and has a contour similar to the curve of flow for the notch, this curve being plotted with head for abscissæ and gallons or pounds per hour for ordinates. A bar capable of sliding parallel to the axis of the drum is actuated by the spiral on the drum, and has an arm carrying the recording pencil. The movement horizontally of the pencil will therefore be a measure of the quantity of water flowing per hour. The record is made on a chart wrapped round a drum which is clock-driven; hence the total flow in a given time is easily ascertained by means of a planimeter. The makers are the Lea Recorder Company, 28 Deansgate, Manchester.

The tenth edition of Messrs. Townson and Mercer's catalogue of scientific apparatus for physical laboratories should prove of service to science masters and others. The volume runs to 413 large pages, and contains well-illustrated information of a great variety of instruments designed to be of assistance in giving instruction in all branches of physics. Some parts of the catalogue, with their full descriptions and well-executed drawings of important pieces of apparatus, partake of the character of a practical text-book of physics. Teachers in charge of physical laboratories should see that a copy of the catalogue is added to their works of reference.

We have received from the Geographical Model Works, Middlesbrough, a photograph of a hypsometrical model of the district of Ingleborough, near Settle, by Mr. J. Foster Stackhouse. The model is said to be correct within 2 feet of the actual district dimension at every part. The area covered is 42 square miles, and the horizontal scale 6 inches to a mile. Vertically, the measurements are one-sixteenth of an inch to every 25 feet. The model is built up of a series of ninety-four layers of cardboard, and between 500 and 600 pieces were used in its formation. The weight of the model in its complete state is above a hundredweight and a half. Accurate full-size copies of the model are now available, and particulars concerning them may be obtained on application to the offices of the Geographical Model Works at Emerson Chambers, Blackett Street, Newcastle-on-Tyne.

OUR ASTRONOMICAL COLUMN.

Comet 1909*b* (Perrine's, 1896 vii.).—The re-discovery of Perrine's, 1896 vii., comet by Herr Kopff is confirmed by a notice in No. 4347 of the *Astronomische Nachrichten*, where it is stated that perihelion passage should occur about October 31·35 (Berlin M.T.). This comet, according to Herr Ristenpart, passed through perihelion for the first time since its discovery in 1896, in April, 1903, but, owing to its small angular distance from the sun, was not found at that return. According to an ephemeris given by Prof. Kobold in No. 4348 of the *Astronomische Nachrichten* (p. 62, August 18), the position of the comet on August 26 will be α=oh. 49·3m., $\delta=+42^\circ\ 35'$, and it is travelling in a direction parallel to, and slightly north of, the line joining ν and 51 Andromedæ; since its discovery on August 12 the magnitude has increased 0·5. A photograph of this object was obtained at Greenwich on August 14.

The Recent Perseid Shower.—Further observations of the recent display of Perseids are published in the *Yorkshire Weekly Post* for August 21 by Mr. J. H. Elgie, of Leeds. A number of bright meteors was seen by him, between 11 p.m. and midnight, on August 11, and he gives the positions of the limits of their tracks. The brightest object seen appeared at 11.30, and, increasing in brightness, travelled from 210°, +35° to 222·5°, +10°. A number of the meteors observed appeared to radiate from a small group of stars which includes β and ξ Draconis. A party of four observers at Sandfield, Moor Allerton, saw 105 meteors between 11h. and 11h. 45m. p.m. on August 11, and one of the party, Mr. J. C. Jefferson, considers it the finest display he has seen since 1866. Another observer, Mr. E. Hawks, of Leeds, recorded 175 meteors between 9 p.m. on August 11 and dawn on August 12.

The Spectroscopic Binary β Orionis.—The radial velocity of Rigel was first determined at Potsdam in the years 1888–91, and variability was suspected, but the measures were not sufficiently definite to confirm the suspicion. Similarly, Frost and Adams obtained a range of about 8·5 km., and Campbell and Curtis suspected one of 10 km., but in neither case were the results considered sufficiently definite to affirm the variability of the velocity. Results now published, by Mr. J. Plaskett, in No. 1, vol. xxx., of the *Astrophysical Journal* (July, p. 26), show, however, from 275 plates taken on fifty-five nights in 1908–9, that the star is probably a binary, with a period of velocity-variation of about 21·90 days. There is, further, a variation of amplitude which suggests the interference of a third body, and may account for the difficulties encountered by the previous observers, but more evidence must be obtained before this can be considered certain.

The elements now published give the eccentricity as 0·296±0·059, the range of velocity as +26·09 km. to +18·55 km., the velocity of the system as +22·616±0·158 km., and the length of the semi-major axis of the orbit as 1,108,900 km. These results are based on the measures of the three lines Mg λ 4481, He λ 4472, and Hγ λ 4341.

Ephemeris for Comet 1909*a* (Borrelly-Daniel).—An ephemeris for comet 1909*a* is published by Dr. M. Ebell in No. 4347 of the *Astronomische Nachrichten* (p. 42, August 13). As the present brightness is given as 0·07, that at discovery being taken as 1·0, it is unlikely that this object will be observed again except with the largest telescopes or by photography.

Maximum of Mira, 1908.—Mr. Naozo Ichinohe, having observed the magnitude of Mira Ceti during the period which included the last three maxima, publishes the results of his observations in No. 4346 of the *Astronomische Nachrichten*, the measures made during the period October, 1907, to February, 1909, being given in detail. The following table shows the observed dates of, and magnitudes at, the maxima, and compares the dates with those calculated by Guthnick :—

Guthnick		Observed date		Magnitude
1906, Dec. 19·6	...	Dec. 12	...	2·00
1907, Nov. 15·5	...	Nov. 1	...	3·60
1908, Oct. 11·3	...	Oct. 11	...	3·33

The Assumed Planet, O, beyond Neptune.—Replying to a criticism which appeared in the previous number, Prof. W. H. Pickering has a letter in the current number of the *Observatory* (No. 412, August, p. 326) in which he recounts some of his reasons for assuming the existence of a planet beyond Neptune, which is exercising a perturbative force on Uranus. After pointing out essential differences between the present problem and that which presented itself to Leverrier and Adams, Prof. Pickering states that in the observations of Uranus he finds six distinct deviations from the computed course of the planet which occur where they should if produced by such a perturbing body as his assumed planet O; without the assumption three must remain unexplained. He then points out that the Greenwich observations of the last ten years show a steadily increasing deviation from those of the previous sixty years, a deviation which he considers is, of itself, a strong argument in favour of the existence of a hitherto unrecognised disturbing force.

With regard to the suggestion, made in Nature for June 17, that the time is ripe for the discussion of the observations of Neptune, for the determination of any perturbing influence, Prof. Pickering suggests that such a discussion would probably be more hopeful in twenty years' time, when the deviations of Neptune should amount to two or three seconds. Another maximum of Uranus will occur about then, and a graphical solution would be likely to furnish trustworthy data concerning the perturbing force, or forces, very quickly.

AGRICULTURE IN THE TRANSVAAL.

THE issue of the annual report of the Transvaal Department of Agriculture is an important event in the agricultural world, and each year's report furnishes fresh proof of what science can do for agriculture. The work has outgrown the accommodation, and Mr. Smith puts in a strong plea for buildings which, in the Transvaal, is not likely to be disregarded.

An account is given by the heads of the separate departments of the work that has been going on. Dr. Theiler reports further experiments with *Piroplasma mutans* and *P. bigeminum*, two organisms causing serious animal diseases, and is making considerable progress with inoculation methods of coping with them. The botanical division, under Mr. Burtt-Davy, has occupied itself with the improvement of the seed maize. Already the Transvaal farmer exports maize, and could export more; he would secure higher prices and greater profits if supplies of trustworthy seed were available. New and promising plants have also been investigated, and one or two appear as if they will be useful, especially the Florida beggar weed, a leguminous plant suitable for the bushveld, and much liked by stock.

The plant pathologist, Mr. Pole Evans, finds that the potato-rot fungus, *Nectria solani*, Pers., hitherto regarded as a saprophyte, is, in the Transvaal at any rate, an active parasite, attacking the tubers at all stages of growth, and causing a putrid rot in them while still in the soil. Infected potatoes are not admitted into the Transvaal, and steps are being taken to eradicate the disease, but the other South African colonies are doing nothing to prevent the disease from establishing itself within their borders. A uniform system of dealing with plant diseases will be not the least among the advantages of unification.

Locust destruction has received much attention from the Entomological Division. There was a serious invasion of brown locusts, doing damage estimated at about 1,000,000*l.*, but the swarms were marked down, and the voetgangers destroyed by spraying with sodium arsenite solution. Unfortunately, some of the farmers and many of the natives are still indifferent about the work, and look upon locusts as a scourge against which it would be impious to contend; thus places where eggs are laid are not always notified.

There is also a general rise in the standard of agriculture in the colonies, in which the experimental farms of the department have played a conspicuous part. An increased area of land has come under the plough. Thrashing machines are being used more commonly; wheat is being taken up. The quality of the live stock is improving; there is a large demand for well-bred animals, and competition for the pedigree stock raised on the Government farms is very keen. Some farmers are interesting themselves in ostrich farming, which is likely to be a valuable industry in some parts of the colony, where the wild birds are fairly numerous.

Altogether the record is a highly satisfactory one, and the director, Mr. F. B. Smith, and the staff, are to be congratulated on what they have accomplished.

SPONTANEOUS COMBUSTION.

DR. JOHN KNOTT has published in the *New York Medical Journal* (April 17 and 24) an article on spontaneous combustion, with the object of showing that the cases of death reported as occurring from that cause are mere fancy legends which were partly the result of ignorance and mainly of imagination. Many years ago Liebig, and later Casper, wrote treatises with the same object; but Dr. Knott's contribution is not devoid of interest, if only for the exhibition of gentle sarcasm with which he attacks the writings and statements of past Fellows of the Royal Society and others of equal standing who lent the sanction of their names to these idle fables. He does not include among his cases the one which is probably best known to English readers, namely, the celebrated case of Mr. Krook recorded by Dickens in "Bleak House." The evidence in favour of spontaneous combustion as the cause of Mr. Krook's death is just about as convincing (or the reverse) as in the majority of the others.

We fancy, however, that Dr. Knott is preaching to the converted, for we can hardly believe him when he states that "spontaneous combustion is still accepted as an article of pathological faith by our recognised leaders in the domain of medico-legal opinion and teaching."

The belief in spontaneous combustion in the human body doubtless originated in the observation of electrical phenomena long before electricity was understood or even discovered. The "will-of-the-wisp" was endowed, as its name suggests, with a personality. The saintly halo and the fiery tongues of painters and poets familiarised the onlooker with imaginary exhalations; the easy combustibility of certain organic substances, the occurrence of phosphorescence in the sea and in decaying organisms, were then mysteries which combined to lend credence in an unusual combustibility of the human frame in those inclined to believe in the miraculous on the slenderest of evidence.

This point of view was accentuated and stimulated by the discovery of a new element, phosphorus, especially as it was first isolated from human urine and bones. The discovery of phosphorus in its day excited just the same kind of interest and imaginative thought as the discovery of radium is doing at the present time.

ETHNOLOGY IN AMERICA.

THE American Ethnological Society has reprinted in facsimile the first part of their Proceedings, originally published in 1853. The most interesting article is that contributed by W. Bartram, which was written in 1789, entitled "Observations on the Creek and Cherokee Indians," being replies to a series of ethnological questions prepared by Dr. B. S. Barton, vice-president of the Philosophical Society of Philadelphia. The connection of this tribe with the Iroquois, of whom they formed the southern branch, has now been established by Horatio Hale and Gatschet. This paper gives a singularly interesting account of the ethnography of a tribe now practically extinct, describing their probable origin, relations with other tribes, their picture records, religious beliefs, forms of tribal government, physical characteristics, social relations, their "Chunkey-yards" or earthworks, tenures of land and conditions of property, diseases and their remedies, food and means of subsistence. In connection with the divine kings of Prof. J. G. Frazer, it is interesting to find that the King of the Seminoles threatened a certain Mr. McLatche that "if he did not comply with his requisitions, he would command the thunder and lightning to descend upon his head, and reduce his stores to ashes." They had also a remarkable cult of the sacred fire. "The Spiral Fire, on the hearth and floor of the Rotunda, is very curious; it seems to light up in a flame of itself at the appointed time, but how this is done I know not."

Another important article in the same reprint is that by E. G. Squier on "The Archæology and Ethnology of Nicaragua." He describes a curious kind of spindle, resembling a gigantic top, which revolved in a calabash, and an equally primitive hand-loom. Mr. Squier was the first traveller who collected a vocabulary and prepared a grammar of the speech of these tribes. They used, he says, the vigentesimal system of counting by twenties instead of the decimal, while the Eskimos, Algonkins, and Choctaws counted by fives. They were emigrants from Mexico, "and presented the extraordinary phenomenon of a fragment of a great aboriginal nation, widely separated from the parent stock, and intruded among other and hostile nations; yet from the comparative lateness of the separation, or some other cause, still retaining its original, distinguishing features, so as to be easily recognised." Their arms were identical with those of the Mexicans—lances and arrows pointed with flint, copper, and fish-bones, with blades of obsidian set on the edges. These papers are specially interesting, because they were written before the age of scientific ethnography, and were prepared without reliance on any particular theory of the origins, social organisation, or beliefs of the tribes which were studied by their authors. The re-publication of this valuable material is a laudable enterprise on the part of the Ethnological Society.

PURIFICATION OF WATER BY STORAGE.

THE third annual report, compiled by Dr. Houston, of the Metropolitan Water Board, on the results of the chemical and bacteriological examination of the London waters for the twelve months ended March 31 has just been issued, and contains a mass of valuable information. The chief conclusions formulated by Dr. Houston may be summarised as follows. The raw waters from which the supplies are derived are usually unsatisfactory, particularly during the winter months, and a judicious selection for waterworks purposes is important. The storage is unequal, and in some cases inadequate in the different works; filtration is also unequal, and in some instances too rapid. The quality of the filtered water is likewise variable, and in some cases not altogether satisfactory, though a remarkable percentage improvement in the quality of the raw water is effected by storage and filtration; on the whole, however, the water supplied to the consumer is of satisfactory quality. Storage has been clearly proved to be advantageous in all respects. The recent investigations of the Board point to the fact that the present sources of the water supply of the metropolis may be regarded with less disfavour than previously.

Dr. Houston, in a fourth report on research work, also details the results of an investigation on the vitality of the cholera microbe in artificially infected samples of raw Thames, Lee, and New River water, which may be considered to be supplementary to his previous report on the vitality of the typhoid bacillus in similar circumstances (see NATURE, vols. lxxviii., p. 377, lxxix., p. 259, and lxxx., p. 286). A number of different strains of the cholera vibrio was dealt with, and only those which, after investigation, might be regarded as undoubted cholera vibrios were employed in the research, and their bacteriological characteristics are detailed. The conclusions are that cholera vibrios rapidly die in the raw waters as a result of storage in the laboratory. At least 99·9 per cent. of the organisms perish within one week, and none could be isolated even from 100 c.c. of the water three weeks after infection. These results are of considerable interest now that cholera is prevalent in Russia and other parts of Europe, and emphasise the importance of storage of the raw water as a safeguard against water-borne disease.

R. T. HEWLETT.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. R. K. MCCLUNG has been appointed lecturer in physics in the University of Manitoba, Winnipeg.

DR. FRITZ COHN, extraordinary professor of mathematics and astronomy at the University of Königsberg, has been appointed professor of theoretical and mathematical astronomy, and director of the Königliche Astronomischen Recheninstitut, at Berlin; he enters upon his new duties on October 1.

THE Central News Agency reports from New York that, by the will of the late Mr. Cornelius C. Cuyler, the sum of 100,000 dollars is bequeathed for the immediate benefit of the Princeton University, and on the death of Mr. Cuyler's widow several million dollars will pass into the hands of the University authorities.

WE have received a copy of the Directory for higher education, 1909–10, issued by the Education Committee of the Staffordshire County Council. The directory contains the regulations of the committee and the details of schemes in operation throughout Staffordshire. We notice that a very complete scheme of technological instruction is provided throughout the county by the committee. In the case of mining, instruction is given by two lecturers, whose whole time is devoted to the work, and their assistants. For this purpose the county is divided into two portions, comprising the North Staffordshire Coalfields and the South Staffordshire Coalfields respectively. Theoretical and practical classes in metallurgy and iron and steel manufacture are conducted in accordance with the regulations of the Board of Education and the City and Guilds of London Institute. Lectures and laboratory work in pottery and porcelain manufacture will be given during the coming session at Burslem, Longton, Stoke, and Tunstall. The services of an instructor in boot and shoe manufacture are engaged jointly by the committee and the Education Committee of the Borough of Stafford. Silk manufacture is taught at Leek, glass manufacture at Stourbridge, and art metal-work at Bilston. To enable teachers in elementary and secondary schools to impart instruction in various branches of technical and manual training, special classes are provided at convenient centres by the committee. Courses of lectures on health and the care of children are delivered at suitable localities in both rural and urban districts, and demonstrations and lectures are also provided on gardening, bee-keeping, and poultry-keeping. An elaborate system of scholarships is in vogue, including training scholarships for teachers and midwives, extensive aid is given to secondary schools, university extension lectures are provided, useful work has been arranged in rural districts, and numerous evening classes are available. Altogether the Staffordshire committee is making adequate provision for the education of young men and women anxious to equip themselves properly for their work in life.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 17.—M. Bouquet de la Grye in the chair.—The synthesis of unsaturated fatty ketones: F. **Boudroux** and F. **Taboury.** Calcium carbide attacks the ketones of the fatty series. Acetone gives mesityl oxide and other condensation products; butanone is dehydrated in a simpler manner, the unsaturated ketone $C_2H_5.C(CH_3)=CH-CO.C_2H_5$ being formed.—The influence of the reaction of the medium on the development and proteolytic activity of Davaine's bacteridium: Mlle. Eleonore **Lazarus.** The limits of acidity or alkalinity between which it is possible for the organism to develop, as well as the reaction corresponding to the maximum proteolysis, depends, not only on the strain, but also on the nature of the food material.—The mitochondria of the muscular fibres of the heart: Cl. **Regaud.**—The geological history of the Tellian Atlas of eastern Numidia (Algeria): J. Dareste **de la Chavanne.**

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part ii. for 1909, contains the following memoirs communicated to the society:—

March 6.—Seismic records at Göttingen in 1907, with an introduction on the working out of seismic diagrams: L. **Geiger.**—Contributions to the theory of tensions in plastic and sand-like media: A. **Haar** and T. **von Karmán.**

May 8.—Procedure for the determination of magnetic inclination by means of the induction-inclinometer: O. **Venske.**—New developments in linear differential equations: E. **Hilb.**—New members of the systems β, γ, δ, ϵ, ζ Ursæ Majoris: E. **Hertzsprung.**—The notion of the work of deformation in the theory of the elasticity of solid bodies: J. J. **Weyrauch.**

The "Business Communications," part i., 1909, include the report of the Samoa Observatory for 1908, a communication on certain notes of Riemann's lectures, and a memorial address on Hermann Minkowski, by D. **Hilbert.**

CAPE TOWN.

Royal Society of South Africa, July 21.—Prof. L. Crawford in the chair.—Notes on the absorption of water by aërial organs of plants: Dr. **Marloth.** Numerous experiments were made with various Karroo plants in order to ascertain whether they are able to absorb water by means of their leaves, and thus to utilise the dew, which is of common occurrence in the Karroo every night during the winter. The results showed that some plants possess specially constructed hairs, like *Mesembrianthemum barbatum* and *Crassula tomentosa*; others, peculiar stipules like *Anacampseros Telephiastrum* and *A. filamentosa*; others, an unusually modified epidermis like *Crassula decipiens*; and others, again, aërial rootlets like *Cotyledon cristata*. These organs absorb sufficient moisture to supply the requirements of the plants during a part of the year, thus enabling them to exist in arid regions like some parts of the Karroo or the desert coast-belt of Namaqualand.—Evaporation in a current of air (part i.): J. R. **Sutton.** The results of previous observations upon the rate of evaporation made under natural conditions at Kenilworth (Kimberley) with gauges of various patterns suggest that the relative humidity of the air is of more importance than the absolute humidity in determining the loss of water from a given surface, and that there is no simple correspondence between the wind and the evaporation. In this paper the author describes some experiments made to determine the rate of evaporation under different conditions of moisture and temperature in the forced draught generated by an electrically driven fan.—The genesis of the chemical elements: James **Moir.** The author has found a relationship between the atomic weights, whereby the accepted values can be calculated with remarkable accuracy. The scheme brings out closer relationship between such groups as the alkali metals and the halogens, and although it follows the periodic law, it would require the latter to be modified in important particulars.—Some flowering plants from the neighbourhood of Port Elizabeth: S. **Schönland.**—Statement of Silavi, a Tembu of the Zemba tribe, with reference to his life among the Bushmen: W. E. **Stanford.** This communication contains interesting information about a clan of Bushmen whose haunts were in the Drakensberg Mountains, and could muster forty-three men. It is a narrative of cattle lifting in various ways and devices, as well as of their domestic habits and mode of life, and also of the ultimate destruction of the clan by the Tembu chief.

CALCUTTA.

Asiatic Society of Bengal, August 4.—The constitution of the roots of *Arisaema concinnum*, Schott, and *A. speciosum*, Mart.: B. B. **Dutta.** These roots contain an abundance of carbohydrates, and are used as food by the Lepchas of Sikkim in case of need, after taking precautions in the cooking to get rid of the irritant needle crystals.—The ova of a Distoma found in the skeletal muscles of *Saccobranchus fossilis*: G. C. **Chatterjee** and T. C. **Ghosh.** Last year, during the small-pox epidemic, a peculiar eruption was noticed on fish offered for sale in the Calcutta markets, and popularly connected with small-pox. This fish disease, on examination, was found to be due to a flat worm of the parasitic genus Distoma. The authors have found the ova in various parts of the body of the fish, but particularly near the dorsal fins in the skeletal muscles towards the posterior third of the body. Two actual moving worms were found in water where diseased fish were which are described as presumably the adult form of the worm.—Chemical examination of aurvedic metallic preparations, part i., "Shata-puta lauha and Shahasra-puta lauha" (iron roasted hundred times and thousand times): Panchanan **Neogi** and Birendra Bhusan **Adhicary.** The method of preparing "Shata-puta" and "Shahasra-puta" lauha, as given in Rasendra-Shara-Shangraha, as well as that followed by modern aurvedic physicians, are given in this paper. Samples of iron heated once, ten times, seventy-eight times, 100 times, and 1000 times have been collected and analysed. Samples which have undergone a fewer number of "putas" are magnetic, and contain ferroso-ferric oxide. As the number of roastings (puta) increases the amount of ferrous oxide diminishes, and "Shata-puta" and "Shahasra-puta" lauhas contain ferric oxide only, and are not magnetic. "Shata-puta" and "Shahasra-puta" lauhas are almost identical in composition, the amount of ferric oxide varying from 78·1 per cent. to 84·6 per cent. Siliceous matter is present in considerable quantities, varying from 10·1 per cent. to 34·1 per cent. These "lauhas" are very light and porous, and "swim on water like a duck," but precipitated ferric oxide does not "swim." It is on account of their fineness and lightness that these "lauhas" are efficacious. Ordinary ferric oxide is not incorporated in the British Pharmacopœia. Incidentally, a method of estimating metallic iron in presence of ferrous iron is given.

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THURSDAY, SEPTEMBER 2, 1909.

THE USE AND MISUSE OF DRUGS.

Drugs and the Drug Habit. By Dr. Harrington Sainsbury. (New Library of Medicine.) Pp. xv+307. (London: Methuen and Co., n.d.) Price 7s. 6d. net.

THERE is required no little courage on the part of both writer and publisher to issue a book with this forbidding title, which to the layman brings memories of the nauseous ransom paid for release from disabilities, and to the medical man renews the griefs of "lectures on materia medica at 8 o'clock on a winter's morning" which Darwin found "something fearful to remember." To those who are not repelled by the exterior, however, we can promise much enjoyment from the perusal of this volume, which is written with the same distinction of literary style and with the same felicity of illustration as marked the author's "Principia Therapeutica." He writes for the educated layman, and, avoiding the technical pitfalls with which medicine is so bestrewn, gives a clear view of the principles on which treatment must rest. Commencing with a short historical review of the deductive medicine of the "systems," among which he places that curious survival homœopathy, he passes quickly to the definition of his subject, noting by the way the etymological connection between drug and dry, and then discusses the general aim of drug-giving and the grounds on which it is based. Here, as throughout, the author draws many analogies between familiar physical phenomena and the action of drugs, and attempts to dispel the mysticism in which therapeutics is still involved to the lay mind.

The mental effect of treatment as apart from the actual effects of the drug and the psychology of the placebo are dealt with at some length. Drugs are thrown into large classes as nutrients, incitants, depressants, alteratives, antiseptics, and sedatives, which may perhaps find justification in treatises of this kind, but which it is difficult to reconcile with the canons of modern pharmacology. The newer methods of therapeutics, such as organotherapeutics and serum therapeutics, are the subjects of an interesting chapter, in which they are claimed as the modern developments of ancient theory and in no way distinct in character from other forms of medication. Is not the theory underlying the use of thyroid extract the same as that which suggested the administration of pepsin, and is not the newest vaccine a direct descendant, even in terminology, from that of Jenner?

A third of the book is devoted to the habitual use or abuse of the narcotic and soporific drugs, such as opium, alcohol, and chloral, and to the treatment of the consequent "drug habits." Here the importance of re-building the character and self-control of the victim is insisted on, and no medicinal treatment is considered of value except in a purely subsidiary and incidental way. Some support is given to the mental treatment of these cases, but its difficulties and drawbacks are recognised. Improvement is often obtained when the environment of the subject is changed and the possibility of indulgence is restricted, so that the impulses to satisfy the craving are not aroused, while those tending to develop control gain ascendancy. The difficulty arises on return to the habitual environment, when the old impulses throng through the well-beaten paths, and the feeble, newly-acquired, guardian impulses are not aroused by the surroundings. One form of drug habit which finds no mention we should like to have seen discussed from the author's standpoint, the most prevalent, and not least pernicious of them all, that of self-drugging with all sorts of nostrums, which becomes an obsession with many of the laity, and is often accompanied by profound distrust of the medical profession.

The drink problem receives some attention, and the solution suggested is not legislation and restriction so much as education in self-control. The shortcomings of the recent Sale of Poisons Act are subjected to criticism; but should we have a Sale of Poisons Act at all? Might we not trust to education here also? On p. 231 it is stated that morphia may be detected in the urine in subjects of the opium habit, which is not in agreement with ordinary experience, and the direct inheritance of drug habits, as apart from the inheritance of the mental weakness which underlies these, requires further confirmation.

EUCLID'S ELEMENTS IN ENGLISH.

The Thirteen Books of Euclid's Elements. Translated from the Text of Heiberg, with Introduction and Commentary, by T. L. Heath, C.B. 3 vols. Vol. i., Introduction and Books i.–ii., pp. x+424; Vol. ii., Books iii.–ix., pp. 436; Vol. iii., Books x.–xiii. and Appendix, pp. 554. (Cambridge: University Press, 1908.) Price *2l. 2s.* net.

OUR island is the last home of ignorant Euclidolatry; *argal*, a German scholar has been allowed to edit, and a German firm to publish, the best and only critical text of Euclid's works. Our ancient universities maintain compulsory Greek; *argal*, Dr. Heath has thought it necessary to undertake, in addition to his commentary, an English translation of the text. Accepting these facts as part of the eternal fitness of things, those who can beg, borrow, or buy these three handsome volumes will be able to learn the actual contents of the "Elements," the history of their propagation and influence on mathematical study, and their relation to Greek science and philosophy in general. Dr. Heath has been so long a devoted student of Greek geometry that he is able to give his readers a very good idea of its developments and peculiar limitations; his commentary seems to cover every point of real interest, and he has rightly given, by way of comparison, some account of the modern theory of irrationals.

Naturally, the definitions and postulates receive a good deal of attention. The definition of a straight line is translated "a straight line is a line which lies evenly with the points on itself," and the same rendering of ἐξ ἴσου is given in the definition of a plane. Readers of the notes on these definitions will probably agree with the editor that ἐξ ἴσου, thus applied, was an obscure phrase even to a Greek, and that it was meant to refer to what we may call the indifferent distribution of points and lines on a line and a plane respectively. At any rate, Proclus's explanation is clearly wrong, though it very likely contains the substance of what a teacher would often say in commenting on Euclid's text.

Another very interesting note is that on the Greek notion of "angle." As this included curvilinear angles, it led to a variety of discussions and some paradoxes; for example, taking a semicircle AMB and a tangent BT at one end of the diameter AB, it was argued that the angle at B between the circle and diameter is less than the rectilineal angle ABT, because BT is outside the circle, while, on the other hand, any acute rectilineal angle can be proved less than the curvilinear angle in question. However (p. 176, bottom), there is some evidence of a way of looking at angles such as we should now express in terms of the differential calculus.

To the famous postulate 5 (generally referred to as the 11th axiom) eighteen pages are devoted. Here it must suffice to say that sufficient references are given to the principal authorities on the theory of parallels and non-Euclidean geometry, and that attention is properly directed to the work of the Jesuit Saccheri.

The books least familiar to students are, of course, the arithmetical books (vii.–ix.) and Book x. With regard to the former, Dr. Heath has given diagrams consisting of straight lines, just like those in Book v.; this is rather misleading, and it would surely have been better to give rows of dots, or, at any rate, graduated straight lines to the same scale. In this part of the work, Dr. Heath gives algebraical paraphrases of the less obvious propositions; these will be found very helpful to those not familiar with Greek methods of reasoning.

As De Morgan said long ago, the most remarkable (and in some ways most characteristically Greek) book of the "Elements" is the tenth. If we turn its propositions into algebra, we find that they contain an exhaustive classification of a certain set of irrationals (or irrational ratios), all, of course, constructible from a given line by means of rule and compass. Dr. Heath, in his introductory note, gives the irrationals in question in an algebraic form, which is perhaps the best suited for comparison with the propositions, but hardly so neat as De Morgan's in his article ("Penny Cyclopædia") on "Irrational Quantities," which is still worth careful reading.

It should be mentioned that there is an appendix containing the spurious Book xiv. (by Hypsicles), and a note on the so-called Book xv., two elaborate indexes, and a beautiful facsimile of a page of the Bodleian MS. D'Orville 301.

Those who are really interested in Greek geometry will be deeply grateful to Dr. Heath for putting together, in such an attractive form, such a large amount of historical information, and thus saving students from an immense amount of toilsome research. Finally, the excellence of the diagrams, especially in Book xiii., should not be overlooked.

G. B. M.

HYPNOTISM AND OCCULTISM.

Hynotism, including a Study of the Chief Points of Psycho-therapeutics and Occultism. By Dr. Albert Moll. Translated from the fourth enlarged edition by A. F. Hopkirk. Pp. xvi+610. (London and Felling-on-Tyne: The Walter Scott Publishing Co., 1909.) Price 6s.

THIS book is a translation from the fourth edition of the original work. The author presents his readers with a survey of all that is most important in the whole province of hypnotism, and indeed has left little unsaid which could be of any value. An opening chapter on the history of hypnotism indicates the gradual progress of the science from the stage in which it was almost hopelessly mixed up with superstitious quackery, through periods of utter neglect on the part of the scientific world, to the era, which is even now only dawning, in which the subject is submitted to the strictest critical examination of physiologists and psychologists. The literature that has grown up round the subject is enormous, and its volume almost daily increases.

Dr. Moll's work is not one which is likely to appeal to the general reader, and, indeed, we are of opinion that this is one of its greatest merits. In this country hypnotism has too long been a subject in which a certain class of mind has taken an interest alternatively to spiritualism, "Christian Science," or other occult system of the day. To such, a carefully attentive and balanced criticism is positively repellent, and it is, unfortunately, in this class that hypnotism has hitherto had its vogue. Dr. Moll deals in very considerable detail with the symptoms of hypnosis. Indeed, by far the longest chapter of his book is devoted to a minute account of the psychological, physiological and even anatomical changes which may be noted during, or as a result of, hypnosis. The various explanations which have from time to time been put forward as to the hypnotic state are subjected to searching analysis, and the confident assertions of many of them are shown to have no foundation. What we know about mental processes is confined to a few concomitant phenomena, while the real nature of such processes appears for ever debarred us, and to our author the endeavours of some investigators to explain mental processes by means of our present knowledge of the central nervous system indicate a disquieting tendency to overestimate the gifts of physiology. It is, at any rate, plain that authorities take up diametrically opposite sides in their hypotheses as to the nature of the hypnotic phenomena.

The medical and legal aspects of hypnotism are dealt with at much length, and an important conclusion that emerges from the consideration of hypnotism from these points of view is that its practice should be confined to those who are properly trained in the diagnosis of the affections which it is sought to treat. To hypnotise those who should not be hypnotised, and to seek to cure disease which is not amenable to such treatment, is to bring hypnotism into disrepute and to wrong the sufferer. Dr. Moll winds up his work with a chapter upon occultism, not because there is any internal affinity between hypnotism and occultism, but because the two subjects are often mentioned together, a connection determined by their historic development. We wish that all enthusiastic investigators of the occult could be induced to peruse this part of the book. With a candid admission of the depth of our ignorance, our author asserts that we have no right flatly to refuse to recognise any domain of research. Yet if the conditions of research into the phenomena of occultism be severe, and if none of the assertions of occultists be accepted without proof, there is, according to Dr. Moll, no single series of experiments that carries with it a convincing proof of the reality of occultistic phenomena. We can warmly recommend this work to our readers as a thorough exposition of an abstruse subject.

ELECTRO-TECHNICS.

Einführung in die Elektrotechnik. By Dr. C. Heinke. Pp. xviii+501. (Leipzig: S. Hirzel, 1909.) Price 13 marks.

AT a first glance this seems a very interesting book, but a closer study of its pages produces a feeling of mental fatigue, not to say impatience; and this is probably due to the fact that many obvious points are set out at great length whilst really important or difficult matters are passed over with tantalising brevity. Thus the author gives us many pages on the calculation of the current in a circuit containing inductance and resistance, or capacity and resistance, but the subject of single-phase commutator motors is dismissed in exactly two and one-third pages.

After a long-winded introduction, in which the author develops his ideas as to what should be taught at a technical high school and what constitutes the real difference between the mere technical man and the scientific engineer, we find a chapter which a less pedantic writer would have simply headed "mechanical analogies," but which bears the title "Conceptions of a Mechanical Nature to facilitate the Mental Connection between all Basic Electromagnetic Phenomena." The fifty-odd pages in which the author develops his analogies are very interesting, but they can only be read with advantage by persons who are already well acquainted with the subject. A beginner will find the analogy more difficult to understand than the electrical phenomenon itself.

Next follows a chapter entitled "Pressure Producers" (German Spannungserzeuger), and in this we find the old-fashioned frictional machine (but not the Wimshurst), Armstrong's experiment, primary batteries, thermopiles, and the dynamic generation of E.M.F. discussed. The latter leads to the following chapter, on "The Technical Production of Electrical Energy." This occupies some 200 pages, and contains a most bewildering collection of all possible things either directly or very remotely connected with dynamos. A few titles of the matters treated will suffice to show how varied is the character of the subjects collected under this head:—mechanical details of armature; commutator and field system; characteristics; interpoles; the Thury system as applied to the Moutiers-Lyon installation; relay for field regulation; mechanical analogy of alternating currents; a number of obsolete alternators; some modern alternators; form factor; oscillograms; vector diagrams; currents in branch circuits; resonance; stationary waves in the antenna of a wireless station; the Slaby-Arco-Braun system of wireless; Dobrovolsky's balancing transformer for three-wire system; electric bells; Rhumkorff interrupter; Wehnelt interrupter; selenium cell; buzzer; maximum cut-out; high-frequency arc; wireless telephony; power of electric currents.

The fifth chapter deals with the application of electricity, and here we get also a great variety, such as Geissler tubes, lifting magnets, bells, telephones, transformers, motors, the Kjellin furnace, a catalogue picture of a chain-welding machine, glow lamps, arc lamps, secondary batteries, a load diagram of a central station, switchboard diagrams for D.C. and A.C. stations. The final chapters deal with measuring instruments, cables and overhead lines, switches, and accessory apparatus. The grouping of all these different matters as adopted by the author may be logically right, but it is not convenient for the reader; it is also irritating to find a page or so of elementary mathematical treatment interleaved between catalogue pictures of some firm's apparatus, whilst the important features of the thing illustrated are hardly mentioned. The book has interesting parts, but to find them the reader must know a good deal of the subject; and even then the search will be rather troublesome, as there is no index.

GISBERT KAPP.

OUR BOOK SHELF.

(1) *Leitfaden der Tierkunde für höhere Lehranstalten.* By Dr. K. Smalian. IV. and V. Teilen. (Leipzig: G. Freytag, 1909.) Price 1.80 marks each.

(2) *Naturwissenschaftliches Unterrichtswerk für höhere Mädchenschulen.* By Dr. K. Smalian and K. Bernan. I. Teil. Pp. 50; illustrated. (Leipzig: G. Freytag, 1909.) Price 1.20 marks.

(1) WITH the two parts referred to under the title of the work first quoted, Dr. Smalian brings to a conclusion his "Leitfaden," of which the earlier parts have been already noticed in NATURE. The fourth part, which is devoted to the Arthropoda, is stated to be for lower third form teaching (Lehrstoff der Untertertia), while the fifth part, dealing with the other invertebrates, is intended for upper third form instruction (Lehrstoff der Obertertia). Whether the parts intended for the higher forms are considered to comprise more difficult zoology than those for the lower grades is not very easy to decide. As regards style of treatment, the two parts before us seem to follow very much the lines of their predecessors, and contain a vast store of information, conveyed in a very condensed and concise manner, this technicality of the text being in some degree relieved by the coloured plates, the subjects of which are well selected, and illustrate the life-history of a number of species.

(2) This text-book has been written by the authors in accordance with the requirements of a new scheme of instruction authorised for higher grade girls' schools in Prussia, and in order to conform exactly

with these regulations Dr. Smalian has enlisted the services of a teacher in one of these schools at Halle. The first half of the part before us is devoted to the elements of botany, and the second to the rudiments of zoology, as exemplified by mammals and birds, the plan being to describe one particular species of plant and animal in considerable detail, and then to discuss some of its relatives. The illustrations, coloured and otherwise, are, if we mistake not, the same as those used in the "Leitfaden," although in certain instances reduced in size. This part is intended for the instruction of the seventh class (Lehrstoff der vii Klasse), so that in this case also the various sections of the work are to be read in consecutive order by the different classes. Both textbooks appear well suited for their respective purposes.

Die Photographie. By W. Zimmermann. Pp. iv+104. (Leipzig: Quelle und Meyer, n.d.) Price 1.80 marks.

In twenty-three short chapters and an introduction the author has provided a general guide for beginners in photography similar to the numerous small guides that we have in English, but differing from them in being more fundamental and less detailed in the matter of manipulation and precautions. The difference may be due to the more general diffusion of elementary scientific knowledge in Germany than in this country. Formulæ for the preparation of various printing papers and plates are given, as well as instructions for their use, so that the volume is in no sense a mere collection of instructions for the manipulation of commercial products. This being as it is and the volume so small, it is interesting to note the selection that the author makes from the innumerable alternatives now available. The formulæ for developers are in the following order:—Ferrous oxalate, pyro-soda, pyrocatechin, pyrocatechin without sulphite, hydroquinone, and metol-hydroquinone.

In a chapter on "the chemical action of light and development" the ionic theory is employed, a commendable procedure if those for whom the book is written may be presumed to understand it. But the author evidently has his doubts, for he sets forth in detail the chief fundamental facts upon which the theory rests. In this case it appears to us that so far as the very little chemistry introduced is concerned, the explanations would have been more simple and still sufficient if the facts had been dealt with on the older plan, without reference to electric charges and their migrations. We notice a few old-fashioned errors with regard to actual products of certain chemical changes, but on the whole the text is trustworthy, interesting, clear, and very concise, and the illustrations are apt.

Science in Modern Life. Edited by Prof. J. R. Ainsworth Davis. Vol. iii. Pp. ix+187. (London: The Gresham Publishing Co., 1909.) Price 6s. net.

The two earlier volumes of this work—which is to be completed in six volumes—were noticed in Nature of March 4 (vol. lxxx., p. 1). The intention of the work is to give a broad outline of the principles of science and their relations to human progress and industry. The various departments of natural knowledge are surveyed by eleven different authors, each of whom is well qualified to deal with his particular subject. The present volume is devoted chiefly to light, sound, magnetism, electricity, and other branches of physics not dealt with in the second volume; and, in addition, about seventy pages are given to general biology and botany.

Mr. J. H. Shaxby's treatment of physics seems to us to be appropriate to the design of the work and calculated to create and foster interest in the subject. Attention is given to the studies of recent years, such as radiation pressure, radio-activity, Hertzian waves, and wireless telephony, and the style of description is both readable and attractive. Dr. H. J. Fleure deals with the difficult subject of the cell and nuclear division, and gives a general survey of simple forms of life. Neither this section, however, nor that by Mr. J. M. F. Drummond on botany which follows it, will be intelligible without preliminary knowledge of the subject, and will not appeal, therefore, to general readers.

A work on various subjects, written by several authors, is rarely uniform in character and scope, and the present series of volumes is no exception to the rule. In spite of this fact, we are glad to express the hope that the work will be the means of bringing problems and advances of modern science under the notice of a wide circle of readers.

The Central Nervous System of Vertebrates. By J. B. Johnston. Pp. 170. (Jena: G. Fischer, 1909.)

This interesting monograph appears in Dr. J. W. Spengel's "Ergebnisse und Fortschritte der Zoologie." It gives an excellent account of the structure and mechanism of the central nervous system founded on morphological and physiological facts, as these have been laboriously collected by the most modern methods by which the nervous elements have been examined. The author deals with the plan of reflex mechanisms, he describes the architecture and localisation of the central ganglia and nerve-roots, and his illustrations are drawn from morphological studies of the simpler types. One of the most important sections is No. vii., in which he discusses the functions of the great divisions of the nervous system. Nowhere have we seen a better discussion of the relations and functions of the cerebellum, or a more lucid account of the remarkable deep connections of the auditory nerves. The author has evidently received illumination from the researches and constructive criticism of Sherrington, while, as indicated by a good bibliography, he is acquainted with the literature of this vast subject. The work is a valuable contribution to human and comparative neurology.

John G. McKendrick.

Vorlesungen über technische Mechanik. By Dr. August Föppl. Vierter Band, Dynamik. Dritte, stark veränderte Auflage. Pp. viii+422. (Leipzig: B. G. Teubner, 1909.) Price 10 marks.

In this volume the vector equation of mass acceleration commonly known as Newton's laws is applied to the "law of areas," the problems of harmonic and oscillatory motion, the brachistochrone, motion of a rigid body, motion under no forces and motion of a top, vibrations of elastic bodies and equations of motion of hydrodynamics. The use of vector equations throughout and differences of notation and terminology make the treatment a little difficult for an English reader to follow; but it is clear that the author has fully realised the subject of his book to be *dynamics*, not the integration of differential equations. If exceptions exist, the most noticeable one is in the sections dealing with cycloidal motion, the whole problem of which can be solved, almost without writing down a single equation, by showing the geometric properties of the cycloid in a diagram where the author employs many formulæ. Among practical illustrations we notice the reference to Schlick's balancing of marine engines, while the reference to the Kegelbahn or skittle-ground takes our thoughts back to the Fatherland, with its pleasant afternoons spent in admiring the view, drinking beer, and listening to the heavy roll of the balls.

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.*]

Beliefs and Customs of the Australian Aborigines.

IN May of last year (1908) I had the good fortune to meet the Bishop of North Queensland (Dr. Frodsham) at Liverpool, and he gave me in conversation some valuable information as to the native Australian beliefs and customs based on his personal knowledge of the aborigines. He told me that he had travelled among the Arunta as well as among various North Queensland tribes, and he asked me whether I was aware that the Australian aborigines do not believe children to be the fruit of the intercourse of the sexes. His Lordship informed me that this incredulity is not limited to the Arunta, but is shared by all the North Queensland tribes with which he is acquainted, and he added that it forms a fact which has to be reckoned with in the introduction of a higher standard of sexual morality among the aborigines, for they do not naturally accept the true explanation of conception and childbirth even after their admission into mission stations. The Bishop also referred to a form of communal or group marriage which he believes to be practised among aboriginal tribes he has visited on the western side of the Gulf of Carpentaria, but, unfortunately, I had not time to obtain particulars from him on this subject.

I pointed out to his Lordship the high scientific importance of the information which he had volunteered to me, and I requested that he would publish it in his own name. He assented; but as some time has passed without his finding leisure to draw up a full account, he has kindly authorised me to publish this brief statement, which has been submitted to him and approved by him as correct. I need not indicate to anthropologists the great interest and value of the Bishop's testimony as independently confirming and extending the observations of Messrs. Spencer and Gillen on the tribes of Central Australia. In the interest of science it is much to be desired that the Bishop, or those of his clergy who know the natives, would publish fuller information on these topics. J. G. FRAZER.

Cambridge, August 23.

A Question of Percentages.

IN NATURE of August 5 (p. 159) Mr. Cunningham asked a question as to the proper method of arriving at the mean percentage of marks obtained on papers of different values in an examination, and this has been very clearly answered by Mr. Whalley. The same question, however, arises in experimental work, particularly in agricultural and horticultural experiments, and there the answer is by no means so evident. An examiner may be supposed to have sufficient knowledge to weight his papers properly, but in an experiment no data may be available for the purpose.

Take a case where three sets of different varieties of trees are subjected to some particular treatment, and compared with three similar sets not so treated, and suppose, as an exaggerated example, that the actual measurements, say, of growth, are as follows:—

	Treated	Untreated	Diff. per cent. A	Diff. per cent. B
I.	240	120	+100	+100
II.	60	50	+ 20	+ 20
III.	4	8	− 50	−100
Sum	304	178	—	—
Mean diff.	+71	—	+ 23	+ 7

If the numbers of trees in the various sets are not the same, the results may, of course, be easily weighted to correct for this; but there are other differences for which they cannot be weighted, namely, those dependent of the differences in nature of the different varieties and of attendant circumstances beyond the control of the experimenter. The mean deduced from working each result out separately (+23) ignores all such differences, and is clearly incorrect; but that deduced from the sums of the measurements (+71) is equally so, for it ignores the difference in habit of the different varieties, and gives undue weight to the results from that variety which happens to be the most rampant grower. This difficulty has been alluded to more than once in the reports of the Woburn Experimental Fruit Farm, and the only way out of it appears to be to take the mean of the means deduced in these two ways; at any rate, it is rarely safe to draw any conclusions as to the results of experiments unless these two means agree fairly with each other.

Similar difficulties arise in interpreting the results of other experiments; with a number of analyses, for instance, in which different quantities of material were taken, the mean of the individual results assumes that none of the errors is proportional to the quantities taken, whereas a mean deduced from the sum of the quantities taken and found assumes that all the errors are directly proportional to these quantities, neither of which assumptions is correct, as a rule.

Another source of error in horticultural experiments is that the differences observed are not unfrequently of different signs, and since a *plus* difference of 50 per cent. has a very different value from a *minus* difference of 50 per cent., the algebraic sum of such differences is fallacious. This is evident from the values given above for I. and III., in which the proportions are exactly reversed, but which figure under A as differences of +100 and −50 respectively. A more correct way of calculating such differences is to take the lowest (or highest) value in each pair of plots as the standard of comparison, instead of the value in the check plot, and to affix a + or − sign to the difference, according to whether the plot under treatment has given a larger or smaller value than the untreated plot. Such differences are given under B, and correctly represent the ratios of the experimental measurements. It would be well if such a method of calculating percentage differences could receive some special designation, so that it might become recognised, for without this its use is likely to lead to misunderstanding.

SPENCER PICKERING.

The Planar Arrangement of the Planetary System.

IN your issue of July 29 your reviewer devotes some space to my paper on the origin of the planetary system (*Astronomische Nachrichten*, No. 4308), and closes by asking, "Why, for instance, on the hypothesis of capture, are the vast majority of the orbits near the plane of the ecliptic and their motion direct?" This is because our system was formed by the unsymmetrical meeting of two streams of nebulosity or by the mere gravitational settling of a single nebula of curved and unsymmetrical figure, giving a rotating cosmical vortex, or spiral nebula, but without hydrostatic pressure as imagined by Laplace. In Lick Observatory Publications, vol. viii., Plate 38, you will find an illustration of H.V. 2 Virginis, a spiral nebula of unsymmetrical figure just beginning to coil up and form a system. What will happen in the later stages of this nebula is sufficiently shown in the Lick photographs of other nebulæ given in this volume. As the mass whirls and condenses under resistance, it will necessarily retain and draw down most of the nebulosity into the plane of motion. This is exactly what has given the planar arrangement of the bodies in the solar system. In *Astronomische Nachrichten*, Nos. 4341–2, your reviewer will find a fuller explanation of the method of capture, and other papers yet to come will make the theory so clear that it need not take up more of your valuable space at present. T. J. J. SEE.

Naval Observatory, Mare Island, Cal., August 12.

The Benham Top.

MY attention has been directed to a paper in the Transactions of the Ophthalmological Society, by Mr. A. S. Taylor, entitled "Colour Phenomena due to Intermittent Stimulation with Light: Note on the Colours of Benham's Top."

It is to the conclusions in the latter part of the paper that I desire to refer, as last year, in a paper before the Physical Society (see NATURE, June 18, 1908, p. 166), I endeavoured to explain this phenomenon in a somewhat different way. The main conclusion in both theories is the same, but Mr. Taylor explains the necessary thinness of the lines as due to irradiation, whereas it appears to me to be a contrast effect. The weak illumination of the disc does not seem to warrant an assumption of irradiation.

Stewart's curves for colour vision and Burch's work on "Artificial Temporary Colour Blindness" show that the colour sensations have different rates of growth and decay. When this difference has been admitted, it is easy to explain the colours of the Benham top by the sequence of white and black divisions on the disc, the thinness of the lines being necessary to reinforce by a contrast the weak colour effect.

F. PEAKE SEXTON.

Hampton Wick.

MAN AND ANIMALS.[1]

THIS volume, of which some chapters have already appeared in the *Contemporary Review*, will be eagerly read and studied by all interested in animal psychology and the treatment of the inferior animals by man. For, mixed up with a large amount of perhaps somewhat irrelevant matter relating to the history of religions, the author has collected a vast store of information relating to the estimation or otherwise in which animals have been held by the ancient nations from Egyptian, Bhuddistic, and Græco-Roman times to the Middle Ages; while the concluding chapter deals with modern ideas on the subject.

The objects, origin, and conception of sacrifice are each treated at considerable length, while folk-lore has been largely drawn upon to illustrate the subject from all points of view. Among numerous other instances of the wide origin of such legends, we may refer to the author's account of how the Welsh story of the wolf-hound Gellert, is paralleled in other countries. The Countess appears to be a firm believer in the doctrine that the intelligence of the lower animals differs only in degree from that of their masters; and the theory that any animals are mere automatons is persistently scouted. Moreover, if we read between the lines, the author appears to be convinced that animals have souls, and are therefore immortal, although we do not find this stated in so many words. That this was the idea of the Jews in biblical times the author considers to be proved by the doctrine that "the blood is the life." If this idea of animal immortality be true, no thoughtful person can read the volume without serious misgivings and heart-searchings.

Throughout, the book is written in an attractive style, and we have read it from preface to index with real pleasure. The attractive style of the text is rendered the more interesting by the numerous excellent plates with which the volume is illustrated. Some of these do not appear, however, to be referred to in the text; and it is a pity that the author did not consult a naturalist before deciding on their titles. We find, for instance, the plate facing p. 108 (herewith reproduced), taken from an Assyrian relief in the British Museum, lettered "wild goats and young"; while in the illustration facing p. 116 we have another Assyrian sculpture, representing a god carrying a horned animal, apparently furnished with a beard, which is designated an "antelope." That the animals in the first figure are not wild goats is evident from the character of the horns of the males, the lack of a beard in that sex, and the absence of both these appendages in the females; and we have a strong suspicion that they really represent one of the larger African gazelles, such as the addra.

Assyrian Relief in the British Museum showing a troop of (?) Gazelles. From the "Place of Animals in Human Thought," where the animals are termed "wild goats."

The work, moreover, sadly wanted revision by a well-educated proof-reader. "Worser," which occurs at least twice, is not English; neither is "Quartenary," also occurring twice, correct orthography; the latter remark also applying to "camel-leopard" (p. 345). A mungoose, moreover, is not a member of the weasel tribe (p. 308), neither is it correct to term a wolf a vulpine animal. If such blemishes occurred in many books we could mention, we should pass them over without notice; the pity of it is that they mar the pages of such a thoroughly interesting volume as the one of which we now take leave.

R. L.

[1] "The Place of Animals in Human Thought." By the Countess Evelyn Martinengo Cesaresco. Pp. 376; illustrated. (London: T. Fisher Unwin, 1909.) Price 12s. 6d. net.

STYLES OF THE CALENDAR.

FEW subjects are more full of pitfalls than that of the change of style and consequent alteration of dates, which therefore requires great care in its consideration. Many articles have appeared from time to time in *Notes and Queries*, and I would refer to two of my own in 9th S., vol. v., pp. 344, 461. Here I need only say that the dates given in Whitaker are correct, though it seems to me it would be better to call May 14 May Day by Julian style instead of old May Day. It is difficult always to remember that no alteration was made in the difference between the two styles in 1600, but was in 1700, 1800, and 1900. None will be made in 2000. There was an old saying about St. Barnabas's Day :—

> "Barnaby, Barnaby, Barnaby bright,
> The longest day and the shortest night."

Saints' days, &c., being kept on the same nominal day, June 11 was still St. Barnabas's Day, though what was that day in the old calendar became June 21 from 1582 to 1700, then June 22 from 1701 to 1800, June 23 from 1801 to 1900, and now June 24. But the saint's day remaining June 11, the above distich ceased to apply. George III.'s birth was announced as on May 24, but when the style was changed in 1752, his birthday became June 4, and was kept on that date during his reign. When Gregory XIII. altered the style in 1582, the count of days was changed by ten; when England adopted it in 1752 we had to change the days by eleven; in 1801 this became twelve, and in 1901 thirteen, so that we differ now from Russia and the Greek Church by that number in our dates.

The question of an alteration is again being discussed, and uniformity is so desirable that we hope Gregorian usage will be adopted, though it is not ideally perfect, and a better rule would have been to drop a leap-year at the end of each period of 128 years.[1] The late Prof. Newcomb thought that the alteration of the style was a mistake, on the ground that there was no particular object in keeping the same dates at the same seasons over very long intervals of time, and the hiatus made by the omission of days caused, as it was bound to do, great confusion. It is not always recollected that the reason why a change was so long advocated in the western Church, and at last carried out, was the supposed necessity of regulating Easter by the full moon following the vernal equinox, which was supposed to fall on March 21 at the time of the Council of Nicæa, A.D. 325, and really did so in the preceding century. To that epoch, then, everything was referred; otherwise it would have been more natural to have started when the alteration was made by which the mean calendar year was made nearly of the true length of the tropical year.

From 1500 to 1700 May Day was kept in England on the day corresponding by the season to what we should now call May 11; after 1700, until the alteration of the style in 1752, on what would be May 12 by the new reckoning. At that time, then, the dancing round the May-pole, so popular in this country, took place at nearly what is now the middle of the month. It is of interest to remember that the great May-pole in the Strand was removed, in 1717, at the instance of Sir Isaac Newton, to Wanstead, to support the Huyghens telescope of great focal length, which had been lent to Pound (the uncle of Bradley, afterwards Astronomer Royal), who made excellent use of it.

Christmas Day, of course, and all holy and saints' days, fell, after the alteration of the calendar, several days later, according to the season; ten days when Gregory XIII. decreed the change in 1582, and eleven when it was adopted in England in 1752. After 1900 the difference between the two styles became thirteen days, and old Christmas Day is marked in Whitaker and other almanacs on January 7. New Year's Day fell seven days afterwards, on the day we now call January 14; that is not marked in Whitaker, but the Russians and the Orientals generally keep it on that day, thirteen days after ours.

It is, of course, necessary to be very careful in comparing historic events (whether astronomical or otherwise) between 1582 and 1752, English dates being given in old style, and many (not all) of the Continental dates in new style.

It has been suggested to me that the following tables will be useful for reference in calendar questions.

The Gregorian calendar was arranged to start from the date of the Council of Nicæa in A.D. 325, so that the vernal equinox should henceforth be made to fall on March 21, as it was supposed to do then. Table I. gives the dates when the equinoxes and the solstices fell by the Julian style from A.D. 200 to the present century. Table II. gives the dates in Gregorian reckoning of the first day of May and the last day of October (All Hallows' Eve) for the same centuries.

TABLE I.

A.D.	Vernal Equinox O.S. March	Summer Solstice O.S. June	Autumnal Equinox O.S. September	Winter Solstice O.S. December
200	21	22	24	22
300	20	21	23	21
400	19	20	22	20
500	19	20	22	20
600	18	19	21	19
700	17	18	20	18
800	16	17	19	17
900	16	17	19	17
1000	15	16	18	16
1100	14	15	17	15
1200	13	14	16	14
1300	13	14	16	14
1400	12	13	15	13
1500	11	12	14	12
1600	10	11	13	11
1700	10	11	13	11
1800	9	10	12	10
1900	8	9	11	9

TABLE II.

A.D.	Gregorian Dates May	Gregorian Dates October
200	1	31
		November
300	2	1
400	3	2
500	3	2
600	4	3
700	5	4
800	6	5
900	6	5
1000	7	6
1100	8	7
1200	9	8
1300	9	8
1400	10	9
1500	11	10
1600	12	11
1700	12	11
1800	13	12
1900	14	13

It will be noticed that, in the first table, as the exact times of the equinoxes and solstices vary in different years (according to the distance from leap-year), and also their local times vary in different places, the dates are for the mean, and usually apply to Europe.

W. T. LYNN.

[1] See the writer's "Celestial Motions," eleventh edition, p. 5.

AFRICAN ENTOMOLOGICAL RESEARCH COMMITTEE.

THE subjoined official announcement of the appointment of an African Entomological Research Committee will be received with much satisfaction in all quarters where the importance of a scientific basis for administrative and other official action is duly recognised. Among the advances of biological science in the last few years, none has been more remarkable than the discovery that the cause of many diseases, the nature and origin of which had hitherto escaped detection, was to be sought in the presence of parasitic micro-organisms of various kinds and qualities in the tissues of animals and plants. The part played by insects and ticks in the dissemination of these morbific parasites is now known to be of immense importance, and great efforts have already been made, not without success, to restrict the occurrence of malarial and other disorders by the systematic destruction of the insect-carriers of the organisms concerned. For this purpose it is essential to distinguish with accuracy between various closely allied species; and it is here that the work of the skilled entomologist proves its necessity. It was well remarked by Mr. A. E. Shipley, in his recent presidential address at Winnipeg to the Zoological Section of the British Association, that "a few years ago no knowledge could seem so useless to the practical man, no research more futile than that which sought to distinguish between one species of a gnat or tick and another; yet to-day they knew that that knowledge had rendered it possible to open up Africa and to cut the Panama Canal." This witness is true; and it would be difficult to point to a more complete demonstration of the fact that natural knowledge pursued for its own sake, without any direct view to future utility, will often lead to results of the most unexpected kind, and of the very highest practical importance. It is this that justifies the demand that both governments and such private individuals as have the means should do all in their power to encourage the study and pursuit of science as science, without waiting for such applications as may prove to be of commercial or political value.

When the benefits to be derived from the scientific treatment of a subject are so manifest as in the present case, even the most indifferent of public bodies can hardly afford to stand aloof; and it is to be hoped that the activity of the Colonial Office in this direction, begun under the auspices of Mr. Chamberlain, and culminating for the present in the recent action of Lord Crewe, may be taken as an indication that the Government of this country is becoming increasingly alive to the desirability of securing the cooperation of scientific authorities in administrative measures. But beyond this, the movement will deserve a still greater welcome if it helps to emphasise the importance of encouraging the pursuit of genuine science, even when no immediate prospect is offered of material results.

F. A. D.

In view of the intimate relation which is recognised as existing between certain insects and the propagation of diseases of both man and animals in tropical Africa, and of the similar relation between insects and economic plants, which is becoming more evident as settlement in the continent progresses, Lord Crewe has appointed a Scientific Committee, the object of which will be to further the study of economic entomology with special reference to Africa.

This body will be known as the African Entomological Research Committee, and Lord Cromer has consented to act as chairman. The other members of the committee are:—Lieut.-Colonel A. W. Alcock, C.I.E., F.R.S., Mr. E. E. Austen, Dr. A. G. Bagshawe, Dr. J. Rose Bradford, F.R.S., Colonel Sir David Bruce, C.B., F.R.S., Dr. S. F. Harmer, F.R.S., Dr. R. Stewart MacDougall, Sir John Macfadyean, Sir Patrick Manson, K.C.M.G., F.R.S., Mr. R. Newstead, Prof. G. F. Nuttall, F.R.S., Prof. E. B. Poulton, F.R.S., Lieut.-Colonel D. Prain, C.I.E., F.R.S., Mr. H. J. Read, C.M.G., the Hon. N. C. Rothschild, Dr. D. Sharp, F.R.S., Dr. A. E. Shipley, F.R.S., Mr. S. Stockman, Mr. F. V. Theobald, and Mr. C. Warburton. Mr. A. C. C. Parkinson, of the Colonial Office, is acting as secretary to the committee, and Mr. Guy A. K. Marshall as scientific secretary.

Arrangements are being made to despatch a trained entomologist to the east side of tropical Africa and another to the west, for the purpose of stimulating official and other residents to collect and observe noxious insects, and of affording instruction in the use of scientific methods. By this means it is hoped to obtain throughout these territories an organised body of investigators who will communicate all their collections and observations to the committee. These collections will be classified by a number of British and in some instances Continental entomologists, and named specimens will be distributed to such institutions as may require them for purposes of instruction, both at home and in Africa. The committee will also keep in touch with the work which is being done in this branch of science in Egypt and the Sudan and in South Africa. The scientific results, including all observations and experiments made by the collectors, will be published from time to time in a journal or bulletin to be issued by the committee.

It is hoped that by such organised cooperation the knowledge of these matters will be materially increased, so as to render possible the application of effective remedial measures. Offers of cordial assistance have been received from such institutions as the British Museum (Natural History), the London and Liverpool Schools of Tropical Medicine, and the leading universities, in all of which valuable work has already been done in the same direction.

THE BRITISH ASSOCIATION AT WINNIPEG.

THE Winnipeg meeting of the British Association has been a complete success. Hundreds of citizens of Winnipeg, together with representatives of science in Canada, the United States, and Great Britain, filled the Walker Theatre when the presidential address was delivered by Sir Joseph Thomson on August 25. Mr. Francis Darwin, the retiring president, was unable to be present, but he sent a letter, which was read by Prof. Carey Foster, expressing the hope that the meeting would be worthy of its distinguished president. The addresses of presidents of sections were delivered on August 26 and 27, and we are able to print two of them this week, with a summary of the lecture delivered by Dr. A. E. H. Tutton on the former date. We have been forced, however, to omit parts of Prof. Armstrong's long address to the chemical section in order to find space this week for Dr. Smith Woodward's address to the section of geology.

The *Times* correspondent at Winnipeg reports that the proposal to create a separate section of agriculture, which at present is a subsection of botany, has been rejected. On Saturday, August 29, there were various excursions to places of interest. Nearly a hundred members visited Portage la Prairie, and were conveyed in motor-cars through the wheatfields, the trip covering a distance of thirty miles. The visitors were thus given the opportunity of seeing one of the finest wheat areas in the province, and of studying modern methods of garnering the harvest. The botanical section visited Winnipeg Beach, while the members of the engineering section inspected St. Andrew's lock, now being built by the Dominion Government in order to furnish uninterrupted navigation, *via* Red River, between Winnipeg and the lake bearing the same name. In Winnipeg itself a reception was given by Lord Strathcona at his former residence at Silver Heights, and was attended by about fifteen hundred people.

The *Times* also reports that one of the tangible results of the meeting of the Association in Canada has been the purchase by Dr. Gray, the Warden of Bradfield College, Berks, and president of the section of educational science, of a ranch of 2000 acres near Calgary. A competent Canadian has been appointed superintendent, and it is Dr. Gray's intention to afford an opportunity to Bradfield boys, on the completion of their school course, to acquire practical knowledge of the farming and ranching conditions of Alberta.

Dr. T. G. Bonney, F.R.S., will be president of the Association for the meeting to be held at Sheffield next year from August 31 to September 7.

SECTION B.

CHEMISTRY.

OPENING ADDRESS (ABRIDGED) BY PROF. H. E. ARMSTRONG, PH.D., LL.D., F.R.S., PRESIDENT OF THE SECTION.

AFTER an interval only a year short of a quarter of a century, it is my privilege again to occupy the chair of this section, and that, too, under conditions of special significance. The British Association has never before sought to carry the banner of science so far west into British Dominions—never before was it so clear that the progress of humanity is linked with the progress of science by an indissoluble bond: science defined in a word being *knowledge*, not mere work nor mere lip knowledge, but systematised established knowledge, not assumed knowledge —although hypothesis often serves to guide inquiry and truth is arrived at only gradually and slowly by a series of rough approximations. Moreover, science is true knowledge *of every kind*—there is too often a tendency to give a narrow interpretation of the word. One reason probably why the term does not produce any proper effect upon the average British ear is that it is not an English word but a mere adaptation from the Latin—a language which apparently cannot be engrafted upon our Saxon tissues, although, perhaps, it may be that we have so little feeling for it because we have been allowed to learn so little else in our higher schools; monotony of diet ever favours diminutive growth. Germans, I always feel, enjoy a great advantage over us in possessing the popular word *Wissenschaft*—in calling science the *business of knowing*, the *business of gaining wisdom*, of *being wise*.

Naturally I am constrained on the present occasion to take stock of the position of our science, to draw a comparison between the condition of affairs chemical when we met in Aberdeen in 1885 and their present state. No like period of human history has been more fruitful of advance; at the same time, no period illustrates more clearly the difficulties that lie in the path of progress—because of the innate conservatism proper to human nature.

Before attempting to deal with any of the problems which concerned us at Aberdeen, I will first briefly pass the more salient features of advance in review. Few probably are aware how extraordinary is the command we now have of our subject. In 1885, in defending the tendency of chemists to devote themselves to the chemistry of carbon, I could speak of the great outcome of their labours as being the establishment of the doctrine of structure. Everything that has happened in the interval is in support of this contention. It is interesting that in a recent lecture[1] on the Physical Aspect of the Atomic Theory, the most prominent living exponent of physical theories has given a not unwelcome recognition of our right-mindedness in saying: "As time goes on it becomes increasingly difficult to resist the direct evidence for the simple view that, in many cases, chemical combination is not so much a fusion or intermingling of the combining atomic structures as rather an arrangement of them alongside one another under steady cohesive affinity, the properties of each being somewhat modified, though not essentially, by the attachment of the others; and that the space formulæ of chemistry have more than analogical significance." And again in the following passage, in which a far-reaching confession is made: "The aim of structural chemistry must go much deeper (than dynamical methods of treatment); and we have found it difficult, on the physical evidence, to gainsay the conclusion that the molecular architecture represented by stereo-chemical formulæ has a significance which passes beyond merely analogical representation and that our dynamical views must so far as possible be adapted to it." The remark made by Helmholtz in one of his letters, "that organic chemistry progresses steadily but in a manner which, from the physical standpoint, appears not to be quite rational," must be regarded as little more than a confession that he was out of his depth. When properly understood, nothing could be more rational and logical than the way in which our theory of structure has been gradually built up on an impregnable basis of fact, with the aid of the very simple conceptions of valency postulated by Frankland and Kekulé. Our security lies in the fact that the postulates of our theory have been tested in an almost infinite variety of cases and never found wanting; this is not to say they are applicable in all cases, but merely that whenever we are in a position to apply them we can do so without hesitation. Larmor refers to the habit of physicists of taking comfort in Helmholtz's remark; it will be well if instead they make themselves acquainted with our methods and with the results we have won, with a minimum of speculative effort, by the cultivation of an instinct or sense of feeling which experience shows to be an effective guide to action. Now that physical inquiry is largely chemical, now that physicists are regular excursionists into our territory, it is essential that our methods and our criteria should be understood by them. I make this remark advisedly, as it appears to me that of late years, while affecting almost to dictate a policy to us, physicists have taken less and less pains to make themselves acquainted with the subject-matter of chemistry, and especially with our methods of arriving at the root-conceptions of structure and of properties as conditioned by structure. It is a serious matter that chemistry should be so neglected by physicists and that the votaries of the two sciences should be brought so little into communion.

The central luminary of our system, let me insist, is the element carbon. The constancy of this element, the firmness of its affections and affinities, distinguishes it from all others. It is only when its attributes are understood that it is possible to frame any proper picture of the possibilities which lie before us, of the place of our science in the Cosmos. But, as Longfellow sings of the sea in his poem, "The Secret of the Sea," "Only those who brave its dangers comprehend its mystery"—only those who are truly conversant with the root-conceptions of organic chemistry are in a position to attempt the interpretation of the problems of our science as a whole or even to understand the framework upon which it is built up. And yet we continue to withhold the knowledge of the properties of carbon from students until a late period of their development; indeed, when I insisted recently that organic and inorganic chemistry should be taught as one subject to medical students,[1] I was told that it could not be; that the attempt had been made with disastrous consequences. I trust that ere long the futility of such an attitude will be generally realised.

It is remarkable how much our conceptions are now guided by geometrical considerations. The development by van 't Hoff of the Pasteur hypothesis of geometrical asymmetry has been attended with far-reaching consequences during the period under review, the completeness with which the fundamental properties of the carbon atom are symbolised by a regular tetrahedron being altogether astounding.

[1] The Wilde Lecture, 1908. By Prof. Larmor, Sec.R.S., Manchester Literary and Philosophical Society Memoirs.

[1] "The Reform of the Medical Curriculum" (*Science Progress*, January and April, 1907).

Our present conception is that the carbon atom has tetrahedral properties in the sense that it has four affinities which operate practically in the direction of the four radii proceeding from the centre towards the four solid angles of a regular tetrahedron.

More than analogical significance—to use Larmor's expression—must be accorded to this symbol on account of its remarkable accordance with the facts generally, whether derived from the study of asymmetric optically active substances or from observation of the activity of ring structures of various degrees of complexity. Nothing is more surprising than the completeness with which the vast array of facts included in organic chemistry may be ordered by reference to the tetrahedral model. In the future, when our civilisation is gone the way of all civilisations and strangers dig on the sites of our ruined cities for signs of our life, they will find the tetrahedron and the benzene hexagon among the mystic symbols which they have difficulty in interpreting; if, like the ancient Egyptians, we made our tombs records of our wisdom, such symbols would long since have acquired sacred significance and the public would probably have learnt to regard them with awe and to respect them as totems. Chemists might at least wear them on aprons in imitation of the Freemasons; perhaps no two other symbols have so great a significance—they reach into life itself.

It would seem that carbon has properties which are altogether special, the influence which it exercises upon other elements in depriving them of their activity is so remarkable. In their recent discussion of the relation of crystalline form to structure, in which valency is represented as a function of the volume sphere of influence exercised by an element, Barlow and Pope arrive at the remarkable conclusion that carbon is probably the only element the atom of which has a volume sphere of influence four times that of the hydrogen atom; although it combines with four atoms of hydrogen, silicon apparently has only half the volume sphere of influence of carbon. This may, in a measure, account for the very great dissimilarity in behaviour of the two elements, which is most pronounced in their oxides, the single atom of carbon all but dominating two atoms of oxygen in carbon dioxide (which is consequently gaseous), whilst the atom of silicon in silicon dioxide in no way eclipses the two atoms with which it is associated but leaves both charged with residual affinity which enables them to form complex collocations of remarkable fixity in the fire. At bottom the differences between organic and inorganic nature are to be regarded as very largely the expression of this difference. Ropes of sand are proverbially treacherous; yet without sand, if silica had been a gaseous substance, our world might have worn a strangely different aspect.[1]

The mineral world apparently owes its rigidity to the fact that the metals and certain other elements are so imperfectly capable of dominating oxygen that oxides generally polymerise with great readiness, giving rise to substances which do not even fuse easily. The organic, on the other hand, appears to be plastic by reason of the close approach to neutrality which is conditioned by association with carbon.

Nothing is more striking than the remarkable diversity of properties manifest both in the materials which at present we are content to call elements and in the compounds formed by their interaction; the range of variation met with in the case of the compounds of carbon with hydrogen and oxygen alone is almost infinite. We are almost compelled to attribute this diversity more to differences in the complexity and structure of the molecules than to differences in their material composition. The chemist, of necessity, must be a dreamer, knowing as he does that things are not as they seem to be. But this is not sufficiently remembered; indeed, students are systematically trained up in an atmosphere of pretence. The beginner is allowed to regard *elementary oxygen*, for example, as a colourless gas, which is generally harmless until things are presented to it in a more or less heated condition, whereat it takes umbrage and burns them up. He would regard elementary carbon as a soft black substance, which if smeared on the face of the white man makes him look like a nigger, were it not that he also learns that at times it is the hardest and whitest substance known; of organic chemistry, which alone can give him honest ideas of carbon, he is not allowed to hear, as I have said. The sting of awakening conscience is salved by the introduction of a long Greek word when he is told that the two substances, soot and diamond, are *allotropic* forms of the element carbon; nevertheless, he regards them both as elementary carbon. Gradually, perhaps, he awakens to a sense of the wrong that he has suffered at the hands of his teachers, as he realises that from no one substance can he gather what the properties of an element are, that after all the elementary substance is but an ideal —in other words, a mere concept. If appreciative, he then learns to think of the blandness of water, the sweetness of sugar, the sourness of vinegar, the causticity of soda, indeed every distinctive property of every known oxygen compound as more or less a property of, more or less conditioned by, the element oxygen; he is brought back, in fact, to the position from which Lavoisier started, as he realises that the oxygen *gas* which he inhales is not elementary oxygen; he can then perhaps appreciate the wonderful acumen which this greatest of chemical philosophers displayed when he wrote: "Nous avons donné à la base de la portion respirable de l'air le nom d'oxygène en le derivant de deux mots grecs ὀξύς, acide, γείνομαι, j'engendre, parce qu-en effet une des propriétés les plus générales de cette base est de former des acides en se combinant avec la plupart des substances. Nous appelerons donc gaz oxygène la reunion de cette base avec le calorique." We have allowed a century to pass without recognising the wonderfully accurate powers of prevision displayed by Lavoisier; what is worse, we have been so far led astray that instead of regarding oxygen as the characteristic and attractive elements in acids, hydrogen has been allowed to usurp the position: the extent to which the cult of the hydrogen ion now dominates the text-books is well known; in days to come, when the history of our times is written, it will be referred to as a remarkable example of chemical shortsightedness.

Names are needed for the elements which would serve to distinguish the ideal elementary substances from the forms in which they are known to us. No more appropriate name than oxygen could possibly be selected for the fundamental material; if the *gen* terminal could be applied to elementary materials generally, it would be an advantage; it would not be easy, however, if this were done, to devise an appropriate separate name applicable to the active constituent of air.[1]

[1] The solid model of silica which Barlow and Pope have constructed has very remarkable attributes, in that the oxygen atoms appear to be uniformly related and in intercommunication throughout its mass: so that a mass of silica, whatever its size, may almost be regarded as a single molecular complex. A similar view may be taken of the plastic metals such as those of the platinum group, gold, silver and copper. Whether when rendered brittle by association with small amounts of impurity these are resolved into simpler molecular complexes or whether the molecules merely become separated by substances which promote discontinuity and brittleness, it is impossible to say at present. The cause of hardness in mineral materials is, however, a question of no slight interest and importance. The property is strikingly exemplified in the diamond. It is difficult to understand the intense hardness of this material, on the assumption that the diamond is composed of paraffinoid carbon—that is to say, carbon with all its affinities satisfied. At present we appear to have no clue to the manner in which affinity acts in promoting the formation of such solids. But it is obvious that all solids are possessed of some degree of "surface affinity," as they not only grow when placed in solutions but determine the separation of solid from a solution at a degree of saturation which is often considerably below that at which the solution is actually saturated with the substance; and such surface affinity, moreover, is selective, as the determinative effect is exercised only upon the substance itself or substances isomorphous with it—although exception must be made in favour of water, which all surfaces appear to attract. Sir James Dewar's observations on the condensation of gases by charcoal at low temperatures afford most striking illustrations of surface affinity.

[1] In naming the inert gas in air, which he ultimately termed *azotic gas*, having proposed the name *azote* for the element, Lavoisier had in view as alternatives the terms *alcaligen* and *nitrogen*. As there was no proof that the element was a constituent of alkalies other than ammonia, he rejected the former name on the gronnd that it might convey too broad an impression; in course of time the latter is become the popular name, except in France, where motives of piety have prevailed; but the French practice has been justified by the universal use of the term *azo* in connection with many nitrogen derivatives.

Had Lavoisier realised that the alkalies and basic oxides generally owe their basicity to oxigen as much as acids and acidic oxides generally owe their acidity to oxygen—the one being oxygen tempered by metal, the other oxygen tempered by non-metal—as the number of basic oxides far outweighs the number of acidic oxides, he might well have chosen the name alcaligen rather than oxygen. The choice he made was a particularly happy one and striking evidence of his genius and sense of euphony—for oxygen is *par excellence* the acid-forming element and is most truly called *sour-stuff*, the stuff of which sour things are made—for whatever the properties of the

In 1885 I closed my address with a reference to the structure of the elements which implied that their behaviour was that of compound substances; the feeling that this is the case has long been general among chemists. Our present attitude towards this problem is a curious one and not altogether satisfactory—it is impossible to deny that we have somewhat lost sense of proportion, even if our methods have not savoured of the unscientific. The discovery of radium appears to have upset our balance—we have been carried away by the altogether mysterious and unprecedented behaviour of this weird and wondrous substance. But may we not ask: Is radium an element? Has it not been too generally, too hastily assumed that it is? Little as we know of it, does not its behaviour straightway outclass it as an element? Surely it does! Is not the established fact that an emanation proceeds from it, which in turn decomposes and gives rise to helium, a proof of its compound nature? Again, is the evidence of such a character as to justify us in asserting that uranium is the parent of radium? If it be such, must not uranium also disappear from the list of elements; must it not indeed be removed on the ground that it gives rise to uranium without any reference to its supposed relationship to radium?

The answers given to such questions must depend on our definition of an element. At present we seem to be without one.

The conception that the breakdown of radium is spontaneous and apart from all external impulse or control is also one which should be received with caution. There is reason to suppose that in all ordinary cases in which compounds undergo decomposition spontaneously, the decomposition is conditioned by an impurity; the effect, moreover, is usually cumulative. This is true of highly explosive substances, such as chloride of nitrogen and gun-cotton, for example. It might be supposed that something similar would happen in the case of radium—but apparently such is not the case; it is assumed that occasionally a molecule explodes spontaneously, not only without being incited thereto, but also without in any way affecting its neighbours.

The alternative explanation that radium in some way acts as a receiver, transforming energy frnm some external source to which ordinary substances fail to respond and being thereby stimulated to decompose, is at present out of favour, although perhaps more in accordance with its peculiar behaviour.[1]

The liberation of helium as a product of radio-active change is in itself a significant fact, in view of the possibility that helium may be an element of intense activity. Nothing in connection with the problem is more surprising, however, than the apparent production, in course of time, of a whole series of degradation products which differ greatly in stability—such behaviour is entirely without precedent and not at all becoming in elements.

No such remarkable and inspiring problem has ever before been offered for solution. We can only wonder at the results and admire the genius which some have displayed in interpreting them, Rutherford in particular. Yet outsiders may well hold judgment in suspense for the present: whilst it is permitted to workers to make use of hypothesis in every possible way in extending inquiry, the public are in no wise called upon to accept such hypothesis as fact.

But apart from the suggestion that elements may give rise to others spontaneously, we have been entertained of late with stories of elements being converted into others under the influence of the energy let loose by the breakdown of radium. There is reason, however, to suppose that the powers of radium may have been greatly overpainted; energy of almost any degree of intensity in the form of high-tension electricity is now at our disposal, and the effect which radium produces on living tissues, glass, &c., is of the same character as that effected by the Röntgen ray discharge, the only difference being that the effect is produced somewhat more rapidly; it is not to be imagined, therefore, that the discovery of radium has put any very novel intensity of power into our hands.

I pass to the consideration of the classification of the elements. The recognition of certain properties, the association of certain ideals with the several elements, is a necessary step in classifying the elements in accordance with Mendelejeff's great generalisation—or rather it may be said to be both involved in and an outcome of Mendelejeff's conception.

Until recently our difficulty was to understand the relationship of the metallic and the non-metallic elements; now we are confronted with another problem—that of the existence of inert "paraffinoid" elements. It is commonly assumed that these are monatomic, but the evidence on which this assumption is based is absolutely unconvincing, and would be generally admitted to be so were we in the habit of looking before we leapt to conclusions. Assuming that the elements are compounds, the formation of inert compounds does not appear to be out of place, in view of the existence of practically inert hydrocarbons. But, on the other hand, in view of the properties of nitrogen, which is one of the most active of substances in the monatomic state, although an inert gas in the diatomic condition, it may well be that the inertness of helium and the other members of the argon group is also simulated. Sir James Dewar's observations have shown that helium and charcoal have no inconsiderable affinity at the boiling point of the former, which is within five degrees of the absolute zero, the molecular heat of absorption (apart from that due to liquefaction) of helium at that temperature being apparently as high as about sixty calories. The proof he has also given that helium alone does not convey an electric discharge is also of significance since the passage of a discharge through it under ordinary conditions is an indication that it can be included with other substances in a conducting system. Such evidence as there is therefore points to the elements under discussion being different from the others only in the degree of stability of their molecules.

Of late years the difficulty of classifying the elements has been increased rather than diminished, not merely because of the discovery of the inert gases but also on account of the apparent impossibility of ordering the position of an element such as tellurium in accordance with its atomic weight. There appears to be little room left for doubt that the value cannot be far removed from that of iodine; it should be considerably lower. It may be pointed out that the accepted value of selenium is closer to that of bromine than would be expected if a relationship were maintained corresponding to that between chlorine and sulphur. It would seem that Mendelejeff's original conception of the elements as a simple series in which the properties are periodic functions of the atomic weights must be abandoned in favour of some more comprehensive scheme. From the chemist's point of view, it is impossible to abandon the guiding principle underlying the arrangement in family groups, which dates back to Dumas; perhaps insufficient attention has been paid in the past to the maintenance of this principle.

initial oxide of a series, as the proportion of oxygen is increased, the acidic qualities are invariably strengthened.

The choice of a terminal connoting the elementary radicles which would be applicable generally and also acceptable is very difficult. If usage do not forbid change, probably our ears will decline to allow us to be systematic. The terminal *gen* is not applicable to many present names. In the interest of euphony, exception may be taken to the adoption of *ion* as a final syllable. In English ears most of the words with this ending have an ugly sound if pronounced so as to make it significant; moreover, our object is to secure a term which is applicable to the elementary material, whatever its state; the term ion is suggestive of a particular state—a state of chemical activity; and at present there is no agreement as to the nature of an ion. The terms atom, radicle (simple and compound), ion and molecule now all have their separate meaning and value and are indispensable.

The only terminal which seems in any way likely to be generally satisfactory in use is the terminal *yl*, which is already applied to organic radicles; its use might well be extended to radicles generally.

[1] I may here put on record the opinion Lord Kelvin expressed on this question in a letter to me dated September 13, 1906:—

"Ever since, nearly four years ago, we heard of the hundred calories per hour given out by radium, I have had on my mind the question of some possible mechanism such as that which you suggest by which energy from surrounding matter (far or near) could automatically come into radium to supply the energy of the heat which it gives out. The more I think of the question the less I see of that possibility. At present I can see nothing else than that tbe energy given out is taken from a previously existing store of potential energy of repulsive force between separable constituents of radium.

"'The disintegration of the radium atom' is wantonly nonsensical. It is nonsense very misleading and mystifying to the general public, because, if what is at present called radium can be broken into parts, it is not an atom.

"'Energy of an atom' implies a thorough misunderstanding of the meaning of the word energy, which is capacity for doing work.

"I admire most sincerely and highly the energy of the workers in Radio-activity and the splendid experimental results which they have already got by resourceful and inventive experimental skill and laborious devotion. I feel sure that as things are going on we shall rapidly learn more and more of the real truth about radium."

Taking into account this principle, it is impossible to arrange a long series of elements such as the rare earths continuously in order of atomic weight, as they would be brought into every family in the table by such a procedure: the difficulty has been got over by Brauner, who has proposed to arrange a large number of the rare earths in a single vertical series under barium. Biltz has made a similar proposal.

The principle had been advocated by me previously in an article written for the "Encyclopædia Britannica."[1]

In the arrangement I have proposed, it is not only assumed that there may be as many as sixteen vertical series of elements of which the elements from hydrogen to oxygen are initial terms, some series being at present unrepresented, it is also suggested that groups of elements occur in perhaps four of these series, numbers 4, 8, 12 and 16, the largest being that of the so-called rare earths in series 8.

The principle which is assumed to be in operation is that which is so clearly manifest in the case of hydrocarbons: successive vertical series of elements correspond to successive isologous series of homologous hydrocarbons. In the case of the hydrocarbons, the passage from one isologous series to another often takes place from a term several places removed from the origin of the series—for example, from benzene, C_6H_6, which may be regarded as primarily a derivative of hexane to naphthalene, $C_{10}H_8$, which is not an immediate derivative of benzene but of butylbenzene. It is conceivable that at the genesis of the elements a process was at work corresponding to that by which a hydrocarbon such as naphthalene is derived from benzene, and by which the former then serves in turn as the point of departure for more complex hydrocarbons of other series. There is no reason, from this point of view, why progression should not take place along a particular line and that terms should exist in a series through which this line passes but below it —for example, that antimony and iodine may bear a direct linear relationship, but that tellurium, instead of being the element in the progression series in the oxygen group, is a homologue of greater weight. The same view may be taken of selenium. In this way, it would be possible to maintain selenium and tellurium in the oxygen-sulphur series, from which they cannot well be separated, whilst retaining Mendelejeff's conception of a genetic relationship along the series. The only departure involved is in assuming that instead of forming a single linear series ascending regularly in spiral progression—a series which can, as it were, be strung on a single spirally wound cord—the elements closely simulate a series of homologous isologous hydrocarbons. From this point of view, it is easy also to understand that some vertical series are unrepresented.

In discussing the chief attributes of the elements none is so difficult to deal with as that of valency, using the term in the broadest possible sense, not merely as indicative of the number of units of affinity but as including the, at present, all but incomprehensible problems of residual affinity and elementary character. I discussed the subject somewhat fully in my former address, dwelling especially on the properties of negative elements and their power of acting as linking agents; this view has met with ample confirmation in the interval, and will, I believe, be found to be of wide application in the future. I have already referred to the manner in which it is exemplified by silica.

The greatest advance in the discussion of the problems of valency in recent years is that made by Barlow and Pope, as their method of treatment is one which applies to solid substances—the correlation of structure with crystalline form which it effects promises to be of far-reaching importance.

Apart from hydrogen, carbon is the one element of certain character, always acting as a tetrad—its affinities may be only incompletely satisfied but they are always exercised, it may be supposed, even in ethenoid and similar compounds; carbon monoxide apparently is the only exception to this rule, its relative inactivity being one of the most puzzling enigmas of our science, especially as the oxide becomes one of the most active of known substances when only two atoms of hydrogen are added to it. Most other elements (non-metallic) seem to vary in valency, the valency beyond a certain minimum being dependent on the nature of the association. Of late years, attention has been directed in particular to the quadrivalency of oxygen in many of its compounds.

[1] *Cf.* Roy. Soc. Proc., 1902, vol. lxx., pp. 86–94.

The quadrivalency of sulphur in substances such as trimethylsulphonium iodide, Me_3SI, having been proved to demonstration by the production of optically active compounds of this type (Pope and Peachey), it can no longer be supposed that in such cases we are dealing with compounds in which the negative constituents of the parent molecules are conjoined, *e.g.* $MeI : SMe_2$. And yet we must contemplate the existence of such compounds as possible—in the case of nitrogen, for example, as ammonia must be supposed to form the compound $NH_3 : OH_2$ in preference to the hydroxide $NH_4.OH$, the latter being only a very minor constituent, the former the major component of the aqueous solution of the gas; hydrogen chloride, on the other hand, appears only to afford one product with ammonia, viz. $NH_4.Cl$. The existence of such differences affords clear proof in the case of the non-metallic elements other than carbon that valency is not merely a variable but also a reciprocal or dependent function.

There is no reason to suppose that hydrogen ever acts otherwise than as a simple monad; and the behaviour of the alkalies and alkaline earths in salts would seem to justify the conclusion that they have no tendency to vary in valency, were it not for the existence of well-defined non-volatile hydrides of these metals which are clearly substances of some degree of molecular complexity. Such compounds are illustrations of the difficulties which surround the subject. It has long been clear that the exhibition of the higher valency by an element is a process of a different order from that manifest when it exerts only its lower proper valency measured in terms of positive radicles such as H or C_nH_{2n+1} radicles. What that difference is we are not able at present to decide—carbon (together with silicon) differs from almost all other elements, especially in combining with hydrogen and analogous radicles to the extent of its maximum valency.

The proposition I made in 1888 (*Phil Mag.*, Series V., 25, 21) that the valency lines should, in some cases, be represented as passing through the atom, so that each is capable of acting in two directions, is the only consistent mode of expressing varying valency which has been devised, the only one, moreover, by which attention is directed to the great difference.

In many cases probably there has been a tendency to exaggerate the valency value—in the case of chlorine, for example, in assuming that it functions as a heptad in the perchlorates. In this and many other instances, it suffices to assume that the chlorine and oxygen atoms are united in a closed ring, the chlorine functioning as a triad. Some such explanation will doubtless be given of the structure of the metallic ammonias and similar compounds. The co-ordination values introduced by Werner serve only to establish certain empirical relationships and are useful for the purposes of classification. The perhaps more rational plan of dealing with such compounds suggested by Abegg has a similar value.

It is to the advantage of the hypothesis formulated by Barlow and Pope that the elements are represented as of constant valency in so far as their relative volume spheres of influence are concerned—the compound in which the higher valency is manifest being derived from that of lower valency by the opening out of the close packed arrangement and the insertion of certain new elements; but the fact that in such cases the volume is altered not in one direction alone in the crystalline structure but proportionately in all directions would seem to show that the volume sphere of atomic influence does actually change; the change is one, however, which affects all the atoms in the complex proportionately.

At present, unfortunately, our methods of treating the problems of valency are such that we cannot in any way give expression to the energy side of the phenomena.

Of late there has been talk of electrons in this connection, but what is said is little more than superficial paraphrase, in the advanced scientific slang of the day, of the ideas which have long been current. When, following Odling, we represent valency by dashes written after the elementary symbol, we give clear expression by means of a simple convention to certain ideas that are well understood by all among us who are versed in the facts; to speak of electrons and use dots instead of dashes may serve to mislead the unwary, who hang on the lips of authority, into a belief that we have arrived at an explanation of the phenomena, but those who know that we have reached only the let-it-be-granted stage and who feel that the electron is possibly but a figment of the imagination [1] will remain satisfied with a symbolic system which has served us so long and so well as a means of giving simple expression to facts which we do not pretend to explain. Not a few of us who listened to the discussion of the nature of the atom at Leicester could not but feel that the physicists knew nothing of its structure and were wildly waving hands in the air in the endeavour to grasp at an interpretation which would permit of mathematical interpretation being given to the facts. Until the credentials of the electron are placed on a higher plane of practical politics, until they are placed on a practical plane, we may well rest content with our present condition and admit frankly that our knowledge is insufficient to enable us even to venture on an explanation of valency.

In 1885 and again in 1888, I ventured to call in question the interpretation of valency which Helmholtz had given in the Faraday lecture in 1881. On the present occasion, I would insist still more emphatically on the insufficiency of the atomic charge hypothesis; especially that it affords no satisfactory explanation of variable valency and of those fine shades of difference which are manifest, especially in the case of nitrogen, when the radicle attached to the dominant element is varied. In 1885 I discussed this question with reference to the nature of electrolytes and questioned the conclusion Helmholtz arrived at that electrolytes belong to the class of typical compounds the constituents of which are united by atomic affinities, not to the class of molecular aggregates. The opinion I then ventured to give was as follows:—

"The current belief among physicists would appear to be that primarily the dissolved electrolyte—the acid or the salt—is decomposed almost exclusively. We are commonly told that sulphuric acid is added to water to *make it conduct*, but the chemist desires to know why the solution becomes conducting. It may be that in all cases the 'typical compound' is the actual electrolyte—*i.e.* the body decomposed by the electric current—*but the action only takes place when the typical compounds are conjoined and form the molecular aggregate*, for it is an undoubted fact that HCl and H_2SO_4 dissolve in water, forming 'hydrates.' This production of an 'electrolytical system' from dielectrics is, I venture to think, *the* important question for chemists to consider. I do not believe that we shall be able to state the exact conditions under which chemical change will take place until a satisfactory solution has been found."

The position is not very different now. Although the propagation of the ionic dissociation cult has assumed the form of a fine art, we are still as far as ever from agreement as to the nature of chemical change; the speculation has not helped us in the least to clarify our ideas; at most we learn that interactions are between ions, and even these, as a rule, are supposed to remain apart until they enter into the solid state. Throughout all these years I have never varied my opinion that the dissociation hypothesis is incompatible with the facts. On more than one occasion I have stated definite reasons which induce me to deny its usefulness,[2] and these arguments have never been met; in fact, there has been little but a conspiracy of silence on the part of the upholders of the creed.

A large amount of work bearing on the subject has been done, chiefly by H. Brereton Baker. Strangely enough, no proper notice of his results has been taken outside England, and even there the importance of the observations has not been sufficiently appreciated. Perhaps the most remarkable feature in the situation is that Baker himself scarcely seems to be alive to the meaning of the evidence which he has supplied; the attitude which he has displayed in his recent Wilde lecture can only be described as halting. Baker has shown, in case after case, that the occurrence of change is dependent on the presence of moisture, his greatest feat perhaps being the observation that it is possible not only to prepare nitrous anhydride in the solid and liquid states but to volatilise it unchanged if only water be excluded.

I venture to think there is only one point of view from which the problem of chemical change can be approached, that, namely, which we owe to Faraday—to which hitherto justice has in no way been done—on which I dwelt persistently in my previous address: that the forces termed chemical affinity and electricity are one and the same. In every case of chemical change there is a coincident electrical change, an electric flux; on the other hand, every case of electrical change is accompanied by chemical change, some alteration in molecular configuration is effected; the force of chemical affinity is in some way disturbed by a momentary displacement of the molecules when a current passes through a conductor. Such being the case, the conditions determinative of chemical change can only be those which permit of an electric flux. Two substances in apposition do not give rise to a current; at least three are required to determine a slope of potential. Chemical change can only take place if one of the three be an electrolyte. In all cases apparently the chemical change supervenes upon the electrical, the electrolyte being resolved into its ions, one of which at least combines coincidently with the adjacent electrode. Apparently these considerations are applicable to changes generally. And it should be added that, according to this view, the catalyst actually determines the occurrence of change.

The only other criterion which it is necessary to apply in order to decide whether change be possible in any given case is to consider if the change contemplated be one involving development of energy. It is important to remember also that a change which could not otherwise take place becomes possible when a suitable depolariser is introduced into the circuit.

The evidence that similar considerations apply to the gaseous and the liquid states cannot well be gainsaid. Before framing a theory of chemical change it is therefore necessary to formulate a definition of an electrolyte. It is doubtful if any single substance be an electrolyte; the conductivity of fused salts may well be and probably is conditioned by some admixture. Aqueous solutions of alkalies, acids and salts without exception are electrolytes. *Everything points to the fact that in such solutions the solvent and solute act reciprocally; the contention that the solute alone is active cannot be justified.* As water is altogether peculiar in its activity as a solvent and is a solvent which gives rise to conducting solutions, an explanation of its efficiency must be sought in its own special and peculiar properties.

Since 1886 this conclusion has been impressed upon me with indisputable force, and I have frequently ascribed the effect produced by the one constituent upon the other in a solution to the residual affinity of the negative elements in the two compounds which act reciprocally. It was only recently, however, that I saw my way to postulate a complete theory which would serve to account for the properties of solutions and generally that I realised how the reciprocal effect might be produced.

I would substitute for the misleading conception that liquids are comparable in their behaviour with gases the idea that the liquid state is one in which the residual affinity of the negative elements in particular always comes into play and causes the formation of molecular aggregates of various degrees of complexity; moreover, that the alteration in the properties of any given solvent by the dissolution in it of another substance is largely, and, in some cases, mainly due to a disturbance of the equilibrium natural to the solvent by an alteration in the proportion in which the several aggregates are present. The alteration in some particular property produced in *a given mass of the solvent* may, from this point of view, be taken as the measure of the activity of a substance, just as the alteration in the pressure of a particular volume is taken as the measure of the alteration produced in a gas. In the case

[1] In my opinion the experimental evidence is in no way satisfactory. It appears to me to be desirable that in studying the phenomena of electric discharge in gases and especially in vapours of complex substances, the horrible pitfalls should be taken into account with which the field of work is studded; unless every precaution to secure purity—precautions such as Baker and Dewar have taught us to use—be taken at every step, the conclusions based on all such observations must be open to grave doubt.

[2] Compare Chem. Soc. Trans. 1895, 1122; Royal Soc. Proc. 1886, xl., 268; 1902, lxx., 99; 1903, lxxii., 258; 1904, lxxiii., 537; 1906, lxxviii., 264; 1907, lxxix., 586; 1908, lxxxi., 80; *Science Progress*, April, 1909.

of non-electrolytes, if only a small amount of the solvent be withdrawn by combination with the solute, the alterations may be regarded as almost entirely due to the "mechanical" interference of the substance introduced, opportunity being given for the simpler, more attractive molecules of the solvent to exist in greater proportion because of the diminution of the chance of reuniting which is conditioned by the presence of practically inert molecules of another kind; if a more or less considerable amount of the solvent become associated with the solute the conditions become more complex, but similar considerations apply. From such a point of view a liquid is rendered more active by the addition of any soluble substance. Its vapour pressure is therefore diminished; the internal "osmotic" stresses are raised; its freezing-point is lowered.

Although it is generally admitted that water is not a uniform substance but a mixture of units of different degrees of molecular complexity, the degree of complexity and the variety of forms is probably underestimated and little or no attention has been paid to the extent to which alterations produced by dissolving substances in it may be the outcome and expression of changes in the water itself. The attempt to extend the "laws" which are applicable to the gaseous state to liquids has led us away from the truth by narrowing our conceptions. If the contention be justifiable that the alterations attending dissolution are very largely alterations in the character of the water, attention has been directed of late far too exclusively to the dissolved substance.

To give emphasis to the view, I have advocated[1] the restriction of the name *water* to the liquid mixture and have proposed that the simple molecule represented by the symbol OH_2 be termed *Hydrone.* The generalised expression

$$(H_2O)_x \rightleftarrows xOH_2$$

may be considered to be representative of the state of equilibrium in water—that is to say, of the character of the change which it undergoes when the conditions are varied either physically or by dissolving substances in it—in the sense that it pictures the resolution of the more complex into simpler forms and *vice versâ*, without taking into account the variety of molecular forms (x, x^1, x^2 . . . .) which are present.

It is probable that the agreement between "theory" and practice on which reliance has been placed, particularly in interpreting osmotic phenomena, is more often than not only apparent and fictitious, and but the outcome of counterbalancing effects which have been left out of account. We are too prone to believe in constants; we need to remember that, except perhaps in the case of the perfectly gaseous state, *constants are dependent variables.* To take an example, it is assumed that glucose and cane sugar produce like osmotic effects when used in equivalent proportions; indeed, it has been the fashion of late years to treat non-electrolytes as harmless neutrals: in point of fact they differ as much in behaviour as do electrolytes, and such a conclusion must be viewed with the gravest suspicion. Recently Dr. Eyre and I have been able to show that three substances so similar as methylic, ethylic and propylic alcohols produce effects in precipitating salts from solution which are markedly different, propylic alcohol being the most effective although the least soluble. It is clear that the precipitant does not act mainly by itself combining with and withdrawing water in direct competition with the salt; but that it promotes the *dissociation of water* by the mechanical interposition of its molecules; in fact, that the "dehydrating" powers *of the water* are enhanced owing to the increase in the proportion of simple molecules in the liquid conditioned by the presence of the solute.

The same effect is obvious when the reduction of the electric conductivity of a salt, such as potassium chloride, by equivalent quantities of the three alcohols is considered. This amounts to about 6 per cent. in the case of methylic, 12 in that of ethylic, and 17 in that of propylic alcohol; the reduction effected by glucose, however, amounts to about 27, and that effected by cane sugar to no less than 42 per cent. In these two latter cases the amount of water actually withdrawn from the solution by the sugar is probably considerable, and the "mechanical effect" of the solute is therefore exercised in a more concentrated solution—more concentrated, that is to say, than those in which the alcohols act. If, therefore, solutions of glucose and cane sugar of equivalent strength produce like osmotic effects, it is because unperceived compensating factors are at work in the solutions which in algebraic sum have the same aggregate influence.

To explain the effect produced by substances which give rise to conducting solutions when dissolved in water (acids, alkalies, and salts), it is necessary to consider the special nature of the changes which may be supposed to attend dissolution in such cases. Why, it may be asked, is an aqueous solution of hydrogen chloride a conductor, whilst that of alcohol is a non-conductor? I believe the answer to be that it is because, in the former case alone, the two components of the solution are *reciprocally distributed*; that it is because two correlative systems—

$$HCl\begin{matrix}H\\OH\end{matrix} \quad \text{and} \quad H_2O\begin{matrix}H\\Cl\end{matrix}$$

are produced which interact under the influence of the electric stress.[1] In the case of alcohol no such interchange takes place. It may be that the alcohol is hydrolated to some slight extent, but the hydrol must be less basic than hydronol; probably, like ammonia, alcohol exists in solution for the most part in the hydronated state:—

$H_2O\begin{matrix}H\\ \diagdown OH\end{matrix}$	$EtHO\begin{matrix}H\\ \diagdown OH\end{matrix}$	$EtHO{=}OH_2$
Hydronol.	Ethanol-hydrol.	Ethanol-hydrone.

Much more must be learnt of the properties of solutions before definite decisions can be arrived at with regard to such delicate and refined issues.

I would apply the interpretation here given of the nature of conducting solutions generally to the explanation of all cases of chemical change: in other words, I assume that in all cases correlative systems are present which are formed by the reciprocal distribution of the interacting substances. From this point of view the solvent is no mere medium but an active participant in the series of interchanges of which, as a rule, only the final product is noticeable.

The solution thus offered of the complex problem discussed very fully in my Address in 1885, which has ever since occupied my thoughts, will, I trust, be found to be helpful, although by no means complete in all its details.

In effect, the doctrine makes no demand which the chemist should not be able to grant forthwith, as it is generally supposed that hydrols are easily formed—to give an example, in the case of the conversion of chloral, $CCl_3.COH$, into chloraldehydrol (chloral-hydrate), $CCl_3.CH(OH)_2$. The novelty of the conception lies in supposing that the occurrence of electrolysis involves the interaction of the hydrol and its correlative and the explanation which it affords of the difference between electrolytes and non-electrolytes.

It is essentially an association theory, although it involves the dissociation of the interacting substances but never the production of separated ions. In the case of aqueous solutions the amount of the distributed substances may be taken as the measure of the activity—of the degree of ionisation, so-called. A wrong view prevails that the so-called molecular conductivities are measures of activity; they are in reality only measures of the relative activities under corresponding conditions of the substances to which they refer. The molecular conductivity of an acid is at a maximum in its weakest solutions: presumably it is then present to the maximum extent in its simplest state and in the active hydrolated state; but as a hydrolytic agent its activity is at a maximum near to the opposite end of the scale. In other words, the hydrolytic activities of a series of acids are in the order of their molecular conductivities in solutions of comparable strength, but molecular-hydrolytic and molecular-electrolytic activity run in opposite directions; the maximum electrolytic conductivity of an acid solution, which is manifest at a particular

[1] Roy. Soc. Proc. 1908, xxxi., 80; *Science Progress*, January, 1909.

[1] I would repeat the plea I put forward in 1885 that the use of the term hydrochloric acid as applied to hydrogen chloride is undesirable if not unjustifiable; the solution of the gas may be said to contain *chlorhydric acid*, $HCl(OH_2)x$. From my point of view, oxygen *is* a constituent of all acids.

degree of concentration—presumably at the point at which the two forms of the distributed materials most nearly balance—is also in no way identical with maximum molecular hydrolytic activity. On these assumptions not a few of the deductions based on the ionic dissociation hypothesis are clearly fallacious.

It has been asserted that the association hypothesis does not admit of quantitative treatment, and that therefore it is at a disadvantage; but if the quantitative meaning given to various results in accordance with the tenets of the dissociation hypothesis be more often than not one which is inadmissible, little is gained by applying the speculation quantitatively. As already remarked, the only cases in which chemical and electrolytic activity can be compared by the methods proposed are those in which the comparison is made between solutions of comparable or equivalent strength—that is to say, between compounds arranged in vertical series in the order of their activity.[1] Electrolytes are comparable in most, if not in all, their properties when the comparison is made in this way; but order of activity is one thing, actual activity another. It is in this sense, and this sense only, that we may agree with Arrhenius in his statement, "L'activité électrolytique se confond avec l'activité chimique."

The ionic dissociation hypothesis is a beautiful mare's-nest, which fails apparently to fit the facts whenever it is examined. "And the moral of *that* is," to quote the words of the classical Duchess so well known to children, "we must not use the words *ion* and *ionisation* in any speculative sense but confine their application to cases such as were contemplated by Faraday when he introduced the term ion; the conception of activity, whether electrolytic or chemical, should alone be attached to such words; no idea of actual, separate, individual existence should enter into our minds in using them: the ion is to be thought of merely as the potentially active, transferable radicle in a compound, not as a separated particle enjoying independent existence." It is so easy to speak of dissociation when it is desired to give expression to the idea; the first thing the scientific speaker or writer should guard against is ambiguity.

The subject of gaseous interchanges must not be left out of account, although it is impossible to do justice to it. Mendelejeff's contention that gaseous interchanges are usually bimolecular has been defended by Dixon and Larmor of late. But the facts must be faced. The almost inconceivable frequency of the molecular impacts must not be forgotten. The extraordinary attractive power of the hydrone molecule is also to be remembered—this would tend to promote the formation of aggregates with which the necessary third substance would every now and then form a bimolecular system—which, however, would in reality be at least trimolecular. The proportion of hydrone molecules in a dried gas has probably been under-estimated —the density of hydrone being very low (9)—as no dehydrating agent can be supposed to remove all such molecules or even nearly all; the hydrated substance must have a certain pressure of dissociation. Sir James Dewar's appears to be the only method which is in any way deserving of the epithet absolute; the results he has obtained with helium in a radiometer are strongly in favour of my view. Lastly, the gradual growth in velocity of the explosive wave up to the point of detonation as the compression becomes greater is clear indication that reduction in volume and increase of opportunity for the formation of systems of the proper degree of complexity is a matter of great consequence. Even the behaviour of cordite is significant, particularly the projection of unburnt rodlets of the material from the gun: apparently it is not decomposed by shock intramolecularly but is decomposed by heat into gases, which interact explosively.

Having dealt with the subjects of chemical change and the nature of solutions, however inadequately, I must now endeavour to justify my opening reference to the importance of the organic side of our science.

The province of organic chemistry is so vast that it may appear to be difficult to distinguish the main lines of advance from the by-paths which intersect the field of inquiry in every direction. In reality this is not the case; certain salient features stand out which must attract attention if once attention be directed to them. The efforts of the chemist to elucidate structure and to correlate structure with function have been extraordinarily successful. In the first place, as already remarked, the student of the subject now has his attention concentrated on the tetrahedron as the symbol of the *functional activity* of carbon; however numerous the compounds, he knows that certain simple rules can be laid down as applicable to all. It is established beyond question that carbon atoms have a remarkable tendency to form ring systems. The affinities of the atom seem to act almost rigidly in certain directions, which appear to be those of lines drawn from the middle point of a regular tetrahedron to its angular points. Rings containing either five or six atoms of carbon are therefore those which are most readily formed and of maximum stability; carbon atoms may and do unite in pairs, threes and fours, but compounds of this order are far less permanent than those containing either five or six atoms, as the affinities appear to meet in such a manner that they do not satisfy each other and consequently the compounds enter somewhat readily into combination with other substances. When the number of carbon atoms exceeds six, not only is there less tendency to form a ring system but the stability of the system is slight; when the number is considerable, stability is attained by the formation of complex systems, consisting of several rings conjoined (camphor, naphthalene, anthracene, &c.).

The behaviour of carbon compounds generally, in so far as this may be regarded as dependent on the condition of the carbon, is extraordinarily simple, and may be summed up in the statement that it is either paraffinoid, ethenoid or benzenoid.[1] Paraffinoid carbon is incapable of combining with other substances and but slightly attractive, so that the hydrogen atoms are by no means easily displaced from paraffinoid compounds[2]; ethenoid carbon combines readily with various substances, forming compounds of paraffinoid type; in the benzenoid state, carbon appears to combine somewhat readily with a variety of substances, but the products enjoy only an ephemeral existence and usually escape notice, as they at once break down, giving rise to benzenoid substitution derivatives, so that in this last form carbon simulates the paraffinoid state but is more active.

In earlier years our attention was concentrated on benzene and the benzenoid compounds; much was done to elucidate the structure of these hydrocarbons and of their derivatives; meanwhile these latter have proved to be of extraordinary significance technically, notably as dyestuffs, but also on account of their medicinal value, as perfumes and in photography.

The structure of benzene has been the subject of much discussion during the period under consideration. I trust I shall not be accused of parental bias if I urge that the centric[3] formula is the best expression of the *functional activity* of the hydrocarbon benzene and its immediate derivatives; the attempts which have been made of late years to resuscitate the Kekulé oscillation hypothesis in one form or another appear to me to be devoid of practical significance. Any formula which represents benzene as an ethenoid must be regarded as contrary to fact. But in considering the properties of benzenoid compounds generally, it is necessary to make use of the Kekulé conception as well as the centric expression. The model of benzene devised by Barlow and Pope subserves a somewhat different and complementary purpose, being primarily of importance

[1] Solutions of acids and alkalies have maximum conducting power at certain relatively high degrees of concentration. Hydrolytic activity also increases steadily in the case of acids as the solution becomes more concentrated; whether it attains to a maximum and whether this coincides with the conductivity maximum is uncertain at present; it is very difficult to decide this point experimentally, as the rate of change is so rapid in strong solution; moreover, the action takes another course in strong solutions, as compounds are formed by the interaction of the hydrolyte and hydrolist, so that two changes are superposed which cannot well be followed separately.

[1] A fourth condition requiring recognition is that of the carbon in acetylene; at present the acetylene compounds are so few in number, however, that this form may be left out of account.

[2] The displacement of the hydrogen associated with carbon is in all probability a secondary phenomenon; it is likely that this is true generally and that hydrogen is never merely removed or attracted away but always has its place taken by a radicle which becomes temporarily attached to the multivalent atom with which the hydrogen is associated.

[3] I have discussed this matter somewhat fully in a recent essay, with reference to the nature of amorphous carbon, in connection with the remarkable work of Sir James Dewar on the absorption of gases by charcoal at low temperatures (*Journal of the Royal Institution*).

on the geometric side in discussing the relation of form to structure.[1]

The discovery of trimethylene by Freund and the subsequent introduction of synthetical methods of preparing polymethylenes by W. H. Perkin, jun., mark the onset of a new era, opening out as they did the possibility of understanding the structure of camphor and the terpenes and other constituents of the volatile oils from plants.

Chemist after chemist had attempted in vain to solve the riddle presented by camphor. Suddenly, in a moment of inspiration, a satisfactory solution of the problem was offered by Bredt. The acceptance of the bridged ring, the special feature of the Bredt formula of camphor, marks the introduction of a new moment into organic chemistry.

The recognition of similar rings in several hydrocarbons of the terpene class, mainly in consequence of the masterly work of von Baeyer, has contributed in no slight degree to an understanding of these compounds; nevertheless, much remains to be learnt and there are many and serious difficulties to be overcome before we shall be in a position to appreciate the genetic relationship of all the substances included in the group. When the account of the work is written it will form one of the most striking and fascinating chapters in the history of our science.

Among the many names of those who have contributed to its development the first to be mentioned is that of Wallach, to whose unwearied efforts, continued during a long series of years, so much is owing. The synthetic work carried out with brilliant success in recent years by W. H. Perkin may also be referred to as of extraordinary promise but of well-nigh inconceivable difficulty.

Before leaving this chapter, reference should be made to the almost protean character of camphor, as disclosed by the work of inquirers such as Kipping, Pope, Forster, Lapworth and Lowry; no other substance has lent itself to use in quite so many directions and with such fruitful results. Special mention may be made of the demonstration which Pope has given, with the aid of the camphorsulphonic acids, that nitrogen, sulphur, selenium and tin give rise to optically active substances in all respects analogous to those furnished by carbon. The success with which Kipping's arduous labours have been crowned is also very noteworthy, taking into account the many difficulties he has overcome in preparing optically active silicon compounds. The extension of the Pasteur-van 't Hoff theory of asymmetry inferentially to all elements which are at least quadrivalent, now accomplished, is of superlative importance.

Lowry's refined observations on the conditions which determine the interconversion of isodynamic forms of some of the camphor derivatives may also be cited as of special value as a contribution to the study of metamerism and the conditions which determine chemical change generally.

Not the least interesting feature of camphor is the light thrown by its behaviour on the influence which oxygen exercises as an attractive element and on the part which spatial configuration may play in determining directions of change. It is clear that, whatever the agent, the attack is always delivered from the oxygen centre and that the direction in which the attack becomes effective depends on the position which the agent can take up relatively to the various sections of the molecule.[1]

It must be confessed that our efforts to penetrate behind the veil in the case of the higher carbohydrates—starch and cellulose in particular—have not been rewarded with success.

Moreover, though much has been done of late years to unravel the nature of the vegeto-alkaloids, substances such as quinine are still only partially deciphered and not one of the more complex alkaloids has been produced synthetically. In view of the fact that quinine is still the one effective and practically safe anti-malarial medicine, the disclosure of its constitution is much to be desired. The isolation of adrenaline from the suprarenal capsule and the discovery that this alkaloid—which is an extraordinarily active substance physiologically—plays a most important part in controlling vital processes is of supreme interest. Other glands—the pituitary gland, for example—appear to contain peculiar active substances, which are of particular consequence in regulating animal functions. The discovery of such substances affords clear proof that life is largely dependent on what may be termed chemical control.

In addition to indigo, the simpler yellow and red natural colouring-matters have now been thoroughly examined, but this class of substance still affords abundant opportunity to investigators. Kostanecki's comprehensive studies of the xanthone group may be referred to as of particular value.

Attention may be directed here to the investigation of brazilin and hæmatoxylin by W. H. Perkin and his various co-workers, not merely as being full of interest and importance as a contribution to our knowledge of the relation between colour and structure and as a brilliant example of technical skill but because of the illustration it affords of the extreme intricacy of such inquiries and of the vast amount of labour they entail. The general public probably has not the slightest conception of the difficulties which attend such research work and of its costliness.

As an investigator of vegetable colouring-matters, no one has been more assiduous or has displayed greater skill of late years than A. G. Perkin. His recent refined investigation of the colour-yielding constituents of the indigo plant is of exceptional value at the present time, although it is to be feared that it comes too late to save the situation in India. The work of the brothers Perkin, it may be pointed out, is of exceptional interest on the human side as well as from the scientific standpoint, as their enthusiasm and wonderful manipulative skill afford a striking and noteworthy example of hereditary genius.

Two substances of commanding interest which have long resisted attack—the red colouring-matter of the blood and leaf-green—are at last going the way of all things chemical, as the secret of their nature is being wrung from them. In Willstätter's skilful hands chlorophyll is proving to be by no means the fugitive material it was supposed to be; the complexity of the problem it offers, however, seems to be far beyond anything that could have been anticipated; so much greater will be the interest attaching to the final solution. The discovery that green chlorophyll is a magnesium salt is of special importance, as the first clear indication of the manner in which magnesium salts are of service to plants.

Apart from the special interest which attaches to the investigation of vegetable colouring-matters on account of their being coloured substances, such inquiries are of value as furnishing material for the discussion of the metabolic activity of plants.[2]

[1] The time is now approaching when it will be possible to extend the study of benzenoid compounds beyond the formal and superficial stage; hitherto we have been content to develop the methods of preparing such substances and to determine their number and their distinctive properties. Everything has to be learnt as to the exact character of the changes which attend their formation from the parent substance benzene and as to the exact nature of their inter-relationship. The impression produced by benzene, in my mind, is that of an eminently plastic system capable of responding to every slight change that may be impressed upon it. Nothing is more remarkable than the difference between benzene and its homologues, so obvious in the extraordinary increase in activity which attends the introduction of hydrocarbon radicles in place of one or more hydrogen atoms. But such plasticity is not characteristic of benzene only: if the properties of benzenesulphonic acid be contrasted with those of the various substituted benzenesulphonic acids, it is clear that every variation meets with some response from the sulphonic group; what is still more remarkable, if the hydrogen in the hydroxylic group in the phenolsulphonic acids be displaced by other radicles, not only does the oxygen atom to which the radicle is attached seem to respond to the change but the benzenoid system and the still more distant sulphonic system are also affected. It is well known that the physical constants are all variables in the case of benzenoid compounds. Perhaps the most remarkable confirmation of the view here advanced, however, is that afforded by the conclusion arrived at by Barlow and Pope that in the case of benzene derivatives, although the spheres of influence of the carbon and hydrogen atoms are relatively the same as in the parent compound, the spatial arrangement of the component spheres of atomic influence remaining practically unchanged, nevertheless the actual volumes of the spheres of influence of both carbon and hydrogen alter proportionally to the alteration in molecular volume. Thus they maintain that in the case of the conversion of benzene (molecular volume 77·4) into tetrabromobenzene (molecular volume 130·2), the volumes of the spheres of influence of both carbon and hydrogen expand in the ratio of 77·4 : 130·2. Such a conclusion is very noteworthy.

[1] *Cf.* Chem. Soc. Trans.

[2] But a note of sadness pervades the story. The effect of learning to understand Nature always appears to be that we at once brush her aside when we have wrested from her the secrets which she has so long preserved inviolate. No sooner did we learn the nature of the madder colouring-matters than we proceeded to prepare them artifically—thus putting an end to the cultivation of a valuable crop. Indigo is meeting with a like fate, a catastrophe which might well have been avoided had scientific assistance been called in at the proper time. Not content with making natural colouring-matters, we set to work to outrival the rainbow in our laboratories and the feminine world is decked with every variety of colour in consequence, although unfortunately our blends too often lack the beauty of those of truly natural origin, which rarely, if ever, offend the eye. We congratulate ourselves on our cleverness in thus imitating Nature but no idea of thrift

Even colloids are being brought into line. Studded as they are with active centres (oxygen or nitrogen atoms), they seem to be able to attract and retain hydrone molecules at their surfaces in ways which give them their peculiar glue-like attributes: as a consequence living tissue appears to be little short of animated water.

To the present generation of students, the organo-metallic compounds must have appeared to belong to the past; the discovery of methides of platinum and gold by Pope will not only serve to re-awaken interest in this group of compounds but is of primary importance as a contribution to our knowledge of the valency of these elements; the stability of the platinum derivatives is altogether astonishing.

The discovery announced in June last, at the International Congress of Chemistry, by Mond, of compounds of carbonic oxide with ruthenium and uranium is a striking and most welcome extension of his previous labours, which had placed us in possession of carbonyls of nickel, iron and cobalt. The metallic carbonyls possess altogether remarkable properties: at present, these defy explanation; nickel carbonyl in particular seems to be an exception to all rules. The complex iron carbonyls made known by Dewar and Jones also have most fascinating attributes, the variety of colours they display being specially interesting. The marked individuality of the members of the iron group as exemplified in their carbonyl derivatives is in striking contrast with the tendency they display to behave as related elements; the deeper problems of valency are clearly exposed for consideration in such peculiarities.

The discoveries of the special activity of magnesium as a synthetic agent and of the superior value of nickel as a catalyst in fixing hydrogen are other illustrations of the individuality of metallic elements. We are greatly indebted to the French chemists for the invaluable preparative methods they have based on the use of these two agents.

Although satisfactory progress has been made in almost every direction, many of the nitrogen compounds are still not properly understood. It is clear that we are as yet in no way seized with understanding of the attributes of this element as we are of those of oxygen and carbon, particularly in the case of mixed carbon-nitrogen compounds: we can make nothing of the physical data such substances afford. Nitrogen, in fact, is an extraordinary element, far more remarkable than any other; its "temper" appears to vary more than that of any other element according to the character of its associates—nothing could be more remarkable, for example, than the change in properties from ammonia, NH_3, through hydrazine, $NH_2.NH_2$, to azoimide, N_3H. No other element can be so poisonous, so immediately fatal to life. We lack a model symbolic of its functions—which means that we are unable to fathom its vagaries and reduce them to simple order.

The oximes and the diazo-compounds in particular have given rise to much dispute. Stereo-chemical formulæ have been assigned to these, but probably they have little relation with the truth; although they have been of service by supplying symbols which can be offered up at examinations, by confining attention they have served to sterilise inquiry. No better illustration could be given of the truth of the remark made by my friend the Professor that man is an idolater by nature, a fact that chemists should always bear in mind.

The compounds in question are difficult substances to handle, far too prone to undergo change without invitation —it is to be feared that many of the conclusions which have been arrived at are based on incomplete if not unsatisfactory evidence.[1] When I think of the state of our knowledge, I am reminded of the father of diazo-chemistry, Peter Griess, and of his marvellous experimental gifts; there is great need of such a man to re-investigate the whole subject.

If we inquire as to the general effect of the increase of knowledge of organic compounds, it is clear that the lessons which emerge from all modern inquiries are such as to justify Larmor's remark that our conceptions of structure must be granted more than analogical significance. Everything tends to show that function and structure are most closely connected—odour, taste, colour, physiological effect, are specific rather than general properties, each conditioned in its special variety by some special structure; we are approaching very closely to a time when it should be possible to discuss such properties with considerable confidence.

Still, it must not be forgotten that the problems they offer are all valency problems, and that the nature of valency eludes us entirely at present.

The greatest advance which chemists may pride themselves upon having made during the past decade or two remains to be considered. In 1885, I spoke as follows:— "The attention paid to the study of carbon compounds may be more than justified both by reference to the results obtained and to the nature of the work before us; the inorganic kingdom refuses any longer to yield up her secrets—new elements—except after severe compulsion; the organic kingdom, both animal and vegetable, stands ever ready before us. Little wonder, then, if problems directly bearing upon life prove the more attractive to the living. The physiologist complains that probably 95 per cent. of the solid matters of living structures are pure unknowns to us, and that the fundamental chemical changes which occur during life are entirely enshrouded in mystery. It is in order that this may no longer be the case that the study of carbon compounds is being so vigorously prosecuted. Our weapons—the knowledge of synthetical processes and of chemical function—are now rapidly being sharpened, but we are yet far from ready for the attack."

My forecast has been more than justified; indeed, the advance to be recorded is nothing short of marvellous: the great problems of vital chemistry appear now no longer to be unattainable to our intelligence—their cryptic character seems to have disappeared almost suddenly. Many have contributed in greater or less degree, but none in such measure as Emil Fischer, whose work both in the sugar group and in connection with the albuminoids must for ever rank as monumental.

It is difficult to appreciate the extent to which the practical genius of this chemist has carried us—difficult alike for those who understand the subject and those who do not; the significance of his labours is only apparent when the bearing of his results on the interpretation of vital phenomena is fully considered. In 1885 we were disputing as to the structure of substances such as glucose and galactose; now we not only are satisfied that they belong to the group of aldhexoses (aldoses) derived from normal hexane, but, taking into account the monumental discoveries of Pasteur, to which precision has been given by van 't Hoff's great generalisation, we are in a position to assign fully resolved structural formulæ not only to the natural products but to the nine other isomeric aldhexoses which Fischer has prepared artificially.

It is a striking fact that only three of the sixteen possible aldhexoses and but a single ketohexose (fructose), of which many are possible, are met with naturally. Nature is clearly most sparing, most economical, in her use of materials. And not only is this true of the hexoses, as very few of the possible lower and higher homologous carbohydrates occur in vegetable or animal materials and the condensed carbohydrates (cane sugar, starch, &c.) are all formed apparently from the hexoses and pentoses which occur naturally. The albuminoids, the alkaloids, the terpenes are also optically active substances; in other words, only a limited number of the possible forms are present. There is reason to suppose that the compounds of natural occurrence stand in close genetic connection and belong with few exceptions to the same series of enantiomorphs; in no other way is it possible to account for the occurrence of one only of the pair of enantiomorphous isomerides and for the relatively small number

possesses us: moreover, our attempts to imitate if not to undo her work are never direct but are always made with her aid, with Nature's product—coal; we are no longer content to ride on horseback but must rush through space and instead of watching the birds fly seek to emulate them but always with the aid of fuel won by Nature from the soil and air in days long past. Too much is being done in every direction to waste natural resources, too little to conserve them, too little to employ man in his proper place—as tiller of the soil. Here lies the chemist's opportunity. At no very distant date, perhaps, when petrol is exhausted, toll will be taken from the sun in the form of starch or sugar and this will be converted into alcohol.

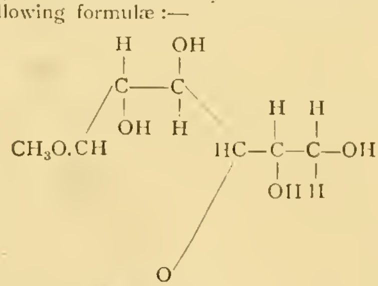
[1] Since this was written, Thiele's discovery of "Azomethane," MeN : NMe, has been announced. This is described as being, in the solid state, a distinctly coloured, very pale yellow substance. There can be little if any doubt, therefore, that, as Robertson and I have argued, the colourless so-called syn- and antidiazo-salts cannot possibly be compounds of the —N : N— or diazene type; such compounds would all be at least yellow in colour.

of compounds. Moreover, not only the sugars and most of the other products of the disintegration of the albuminoids but also the amino-acids, in like manner, are derivatives of compounds containing at most six atoms of carbon; the fats alone are of a considerably higher degree of complexity but they are probably collocations of the simpler units.

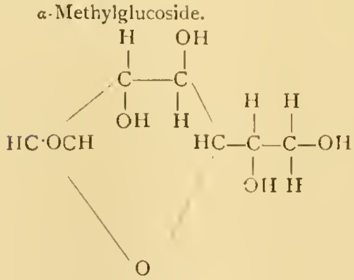
The terpenes and essential oils are mostly C_{10} derivatives; the alkaloids have complex formulæ but the units of which they are composed are simple; as all of them are optically active, it is clear that only some of the possible enantiomorphous combinations are present.

We are bound, therefore, to assume that a large proportion of the changes which occur in living organisms—which constitute vital metabolism—are directed changes. What is the nature of the directive power? We are already able to go far in explaining this, although our knowledge is mainly of analytical changes, the nature of synthetic changes being, at present, only inferentially disclosed to us.

It has long been known that under natural conditions many complex compounds such as starch, cane sugar, and other similar substances are broken down hydrolytically, not by the unassisted action of water but by the co-operation of enzymes; the effect produced by these enzymes is precisely similar to that of acids, except that all acids produce the effect, acting only with different degrees of readiness, whilst enzymes are strictly selective, a given enzyme acting only, as a rule, either on a single substance or on a series of substances similar in structure. Indisputable evidence has been obtained that the enzymes which act on the carbohydrates are intimately related in structure to the compounds which they attack, fitting them—to use the apt simile introduced by E. Fischer—much as a key fits into a good lock: the slightest alteration in the structure of the carbohydrate is sufficient to throw the enzyme out of action. The closeness of the association is well illustrated by the case of the two methylglucosides, which differ merely in the manner displayed by the following formulæ:—



α-Methylglucoside.



β-Methylglucoside.

The relative positions of the single hydrogen atom and of the hydroxyl group attached to the carbon atom are merely interchanged, but this is sufficient to render the one (the α) proof against the action of emulsin, the enzyme of the almond; the other (the β) proof against that of maltase, the enzyme present in yeast.

The enzyme may be pictured as attaching itself to a surface of the molecule, and at the same time as associated with hydrone in such a manner that this is brought to bear at the junction which undergoes disruption. The action of acids, although similar, is simpler in that the attachment is not to the molecule as a whole but only at, or near to, the junction which is resolved.

In the case of the albuminoids, the action is probably more local in character, in so far as the resolution of their polypeptide section is concerned, the same enzyme being able to effect the resolution of a considerable number of compounds.

All the peptolytes have in common the junction C.CO.N; the peptoclasts by which such substances are gradually resolved probably fit this group alone; but other enzymes are of more complex organisation, akin to that of the sucroclasts—such as arginase, for example. In principle, however, the enzymes are to be regarded as all acting alike, each as fitting some particular asymmetric centre if not the whole of the molecule which undergoes hydrolytic disruption under its influence, the asymmetric centre being that at which the cleavage is effected.

In synthetic changes the operation is reversed. It may be supposed that the separation of hydrone is determined by the circumstance that water can be formed by the interaction of this hydrone as it separates with that which is attached to the hydrolated enzyme; the formation of water, in fact, plays a great part in such changes.

The action of oxydases may be regarded from a similar point of view. The early observations of Adrian Brown on the oxidising activity of *Bacterium Xylinum*, coupled with the later work of Bertrand, afford clear proof that these enzymes are possessed of selective powers. It is conceivable that such enzymes become attached to a molecule at some one centre, and that they then deliver their attack at some more or less distant point by presenting the oxygen with which they are loosely associated at this point. It is easy, on such an assumption, to understand how ethenoid linkages may be developed in various positions in the molecule of a fatty acid.

Rosenthaler's recent observations on the formation of optically active phenyl hydroxycyano methane,

$$PhCH(OH)CN,$$

from hydrogen cyanide and benzaldehyde on shaking the solution with emulsin are, however, among the most significant yet made. I have myself confirmed his statements. The ease with which the change takes place—the manner in which the change is accelerated by the enzyme—is altogether remarkable.

Although there can be little doubt, in the case of plants and animals, that the synthetic processes do not occur spontaneously and directly between the interagents, but are for the most part at some stage or other directed or controlled, it cannot well be supposed that every asymmetric compound is the direct outcome of a controlled process; nor is it necessary to assume that such is the case. Not a few asymmetric compounds are probably but secondary products formed by the breakdown of compounds which are the products of directed synthesis.

Ehrlich's observations on the formation of the amylalcohols from the isomeric aminocaproic acids (leucines) may be referred to in this connection. Taking into account the manner in which the vegetable organism is provided with conservative powers and its tendency to retain nitrogen, in view of the peculiar structure of the members of the terpene group—especially the presence of the isopropyl group and of methyl in association with the ring in such hydrocarbons—it is highly probable that the terpenes are derived from amino-acids. A molecule of leucine, a molecule of alanine and a molecule of formaldehyde obviously provide the materials for the production of methylisopropyldihydrobenzene; it is not difficult to picture the series of changes which would lead to the formation of the hydrocarbon from such a conjunction.

The general impression produced by facts such as have been referred to is that directive influences are the paramount influences at work in building up living tissues. These come into operation, it is to be supposed, at a very early stage in the case of the plant. The initial step probably involves the electrolysis of water under the influence of solar energy and the reduction by the hydrogen thus liberated of the carbon dioxide, which is eventually converted into formaldehyde, either directly or, it may be, through the intermediation of oxalic and formic acids. The part which chlorophyll plays in this process can only be surmised: it is not improbable that reduced chlorophyll is the active reducing-agent: that chlorophyll itself is active in conditioning the resolution of water under the influence of solar energy into reduced chlorophyll and oxygen or, more probably, a labile peroxide, from which oxygen is independently split off at a subsequent stage, it may be under the influence of a so-called catalase.

Whatever the process by which the plant acquires its initial store of carbonaceous material, the formaldehyde is apparently at once made use of and, in part at least, converted into starch. The view may be taken that glucose is the primary product of condensation—that the formaldehydrol molecules become ranged against a glucose template in series of sixes, which are soldered by enzymic influence into a single molecule by the interaction of contiguous hydrogen and hydroxyl radicles along the chain.

The glucose is thereafter carried a stage higher and converted into maltose or it may be that a maltose template is effective from the beginning and that the biose is the immediate product of condensation; the conversion of maltose into starch must take place in some similar manner. The recent observation that cellobiose is a β-glucoside enables us to realise that the formation of cellulose differs from that of starch in that the glucose molecule, instead of being converted into the β-glucoside maltose, becomes changed into the correlated β-glucoside, a membrane being thus secured which can resist the diastic enzymes by which starch is attacked.

The formation of the albuminoid substances may be regarded from a similar point of view. At present, however, there is no satisfactory evidence to show at what stage nitrogen is introduced into the molecule. As the plant takes up nitrogen in the form of nitrate, not as ammonia, it is probable that the nitrate is reduced to hydroxylamine and that this, rather than ammonia, is the active synthetic agent. Formaldehyde and hydroxylamine would yield formaldoxime, which would easily pass into methylamine on reduction; the interaction of formaldoxime and formaldehydrol might give rise to a higher aldoxime which would be easily convertible into amino-acetic acid (glycine). Higher glycines might be formed from glycine by syntheses similar to those Erlenmeyer has effected; but to account for the formation of asymmetric amino-acids it is necessary to assume that the action is controlled at this stage and that the glycine is formed against a template perhaps under the influence of an enzyme.

Another conceivable mode of formation is by the fermentative degradation of glucosamine.

Until we know more of the order in which the amino-acid radicles are united in the various albuminoids and of the character of the associations other than those which are characteristic of polypeptides, we can consider the formation of albuminoids only from a very general point of view; but taking into account the very different proportions in which amino-acids and other cleavage products are formed on hydrolysing substances of different origin, it is clear that the several sections of the molecule must be differently ordered in the different proteins; again, therefore, it is necessary to assume that the formation of such substances is directed. We may picture molecule after molecule as being "brought into line" against a template and the junctions which are required to bind the whole series together as being made through the agency of the enzymic dehydrating influence before referred to.

Attention has been directed to the relatively simple way in which the hydrocarbons are constructed, that even the paraffins are not to be visualised as so many ducks strung upon a ramrod, Münchausen fashion, but as forming curls, owing to the natural set of the affinities. This probably is true of complex substances such as the proteins.

Protoplasm, in fact, may be pictured as made up of large numbers of curls, like a judge's wig—all in intercommunication through some centre, connected here and there perhaps also by lateral bonds of union. If such a point of view be accepted, it is possible to account for the occurrence in some sections of the complex series of interchanges which involve work being done upon the substances brought into interaction, the necessary energy being drawn from some other part of the complex where the interchanges involve a development of energy.

The conclusions thus arrived at may be utilised in discussing the problem of heredity. The inheritance of parental qualities, the need to assume continuity of the germ plasm and the comparative unimportance from the standpoint of heredity of somatic qualities, as well as the non-inheritance of mere environmental effects (acquired characters), are all necessary consequences of the view I have advanced.

The general similarity of structure throughout organised creation may well be conditioned primarily by properties inherent in the materials of which all living things are composed—of carbon, of oxygen, of nitrogen, of hydrogen, of phosphorus, of sulphur. At some early period, however, the possibilities became limited and directed processes became the order of the day. From that time onward the chemistry prevailing in organic nature became a far simpler chemistry than that of the laboratory; the possibilities were diminished, the certainties of a definite line of action were increased. How this came about it is impossible to say; mere accident may have led to it. Thus we may assume that some relatively simple asymmetric substance was produced by the fortuitous occurrence of a change under conditions such as obtain in our laboratories and that consequently the enantiomorphous isomeric forms of equal opposite activity were produced in equal amount. We may suppose that a pool containing such material having been dried up dust of molecular fineness was dispersed; such dust falling into other similar pools near the crystallisation point may well have conditioned the separation of only one of the two isomeric forms present in the liquid. A separation having been once effected in this manner, assuming the substance to be one which could influence its own formation, one form rather than the other might have been produced. An active substance thus generated and selected out might then become the origin of a series of asymmetric syntheses. How the complicated series of changes which constitute life may have arisen we cannot even guess at present; but when we contemplate the inherent simplicity of chemical change and bear in mind that life seems but to depend on the simultaneous occurrence of a series of changes of a somewhat diverse order, it does not appear to be beyond the bounds of possibility to arrive at a broad understanding of the method of life. Nor are we likely to be misled into thinking that we can so arrange the conditions as to control and reproduce it; the series of lucky accidents which seem to be required for arrangements of such complexity to be entered upon is so infinitely great.

It is impossible to rate chemistry at too high a value in Canada. The maintenance of the fertility of your fields, the proper utilisation of your vast mineral wealth, the purity of your food supplies [1] will depend mainly on the watchful care and skill of chemists; but the educational value of the subject may also be set very high. If properly taught in your schools, it will afford a means superior to all others, I believe, of training faculties which in these days should be developed in every responsible citizen. No other subject lends itself so effectively as a means of developing the experimental attitude of mind—the attitude of working with a clearly conceived purpose to a desired end, which is so necessary to success in these days; and if care be taken to inculcate habits of neatness and precision and of absolute truthfulness, if care be taken to teach what constitutes evidence, the moral value of such work is incalculable. But to be effective it must be done under proper conditions, systematically; the time devoted to the work must be adequate; I would even advocate that the subject be allowed to come before conventional geography and history and other unpractical subjects, assuming that the training is given in a practical way and with practical objects in view, not in the form of mere lessons learnt by rote; if taught in the form of mere didactic lessons it is as worthless as any other subject as mental discipline. Let me add that I would confine the teaching to a narrow range of problems but make it very thorough with reference to these.

[1] I should like to take this opportunity of saying that it is impossible to over-rate the public value of the great work which Dr. Wiley has undertaken in the United States in endeavouring to secure the supply of food free from deleterious ingredients. At home we certainly need some one to preach a similar crusade and to free us from doctored infants' foods and the innumerable host of medicines by which even our fair fields are disfigured.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY ARTHUR SMITH WOODWARD, LL.D., F.R.S., V.P.Z.S., SEC. G.S., KEEPER OF GEOLOGY IN THE BRITISH MUSEUM, PRESIDENT OF THE SECTION.

THE circumstances of the present meeting very clearly determine the subject of a general address to be expected from a student of extinct animals. The remarkable discoveries of fossil backboned animals made on the North American continent during the last fifty years suggest an estimate of the results achieved by the modern systematic methods of research; while the centenary celebration of the birth of Darwin makes it appropriate to consider the extent to which we may begin deducing the laws of organic evolution from the life of past ages as we now know it. Such an address must, of course, be primarily biological in character, and treat of some matters which are not ordinarily discussed by Section C. The subject, however, can only be appreciated fully by those who have some practical acquaintance with the limitations under which geologists pursue their researches, and especially by those who are accustomed to geological modes of thought.

There has been an unfortunate tendency during recent years for the majority of geologists to relinquish the study of fossils in absolute despair. More ample material for examination and more exact methods of research have altered many erroneous names which were originally used; while the admission to scientific publications of too many mere literary exercises on the so-called "law of priority" has now made it necessary to learn not one, but several names for some of the genera and species which are commonly met with. Even worse, the tentative arrangement of fossils in "genetic series" has led to the invention of a multitude of terms which often serve to give a semblance of scientific exactitude to the purest guesswork, and sometimes degenerate into a jargon which is naturally repellent to an educated mind. Nevertheless, I still hope to show that, with all these difficulties, there is so much of fundamental interest in the new work that it is worth while to make an effort to appreciate it. Geology and palæontology in the past have furnished some of the grandest possible contributions to our knowledge of the world of life; they have revealed hidden meanings which no study of the existing world could even suggest; and they have started lines of inquiry which the student of living animals and plants alone would scarcely have suspected to be profitable. The latest researches are the logical continuation of this pioneer work on a more extensive scale, and with greater precision; and I am convinced that they will continue to be as important a factor in the progress of post-Darwinian biology as were the older studies of fossils in the philosophy of Cuvier, Brongniart, and Owen.

In this connection it is necessary to combat the mistaken popular belief that the main object of studying fossils is to discover the "missing links" in the chain of life. We are told that the idea of organic evolution is not worthy of serious consideration until these links, precise in character, are forthcoming in all directions. Moreover, the critics who express this opinion are not satisfied to consider the simplest cases, such as are afforded by some of the lower grades of "shell-fish" which live together in immense numbers and have limited powers of locomotion. They demand long series of exact links between the most complex skeletal frames of the backboned animals, which have extreme powers of locomotion, are continually wandering, and are rarely preserved as complete individuals when they are buried in rock. They even expect continual discoveries of links among the rarest of all fossils, those of the higher apes and man. The geologist, on the other hand, knowing well that he must remain satisfied with a knowledge of a few scattered episodes in the history of life which are always revealed by the merest accident, marvels that the discovery of "missing links" is so constant a feature of his work. He is convinced that, if circumstances were more favourable, he would be able to satisfy the demand of the most exacting critic. He has found enough continuous series among the mollusca, for example, and so many suggestions of equally gradual series among the higher animals, that he does not hesitate to believe without further evidence in a process of descent with modification. The mere reader of books is often misled by the vagaries of nomenclature to suppose that the intervals between the links are greater than in reality; but for the actual student it is an everyday experience to find that fossils of slightly different ages which he once thought distinct are linked together by a series of forms in which it is difficult to discover the feeblest lines of demarcation. He is therefore justified in proceeding on the assumption that in all cases the life of one geological period has passed by a natural process of descent into that of the next succeeding period; and, avoiding genealogical guesswork which proves to be more and more futile, he strives to obtain a broad view of the series of changes which have occurred, to distinguish between those which denote progress and those which lead to stagnation or extinction. When the general features of organic evolution are determined in this manner, it will be much easier than it is at present to decide where missing links in any particular case are most likely to be found.

Among these general features which have been made clear by the latest systematic researches, I wish especially to emphasise the interest and significance of the persistent progress of life to a higher plane, which we observe during the successive geological periods. For I think palæontologists are now generally agreed that there is some principle underlying this progress much more fundamental than chance-variation or response to environment however much these phenomena may have contributed to certain minor adaptations. Consider the case of the backboned animals, for instance, which I happen to have had special opportunities of studying.

We are not likely ever to discover the actual ancestors of animals on the backboned plan, because they do not seem to have acquired any hard skeleton until the latter part of the Silurian period, when fossils prove them to have been typical and fully developed, though low in the backboned scale. The ingenious researches and reasoning of Dr. W. H. Gaskell, however, have suggested the possibility that these animals originated from some early relatives of the scorpions and crustaceans. It is therefore of great interest to observe that the Eurypterids and their allies, which occupy this zoological position, were most abundant during the Silurian period, were represented by species of the largest size immediately afterwards at the beginning of the Devonian, and then gradually dwindled into insignificance. In other words, there was a great outburst of Eurypterid life just at the time when backboned animals arose; and if some of the former were actually transformed into the latter, the phenomenon took place when their powers both of variation and of multiplication were at their maximum.

Fishes were already well established and distributed over perhaps the greater part of the northern hemisphere at the beginning of Devonian times; and then there began suddenly a remarkable impulse towards the production of lung-breathers, which is noticeable not only in Europe and North America, but also probably so far away as Australia. In the middle and latter part of the Devonian period, most of the true fishes had paddles, making them crawlers as much as swimmers; many of them differed from typical fishes, while agreeing with lung-breathers, in having the basis of the upper jaw fused with the skull, not suspended; and some of them exhibited both these features. Their few survivors at the present day (the Crossopterygians and Dipnoans) have also an air-bladder, which might readily become a lung. The characteristic fish-fauna of the Devonian period, therefore, made a nearer approach to the land animals than any group of fishes of later date; and it is noteworthy that in the Lower Carboniferous of Scotland—perhaps even in the Upper Devonian of North America, if footprints can be trusted—amphibians first appeared. In Upper Carboniferous times they became firmly established, and between that period and the Trias they seem to have spread all over the world; their remains having been found, indeed, in Europe, Spitsbergen, India, South Africa, North and South America, and Australia.

The Stegocephala or Labyrinthodonts, as these primitive amphibians are termed, were therefore a vigorous race; but the marsh-dwelling habits of the majority did not allow of much variation from the salamander-pattern. Only in Upper Carboniferous and Lower Permian times did some of their smaller representatives (the Microsauria) become lizard-like, or even snake-like in form and habit; and then there suddenly arose the true reptiles. Still, these reptiles did not immediately replace the Stegocephala in the economy of Nature; they remained quite secondary in importance at least until the Upper Permian, in most parts even until the dawn of the Triassic period. Then they began their flourishing career.

At this time the reptiles rapidly diverged in two directions. Some of them were almost exactly like the little Sphenodon, which still survives in some islands off New Zealand, only retaining more traces of their marsh-dwelling ancestors. The majority (the Anomodonts or Theromorphs) very quickly became so closely similar to the mammals that they can only be interpreted as indicating an intense struggle towards the attainment of the higher warm-blooded grade; and there is not much doubt that true mammals actually arose about the end of the Triassic period. Here, again, however, the new race did not immediately replace the old, or exterminate it by unequal competition. Reptiles held their own on all lands throughout the Jurassic and Cretaceous periods, and it was not until the Tertiary that mammals began to predominate.

As to the beginning of the birds, it can only be said that towards the end of the Triassic period there arose a race of small Dinosaurs of the lightest possible build, exhibiting many features suggestive of the avian skeleton; so it is probable that this higher group also originated from an intensely restless early community of reptiles, in which all the variations were more or less in the right direction for advancement.

In short, it is evident that the progress of the backboned land animals during the successive periods of geological time has not been uniform and gradual, but has proceeded in a rhythmic manner. There have been alternations of restless episodes which meant real advance, with periods of comparative stability, during which the predominant animals merely varied in response to their surroundings, or degenerated, or gradually grew to a large size. There was no transition, for instance, between the reptiles of the Cretaceous period and the mammals which immediately took their place in the succeeding Eocene period: those mammals, as we have seen, had actually originated long ages before, and had remained practically dormant in some region which we have not yet discovered, waiting to burst forth in due time. During this retirement of the higher race the reptiles themselves had enjoyed an extraordinary development and adaptation to every possible mode of life in nearly all parts of the globe. We do not understand the phenomenon—we cannot explain it; but it is as noticeable in the geological history of fishes as in that of the land animals just considered. It seems to have been first clearly observed by the distinguished American naturalist, the late Prof. Edward D. Cope, who termed the sudden fundamental advances "expression points" and saw in them a manifestation of some inscrutable inherent "bathmic force."

Perhaps the most striking feature to be noticed in each of these "expression points" is the definite establishment of some important structural character which had been imperfect or variable before, thus affording new and multiplied possibilities of adaptation to different modes of life. In the first lung-breathers (Stegocephala), for example, the indefinite paddle of the mud fishes became the definite five-toed limb; while the incomplete backbone reached completeness. Still, these animals must have been confined almost entirely to marshes, and they seem to have been all carnivorous. In the next grade, that of the reptiles, it became possible to leave the marshes; and some of them were soon adapted not only for life on hard ground or in forests, but even for flight in the air. Several also assumed a shape of body and limbs enabling them to live in the open sea. Nearly all were carnivorous at first, and most of them remained so to the end; but many of the Dinosaurs eventually became practically hoofed animals, with a sharp beak for cropping herbage, and with powerful grinding teeth. In none of these animals, however, were the toes reduced to less than three in number, and in none of them were the basal toe-bones fused together as they are in cattle and deer. It is also noteworthy that the brain in all of them remained very small and simple. In the final grade of backboned life, that of the mammals, each of the adaptive modifications just mentioned began to arise again in a more nearly perfected manner, and now survival depended not so much on an effective body as on a developing brain. The mammals began as little carnivorous or mixed-feeding animals with a small brain and five toes, and during the Tertiary period they gradually differentiated into the several familiar groups as we now known them, eventually culminating in man.

The demonstration by fossils that many animals of the same general shape and habit have originated two or three times, at two or three successive periods, from two or three continually higher grades of life, is very interesting. To have proved, for example, that flying reptiles did not pass into birds or bats, that hoofed Dinosaurs did not change into hoofed mammals, and that Ichthyosaurs did not become porpoises; and to have shown that all these later animals were mere mimics of their predecessors, originating independently from a higher yet generalised stock, is a remarkable achievement. Still more significant, however, is the discovery that towards the end of their career through geological time totally different races of animals repeatedly exhibit certain peculiar features, which can only be described as infallible marks of old age.

The growth to a relatively large size is one of these marks, as we observe in the giant Pterodactyls of the Cretaceous period, the colossal Dinosaurs of the Upper Jurassic and Cretaceous, and the large mammals of the Pleistocene and the present day. It is not, of course, all the members of a race that increase in size; some remain small until the end, and they generally survive long after the others are extinct; but it is nevertheless a common rule that the prosperous and typical representatives are successively larger and larger, as we see them in the familiar cases of the horses and elephants of the northern hemisphere, and the hoofed animals and armadillos of South America.

Another frequent mark of old age in races was first discussed and clearly pointed out by the late Prof. C. E. Beecher, of Yale. It is the tendency in all animals with skeletons to produce a superfluity of dead matter, which accumulates in the form of spines or bosses as soon as the race they represent has reached its prime and begins to be on the down-grade. Among familiar instances may be mentioned the curiously spiny Graptolites at the end of the Silurian period, the horned Pariasaurians at the beginning of the Trias, the armour-plated and horned Dinosaurs at the end of the Cretaceous, and the cattle or deer of modern Tertiary times. The latter case—that of the deer—is specially interesting, because fossils reveal practically all the stages in the gradual development of the horns or antlers, from the hornless condition of the Oligocene species, through the simply forked small antlers of the Miocene species, to the largest and most complex of all antlers seen in *Cervus sedgwicki* from the Upper Pliocene and the Irish deer (*C. giganteus*) of still later times. The growth of these excrescences, both in relative size and complication, was continual and persistent until the climax was reached and the extreme forms died out. At the same time, although the palæontologist must regard this as a natural and normal phenomenon not directly correlated with the habits of the race of animals in which it occurs, and although he does not agree with the oft-repeated statement that deer may have "perfected" their antlers through the survival of those individuals which could fight most effectively, there may nevertheless be some truth in the idea that the growths originally began where the head was subject to irritating impacts, and that they so happened to become of utility. Fossils merely prove that such skeletal outgrowths appear over and over again in the prime and approaching old age of races; they can suggest no reasons for the particular positions and shapes these outgrowths assume in each species of animal.

It appears, indeed, that when some part of an animal (whether an excrescence or a normal structure) began to grow relatively large in successive generations during geological time, it often acquired some mysterious impetus by which it continued to increase long after it had reached the serviceable limit. The unwieldy antlers of the extinct Sedgwick's deer and Irish deer just mentioned, for example, must have been impediments rather than useful weapons. The excessive enlargement of the upper canine teeth in the so-called sabre-toothed tigers (Machærodus and its allies) must also eventually have hindered rather than aided the capture and eating of prey. The curious gradual elongation of the face in the Oligocene and Miocene Mastodons, which has lately been described by Dr. Andrews, can only be regarded as another illustration of the same phenomenon. In successive generations of these animals the limbs seem to have grown continually longer, while the neck remained short, so that the head necessarily became more and more elongated to crop the vegetation on the ground. A limit of mechanical inefficiency was eventually reached, and then there survived only those members of the group in which the attenuated mandible became shortened up, leaving the modified face to act as a "proboscis." The elephants thus arose as a kind of after-thought from a group of quadrupeds that were rapidly approaching their doom.

The end of real progress in a developing race of backboned animals is also often marked by the loss of the teeth. A regular and complete set of teeth is always present at the commencement, but it frequently begins to lack successors in animals which have reached the limit of their evolution, and then it soon disappears. Tortoises, for instance, have been toothless since the Triassic period, when they had assumed all their essential features; and birds have been toothless since the end of Cretaceous times. The monotreme mammals of Australasia, which are really a survival from the Jurassic period, are also toothless. Some of the latest Ichthyosaurs and Pterodactyls were almost or quite toothless; and I have seen a jaw of an Upper Cretaceous carnivorous Dinosaur (Genyodectes) from Patagonia so completely destitute of successional teeth that it seems likely some of these land reptiles nearly arrived at the same condition.

Among fishes there is often observable still another sign of racial old age—namely, their degeneration into eel-shaped forms. The Dipnoan fishes afford a striking illustration, beginning with the normally shaped Dipterus in the Middle Devonian, and ending in the long-bodied Lepidosiren and Protopterus of the present day. The Palæozoic Acanthodian sharks, as they are traced upwards from their beginning in the Lower Devonian to their end in the Permian, also acquire a remarkable elongation of the body and a fringe-like extension of the fins. Among higher fishes, too, there are numerous instances of the same phenomenon, but in most of these the ancestors still remain undiscovered, and it would thus be tedious to discuss them.

Finally, in connection with these obvious symptoms of old age in races, it is interesting to refer to a few strange cases of the rapid disappearance of whole orders of animals, which had a practically world-wide distribution at the time when the end came. Local extinction, or the disappearance of a group of restricted geographical range, may be explained by accidents of many kinds; but contemporaneous universal extinction of widely spread groups, which are apparently not affected by any new competitors, is not so easily understood. The Dinosaurs, for instance, are known to have lived in nearly all lands until the close of the Cretaceous period; and, except perhaps in Patagonia, they were always accompanied until the end by a typically Mesozoic fauna. Their remains are abundant in the Wealden formation of Western Europe, the deposit of a river which must have drained a great continent at the beginning of the Cretaceous period; they have also been found in a corresponding formation which covers a large area in the State of Bahia, in Brazil. They occur in great numbers in the freshwater Upper Cretaceous Laramie deposits of Western North America, and also in a similar formation of equally late date in Transylvania, South-east Europe. In only two of these regions (South-east England and West North America) have any traces of mammals been found, and they are extremely rare fragments of animals as small as rats; so there is no reason to suppose that the Dinosaurs suffered in the least from any struggle with warm-blooded competitors. Even in Patagonia, where the associated mammal-remains belong to slightly larger and more modern animals, these fossils are also rare, and there is nothing to suggest competition. The race of Dinosaurs seems, therefore, to have died a natural death. The same may be said of the marine reptiles of the orders Ichthyosauria, Plesiosauria, and Mosasauria. They had a practically world-wide distribution in the seas of the Cretaceous period, and the Mosasauria especially must have been extremely abundant and flourishing. Nevertheless, at the end of Cretaceous times they disappeared everywhere, and there was absolutely nothing to take their place until the latter part of the Eocene period, when whales and porpoises began to play exactly the same part. So far as we know, the higher race never even came in contact with the lower race; the marine mammals found the seas vacant, except for a few turtles and for one curious Rhynchocephalian reptile (Champsosaurus), which did not long survive. Another illustration of the same phenomenon is probably afforded by the primitive Carnivora (the so-called Sparassodonta), which were numerous in South America in the Lower Tertiary periods. They were animals with a brain as small as that of the thylacines and dasyures which now live in Tasmania. They appear to have died out completely before they were replaced by the cats, sabre-toothed tigers, and dogs, which came down south from North America over the newly emerged isthmus of Panama at the close of the Pliocene period. At least, the remains of these old carnivores and their immigrant successors have never yet been found associated in any geological formation.

These various considerations lead me to think that there is also deep significance in the tendency towards fixity in the number and regularity (or symmetry) in the arrangement of their multiple parts, which we frequently observe in groups of animals as we trace them from their origin to their prime. It is well known that in certain of the highest and latest types of bony fishes the vertebræ and fin-rays are reduced to a fixed and practically invariable number for each family or genus, whereas there is no such fixity in the lower and earlier groups. In the earliest known Pycnodont fishes from the Lower Lias (Mesodon) the grinding teeth form an irregular cluster, while in most of the higher and later genera they are arranged in definite regular rows in a symmetrical manner. Many of the lower backboned animals have teeth with several cusps, and in some genera the number of teeth seems to be constant; but in the geological history of the successive classes the tooth-cusps never became fixed individual entities, readily traceable throughout whole groups, until the highest or mammalian grade had been attained. Moreover, it is only in the same latest grade or class that the teeth themselves can be treated as definite units, always the same in number (forty-four), except when modified by degeneration or special adaptation. In the earlier and lower land animals the number of vertebræ in the neck depends on the extent of this part, whereas in the mammal it is almost invariably seven, whatever the total length may be. Curiously constant, too, in the modern even-toed hoofed mammals is the number of nineteen vertebræ between the neck and the sacrum.

I am therefore still inclined to believe that the comparison of vital processes with certain purely physical phenomena is not altogether fanciful. Changes towards advancement and fixity which are so determinate in direction, and changes towards extinction which are so continually repeated, seem to denote some inherent property in living things, which is as definite as that of crystallisation in inorganic substances. The regular course of these changes is merely hindered and modified by a succession of checks from the environment and Natural Selection. Each separate chain of life, indeed, bears a striking resemblance to a crystal of some inorganic substance which has been disturbed by impurities during its growth, and has thus been fashioned with unequal faces, or even turned partly into a mere concretion. In the case of a crystal the inherent forces act solely on molecules of the crystalline substance itself, collecting them and striving, even in a disturbing environment, to arrange them in a fixed geometrical shape. In the case of a chain of life (or organic phylum) we may regard each successive animal as a temporary excrescence of colloid substance round the equally colloid germ-plasm which persists continuously from generation to generation. The inherent forces of this germ-plasm, therefore, act upon a consecutive series of excrescences (or animal bodies), struggling not for geometrically arranged boundaries, but towards various other symmetries, and a fixity in number of multiple parts. When the extreme has been reached, activities cease, and sooner or later the race is dead.

Such are some of the most important general results to which the study of fossils has led during recent years; and they are conclusions which every new discovery appears to make more certain. When we turn to details, however, it must be admitted that modern systematic researches are continually complicating rather than simplifying the problems we have to solve. Prof. Charles Depéret has lately written with scant respect of some of the pioneers who were content with generalities, and based their conclusions on the geological succession of certain anatomical structures rather than on a successive series of individuals and species obtained from the different layers of one geological section; but even now I do not think we can do much better than our predecessors in unravelling real genealogies. At least Prof. Depéret's genealogical table of the Lower Tertiary pig-like Anthracotheriidæ, which he publishes as an illustration of "évolution réelle," seems to me to be no more exact than several tables of other groups by previous authors which he criticises. His materials are all fragmentary, chiefly jaws and portions of skulls; they were obtained from several isolated lake-deposits, of which the relative age cannot be determined by observing the geological superposition; and they represent a group which is known to have lived over a large part of Europe, Asia, Northern Africa, and North America. There is therefore no certainty that the genera and species enumerated by Prof. Depéret actually originated one from the other in the region where he happened to find them; he has demonstrated the general trend of certain changes in the Anthracotheriidæ during geological time, but really nothing more.

Even when a group of animals seems to have been confined to one comparatively small region, where the series is not complicated by migration to and from other parts of the world, modern research still emphasises the difficulty of tracing real lines of descent. The primitive horned hoofed animals of the family Titanotheriidæ, for example, are only known from part of North America, and they seem to have originated and remained there until the end. As their fossil skeletons are abundant and well preserved, it ought to be easy to discover the exact connections of the several genera and species. Prof. Osborn has now proved, however, that the Titanotheres must have evolved in at least four distinct lines, adapted "for different local habitat, different modes of feeding, fighting, locomotion, &c., which took origin, in part at least, in the Middle or Upper Eocene." They exhibit "four distinct types in the shape and position of the horns, correlated with the structure of the nasals and frontals, and indicative of different modes of combat among the males." The ramifications of the group are indeed so numerous that the possibility of following chains of ancestors begins to appear nearly hopeless.

Among early reptiles the same difficulties are continually multiplied by the progress of discovery. About twenty years ago it began to appear likely that we should soon find the terrestrial ancestors of the Ichthyosauria in the Trias; and somewhat later a specimen from California raised hopes of obtaining them by systematic explorations in that region. During more recent years Prof. J. C. Merriam and his colleagues have actually made these explorations, and the result is that we now know from the Californian Trias a multitude of reptiles, which need more explanation than the Ichthyosauria themselves. Prof. Merriam has found some of the links predicted between Ichthyosaurs and primitive land reptiles, but he has by no means reached the beginning of the marine group; and while making these discoveries he has added greatly to the complication of the problem which he set out to solve.

Serious difficulties have also become apparent during recent years in determining exactly the origin of the mammals. For a long time after the discovery of the Anomodont or Theromorph reptiles in the Permian-Trias of South Africa, it seemed more and more probable that the mammals arose in that region. Even yet new reptiles from the Karoo formation are continually being described as making an astonishingly near approach to mammals; and, so far as the skeleton is concerned, the links between the two grades are now very numerous among South African fossils. Since these reptiles first attracted attention, however, they have gradually been found in the Permian and Trias of a large part of the world. Remains of them were first met with in India, then in North America, and next in Scotland, while during the last few years Prof. W. Amalitzky has disinterred so many nearly complete skeletons in the north of Russia that we are likely soon to learn more about them from this European country than from the South African area itself. Quite lately I have received numerous bones from a red marl in Rio Grande do Sul, Southern Brazil, which show that not merely Anomodonts, but also other characteristic Triassic land reptiles were likewise abundant in that region. We are therefore now embarrassed by the richness of the sources whence we may obtain the ancestors of mammals. Whereas some years ago it appeared sufficient to search South Africa for the solution of the problem, we are now uncertain in which direction to turn. We are still perhaps inclined to favour the South African source; but this is only because we know nothing of the Jurassic land animals of that part of the world, and we cherish a lingering hope that they may eventually prove to have included the early mammals for which we have so long sought in vain.

The mystery of the origin of the marine mammals of the order Sirenia and Cetacea appears to have been diminished by the discoveries of the Geological Survey of Egypt, Dr. Andrews and Dr. Fraas in the Eocene and Oligocene deposits of the Mokattam Hills and the Fayum. It is now clear that the Sirenians are closely related to the small primitive ancestors of the elephants; while, so far as the skull and dentition are concerned, we know nearly all the links between the early toothed whales (or Zeuglodonts) and the primitive ancestors of the Carnivora (or Creodonts). The most primitive form of Sirenian skull hitherto discovered, however, is not from Egypt, but from the other side of the world, Jamaica; and exactly the same Zeuglodonts, even with an associated sea-snake, occur so far away from Egypt as Alabama, U.S.A. The problem of the precise origin of these marine mammals is therefore not so simple as it would have appeared to be had we known only the Egyptian fossils. The progress of discovery, while revealing many most important generalities, has made it impossible to vouch for the accuracy of the details in any "genealogical tree."

Another difficulty resulting from the latest systematic researches is suggested by the extinct hoofed mammals of South America. The llamas, deer, and peccaries existing in South America at the present time are all immigrants from the northern continent; but during the greater part of the Tertiary period there lived in that country a large number of indigenous hoofed mammals, which originated quite independently of those in other regions. They seem to have begun in early Eocene times much in the same manner as those of the northern hemisphere; but as they became gradually adapted for life on hard ground, they formed groups which are very different from those with which we are familiar in our part of the world. Some of them (Proterotheriidæ) were one-toed mimics of the horses, but without the advanced type of brain, the deepened grinding teeth, the mobile neck, or the really effective wrist and ankle. Others (Toxodontidæ) made some approach towards rhinoceroses in shape and habit, even with a trace of a horn on the nose. Until their independent origin was demonstrated, these curious animals could not be understood; and it is probable that there are innumerable similar cases of parallel development of groups, by which in our ignorance we are often misled.

It would be easy to multiply instances, but I think I have now said enough to show that every advance in the study of fossils reveals more problems than it solves. During the last two decades the progress in our knowledge of the extinct backboned animals has been truly astonishing, thanks especially to the great explorations in North America, Patagonia, Egypt, Madagascar, and South Africa. Whole groups have been traced a long way towards their origin; but with them have been found a number of previously unknown groups which complicate all questions of evolution to an almost bewildering extent. Animals formerly known only by fragments are now represented by nearly complete skeletons, and several which appeared to have a restricted geographical range have now been found over a much wider area; but while this progress has been made, numerous questions have arisen as to the changing connections of certain lands and seas which previously seemed to have been almost settled. The outlook both of zoology and of geology has, therefore, been immensely widened, but the only real contribution to philosophy has been one of generalities. Some of the broad principles to which I have referred are now so clearly established that we can often predict what will be the main result of any given exploration, should it be successful in recovering skeletons. We are no longer bold enough to restore an entirely unknown extinct animal from a single bone or tooth, like the trustful Cuvierian school; but there are many kinds of bones and teeth of which we can determine the approximate geological age and probable associates, even if we have no exact knowledge of the animals to which they belong. A subject which began by providing material for wonder-books has thus been reduced to a science sufficiently precise to be of fundamental importance both to zoology and to geology; and its exactitude must necessarily increase with greater and greater rapidity as our systematic researches are more clearly guided by the experience we have already gained.

NOTES.

THE special report agreed upon by the Select Committee on the Daylight Saving Bill contains the following conclusion:—"Having regard to the great diversity of opinion existing upon the proposals of the Bill and to the grave doubts which have been expressed as to whether the objects of the measure can be attained by legislation without giving rise, in cases involving important interests, to serious inconvenience, your committee recommend that the Bill be not further proceeded with." We are glad the committee has arrived at this conclusion, which embodies the views expressed in these columns on several occasions. Most people are in favour of the principle of making the best and fullest use of daylight hours, but the compulsory alteration of the system of time-reckoning for several months of the year is quite a different matter. As we have pointed out, in engineering, building, agricultural and other industries in which it is difficult to carry on work by artificial light, the hours of labour are already adapted to the daylight hours in different seasons. Here we have the voluntary adoption of the principle of daylight saving, and we are in complete sympathy with any movement to encourage the extension of the custom to other industrial or commercial circles where earlier hours of commencing work during certain months are practicable or desirable. This can be accomplished, however, without legislation, and the committee has acted wisely in recommending that the Bill, which would make a seasonal change of time compulsory, be not carried further.

A BILL to promote the economic development of the United Kingdom and the improvement of the roads therein was introduced in the House of Commons on August 26 by the Chancellor of the Exchequer. In the explanatory memorandum of this Bill it is stated that Part i. enables the Treasury to make free grants and loans for the purpose of aiding and developing forestry, agriculture, and rural industries, the reclamation and drainage of land, the improvement of rural transport (other than roads), the construction and improvement of harbours and canals, and the development and improvement of fisheries, and for any other purpose calculated to promote the economic development of the United Kingdom. A grant or loan must be made either to or through a Government department, and all applications for grants or loans have to be referred to an advisory committee, and the recommendations of the committee considered before the grant or loan is made; but the responsibility of making the grant or loan will rest with the Treasury, who will not be bound by the recommendations of the committee. All grants and loans will be made out of a separate fund, which will be fed by (1) sums annually voted by Parliament; (2) a sum of 2,500,000*l*. charged on the Consolidated Fund and payable in five annual instalments of 500,000*l*. each in 1911, 1912, 1913, 1914, and 1915; (3) sums received by way of interest on and repayment of loans and the profits made as the result of a grant or loan in cases where the repayment of such profits is made a condition of the grant or loan. Power is given to the Board of Agriculture and Fisheries and the Department of Agriculture and Technical Instruction for Ireland to acquire land (compulsorily if necessary) for any purpose for which a grant is made to them. As the *Times* points out, this part of the Bill will permit the expenditure of money on scientific research and experimental work of a kind likely to be beneficial to agriculture. Part ii. of the Bill constitutes a Road Board for the purpose of improving the facilities for motor traffic. In addition to the power of acquiring land for the purposes of new roads proposed to be constructed by the Road Board, the Board is given power to acquire land in rural districts on either side of any such proposed road to the extent of 220 yards in depth.

DR. ALEXANDER RUSSELL has been appointed principal of Faraday House in succession to the late Mr. H. E. Harrison.

DR. T. H. BRYCE, lecturer on anatomy at Queen Margaret College, Glasgow, has been appointed Regius professor of anatomy in the University of Glasgow in succession to Prof. J. Cleland.

WE regret to see the announcement of the death, at sixty-seven years of age, of Prof. E. C. Hansen, head of the physiological department of the Carlsberg Laboratory, Copenhagen, for studies of chemistry and plant physiology, with particular reference to fermentation.

THE death is announced, at sixty-four years of age, of Dr. Radcliffe Crocker, distinguished particularly by his work on diseases of the skin. Dr. Crocker was the first president of the dermatological section of the Royal Society of Medicine, and made many valuable contributions to the literature of dermatology, among them being his "Treatise on Diseases of the Skin" and "Atlas of Diseases of the Skin."

THE twentieth annual general meeting of the Institution of Mining Engineers will be held at Newcastle-upon-Tyne on September 15. The following are among the papers to be read or discussed:—fire-damp caps and the detection of fire-damp in mines by means of safety-lamps, E. B. Whalley and W. M. Tweedie; equipment for the study of flame-caps and for miscellaneous experiments on safety-lamps, Prof. G. R. Thompson; electricity in coal mines, R. Nelson.

THE Budapest correspondent of the *Times* reports that the sixteenth International Congress of Medicine was officially opened there on August 29 by the Archduke Joseph in the name of the King of Hungary and Emperor of Austria. More than 4300 members have enrolled their names in the list, and they include a large number of eminent authorities on medicine from all parts of the world. We hope to give, in a future issue, an account of subjects of wide scientific interest and importance brought before the congress.

THE next International Congress of Mining, Metallurgy, Applied Mechanics, and Practical Geology will be held at Düsseldorf during the last week of June, 1910, under the auspices of the Rhenish-Westphalian Mining Industry. An influential committee of organisation has been formed which is charged with the making of the arrangements for the reading and discussion of papers, visits to places of technical interest, and social entertainments. Further information can be obtained in due course on application to the secretary of the Iron and Steel Institute or to the committee of organisation, Jacobistrasse, 3–5, Düsseldorf.

ON August 28 a West Indian hurricane struck the coast of north-eastern Mexico, and thence travelled inland over the States of Tamaulipas and Nuevo Leon. According to a *Times* correspondent, a deluge of rain fell for ninety-six hours, registering in all $17\frac{1}{2}$ inches, and the rivers, overflowing their banks, inundated territory estimated at 300 miles by 400 miles in area. Monterey, the capital town of Nuevo Leon, appears to have suffered most. The overflowing river swept through the lower parts of the town as a torrent half a mile, destroying life and property in its course.

IN accordance with previous announcements, arrangements have been made to hold the autumn meeting of the Iron and Steel Institute in London on September 27–30 and October 1. The programme includes the following papers:—the determination of the power consumption of reversing rolling-mills, C. A. Ablett; comparative tests of cast iron, E. Adamson; artificial magnetic oxide of iron, F. J. R. Carulla; action of air and steam on pure iron, Dr. J. Newton Friend; corrosion of iron, Dr. J. Newton Friend; uniform moisture in blast, Greville Jones; the refining of steel by electricity, Disponent E. J. Ljungberg; the fuel economy of dry blast, as indicated by calculations from empirical data, R. S. Moore; the "growth" of cast irons after repeated heatings, Prof. H. F. Rugan and Dr. H. C. H. Carpenter; the maintenance and renewal of permanent way, R. Price-Williams; the constitution of carbon-tungsten steels, T. Swinden.

THE past summer, comprised by the three months June, July, and August, was of a generally unsettled character over the whole of the British Islands; rain was of very frequent occurrence, and the days were, as a rule, decidedly cool. At Greenwich there were in all forty-one days with the temperature above 70°, of which twenty occurred in August, and there were six days with the thermometer above 80°, all of which occurred in August. Of recent years, 1903 and 1907 are the only summers as cold. The mean temperature for the whole period of three months was rather more than 2° below the average; the mean for the respective months was 55° in June, 61° in July, and 63° in August. The aggregate rainfall for the three months was 8·65 inches, of which 3·69 inches fell in June, 3·16 inches in July, and 1·80 inches in August; the total for the summer was 1·87 inches more than the average. Rain fell on forty-eight days, of which eighteen occurred in June, nineteen in July, and eleven in August. The total duration of sunshine was 502 hours, of which 106 occurred in June, 179 in July, and 217 in August. The deficiency of sunshine at Greenwich for the three months was 141 hours.

THE council of the National Museum of Wales is prepared to receive designs for a new museum at Cardiff, at a cost for the completed building of 250,000*l.*, inclusive of carving, but exclusive of decorative sculpture. A copy of a detailed statement of conditions and instructions to competing architects has reached us from Dr. W. E. Hoyle, director of the museum, and the prospect it presents is very pleasing. The museum is to afford the accommodation known to be necessary in all the various departments of a national museum, and will include the following exhibition galleries:—history and antiquities; geology and mineralogy; Welsh natural history; zoology and botany general; industries; art; children's room; aquarium. There will also be special rooms for study and reserve collections for each department. The circular of instructions states that the purpose of the building is to preserve and display articles of various kinds, not only with satisfaction to the connoisseur in each variety, but with a taste and artistic refinement likely to waken the interest of the public generally. The exhibition cases will, as a rule, stand free in the rooms and not against the walls. Designs for the building must be sent in (carriage paid) addressed to the director, National Museum of Wales, City Hall, Cardiff, on or before January 31, 1910.

THE aviation week at Rheims ended on Saturday, August 28, when several remarkable flights and achievements were accomplished. The meeting has shown that aëroplanes of various designs are able to remain in the air for two or three hours, and to attain speeds of about fifty miles an hour. The Grand Prize for the longest flight was won by Mr. Farman, with a flight of nearly 112 miles in 3h. 4m. 56·4s.; the Gordon-Bennett Cup for speed by Mr. Curtiss, who flew the two-lap twenty-kilometre course in 15m. 50·6s.; the speed prize for swiftest flight over thirty kilometres by Mr. Curtiss, who did the distance in 26m. 40·2s.; the passenger prize by Mr. Farman, who flew six miles with two passengers in 10m. 39s.; and the altitude prize by Mr. Latham, for reaching the greatest height of 155 metres. The *Morning Post* of August 28 gives the following interesting table showing the successive stages of distances achieved in aëroplane flights since the commencement of public flights in Europe:—

Date	Aëroplanist	Place	Time	Distance
			h. m. s.	Metres
Oct. 14, 1897	Ader	Satory ...	—	300
Dec. 17, 1903	O. Wright...	Dayton ...	0 0 59	260
				Kilom.
Dec. 17, 1904	O. Wright...	Dayton ...	—	4·5
Sept. 26, 1905	O. Wright...	Dayton ...	0 18 9	17·9
Sept. 29, 1905	O. Wright...	Dayton ...	0 19 55	19·5
Oct. 3, 1905	O. Wright...	Dayton ...	0 25 5	24·5
Oct. 4, 1905	O. Wright...	Dayton ...	0 33 17	33·4
Oct. 5, 1905	O. Wright...	Dayton ...	0 38 3	38·9
Sept. 14, 1906	S. Dumont..	Bagatelle ...	0 0 8	—
				Metres
Oct. 24, 1906	S. Dumont..	Bagatelle ...	0 0 8	50
Nov. 13, 1906	S. Dumont..	Bagatelle ...	0 0 8	60
Nov. 13, 1906	S. Dumont..	Bagatelle ...	0 0 8	82·60
Nov. 13, 1906	S. Dumont..	Bagatelle ...	0 0 $21\frac{1}{5}$	220
Oct. 15, 1907	H. Farman..	Issy	0 0 21	285
Oct. 26, 1907	H. Farman .	Issy	0 0 27	363
Oct. 26, 1907	H. Farman..	Issy	0 0 $31\frac{3}{5}$	403
Oct. 25, 1907	H. Farman..	Issy	0 0 $52\frac{3}{5}$	771
Nov. 9, 1907	H. Farman..	Issy	0 1 14	—
Jan. 11, 1908	H. Farman..	Issy	0 1 45	—
				Kilom.
Jan. 13, 1908	H. Farman..	Issy	0 1 28	1·5
Mar. 21, 1908	H. Farman..	Issy	0 3 31	2
April 10, 1908	Delagrange.	Issy	—	2·5
April 11, 1908	Delagrange.	Issy	0 6 30	3·9
May 27, 1908	Delagrange.	Rome	0 15 25	9
May 30, 1908	Delagrange.	Rome	0 15 $26\frac{4}{5}$	12·7
June 22, 1908	Delagrange.	Milan	0 16 30	17
July 6, 1908	H. Farman..	Issy	0 20 $19\frac{3}{5}$	19·7
Sept. 6, 1908	Delagrange.	Issy	0 29 $53\frac{4}{5}$	24·7
Sept. 9, 1908	O. Wright...	Fort Myer...	0 57 31	—
Sept. 9, 1908	O. Wright...	Fort Myer...	1 3 15	—
Sept. 10, 1908	O. Wright...	Fort Myer...	1 5 52	—
Sept. 11, 1908	O. Wright...	Fort Myer...	1 10 50	—
Sept. 12, 1908	O. Wright...	Fort Myer...	1 15 20	—
Sept. 21, 1908	W. Wright..	Auvours ...	1 31 $25\frac{4}{5}$	66·6
Dec. 18, 1908	W. Wright..	Auvours ...	1 54 $53\frac{3}{5}$	99·8
Dec. 31, 1908	W. Wright..	Auvours ...	2 20 $23\frac{1}{5}$	124·7
Aug. 7, 1909	Sommer ...	Châlons ...	2 27 15	—
Aug. 25, 1909	Paulhan ...	Bétheny ...	2 43 $24\frac{4}{5}$	133·6
Aug. 26, 1909	Latham ...	Bétheny ...	2 17 $21\frac{3}{5}$	154·6
Aug. 27, 1909	Farman ...	Bétheny ...	3 4 $56\frac{3}{5}$	180

SEVERAL remarkable pictures illustrate Lieut. Shackleton's account of his Antarctic expedition which he commences in the September number of *Pearson's Magazine*. The article is an interesting narrative of the origin and early work of the expedition, and may be regarded as an earnest of the detailed account to be published this autumn. We notice a few of the noteworthy points. Pack ice was sighted about 1500 miles from Lyttelton, and the journey was then continued southwards along the 178th meridian west. After passing through hundreds of tabular icebergs by means of narrow lanes, the Ross Sea was reached, and the *Nimrod* was taken along the edge of the Great Ice Barrier, the enormous cliff of ice towering high above the vessel's crow's nest. The pack ice barred the way to King Edward VII. Land, where it had been intended to winter, so the vessel steamed to McMurdo Sound, and winter quarters were established at a spot twenty miles north of the point at which the *Discovery* expedition wintered. The party which ascended Mount Erebus made valuable observations of the volcano. In the old crater, above the southern end of which rises the active cone, a number of curious mounds were seen which proved to be fumeroles. The steam from the fumeroles is converted into ice as soon as it reaches the surface of the snow plain, and the result is the production of ice mounds. The active crater of Erebus was found to be between 800 feet and 900 feet deep, with a maximum width of half a mile, and at the bottom were seen three well-like openings from which the steam is projected. The height of the volcano was found to be 13,350 feet, and immense moraines ascend the western slope to a height of fully 1000 feet above sea-level. As the adjacent sea is at least 300 fathoms deep, this indicates that when at its maximum development the ice sheet must have had a thickness of not less than 2800 feet.

IN Publication No. 60 of the Hull Museum Mr. T. Sheppard figures a fine skull of *Bison priscus* recently obtained from gravel at Kelsey Hill, Yorks.

WE have to acknowledge the receipt from Mr. B. B. Woodward of a copy of his presidential address to the Malacological Society upon the subject of Darwinism and malacology.

IN the Proceedings of the Academy of Natural Sciences of Philadelphia for May Mr. J. P. Moore describes part of a collection of polychætous annelids dredged in 1904 off southern California; a large number of new species are included in the collection.

IN the Journal of the Royal Microscopical Society Messrs. Heron-Allen and Earland continue their account of the Foraminifera found in the sand at Selsey Bill, Sussex. These include, not only recent, but also many extinct forms from various geological horizons.

IN No. 191 of the Proceedings of the American Philosophical Society are included addresses on Darwin and Darwinism delivered at a commemorative meeting held at Philadelphia on April 23. In the first of these Mr. Bryce, British Ambassador at Washington, gives interesting personal reminiscences of Darwin and of the reception accorded to the "Origin of Species" on its first appearance. Mr. G. L. Goodale and Mr. G. S. Fullerton follow on with addresses respectively devoted to the influence of Darwin on the natural and on the mental and moral sciences, while Mr. E. G. Conklin winds up with the world's debt to Darwin.

IN February last Dr. N. Annandale obtained on the Orissa coast of India a number of small more or less nearly globular organisms in the tide-wash. When placed in water their shape changed from globular to conical, and indicated that they were evidently pelagic sea-anemones, although devoid of tentacles. The mouth is conspicuous, forming a relatively long, narrow slit expanded at one end, and the whole organism presents a milky appearance, which conceals the internal organs. Externally a vinous tinge, deepening into brown at the aboral pole (which is perforated by a pore) was noticeable. As these actinians, which are apparently adult, although no gonads are visible, evidently indicate a new generic and specific type, Dr. Annandale has described them under the name *Anactinia pelagica*.

Investigator sicarius is the name proposed by Captain F. H. Stewart in vol. i., No. 4, of Memoirs of the Indian Museum for a new type of gephyrean worm of which specimens were obtained by the s.s. *Investigator* in the Gulf of Manaar and off the Arakan coast. This annelid is regarded as indicating, not only a new genus and species, but likewise a new order, which it is proposed to designate by the uncouth title of "Investigatoroidea." This order is defined as gephyreans with an anterior terminal mouth and posterior subterminal vent, and a nervous system composed of dorsal cerebral ganglia and two lateral nerve-cords. The replacement of the median ventral nerve-cord by a pair of ventro-lateral cords is not considered sufficient to bar the inclusion of the new organism in the Gephyrea.

CONSIDERABLE interest attaches to an article in the August number of the *American Naturalist*, by Prof. D. H. Campbell, on the new flora of Krakatau (Krakatoa). When the island was first visited by scientific men two months after the great eruption of 1883, the whole surface was buried under a layer of ashes and pumice averaging 90 feet in depth, and in some places reaching double this depth. A clean sweep of living organisms was thus made. Except phosphorus and nitrogen, the elements necessary for plant-life existed in the ashes. By 1886, when the island was visited by Dr. Treub from Java, a number of plants had already established themselves, slimy, blue-green algæ being of special importance in preparing the soil for higher plants. The plants in the interior were found to be quite different from those near the coast, and the preponderance of ferns was remarkable. Since 1897, when another visit was paid, the progress of the new flora has been rapid, this being especially noticeable in 1906 in the case of the forest trees, which make it evident that the island will ere long be as densely afforested as ever. Nitrogen-forming bacteria have played an important part in rendering the soil fitted for vegetation. As regards distributional agencies, there seems no doubt that the earliest plant-immigrants, such as bacteria, blue-green algæ, ferns, and mosses, were wind-borne, and the same is probably true of the first phanerogams, Compositæ, and grasses to reach the island. On the other hand, ocean-currents have probably been the chief agents in transporting seeds and fruits, those of the strand-plants being almost certainly water-borne.

AN article on the American Forest Service contributed by Mr. T. S. Woolsey to the *Indian Forester* (June and July) for the information of foresters in British India will certainly interest readers who follow the development of scientific forestry. It is mentioned that the actual administration of national forests in America by trained foresters only dates back four years, and in that time opposition has been overcome and public opinion educated by the publications which have been liberally distributed. The general nature of arrangements for timber sales is described in detail, and the outlines for working plans on national forests are indicated. Research at the experiment stations is concerned with tree and stand studies, run-off and ground-water measurements, and meteorological observations.

IN consequence of the observation that lumps of gum are occasionally exuded by the bromeliad, *Guzmannia zahnii*, an investigation of other plants belonging to the same family was undertaken by Mr. K. Boresch. It was then found that several allied plants, notably *Aechmea pineliana*, showed the same phenomenon. The gum passages are situated in the cortex of the stem; they usually originate lysigenously and the adjoining parenchymatous cells frequently grow in like thylloses; although not definitely ascertained, it seems probable that the process is pathological. Incidentally, the author traced a meristematic zone which gives rise to a thickening of the stem, as in Ruscus. The paper appears in the *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften*, Vienna (vol. cxvii., part viii.).

The first portion of a study of various morphological features in the Umbelliferæ is contributed by Dr. K. Domin to the *Bulletin International* (1908), published by the Académie des Sciences de l'Empereur François Joseph I. Various interesting points are noted regarding the seedlings, *e.g.* the tubular shape of the cotyledon stalks in species of Ferula, the occurrence of so-called monocotyledonous embryos as in Bunium, and three cotyledons observed in various species of Eryngium. The formation of the tuber in such genera as Smyrnium and Bunium is traced to the hypocotyl, which also produces roots above the tuber. The most important statement refers to the stipules, which are stated to be universally present and free in all species of Hydrocotyle; Schizeilema and Huanaca possess adnate stipules, while species of Bowlesia show various modifications from an ochrea to laciniate appendages.

The chief of the U.S. Meteorological Service decided to make some important changes in the scope and character of the *Monthly Weather Review*, beginning with July 1. The data are now grouped according to natural topographic districts; for this purpose the United States has been divided into twelve climatological districts conforming to its principal drainage areas, each being under the supervision of a selected division director. The Review is to be devoted almost exclusively to the publication and discussion of climatological, river, and forecast data; special articles of a scientific nature, but not strictly climatological, will be published in the Bulletin of the Mount Weather Observatory or in separate form. The editors (Messrs. Abbe and Abbe, jun.) will prepare, as hitherto, brief notes on the progress of meteorological science throughout the world, so that the Review may still mark the development of the science, without publishing extensively the details of meteorological papers.

We have received a reprint of an article on "The Tides: their Causes and Representation," published by Mr. R. A. Harris in the June number of the *Popular Science Monthly*. The article is illustrated by useful charts showing the co-tidal lines in the different oceans.

A new rainfall map of the Balkan peninsula, compiled by Herr Franz Trzebitzky, appears in the August number of *Petermann's Mitteilungen*. The data are obtained from 380 stations, 95 in Croatia and Dalmatia, 93 in Bosnia and Herzegovina, 50 in Servia, 105 in Bulgaria, 1 in Montenegro, 12 in Turkey, and 24 in Greece. The averages are reduced to the period 1894–1905.

The *Zeitschrift* of the Berlin Gesellschaft für Erdkunde (1909, p. 361) publishes a lecture delivered before the society by Prof. Hecker on the determination of the value of gravity and its application to the problem of the distribution of mass in the earth's crust. A general outline of modern methods is given, and a summary of the most important results obtained from observation.

The *Mitteilungen* of the Vienna Geographical Society (1908, p. 150) contains a very interesting and suggestive paper by Dr. Max Müller on the graphical solution of a number of problems in "astronomical" geography. Some ten important problems are fully discussed, and methods of solution with the help of rule and compasses alone described. A final example shows how to determine the approximate latitude and longitude of a place, from two observations of the sun's altitude, using a large globe.

Prof. Hammer, discussing a paper on the forty-ninth parallel by Dr. Klotz (Journal of the Royal Astronomical Society of Canada, 1908, p. 282), deals with the determination of the boundary line between Canada and the United States west of the Lake of the Woods in a note in *Petermann's Mitteilungen* (viii., p. 188). The extraordinary difficulties inherent in the accurate laying down of a parallel of latitude are dwelt upon with great emphasis.

The director-general of the Egyptian Survey Department has issued a reprint of a technical lecture—one of a series of such lectures—by Mr. J. I. Craig, on map projections. The general principles of the subject are outlined, and examples given of projections employed for different kinds of maps. The construction of a network for a special purpose is illustrated in an extremely interesting manner by a "Mecca azimuthal" projection, which is designed to give the true bearing of Mecca from every point of the map. As the author remarks, "its usefulness in finding the direction of the *Qibla* is evident."

The June number of the *National Geographic Magazine* contains an article by Mr. Charles E. Fay on "The World's Highest Altitudes and First Ascents," which is accompanied by some remarkably beautiful illustrations. Mr. Milnor Roberts describes the Mount Rainier National Park in an article entitled "A Wonderland of Glaciers and Snow," and an interesting table, compiled by Mr. N. H. Darton, gives the highest point in each of the States. Mr. Hugh M. Smith, deputy commissioner of the U.S. Bureau of Fisheries, contributes a graphic account of "Brittany, the Land of the Sardine."

The *Journal de Physique* for August contains the address delivered by Prof. Paul Janet to the Société française de Physique in April, on the history and the present position of the question of the fundamental electrical units. After giving a brief history of the various commissions which have dealt with the subject, he gives in detail the decisions arrived at under the headings ohm, ampere, volt, and states to what extent these decisions have been adopted officially by the various Governments. He is of opinion that the action of many of these Governments in adopting particular numbers as official has been rather precipitate, and would prefer them to wait until the institution of an international electrical laboratory has permitted comparisons to be made between the electrical standards kept at the various national laboratories.

The second of a series of papers dealing with the phenomena exhibited by electric arcs between metal electrodes appears in the *American Journal of Science* for August. It is by Messrs. W. G. Cady and G. W. Vinal, and treats of the oscillations which, under certain conditions, can be produced. If an electromotive force of several hundred volts is connected through a variable resistance to an air-gap having, say, a copper kathode and an anode of any conducting material, and an arc is started, on increasing the resistance until the current falls to about 0·4 ampere the arc begins to oscillate with a frequency which in general lies between 1000 and 50,000 per second, and finally, as the resistance in series is increased, becomes a glow discharge or is extinguished. The authors explain with the aid of the volt-ampere curve the conditions which control the production of these oscillations, and give a provisional theory which covers the phenomena observed up to the present time.

ENGINEERING units of measurement form the subject of a pamphlet which has just been produced by Mr. J. Ramsay, of the Glasgow and West of Scotland Technical College. The greater part of the thirty-six pages consists of definitions of the quantities and symbols which more commonly occur in engineering, and in each case the author gives both British and metrical units, together with the connection between them. Several useful tables are given at the end. The value of the pamphlet will be appreciated when it is remembered that students of engineering in this country are compelled to use both British and metrical systems of measurement, a condition which tends to produce much mental confusion and hinders progress. While most of the author's explanations are good, we do not think that his remarks on pp. 8 and 9 regarding weight, mass, and gravitational and dynamical units of force are sufficiently clear; but few writers have succeeded in producing absolutely convincing statements when they take, as the present author does, the British gravitation unit of force as the force with which the earth attracts a pound weight at the sea-level at Greenwich, and also a unit of mass of 32·2 lb. The publishers of the pamphlet are Messrs. John Smith and Son, Glasgow, and the price is 1*s*. net.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER:—

Sept. 1. 16h. 0m. Mars in conjunction with Moon (Mars 1° 4′ S.).
2. 17h. 0m. Saturn in conjunction with Moon (Saturn 1° 14′ N.).
3. 9h. 2m. to 9h. 50m. Moon occults ξ' Ceti (mag. 4·5).
7. Maximum of Mira Ceti (mag. 3·3–8·5).
10. Saturn. Major axis of outer ring = 45·31″, Minor axis = 10·00″.
15. 12h. 5m. Minimum of Algol (β Persei).
16. 22h. 0m. Mercury at greatest elongation (26° 34′ E.).
18. 8h. 54m. Minimum of Algol (β Persei).
23. 22h. 0m. Mars at opposition to the Sun.
,, 15h. 3m. Uranus in conjunction with Moon (Uranus 2° 35′ N.).
,, 3h. 39m. to 4h. 53m. Moon occults σ Sagittarii (mag. 2·1).
28. 15h. 0m. Mars in conjunction with Moon (Mars 0° 9′ N.).
30. 0h. 0m. Saturn in conjunction with Moon (Saturn 1° 8′ N.).

THE SOUTH POLAR SPOT ON MARS.—With regard to the recent observation by M. Jonckheere, Dr. Lohse records in No. 4348 of the *Astronomische Nachrichten* (p. 61) that he observed the bright patch which has detached itself from the polar snow-cap on August 8. The position of the spot, in areographical coordinates, was:—longitude, 304·5°; latitude, −74·5°. A measure of the south polar spot gave a diameter of about 30°.

COMET 1909*b* (PERRINE, 1896 VII.).—The position of comet 1909*b*, according to the ephemeris given in No. 4348 of the *Astronomische Nachrichten*, on September 3 will be α (1910·0) = 1h. 12·9m., $\delta = +46°$ 24·8′, whilst that on September 15 will be α = 2h. 0m., $\delta = +51°$ 32·9′. Thus we see the comet is passing from Andromeda to Perseus, and on September 9 will pass about half a degree north of ν Persei; at the same time it is approaching both the earth and the sun, and is now about one magnitude brighter than when re-discovered.

THE ORBITS OF CERTAIN SPECTROSCOPIC BINARIES.—Nos. 15 and 17, vol. i., of the Publications of the Allegheny Observatory deal, respectively, with the orbits of the spectroscopic binaries π^4 Orionis and ζ^1 Lyræ. The former is discussed by Mr. R. H. Baker on the basis of thirty-six spectrograms obtained with the single-prism Mellon spectrograph. The orbit is nearly circular, the eccentricity, in the final elements, being given as 0·027 ± 0·013, and the length of the semi-major axis is 3,393,000 km.; the amplitude of the velocity-variation is 51·8 km., and the period is 9·5 days. The spectrum is of the helium type, but does not show the spectra of both components. Mr. F. C. Jordan finds, from the discussion of sixty-four plates, that the orbit of ζ^1 Lyræ is circular and the period is 4·29991 days; the amplitude of the variation is 102·48 km.

Mr. Jordan has also observed four of the stars in Taurus which Prof. Boss suggested belonged to a group having a common movement. He finds (Publication No. 16) that two of the four stars, Piazzi 234 and Bradley 716, give results in accordance with the idea that they belong to a cluster; the other two, 51 Tauri and ι Tauri, appear to have variable velocities.

THE BOLIDE OF APRIL 20 AS OBSERVED IN FRANCE.—The August number of the *Bulletin de la Société astronomique de France* contains a number of drawings and descriptions (pp. 357–61) of the remarkable meteor seen on April 20 at about 10 p.m. This meteor traversed Ursa Major, leaving behind it a train which lasted for about two minutes as a naked-eye object, according to M. Quénisset, and could be seen for five minutes with a prismatic binocular. The train moved in an east-and-west direction, and developed a condensation, which is shown by some observers as being at one side of a break in the train, and by others, M. Quénisset among them, as a bright loop. The brightness of the meteor was about equal to that of Venus at its brightest, whilst that of the train was comparable with the brightness of the Milky Way.

MATERIA MEDICA AMONG THE ZULUS.

IN the July number of the Annals of the Natal Government Museum, Father A. T. Bryant, a competent observer of native life and author of a valuable dictionary of the tribal language, has for the first time collected materials for the study of Zulu materia medica and the methods of the local medicine-man. He records some 240 Zulu plants used in medicine, giving what the people believe to be their properties and the modes in which they are administered to the patient. Here, as among other savage races, the medicine-man was a personage originally distinct from the diviner or so-called witch-doctor; but their functions tend occasionally to overlap, the medicine-man dealing largely in magic and charms, while the witch-doctor makes himself familiar with curative herbs, though his real business is to indicate or "smell out" the agency which is supposed to have caused the illness.

The Kafir medical man has no knowledge of pathology. He knows as much of anatomy as can be learned from cutting up cattle for food; but the nervous system is a complete mystery to him, and though he has observed that the blood runs through the body, he does not associate its circulation with the beating of the heart. He works by the examination of symptoms, though he is ignorant of their cause, treating paraplegia, for instance, by local applications, and not connecting its occurrence with any brain disease. His occasional successes seem to be generally due to the influence of suggestion, by exciting the feeling of confidence or imagination which summons into action the remarkable recuperative powers of the patient. In his profession medicine and magic constitute a single art, and he is called upon to combat, not only the disease which has actually shown itself in the system, but also the machinations and forms of the black art which are believed to have induced it.

Like most savages, the Zulu is unusually susceptible to new diseases, though he is hardened against those which are old. Father Bryant gives interesting details of the more common diseases and their popular treatment. He records a form of disease, believed not to be known to medical science, resulting from an intestinal parasite developing into a species of beetle. The local form of phthisis seems to be different from that of Europe, the former setting in at the bottom, the latter at the top, of the lung. The medicine-man deals largely in blood-letting, poulticing, the use of ointments, the clyster and the emetic. He knows many of our standard remedies, while of others equally accessible to him he is ignorant. Thus he uses indigenous species of Nephrodium for the relief of tape-worm, and croton as a purgative, but it is apparently from the white man that he has learned that the *Ipomoea purpurea* has qualities analogous to jalap, and though castor-oil is used for dressing hides he is not aware of its medicinal value. But he undoubtedly is acquainted with a great number of simples, mostly vegetable; and Father Bryant believes that the further investigation, and in particular the chemical examination, of many of the drugs which he names will in all probability add valuable remedies to our pharmacopœia. Dr. E. Warren, curator of the museum, promises that his department will provide all possible assistance in material and information to any competent chemist who is prepared to undertake such an inquiry.

AMERICAN INVERTEBRATES.

BULLETIN No. 63 of the United States National Museum is devoted to a monographic revision, by Mr. F. E. Blaisdell, of the beetles of the Eleodine section of the family Tenebrionidæ inhabiting the United States, Lower California, and the adjacent islands. The memoir includes 534 pages of text and thirteen plates.

In No. 2 of the Leland Stanford Junior Publications of the University of California Prof. F. M. Macfarland describes in considerable detail the anatomy of the opisthobranchiate molluscs obtained during the Brauner-Agassiz expedition to Brazil in 1899. The collection, although small, adds seven to the list of Brazilian species of the group; and since little was previously known with regard to the structure of the opisthobranchs of the district, the opportunity was taken of studying this as minutely as the amount of material permitted. A number of diagrammatic figures of the radula in different genera is given.

The feather-stars, or ophiurids, of the San Diego region form the subject of vol. vi., No. 3, of the University of California Publications in Zoology. The author, Mr. J. F. McClendon, began his investigation in the hope that a taxonomic and biological study of the local members of the group might facilitate work in which it was important to know the breeding-seasons and habitats of different species, but, unfortunately, he could not remain long enough to obtain all the data desired. It is believed, however, that the height of the breeding-season for most of the species is in the spring, although individuals full of apparently unripe eggs were taken in spring.

A number of new fossil echinoderms from the Cretaceous and Tertiary Ripley beds of Mississippi are described and figured by Mr. A. W. Slocum in vol. iv., No. 1, of the Geological Publications of the Field Museum, Chicago.

The re-arrangement of the large collection of graptolites which for many years has been in course of formation in the U.S. National Museum has afforded to Mr. R. S. Bassler the opportunity of revising the species of the dendroid group from the Niagaran Dolomite of Hamilton, Ontario, and the results of his studies are published, with a large number of illustrations, in Bulletin No. 65 of the museum.

THE SEVEN STYLES OF CRYSTAL ARCHITECTURE.[1]

THE proverbial importance of the number seven is once more illustrated in regard to the systems of symmetry exhibited by solid matter in its most perfectly organised form, the crystalline. For there are seven such systems or styles of architecture of crystals, just as there are seven distinct notes in the musical octave, and seven chemical elements in the octave or period of Newlands and Mendeléeff, the eighth or octaval note or element being but a repetition on a higher scale of the first.

A crystal appeals to us in two distinct ways, first compelling our admiration for its beautifully regular exterior shape, and next impressing us with the fact of its internal homogeneity, expressed in the cases of transparent crystals by its perfect limpidity, and the obvious similarity throughout its internal structure. As it is with human nature at its best, the external appearance is but the expression of the internal character.

The purpose of this discourse is not so much to dilate upon the seven geometrical systems of crystals as to show how they are occasioned by differences in the internal structure, and to demonstrate this internal structure in an ocular manner, unfolding at the same time some interesting phases of recent investigation.

To the Greeks, whose wonderfully perfect knowledge of geometry we are ever admiring, the cube was the emblem of perfection, for like the Holy City, lying "foursquare," described in the inimitable language of the book of Revelation, "The length and the breadth and the height of it are equal." Moreover, even when we have added that all the angles are right angles, these are not the only perfections of the cube, for they carry with them, when the internal structure is developed to its highest possibility, no fewer than twenty-two elements (thirteen axes and nine planes) of symmetry.

At the other extreme is the seventh, the triclinic, system, in which the symmetry is at its minimum, neither planes nor axes of symmetry being developed, but merely parallelism of faces, sometimes described as symmetry about a centre, and in which there are no right angles and there is no equality among adjacent edges. Between these two extremes of maximum and minimum symmetry we have the five systems known as the hexagonal, tetragonal, trigonal, rhombic, and monoclinic, possessing, respectively, 14, 10, 8, 6, and 2 elements of symmetry. All crystals do not possess the full symmetry of their system, each system being subdivisible into classes possessing a definite number of the possible elements. Altogether there are thirty-two such classes, and their definite recognition we owe to the genius of von Lang and Story Maskelyne.

The characteristic property possessed in common by all crystals is that the exterior form consists of and is defined by truly plane faces, inclined, in accordance with one of the thirty-two classes of symmetry, at specific angles which are characteristic of the substance. This has only been proved to be an absolute fact within the last few years, although asserted by Haüy so long ago as the year 1783; for the numerous cases of so-called "isomorphous" salts, the first of which were discovered by Mitscherlich in the year 1820, were for long believed to be exceptions, and until the year 1890 no actual evidence one way or the other was forthcoming. But it was eventually shown that the crystals of the members of an isomorphous series did differ, both in their angles and in all their other crystallographic and physical properties, although in the cases of the angles the differences were very small. Moreover, the differences were shown to obey a simple but very interesting law, namely, that they were functions of the atomic weight of the chemical elements of the same family group the interchange of which gives rise to the series.

All crystals possess one other obvious property, that of homogeneity, and we now know that it is the character of the homogeneous substance which determines the external form. There are no fewer than 230 different kinds of homogeneous structures, neither more nor less, the elucidation of which we owe to the independent recent labours of Schönflies, von Fedorow, and Barlow; and it is a significant fact that the whole of them fall naturally into the thirty-two classes of crystals, leaving no class unaccounted for. Of these 230 modes of regular repetition in space fourteen are the space-lattices long ago revealed to us by Bravais, and all recent investigation concurs in indicating two facts, first, that it is the space-lattice which determines the crystal system, and second that it is the arrangement of the chemical molecules which is represented by the space-lattice. Each cell of the space-lattice corresponds to a molecule. The structure is certainly not solid throughout, however, part only being matter, and the rest æther-filled space, the relative proportions and the shape of the material portion being as yet unknown. We limit ourselves, therefore, to considering each molecule as a point, and we draw the lattice as a network of three systems of parallel lines, parallel to the directions of the three principal crystal edges, analogous, according to the system of symmetry, to

[1] Summary of evening discourse delivered before the British Association at Winnipeg on August 26 by Dr. A. E. H. Tutton, F.R.S.

those of the cube. The points of intersection we consider as those representing the molecules, inasmuch as any point within the limits of the cell may equally well be taken to represent the cell and the molecule, provided the choice is analogously made throughout the structure.

It has recently been found possible to determine the relative dimensions of these molecular cells, the distances of separation of the points of the space-lattice, in those cases where we know that the structure is similar, as in isomorphous salts; and the interesting discovery has been made that the "molecular distance ratios," as these space-dimensions are called, are functions of the atomic weights of the interchangeable members of the family of chemical elements constituting the series, just as the crystal angles have been shown to be.

We are now able, moreover, to take yet one further step, for the chemical molecules are composed of atoms, and it has been indubitably shown that the atoms occupy definite positions in the crystal. For when we replace, say, the alkali metal in a sulphate or selenate by another, we observe a marked alteration in the crystal angles and the molecular distance ratio along a particular direction, this direction being the same whichever metals of the group are interchanged; whereas if we replace the sulphur by selenium, a similar kind of alteration occurs, but along a totally different direction. Now we know that the atoms are arranged in the chemical molecule in what is known to chemists as their stereometric arrangement, depending on the maximum satisfaction of their chemical affinities. Hence this important experimental fact of the occupation by the atoms of definite positions in the crystal proves, first, the homogeneous similarity of arrangement of the molecules, and, secondly, explains why we have classes or subdivisions within the systems. For it is the arrangement of the atoms within the molecule which causes the variations of the degree of symmetry, within the limits prescribed by the system and space-lattice; in other words, which determines the class.

Now obviously any one of the atoms in the molecule may be chosen to represent the latter, and the points thus chosen analogously throughout the structure will constitute the molecular space-lattice. Hence the whole structure may be considered as made up of as many interpenetrating similar space-lattices as there are atoms in the molecule. The crystal structure will thus be dependent on two factors, the space-lattice and the scheme of interpenetration of the space-lattices, the former dominating the style of architecture, the crystal system, and the latter the vagaries of the style, the crystal class. Sohncke has shown that there are sixty-five such vagaries possible, which he terms regular point systems, and these coincide with sixty-five of the 230 possible modes of partitioning space.

These are the broad, simple facts, now proved up to the hilt, which explain the majority of crystal structures, all, in fact, but a very few, of the more complicated classes of the thirty-two. For the remaining 165 ways of appropriating space all fall into a very small number of crystal classes. They are of very great interest, however, and involve an entirely new principle, that of "reflective" or "mirror-image" symmetry, enantiomorphism as it is technically termed, and include those crystals which possess the remarkable property of rotating the plane of polarised light. These are the cases the geometrical possibility of which has been accounted for by the simultaneously independent work of Schönflies, von Fedorow, and Barlow, and to which we were experimentally introduced by the discovery of the right- and left-handed varieties of tartaric acid by Pasteur. The latter has since been followed by the revelation of many similar cases of two forms of the same chemical substance, related crystallographically and structurally like a right hand to a left-hand glove, and optically differing by the direction in which they rotate a beam of plane polarised light.

With their discovery and explanation the elucidation of the seven styles of crystal architecture and their thirty-two subdivisions becomes *un fait accompli*, and although many difficult problems still confront the crystallographer, problems of vast importance to chemistry, the groundwork is now securely laid, the memorable achievement of the last twenty years. The results, moreover, are in entire accordance with the now well-proved fact that the chemical atom is composed of electronic-corpuscles. For the definite orientation of the atom and its sphere of influence within the molecule and the crystal is thereby accounted for, the motion in the solid state so frequently hitherto attributed to the atom being a myth, such motion relating, in fact, to the corpuscles within the atom.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 23.—M. Bouquet de la Grye in the chair.—The calculation of the roots of numerical equations: M. **Lémeray.** Referring to a recent paper by M. de Montessus on this subject, the author points out that he published a method on the same principle in December, 1898.—Movements from the vertical due to the attraction of the moon and sun, the earth being supposed absolutely rigid: Ch. **Lallemand.**—A poison elaborated by yeast: A. **Fernbach.** It has been recently shown by F. Hayduck that there exists in the yeast cell a substance which is toxic to yeast. The present paper contains some new observations on the same subject. A solution of the toxic substance is shown, not only to be antiseptic to yeast cells, but also to bacteria such as *B. coli* and Staphylococcus, although it has no effect on moulds. The most remarkable property of this substance is that it is volatile under reduced pressure at a temperature not above 40° C. The distillate contains no formaldehyde; further researches on the nature of this substance are in progress.—The development of the eggs of *Philine aperta* exposed to the action of radium: Jan **Tur.**

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THURSDAY, SEPTEMBER 9, 1909.

A MONOGRAPH ON THE TRANSIT CIRCLE.

Les Observations méridiennes: Théorie et Pratique. By F. Boquet. Tome Premier, Instruments et Méthodes d'Observation. Pp. xi+314. Tome Second, Corrections instrumentales et Équations Personelles. Pp. iv+342+xii. (Paris: Octave Doin et Fils, 1909.) Price, 2 vols., 10 francs.

THESE two volumes comprise one of two completed sections out of a total of twenty-nine devoted to astronomy and celestial physics in a new form of scientific encyclopædia in which astronomy is only one of forty divisions. The whole work, if and when completed, should run to at least a thousand handy little volumes at a uniform price of 5 francs per volume. An index to the complete series is also promised, but it is hardly contemplated that the demand for the whole set will be very great, the idea being that each subject is to be totally distinct, so that a minimum of irrelevant matter need be purchased by any interested specialist, and that such sections as are rapidly rendered out-of-date may be quickly replaced by revised editions without necessitating alteration of the whole work.

Our purpose now, however, is to deal only with the two volumes before us, premising that the "Bibliothèque d'Astronomie et de Physique céleste," to which they belong, is under the directorship of M. Jean Mascart. It may be fairly remarked, inasmuch as the titles of the other twenty-eight sections of this "Library" are given, that it is quite possible the number will have to be augmented, as there is at present no obvious place for more than one modern investigation without straining the meaning of some of the published titles. With some 600 pages entirely devoted to meridian observations, we are at first inclined to wonder why so much space was thought necessary. But the wonder does not last long, for the pages are quite small, and the amount of detail is very great, as is only fitting in an encyclopædia. Moreover, we soon perceive that the transit-circle, though the two parts are inevitably studied separately, is the *only* instrument considered. This strikes us as an error of omission, for there is no other place for discussion of the zenith telescope in any form. There is no mention of the various forms suggested in substitution for the ordinary one, such as the fixed telescope with meridian mirror or the transit with axis view, simply rotating in bearings east and west. A very possible explanation is that these various forms are not of much account in France, but their omission seems to be a mistake.

There does not seem to be much, if anything, of consequence omitted in reference to the transit circle itself, all kinds of instrumental errors being fully and carefully dealt with, several methods of determination or correction being given in many cases. For instance, a very clear account is given of Cowell's refraction tables as used at Greenwich, while division error and eccentricity, screw value and error, pivot error, wire intervals and inclination, flexure, and so on, are treated with great fulness. The printing chronograph in various forms is naturally conspicuous, this subject being one on which M. Boquet has written more than once before. Another subject with which he has similarly shown familiarity is given an importance we do not remember to have seen before, and that is personal equation, the adequate treatment of which is especially welcome. The various physiological or psychophysiological causes of error are very carefully differentiated, and at the same time no space is wasted on the numerous devices for determining absolute personal equation in transit observations, though a long list of references is given for the use of those who care to pursue the subject.

Perhaps those whose "eye-and-ear" observations are consciously or unconsciously taken by what may be called the chronometer comparison method, as distinct from Bradley's (M. Boquet calls it "méthode de l'œil et de l'oreille par estime du temps"), will question whether their observations are so inferior as M. Boquet assumes. The use of screens also for magnitude equation is liable to meet with similar objections to those urged against the pierced cube of the Greenwich transit-circle, but in this the author is only summarising what has been done and projected. There are, in fact, very few places where he has expressed a decided personal opinion, so that we are inclined to regret that the plan of the work allowed so little scope for personality. With the reservation as to omissions to which we have alluded, we can only hope that the rest of the thousand-odd volumes will maintain the high standard of thoroughness set by M. Boquet. W. W. B.

THE HISTORY OF MECHANICS.

Lectures de Mécanique. By E. Jouguet. Première Partie: La Naissance de la Mécanique. Deuxième Partie: L'Organisation de la Mécanique. Pp. x+210 and 284. (Paris: Gauthier-Villars, 1908–9.) Price 7.50 and 10 francs.

SINCE the eventful appearance of Mach's works on mechanics and heat, much greater interest has been shown in the historical development of applied mathematics, both for its own sake and from a growing conviction that the teacher of a subject ought to know something of its actual growth and expansion, as well as the current methods of expounding it. Recent works by M. Duhem show that even in France, the birthplace and home of clear-cut analytical systems, there is an appreciation of the value of historical research and of tracing the slow formation of the leading ideas and principles of mechanics.

For several reasons M. Jouguet's book will be found a useful supplement to its predecessors. In the first place he is an engineer, so that he is in full sympathy with such men as Stevinus and Huygens and Galileo, and gives considerable attention to those who, like Reich and Andrade, propose to deduce the laws of mechanics from actual experiment. At the same time he is by no means the case-hardened empiric who ignores the claims of logic, and despises speculation. In fact, it is noteworthy, and gratifying, that he practically admits Kirchhoff's thoroughly abstract, and so to say *a priori*, presentation of dynamics to be the best extant from a critical point of view; and he is conscious of the value of a self-consistent theory which can be applied as at least a first approximation to the actual facts of experience.

Another advantage of the work is that it does not pretend to be exhaustive. By choosing definite problems (such as impact, for example) and restricting himself to the consideration of really eminent writers, the author is able to give extracts of some length from works of great interest which are not generally accessible. In some ways this is more instructive than any amount of comment can be.

M. Jouguet stops short of hydrodynamics, and only gives very brief accounts of the principles of least action and least constraint. Otherwise most of the main principles of dynamics and statics are illustrated. The chapters on internal forces are particularly interesting; so is a passage from Euler, which shows that he was vaguely conscious of the difficulties connected with the relativity of motion, and the impossibility of defining absolutely fixed axes of reference.

One reflection is almost certain to occur to the reader of these volumes, namely, that one great advance in the study of natural science has been the rejection of sham proposition about cause and effect, and adequate causes, and so on. It is distressing to find an able man like Wallis giving definitions of the most question-begging description, and stringing together such propositions as "other things being equal, a heavy body has a preference for the path by which it can sink the furthest." However, these early pioneers had a remarkable power of solving problems by elementary principles which they used without being able to express them in a proper, or even intelligible way; and the modern theories of light and electricity once more illustrate the curious paradox that theories based on the undefined and undefinable have the power, not only of simplifying our accounts of phenomena, but also of suggesting paths of discovery, and leading to larger control of the energy surrounding us.

If M. Jouguet's work reaches a second edition, he will doubtless correct "Bernouilli" to "Bernoulli." In a work of this kind it is rather irritating to find this time-honoured blunder repeated once more.

G. B. M.

ORGANIC MEMORY.

Die mnemischen Empfindungen in ihren Beziehungen zu den Originalempfindungen. By Prof. Richard Semon. Pp. xv+392. (Leipzig: W. Engelmann; London: Williams and Norgate, 1909.) Price 9 marks.

THE theory of the Mneme, propounded by Prof. Semon, has attracted the attention both of psychologists and of those naturalists who are interested in the profound problems of hereditary transmission. It is founded on the statement, which everyone is ready to admit, that a stimulus must affect the quality of living matter in such a way that the matter is not the same as it was before the stimulus acted. A permanent change, which, in a sense, may be called a memory, has been effected, or, to use the terminology invented by Semon, the action has been engraphic and the change itself is an engram. Repeated stimulation will make the engram more lasting. All stimuli then produce engrams, and the sum of the engrams of a living being is its mneme. Complex stimuli cause complex engrams, and if there is, under the action of some stimulus or other, a revivification of the complex engrams, then a condition termed ecphoria is produced, and the assemblage of engrams is ecphorized. If the new stimulus is in concord with the awakening of the complex engrams, this concord is termed by Semon homophonia, but if there is a discord, the homophonia may be restored in the case of psychical processes, by an introspective activity of the power of attention, or, in the case of a living organism, by regenerative processes acting ontogenetically, or by adaptation to the new conditions acting phylogenetically.

In this volume Prof. Semon discusses the theory with great clearness and commendable brevity, and he gives many illustrations. The theory may help to explain certain peculiar nervous conditions, as has been suggested by Dr. August Forel in his book on "Hypnotism." On the other hand, it may be of service to the naturalist in his ceaseless efforts to explain heredity, as was so forcibly put by Prof. Francis Darwin in his Dublin address to the British Association last year. Thus a stimulus may produce effects which radiate from the organised matter first affected to organised matter throughout the whole organism, either by nerve paths or by proplasmic intercellular filaments, and in this way faint engrams may be made on the matter of the reproductive elements, ova or spermatozoids. In some such way we may account for the transmission of acquired characters, a mode of thought, however, only to be ridiculed by those who hold that acquired characters are never transmitted. It may be said with much cogency that such a theory is only another method of arranging items of knowledge in one's mind; it is only an aid to memory and thought, without being a step towards an explanation. Although founded on well-known physiological facts, it rides off on the wings of the imagination, and it may be questioned if it really advances knowledge. Still, an ingenious theory is a stimulus and possibly a guide, and science is indebted to Prof. Semon for stating it in a succinct form in this interesting book.

JOHN G. MCKENDRICK.

THE PHYSICS OF THE ION.

Les Découvertes modernes en Physique. By Dr. O. Manville. Deuxième édition. Pp. iii+463. (Paris: A. Hermann et Fils, 1909.) Price 8 francs.

THE title of this work, "Les Découvertes modernes en Physique," since it is a single volume by a single author, is obviously incomplete. In effect the book is almost entirely, and might have been with great advantage entirely, confined to the relations between electricity and matter consequent upon the conception of the atomic charge and the isolation of the free negative charge as an electron. It is true that two chapters are devoted to the subject of radio-activity, concerning which we read in the preface:—

"Sur la *radioactivité de la matière* . . . nous avons dit que des généralités. Le domaine des faits dans cet ordre d'idées est si vaste et surtout si mobile, qu'il est encore très difficile de s'y orienter."

Ideas at the present time in radio-activity are more definite and well-grounded than in any other branch of physical chemistry, but it is clear the author's lack of knowledge in the recent and even the older work of the subject is responsible for his views. In subsequent editions this part of the work might be omitted. It follows, no doubt, the precedent set by Sir J. J. Thomson's well-known book on the conduction of electricity through gases; but what was natural enough when that book was written does not apply to a book published in 1909.

In the ground covered, the work does not differ materially from the one just quoted and many similar which have since appeared, but the treatment is interesting and lucid, and the critical examination and selection of the material chosen for presentation has been done impartially and well. The lack of any conspicuous originality is compensated for by clearness of exposition. In one respect, in that this is a French work dealing with a scientific movement which, if we exclude radio-activity, has proceeded mainly from this country and from Germany, the author is at an advantage, for the whole territory is surveyed in better perspective in consequence.

Both in the first part, which is of a general elementary character, and in the second, which deals for the most part with the mathematical theory of ions in physical phenomena, the author introduces his subject with an excellent account of the older work on the passage of electricity through ionised liquids before passing on to the newer ideas which followed the study of the discharge of electricity, first in high vacua and later, after the discovery of X-rays and other ionising agencies, in gases at various pressures. We are thankful for this juxtaposition of subjects which are usually regarded as independent owing to the fact that the one has been largely developed by chemists and the other by physicists; but at the same time it brings out the difficulties that arise when we seek to apply the newer views to the case of liquid electrolytes. The two subjects have surprisingly little connection with one another at the present time, and anyone who has to teach both must be painfully aware of the difficulties of harmonising them. In this book the newer work on gaseous ions and their properties, the various means of producing ionisation by kathode-rays, X-rays, flames, &c., the re-combination and diffusion of ions are discussed very thoroughly from the physical point of view along regular lines. In the second part an account of the electronic theories of metallic conduction and of magneto-optical phenomena is given, while the more metaphysical developments connected with the electronic constitution of matter, and the entanglement of ether by moving masses are properly left to the end of the two parts respectively. The book has no index, and is marred by an extraordinary number of misprints, the rectification of which occupies many pages of errata at the end.

OUR BOOK SHELF.

Problemi grafici di Trazione Ferroviaria. By P. Oppizzi. Pp. viii+204. (Milan: Ulrico Hoepli, 1909.) Price 3.50 lire.

In the preface the author tells us that although graphic methods are often used by the general mechanical engineer, they have up to now been neglected by the railway engineer. This book is intended to show how such methods may be applied to the solution of nearly all problems in connection with the working of trains on railways. In this object the author has well succeeded, and it may safely be predicted that any reader who has once used graphics in the very easy and simple manner represented in this book will never again have recourse to analytical methods. Indeed, there are cases where analysis becomes so complicated that its use by a busy engineer, even if he has the required mathematical ability, is out of the question; as an example may be cited the acceleration diagram of a train drawn by a steam locomotive. Tractive effort and resistance vary in a very complicated manner with the speed, and this, again, being the time integral of acceleration, which in turn depends on the difference between tractive effort and resistance, it is easy to see that a purely analytical treatment leads to almost hopelessly involved formulæ. Yet the author is able to solve this and many other problems by his graphics in a comparatively easy way, and with a degree of accuracy quite sufficient for practical purposes.

The book contains eight chapters, in which the following subjects are treated:—train resistance as a function of speed, weight, and type of coach and locomotive; tractive effort of locomotives of various types at various speeds, gradients, and curvature of line; speed-time-distance diagrams during acceleration; possibility of making up for lost time; running down long gradients and action of brakes; total time required for a given run; consumption of fuel or electrical energy and conditions of greatest economy; efficiency of service. In all cases the author gives numerous examples to show the application of his methods to cases which are taken from practical work, and thus even a reader whose mathematical knowledge is only elementary is able to profit by this book.

This work should prove most useful to railway engineers, and an English translation would be welcome to many. There is only one fault to find with the book, and that is the very untidy appearance of the diagrams. They have all been drawn on squared paper, the divisions being in millimetres. A page covered closely with such lines is very tiring to the eyes, and if, in addition to the multiplicity of lines, there is some writing added to the curves and the whole is reduced in rather a coarse way by photography, the effect is by no means pleasing. It would have been better if the author had omitted the millimetre divisions and retained only the lines placed a centimetre apart.

Gisbert Kapp.

General Treatise of Meteorology. Part i., Statical Meteorology. By Prof. A. Klossovsky. (In Russian.) Pp. xii+642. (Odessa, 1908.)

The complete work will comprise four parts. The two first—statical meteorology and dynamical meteorology—will not necessitate a knowledge of higher mathematics; they will form the course of meteorology properly so-called, while parts iii. and iv. will be devoted to the exposition of special questions and to the principles and use of instruments. A glance at the first volume of Klossovsky's "Meteorology" shows at once that it is the outcome of a long and useful career. In fact, the first meteorological labours of the author date from the year 1882, and from that time Klossovsky has not ceased to devote all his efforts to teaching at the Odessa University, and to the organisation and direction of the network of meteorological stations in the south of Russia.

Klossovsky's manual, far from being simply a work of compilation—the most complete of any now extant —is distinguished by its originality and by the wealth of the author's critical views. In many parts of the work we meet with pages where certain connections between meteorological data and those of other sciences are admirably described; *e.g.* at p. 179 and following pages the calorific economy of the human body is discussed. Further, original observations are met with for the first time; thus, at p. 273, the results of the actinometric observations made by Savelieff at Kiev. Again, the whole chapters devoted to solar radiation and to the study of earth temperature are interesting to read.

In no other treatise are the questions relating to underground temperature expounded in so complete a manner. The discussion of the results of the author's observations on the temperature at different depths in soil covered with grass and otherwise is especially noteworthy. On p. 334 there is a table giving for each month of the year the temperature at depths of 0·60 m. and 1·20 m. in forest and field adjoining. The forest diminishes the annual amplitude; the differences (field—forest) are $+3·0^{\circ}$ C. and $+2·7^{\circ}$ for the means of July, $-0·4^{\circ}$ at a depth of 60 cm. and $-0·2^{\circ}$ at 1·20 m. in January.

One of the characteristics of Klossovsky's work is the care with which the most recent advances have been taken into consideration; *e.g.* at p. 512 observations made in January, 1907, are noted, and at p. 606 the results of unmanned balloon ascents at Uccle up to April 11, 1907, are included. The titles of the chapters in this first volume are :—Composition of the atmosphere; physical properties; water in the atmosphere; the oceans; solar radiation; terrestrial radiation; earth temperature; increase of heat with depth; ocean temperatures; temperature of the lower strata of the atmosphere; atmospheric pressure; formation of hydrometeors; temperature and pressure in the upper atmosphere; abnormal departures. H. A.

An Introduction to the Study of Integral Equations. (Cambridge Tracts in Mathematics and Mathematical Physics.) By M. Bôcher. Pp. vi+72. (Cambridge: University Press, 1909.) Price 2*s.* 6*d.* net.

ONE main problem discussed in this tract is the following: let $f(x)$ and $K(x, \xi)$ be known functions, it is required to determine the function $u(x)$ so as to satisfy the equation

$$u(x)=f(x)+\int_a^b K(x, \xi)u(\xi)d\xi.$$

Prof. Bôcher shows, mainly after Fredholm, that under certain conditions of a very general kind, a solution exists, and may actually be put into the explicit form

$$u=f(x)+D^{-1}\int_a^b D(x, \xi)f(\xi)d\xi,$$

where D is a determinate function of a, b, and $D(x, \xi)$ a determinate function of a, b, x, ξ. That it should be possible to prove this in a simple, and at the same time rigorous manner is a good illustration of the increasing power of modern function-theory. Prof. Bôcher's exposition is very good; he begins by a heuristic discussion, which in a way resembles the ordinary method of successive approximations. Having thus been led to a certain expression as a presumptive solution, he proceeds to verify the fact that it is one.

Other workers in the same field who receive due attention are Abel, Liouville, Hilbert, Schmidt, and Volterra; and there are various subsidiary or supplementary articles of great interest.

As No. 10 of the "Cambridge Tracts in Mathematics and Mathematical Physics," Prof. Bôcher's work thoroughly helps to fulfil the object of the series; it is brief, self-contained, and stimulating, while giving sufficient reference to original sources.

The Scaly-winged. A Book on Butterflies and Moths for Beginners. By R. B. Henderson. Pp. xii+115. (London: Christophers, n.d.) Price 1*s.* net.

THE study of entomology is always extending its range, as shown by the numerous books which continue to be published especially relating to the order Lepidoptera, or butterflies and moths, which always seems to be the most popular of all, probably because many insects included in it are attractive in appearance, and easy to collect. The study is pursued systematically in several of our great public schools, and Mr. Henderson informs us in his preface that "the entomological, like most of the other sections of the Natural History Society of Rugby School, is entered by examination," and that as he did not find a suitable book for beginners to use in preparation for such an examination, he has compiled one for the purpose.

The various chapters deal with insects in general, and the Scaly-Winged in particular; metamorphosis; Psyche (imago); the Sister States (difference between butterflies and moths); bionomics: the place of Lepidoptera in the scheme of nature; the museum; appendix: note on the vision of insects; and list of some useful books for consultation, Furneaux's "Butterflies and Moths" being specially recommended. There are twenty-two useful text-illustrations of structure and apparatus, and the instructions for collecting and preservation in the chapter on the museum are particularly good.

Fossil Plants. Sixty Photographs illustrating the Flora of the Coal-measures. By E. A. Newell Arber. Pp. 75. Gowans's Nature Books, No. 21. (London: Gowans and Gray, Ltd, 1909.) Price 6*d.* net.

IT is not often that anything has been done to popularise the study of the plants of the past, a subject of which the "educated layman" is, as a rule, profoundly ignorant. This neat little volume, with its beautiful photographic illustrations of some of the most important coal-plants (club-mosses, ferns and fern-like seed-plants, horsetails, sphenophylls, and early gymnosperms) is well calculated to rouse an interest in the flora of so many million years ago. The great majority of the photographs are from casts and impressions, showing the external aspect of the fossils, and these are all admirable; we have never seen a better collection. Some of the few microphotographs of sections, illustrating the internal structure, are equally good, though in one or two cases clearer examples might have been selected. The short explanatory notes (scarcely a dozen pages in all) are, as the name of the author guarantees, thoroughly sound and up to date; they are just enough to whet the reader's appetite for more, which is all that can be expected or desired of a sixpenny nature picture-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.*]

The Systematic Position of Mœritherium.

PERHAPS of all the groups of mammals at present existing, no two are more dissimilar in general form than the Proboscidea and the Sirenia, but, nevertheless, the suggestion made long ago by de Blainville, that these animals are nearly related, has of late years been shown to be almost certainly correct, the discovery of early members of both groups in the Lower Tertiary beds of Egypt having to a great extent bridged the gap between the two orders. The animal that perhaps most nearly approaches the ancestral type of the two groups is Mœritherium, which, however, has hitherto been regarded as already far advanced along the proboscidean line, and if not directly ancestral to the undoubted primitive elephant Palæomastodon, at least closely related to its ancestor, and representing a stage of evolution through which it must have passed.

In an article "On the Feeding Habits of Mœritherium and Palæomastodon," published in NATURE of July 29, Prof. H. F. Osborn seems to dissent from this view to some extent, to emphasise the Sirenian characters of Mœritherium, and to regard it rather as a belated Sirenian which had not undergone the specialisation for a purely aquatic life already attained by some Sirenians contemporary with, or even earlier than, it. Prof. Osborn to a large extent bases his conclusions on peculiarities shown in some more or less conjectural restorations of the heads of Mœritherium and Palæomastodon, his chief reasons for the separation of Mœritherium from the Proboscidea being (1) the small size and high anterior position of the eyes and the high position of the ears, both said to be characteristic of the Sirenia; (2) the difference in the arrangement of the anterior teeth and mouth-parts from that found in Palæomastodon.

As to the characters of the eyes and ears, they seem to be purely adaptive, and are simply the result of the admittedly semi-aquatic habits of Mœritherium, and would not be expected to exist in purely terrestrial members of the group. The apparent height of the ears is, moreover, mainly the consequence of the small development of the occipital region of the skull compared with that found in the heavier-headed Palæomastodon. As to the arrangement of the jaws and the anterior teeth, it seems to represent exactly such a stage as a mammal with the normal Eutherian dentition would be expected to pass through before attaining the condition found in Palæomastodon. Certainly the anterior dentition of Mœritherium is quite unlike that of any known Sirenian; thus in Eosiren, a contemporary of Mœritherium, it is the first pair of upper incisors, not the second, that is enlarged, while the other incisors and the canine are already in a fair way to the complete disappearance characteristic of the later Sirenia. In the lower jaw the differences are greater still, Eosiren possessing the strongly deflected symphysis probably already partly covered with a horny plate, and in which the incisors are undergoing reduction; in Mœritherium, on the other hand, there is no deflection of the symphysis, and the first pair of incisors is small, while the second form large procumbent tusks, very similar to those found in many primitive Proboscidea. Mœritherium is further distinguished from the contemporary and even earlier Sirenians by the possession of a well-developed pelvis, which was supported by a strong sacrum composed of three fused vertebræ. The hind limb is, unfortunately, not completely known, but the femur was large and straight, being similar in many respects to that of Palæomastodon. In several other ways, also, Mœritherium differs from the Sirenia and approaches the Proboscidea; thus the position of the auditory meatus with reference to the zygomatic process of the squamosal and to the neighbouring bones is as in Palæomastodon, and quite unlike what is seen in the Sirenia. Again, the cervical vertebræ, though short, show no traces of the extreme shortening already present in Eosiren.

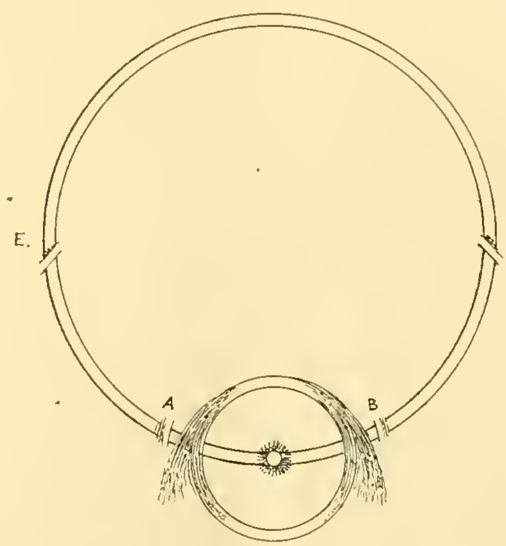
Another argument in favour of the relationship of Mœritherium to Palæomastodon is the existence of forms like *Moeritherium trigonodon* and *Palaeomastodon minor*, which, though unfortunately at present very imperfectly known, appear, both in their size and in some respects in their tooth structure, to be annectant forms.

On the whole, it seems that the weight of evidence is in favour of regarding Mœritherium as a proboscidean, though perhaps not on the direct line of ancestry of Palæomastodon, and retaining some characters of the original Proboscideo-Sirenian stock.

CHAS. W. ANDREWS.

Remarkable Halo of August 21.

THE accompanying diagram is a sketch of the Danzig phenomenon as observed at Blackpool on Saturday, August 21, between 11.45 a.m. and 0.30 p.m. There had been heavy rain and stormy winds on the previous night and in the early morning up to 10 a.m. At 11.45 a.m. thunder cloud and cumulus extended all around the horizon, but in the vicinity of the zenith, where the 22° halo and the western portion of the mock sun ring now appeared, there was no trace of cirrus or other cloud form, although a very pale milky tint might be discerned.



At noon the sky was overcast, but by 0.25 p.m. it was again clear at the zenith, and the complete phenomenon stood out very prominently, the 22° halo very vivid and brilliant with what would appear to be its arc of upper contact, the mock sun ring being very clear and of a silvery hue, and the mock suns; the two furthest from the real sun being apparently at the intersection of the mock sun ring with the 90° halo. This halo, however, was nowhere else visible.

There was nothing like an image of the sun at the N. point of the 22° halo; but this was a position of very great brilliancy, with the usual reddish colouring on the edge nearest the sun and the gradual shading off outwards to a bluish-white. The S. point was also a position of maximum brightness, though less intense than the N. point, while the E. and W. portions of the halo were fainter and untinted, but quite discernible.

The two nearer mock suns at A and B likewise could hardly be called images of the sun, but resembled the N. point of the 22° halo, as though they were the intersections in the mock sun ring of another halo, nowhere else visible, of about 33° radius. They were thus somewhat elongated, projecting slightly on either side of the ring. The two further mock suns were of a similar character, but with no colour.

Some special peculiarities seem to have been :—(1) The absence of cloud in the region of observation where the phenomenon was at its brightest. (2) The complete continuity of the mock sun ring, the portion within the 22° halo being quite distinct. (3) The fact that the arc of upper contact had its *concave* side towards the sun, and extended for more than 90° on either side of the point of contact, gradually growing more diffuse and faint. This seems to be quite a special characteristic. (4) The peculiar shape of the mock suns and the positions of the two nearer the sun. These were not on the 22° halo, but outside the arc of upper contact, as shown in the sketch, the arc bisecting the distances measured along the ring between the mock suns and the halo.

At 0.30 p.m. the sky again became overcast, nor could any trace of the phenomenon be seen afterwards. In the afternoon and evening the wind was very cold, and there was a fair amount of cloud, but on the whole it was fine and sunny. The night, however, was wet and stormy.

W. McKEON.

Stonyhurst College Observatory, August 30.

Man and Environment.

I AM under the impression that it is recorded somewhere that Darwin expressed the following opinion:—He considered the fact that when man appears he appears, not as a "blind" subject of his environments, but with power to determine largely, not only his own environments, but those of generations of men succeeding his own generation; and, faced by this fact, he expressed a doubt whether, when man appears, some new factor may not come into play in "natural selection" (*cf.* "The Descent of Man," 2nd ed., p. 613, lines 15 to end of paragraph). But I cannot find the reference. Could any reader of NATURE assist me?

F. C. CONSTABLE.

Wick Court, near Bristol.

THE ATTAINMENT OF THE NORTH POLE.

DURING the past week great attention has been given to the announcement on September 1 that Dr. F. A. Cook had returned from north polar regions, having reached the North Pole on April 21, 1908. The interest excited by this statement has since been increased by a message, dated September 6, received at New York from Commander Peary, reporting that he reached the pole on April 6, 1909.

Commander Peary departed for the north from Sydney, Cape Breton, on July 17, 1908, his intention being to proceed by the Smith Sound route to his winter quarters on the northern shore of Grant Land. He hoped to start for the pole with fully-loaded sledges from the "Big head" he encountered in the Polar Ocean in 1906, to the north of Grant Land, in about latitude 84° N. The last information concerning him indicated that in the middle of August last year his ship, the *Roosevelt*, was continuing her voyage northwards from Etah, the expedition's base of supplies on Smith Sound. He took sounding apparatus with him, with the intention of obtaining a line of soundings from Grant Land to the pole. When he left last year he stated that, should he reach the pole, news of his success might be expected between August 15 and September 15, and the message received on September 6 has justified his expectations.

It is difficult yet to arrive at a satisfactory opinion as to the value of the observations from which the explorers conclude that they reached the North Pole, but as both Dr. Cook and Commander Peary are responsible travellers, it must be assumed that they realise the difficulty of determining the position of the pole, and took the necessary precautions to establish the validity of their claims. We have no right to doubt their statements, but the publication of the observations at an early date is greatly to be desired, so that the matter can be placed beyond question. In the case of Commander Peary, his previous work in Arctic regions is so well known that geographers have accepted his announcement without hesitation, and a congratulatory message has been sent to him by the Royal Geographical Society. On the occasion of his previous expedition in 1906, he approached to within two hundred miles of the pole, and there was every reason to anticipate that this year he would reach the pole itself. His plans were known, and his long experience of Arctic conditions justified confidence in their successful accomplishment. There has, however, been much discussion upon Dr. Cook's journey and achievement, and as he claims to have reached the North Pole nearly a year before Commander Peary, it is of interest to give a few particulars relating to him and his expedition.

Dr. Cook is an American medical man, with varied experience of exploring work in both the Arctic and Antarctic regions. He served as surgeon on Commander Peary's second expedition to West Greenland in 1891, and was a member of the Belgian Antarctic expedition under Commander De Gerlache, which spent the Antarctic winter of 1898 drifting about on board the *Belgica* in the ice-covered seas to the southwest of Graham Land. Both in 1903 and 1906 Dr. Cook conducted expeditions to Alaska, with the object of achieving the ascent of Mount McKinley, 20,390 feet high, the loftiest mountain on the North American Continent, and after repeated failures reported that he had succeeded in reaching the summit. Two years ago it was announced that he was desirous of organising an expedition to the South Pole, and it came as a surprise to most people to learn in the autumn of 1907 that he was encamped at Etah, on the northwest coast of Greenland, and proposed to make a "dash" for the North Pole.

Briefly, Dr. Cook's story is that he left his base at Etah on February 19 of last year, accompanied only by a force of Eskimos, and dogs for pulling the sledges. The route varied slightly from that adopted by Commander Peary. Dr. Cook struck westwards across Smith Sound to Ellesmere Land, and continued westwards across that island to Nansen Sound, which separates Ellesmere Land from Axel Heiberg Land, one of the new lands discovered by the Sverdrup expedition on board the *Fram* in 1898–1902. From Cape Hubbard, the northernmost point of Axel Heiberg Land, Dr. Cook pushed out over the polar ice on March 18. Three days later the last of the supporting parties returned, and Dr. Cook continued his march to the pole with only a couple of Eskimos. Between the 84th and 85th parallels of north latitude, he sighted land to the west, but "the urgent need of rapid advance on our main mission did not permit a detour to explore the coast." This, continues Dr. Cook, in the narrative which he has supplied to the *New York Herald*, was the last sign of solid earth seen on the northward march, though, "from the 87th to the 88th parallel much surprise was caused by an indication of land ice. For two days we travelled over ice which resembled a glacial surface. . . . There was, however, no perceptible elevation, and no positive sign of land or sea." Farther north, Dr. Cook says, "signs of land were still seen every day, but they were deceptive illusions, or a mere verdict of fancy. . . . The mirages turned things topsy-turvy, inverted mountains, and queer objects even rose and fell in shrouds of mystery; but all of this was due to the atmospheric magic of the midnight sun."

Finally, to quote the words used by Dr. Cook on September 7, in a lecture to the Royal Geographical Society of Denmark:—"On April 21 my observation gave 89° 59′ 40″—that is, 20″ from the pole. We advanced the 20″ and I made another observation, and several others that day and the next. I think there is no doubt that these observations will prove that we have been on and around 90°—the North Pole." The return march was then begun. Instead of being carried by an easterly drift to the Greenland coast, the little party found themselves some distance west of Axel Heiberg Land. Continuing south to Jones Sound, they wintered in primitive fashion at Cape Sparbo, on the coast of North Devon, and subsequently made their way across to the Greenland coast, whence Dr. Cook obtained a passage to Copenhagen on board a Danish Government steamer.

Not so much the fact that Dr. Cook was unaccompanied by any white companion, as certain surprising features in the above story make it advisable to await the examination of Dr. Cook's instruments and journal of observations before his claim to have reached the pole is definitely admitted. Cape Hubbard, from which Dr. Cook pushed out into the Polar Ocean, is situated in about latitude 81° 15′ N., *i.e.* 525 geographical or rather more than 600 statute miles from the pole. To have covered this in thirty-five days Dr. Cook must have advanced northwards at an average rate of seventeen statute miles a day, making no allowance for deviations from a due north and south line. An even greater rate of travel was maintained for a longer period of time by Lieutenant Mecham on a sledge journey among the islands of Arctic Canada during the long series of the Franklin search expeditions. Nothing like such a rate of progression northwards has, however, been achieved by any previous traveller over the ice of the open polar sea. Nor is it correct to say, as Dr. Cook is reported to have said, that he was able to rely on more favourable conditions because he travelled earlier in the year than previous explorers. Dr. Nansen and Lieutenant Johansen left the *Fram* in about 84° north on March 14, 1895, and reached their farthest north in latitude 86° 5′ north on April 8, their average daily northing being thus about six miles. Captain Cagni, of the Duke of the Abruzzi's expedition, left the winter quarters of the *Stella Polare* in Teplitz Bay, Franz Josef Land, latitude 81° 47′ north, on March 11, 1900, and reached his farthest north in latitude 86° 33′ on April 25, his average daily northing having been about seven miles. In 1906 Commander Peary pushed out over the polar ice from the northern coast of Grant Land, just south of the 83rd parallel, on March 6, and reached his farthest north in latitude 87° 6′ on April 21, his average daily northing having been about six miles.

From these records it will be seen that by travelling northwards over the Polar Ocean at the rate of seventeen miles a day, Dr. Cook has far surpassed the most strenuous efforts of his predecessors. All the explorers mentioned were capable of, and did on occasion perform, journeys of twenty and more miles a day. But in advancing northward they all found themselves greatly delayed by open lanes of water and pressure ridges in the ice. Dr. Cook says very little about any difficulties of this nature, although he does on one occasion mention that "much of our hard work was lost in circuitous twists around troublesome pressure lines and high irregular fields of very old ice. The drift, too, was driving eastward with sufficient force to give some anxiety." If the conditions he encountered throughout his march were similar to those experienced by previous travellers over the Polar Ocean, it is astounding that he should have been able to travel so much faster than they.

Of course, conditions vary in different seasons and along different routes, and Dr. Cook may have been exceptionally favoured. There is no need to doubt his good faith, but for confirmation of his calculations it will be necessary to await the examination of his records. The precision with which he reports his position on April 21 would seem to show that he scarcely appreciates the difficulty of securing exact observations under the conditions as regards refraction, &c., which prevail near the pole.

However this may be, and whatever the precise point attained by Dr. Cook, there seems little doubt that he made an extended journey over the polar ice; but scientific research was not Dr. Cook's object, and his journey can possess little scientific value. He carried no sounding apparatus, and has brought back only the vaguest information about the new lands to the north-west of Greenland. The land which he did

North Polar Map. Dr. Cook's route is shown by broken lines. Commander Peary's route is not indicated, because the details are not yet available.

sight, indeed, was probably the land which Peary sighted in 1906, or some extension thereof. Further north, there is a suggestion that the party travelled over glacial ice, but Dr. Cook has nothing definite to report which indicates the existence near the pole of anything but the ice-covered Polar Ocean. Some points have still to be cleared up. In more than one report Dr. Cook is credited with stating that the land he sighted after leaving Axel Heiberg Land abounds with game; yet he did not come within several miles of the land, and, according to the *Times*, met with no game beyond Heiberg Island. If Dr. Cook reached the pole, he has given a remarkable illustration of pluck and endurance, but his journey seems likely to have a minimum of scientific value, and there is still room where he has been for a well-equipped scientific research expedition to do excellent work in studying the geographical problems of the region. A mere "dash" to the pole may awaken a certain amount of sentimental interest, and direct public attention to the traveller, but it is of no value from the scientific point of view unless exploration—physical or geographical—is carried on. Commander Peary appears to have been equipped with apparatus for taking soundings and making other observations of polar conditions, and he has telegraphed to the director of the American Museum of Natural History, New York, "I am bringing a large amount of material for the museum." The scientific importance of polar expeditions must be judged by the new knowledge obtained rather than by the determination of a mathematical point more or less accurately according to the instruments used and precautions taken. Assuming that the North Pole has been reached by one or both the explorers, the way is now clear for the scientific study of Arctic hydrography, meteorology, and many other problems of terrestrial physics without the disturbing effort to attain the highest latitude.

THE WHISKEY COMMISSION.

THE Royal Commission on Whiskey and other Potable Spirits, the final report of which has just been issued, originated out of the attempts made by various local authorities to obtain legal decisions as to what should or should not constitute brandy and whiskey. In the case of the other recognised forms of ordinary potable spirits, no acute differences of opinion appear to have arisen. When a man asked for rum or gin the legal mind representing the man in the street was content to assume that that long-suffering individual received an article of the nature, substance, and quality he demanded. As a matter of fact, the man in the street raised no difficulty even about the two forms of potable spirits which have more particularly engaged the prolonged attention of the Royal Commission. He had absolutely no interest in the touching solicitude which was displayed on his behalf by a number of professional gentlemen, who, apparently from purely altruistic motives, were determined that he should be awakened to a proper sense of the importance of knowing the origin and mode of manufacture of articles which he had hitherto been perfectly content to purchase because he was satisfied with their quality and price.

What is brandy and what is whiskey have been the occasional subjects of discussion in the public journals and in the trade organs at intervals during the past three or four years, but it has been impossible to arouse any public feeling on these momentous questions. The fact is, the agitation, such as it was, was wholly artificial. It simply originated in, and turned upon, a struggle between competing trade interests. Brandy, by use and wont, has been universally regarded as a spirit obtained by the distillation of fermented grape-juice; whiskey as a spirit obtained by the distillation of a fermented "wash" derived from some form of cereal, usually, but not invariably or wholly, malted barley. But owing to the unfortunate grape disease (Phylloxera) which, a generation ago, devastated the French vineyards, especially in the Charentes, where the particular grapes mainly employed in the manufacture of Cognac are grown, the manufacture of factitious brandy was greatly stimulated. This consisted of some form of distilled spirit—obtained usually from grain, or from beetroot molasses, or, occasionally, from potatoes, artificially flavoured with "brandy essence" and coloured with caramel. This article entered into competition, not only with the genuine product, but with a factitious brandy "drawn and made from malted corn," which has been produced for more than a couple of centuries in this country under the name of "British brandy," a term first legally sanctioned by the Spirits Acts of 1860. In due time the vineyards were re-planted, the Charente vines being grafted on American stocks, and the manufacture of Cognac by the time-honoured methods was re-established. Naturally the manufacturers contended that their product was the only legitimate brandy, and that the factitious articles were not entitled to the name of Cognac, or when sold in this country to the term brandy, unless this was qualified, as in the case of "British brandy," by some prefix which should serve to differentiate it from the product of the grape.

This, then, as regards brandy, is the *fons et origo* of the trouble. It was useless for the contending parties to appeal to our law, since, as the Commission states, there is no statutory definition of the term "brandy"; nor is there any binding judicial decision on the subject. The 148th Section of the Spirits Act of 1860, it is true, contained an implied definition of "British brandy," which would have covered the case of all factitious brandies sold in this country, whether made here or not, but this was repealed in 1880, so that there is no longer a legal definition even of "British brandy."

As regards whiskey, the cause of contention was not so much the nature of the material from which the spirit was derived, although this did to some extent enter into consideration, as the manner in which the distillation was effected. Originally all whiskey was made by means of comparatively small stills—of the type known as pot-stills—in which the fermented wort was distilled by the direct application of fire. But about the year 1831, Eneas Coffey invented and patented a form of still adapted for continuous working, in which the alcohol is driven out of the wort by means of steam, and the mixture of steam and spirit is then separated by an ingeniously contrived condensing or rectifying arrangement which enables a much "cleaner" spirit to be produced—that is, a spirit much more free from what are held to constitute the characteristic constituents of whiskey, as distinguished from plain spirit. This process not only resulted in the production of a purer form of alcohol—that is, purer in the sense commonly understood by chemists—but it was more economical in use, and consequently materially cheapened the cost of production. This, of course, made the "patent still" a formidable competitor of the "pot-still," and those who had a vested interest in the pot-still naturally complained that this interest was jeopardised by the employment of a piece of apparatus which might make alcohol, but, it was contended, did not necessarily make whiskey.

In the autumn of 1905 the Islington Borough Council was induced to bring two test cases before a London stipendiary under Section 6 of the Sale of Food and Drugs Acts, in one of which it was held that a certain publican had sold, to the prejudice of a purchaser who demanded Irish whiskey, something which was not of the nature, substance, and quality of Irish whiskey; and, in the other, that another publican had sold, to the prejudice of a purchaser who demanded Scotch whiskey, something which was not of the nature, substance, and quality of Scotch whiskey. In each case the analyst had certified that what was sold as whiskey "consisted entirely of patent-still, silent or neutral spirit," and was not, therefore, in his opinion, whiskey.

The learned magistrate ruled that patent-still spirit alone is not whiskey; and that the produce of a patent still cannot be Irish or Scotch whiskey, although made in Ireland or Scotland. He further held that

Irish whiskey was to be made from a mixture of 75 per cent. of barley malt, with 25 per cent. of barley, wheat, oats or rye, or any of them; whereas Scotch whiskey was to be made wholly from barley malt. He specifically excluded maize, which is frequently used in connection with the patent still, as a cereal from which whiskey may be made. Accordingly he convicted the defendants as having sold articles to the prejudice of the purchaser.

Attempts were made to upset the convictions by appeals to quarter sessions, but the trials proved abortive. Whiskey manufacturers took a very serious view of the position in which they were thus placed, and eventually they induced the authorities to issue a Royal Commission to determine whether, in the general interest of the consumer, or in the interest of the public health, or otherwise, it is desirable (*a*) to place restrictions upon the materials or the processes which may be used in the manufacture or preparation in the United Kingdom of Scotch whiskey, Irish whiskey, or any spirit to which the term whiskey may be applied as a trade description; (*b*) to require declarations to be made as to the materials, processes of manufacture or preparation, or age of any such spirit; (*c*) to require a minimum period during which any such spirit should be matured in bond; (*d*) to extend any requirements of the kind mentioned in (*b*) and (*c*) to any such spirit imported into the United Kingdom; and, lastly, to make the like inquiry as regards other kinds of potable spirits which are manufactured in or imported into the United Kingdom.

It should be stated that the terms of the reference relating to public health arose from the character of the evidence needed to establish the count of "prejudice to the consumer," without which it would have been impossible to have obtained a conviction under Section 6 of the Food and Drugs Acts.

The real nature of the issues to be determined was at once seen from the character of the criticisms which were passed, mainly by Irish distillers or their representatives, on the constitution of the Commission. As a fact, the *personnel* of the Commission was very carefully chosen, and every legitimate interest was adequately represented. The printed evidence proves how competent the members were to inquire into the somewhat complicated questions which were raised, and how carefully and how impartially they sifted and weighed the statements of avowedly interested witnesses. It was, of course, to be expected that their findings would not give universal satisfaction, but every fair-minded critic will admit that they have been arrived at in good faith, and are abundantly justified by the weight of the evidence.

As regards the materials to be used in the manufacture of whiskey, the commissioners find no ground for any interference with existing practice. The contention that Irish or Scotch whiskey should alone be produced from cereals actually grown in those respective countries, or even from cereals capable of being grown there, found no favour in their eyes. Of course, the contention was really aimed at the exclusion of maize, which is largely used in the manufacture of patent-still spirit. The commissioners see no valid reason for excluding maize. There is no evidence to show that it is not a perfectly wholesome material, or that the spirit derived from it is not as wholesome as that derived from any other cereal.

Nor as regards processes of manufacture, that is, modes of distillation, does any sufficient ground exist, in the opinion of the commissioners, for any interference with established procedure. To have supported Mr. Fordham's finding would have effected nothing short of a revolution in the manufacture of whiskey, inasmuch as nearly two-thirds of the potable spirits produced at the present time in Scotland and Ireland are distilled in patent stills. Moreover, spirit produced in the patent still has long been employed for blending with or diluting whiskeys distilled in other forms of still, and most of the whiskey now sold in the United Kingdom contains more or less spirit which has been obtained by the patent still. Lastly, no evidence was tendered to show that the form of still had any necessary relation to the wholesomeness of the spirit produced.

Suggestions were made to the Commission either to "standardise" the mash or to "standardise" the blend with a view of ensuring that at least a certain minimum proportion of pot-still whiskey should ultimately find its way into the whiskey as sold, but here again the commissioners saw no reason to interfere with the discretion of the blender. In their opinion "the proportion of the different whiskeys to be employed in these blends is controlled by an influence stronger than that of the law. The taste of the consumer creates the demand which ultimately controls the trade. The public purchases the whiskey that meets its taste, and the blender must satisfy that taste or lose his trade. It is not for the State to say what that taste ought to be."

The general conclusion which the commissioners came to was that "'whiskey' is a spirit obtained by distillation from a mash of cereal grains saccharified by the diastase of malt; that 'Scotch whiskey' is whiskey, as above defined, distilled in Scotland; and that 'Irish whiskey' is whiskey, as above defined, distilled in Ireland." It is difficult to see how the commissioners could have escaped reaching this luminous and oracular conclusion. At the same time, to the scoffer the whole business is eminently suggestive of one of Molière's comedies. Monsieur Jourdain would have been profoundly impressed by the strict logic and admirable lucidity of such a finding.

After this the question of brandy, as may be anticipated, presented little or no difficulty. The commissioners define brandy as a potable spirit manufactured from fermented grape-juice, and from no other materials, and that the determination of the application of the term in this country cannot be controlled by the nature of the apparatus or process used in the distillation of the spirit. They are further of opinion that the compounded spirit long recognised by the name of British brandy is entitled still to be so named and sold as "British brandy."

The limitations of space preclude any attempts to deal with the other and less important matters dealt with in this report, but the general tenor of the conclusions in respect to these is on a par with the *laissez-aller* tone which pervades the whole.

As might have been expected, the report has not been received with a unanimous chorus of approval, and the Irish distillers, in particular, have not been slow to express their dissatisfaction. But it is to be hoped that on reflection even they will be led to the conviction that the conclusions to which the commissioners have been led represent the common-sense of the question. The conflict of the stills is one more illustration of the inevitable result of what is called the "march of improvement" in which a time-honoured process has eventually to succumb, by the mere force of circumstances, to the economic pressure of a mode of manufacture based upon more rational principles. The commissioners have evidently been fully alive to this aspect of the problem which has been presented to them. At all events, they have shown themselves as not unmindful of the advice of the old merchant, who, being consulted by Colbert about what he should do in favour of trade, said, "*Laissez nous faire.*"

T.

PROF. EMIL CHRISTIAN HANSEN.

IT is with profound regret that we have to announce the death of Prof. Emil C. Hansen, director of the Carlsberg Laboratory, Copenhagen, which occurred after a brief illness on August 27. Born in 1842, he attended in his youth the art school at Copenhagen, but subsequently, between 1871 and 1876, devoted himself to the study of science at Copenhagen University. He entered the Carlsberg Institute in 1877, where he commenced his memorable researches on microbiology.

Hansen's life-work was practically confined to the study of the Saccharomycetes, but his researches in this domain of biological science stand out as a model of thoroughness. Prior to his time little was known concerning the different species of yeasts, although so early as 1857 Bail had observed that types of yeast existed giving rise to what he termed "wild fermentations." This did not, however, attract much notice among either scientific men or technologists, and even Pasteur—who must ever be regarded as the pioneer of biology as applied to the fermentation industries—regarded bacteria alone as the cause of diseases of beer. Rees, however, in 1870, had arrived at the conclusion from his experiments that brewery yeasts represent species which are quite distinct from wine yeasts, and that still other species are concerned in the secondary fermentation of beers and in so-called "wild fermentations." None of these observations were, however, convincing, and the truth only became apparent after the publication of the exact experimental data on the subject by Hansen.

In 1880, when Hansen first commenced his remarkable studies on the Saccharomycetes, biological methods of isolating micro-organisms were but little developed. The dilution method devised by Lister and employed by that observer, as well as by Naegeli and by Fitz, was the only one available, yet it was by an improved modification of this extremely tedious, not to say uncertain, method that Hansen succeeded for the first time in cultivating yeasts from a single cell. In his paper published in 1883 he described accurately six species of Saccharomycetes. The subsequent adoption by Hansen of the method of culture on a solid substratum—which had been developed by Koch—added much to the precision of his work, but he always insisted that in order to obtain absolutely pure cultures it was necessary in all cases to start from a single cell. Some might, indeed, think that he carried this injunction a little too far, in view of the results which have been obtained in the isolation of other micro-organisms by cultures from colonies; but it must be remembered that Hansen's researches were directed, not merely to the isolation of species, but of varieties.

Hansen's work consisted, however, not only in isolating distinct species of the Saccharomycetes, but he elaborated methods for their characterisation, and for this purpose he made use of film-formation, and more especially ascospore-formation, under definite conditions of temperature. By the sporulation test it is possible to detect 1/900th to 1/200th part of a wild yeast—such as a *S. Pastorianus* species—in admixture with *S. cerevisiae*. Thus the microbiologist was put in possession of a method for the quantitative as well as the qualitative analysis of yeast mixtures. Previously for the qualitative analysis of such mixtures morphological considerations alone were available, the results being rough and inconclusive, for one and the same species may under different conditions assume a different form.

Practical brewers have long known that yeasts in practice vary according to the system of fermentation adopted; it has even been suggested that a given type of yeast consists of more than one variety or race, and in this country, at all events, such a type is always associated with a certain number of cells of wild species. Whether these varieties, which seem to be the result of environment, are immutable is a moot point, and it may be pointed out that Hansen at first believed that the top-fermentation races of *S. cerevisiae* employed in this country were under no conditions convertible into bottom-fermentation races, but recently he found that the conversion was possible.

The employment of yeast grown from a single cell has met with great success in Continental bottom-fermentation breweries. Not so, however, in British breweries. One of the first to give the system a trial in this country was Dr. Horace T. Brown, who ultimately abandoned it since he was not able to obtain a satisfactory secondary fermentation; and in confirmation of Dr. Brown's results it has since been shown and fully admitted by Hansen that for the secondary fermentation of British beers, organisms other than the normal *S. cerevisiae* are needful. In this connection it should be mentioned that Schionning recently confirmed Clausen's observations that certain torulæ play an important *rôle* in bringing about the secondary fermentation and conditioning of British beers.

Few men of science since Pasteur's time can lay claim to a greater debt of gratitude from fermentation technologists all over the world than Hansen. His numerous papers are published in the *Comptes rendus* of the Carlsberg Laboratory, the *Centralblatt für Bacteriologie und Parasitenkunde*, the *Annals of Botany*, and the *Journal of the Institute of Brewing*.

ARTHUR R. LING.

NOTES.

MISS DOROTHEA BATE, already well known for her researches in the caverns of Cyprus and elsewhere, has had the good fortune to make a very remarkable and interesting discovery in a cave in Majorca. On her return home Miss Bate remarked that the cave contained only a few bones of goats, but on further examination these despised relics proved to indicate an entirely new type of an extraordinary nature—in other words, neither more nor less than a "rodent-goat." For the skull, which with certain other remains is described by its discoverer in the September number of the *Geological Magazine*, under the name of *Myotragus balearicus*, is characterised by its extreme shortness, and the presence in the front of the lower jaw of a single pair of incisor teeth, in place of the four pairs of incisors *plus* canines characteristic of ruminants generally. In all respects these incisors are rodent-like, growing from persistent pulps, having the enamel restricted to the front and outer surface, and presenting a terminal worn surface. To explain this worn facet almost seems to require the presence of a pair of upper incisors (the front of the skull is unfortunately imperfect), and if such were really the case a revision of the diagnosis of the Pecora would be rendered necessary. The cannon-bones in both limbs are remarkably short and wide, exceeding, apparently, in these respects those of the takin and white goat.

THE article by Mr. E. B. Iwan-Müller on "The Cult of the Unfit," recently noticed in these columns, has called forth a reply from Mr. Sidney Low in the *Fortnightly Review* for September. It was not to be expected that Mr. Iwan-Müller's arraignment of ill-considered sentimentalism in legislation should pass unchallenged, and Mr. Low's rejoinder, entitled "Darwinism and Politics," argues forcibly in favour of the collectivist principle as against unrestricted individual competition. Opinions will differ as to the practicability and desirability of the respective ideals of the two writers, but whatever may be the value of Mr. Low's political criticisms, they appear to miss what is the gist of his opponent's contention, viz. that the measures of statesmen should be constructed on the basis of scientific principle, and not, as is too often the case, with a haphazard disregard of natural laws and conditions. Mr. Low enlarges on the well-known fact that in some circumstances it is not the highest type that proves to be the best fitted to survive; but he appears to forget that, in spite of all counteracting influences, the net result of competition has been the evolution of forms possessing the most excellent qualities known in nature. Moreover, the struggle for life is not abolished by the association of individuals in altruistic communities. All Darwinians know this, and they also know that, as common sense teaches, there must be a limit to altruism. It is the business of scientific thinkers to determine the limit, and of politicians to shape their measures accordingly.

THE death is announced of M. L. Bouveault, assistant professor of organic chemistry at the Sorbonne, Paris, at forty-five years of age.

WE regret to see the announcement of the death of Mr. Thomas Southwell, for many years secretary, and twice president, of the Norfolk and Norwich Naturalists' Society, at the age of seventy-nine.

NEWS has reached us of the regretted death, unexpectedly, of Dr. Fritz Erk, honorary professor of meteorology in the University of Munich, and the first president of the Munich Meteorological Society.

THE Geneva correspondent of the *Times* reports that the Janssen Observatory on the summit of Mont Blanc is about to be demolished. It will be replaced by the Cabane on the Rochers Rouges. All the scientific instruments in the observatory, which was completed in 1894 under great difficulties, have been removed to the Vallot Observatory, which is at a lower altitude.

THE Scottish expedition to Spitsbergen under Dr. W. S. Bruce has arrived at Tromsö on board the steam yacht *Conqueror*, with all well on board. The expedition, which left Leith in July, is reported to have completed the survey of Prince Charles Foreland and made important geological and other investigations. An account of the constitution and proposed work of the expedition appeared in NATURE of July 15.

DR. A. DU PRÉ DENNING, for several years lecturer in experimental physics in the University of Birmingham, and principal of the Municipal Technical School, Smethwick, has been appointed by the Secretary of State for India to the newly created post of superintendent of industries and inspector of technical and industrial institutions in Bengal.

THE *Times* correspondent at Paris announces that the following members of the Bureau of Longitudes will represent France at the meeting of the International Geodetic Association to be held in London on September 21:—General Bassot, president; M. Henri Poincaré; M. Hanusse, director of hydrography in the French Ministry of Marine; M. Charles Lallemand, director-general of the French Ordnance Survey Department; and Colonel Bourgeois, chief of the surveying section of the Geographical Department of the War Office.

THE tenth meeting of the Astronomical and Astrophysical Society of America was held at the Yerkes Observatory, Williams Bay, Wisconsin, on August 18–21, Prof. E. C. Pickering, president, presiding. About sixty members, with a few guests, were in attendance, and forty papers, many of them illustrated with lantern-slides, were presented upon various topics. Reports were also made by the committee on comets and the committee on luminous meteors. The official account of the meeting, with abstracts of the papers, will be published, as usual, in *Science* a few weeks hence. The meeting was favoured with a cloudless sky, and the visitors had an opportunity for observing with the 40-inch telescope and inspecting all departments of the work of the Yerkes Observatory. The next meeting of the society will be held at the Harvard College Observatory in the latter part of August, 1910.

THE eighth International Congress of Zoology is to be held next year at Graz (Austria). As entomology plays only a subordinate part at such a congress, a movement has been started to unite entomologists in a congress entirely devoted to entomology in its various aspects, and to establish a permanent committee which may act as a central organisation in the interest of this subject. It is proposed that a congress of entomology be held every three years, about a fortnight before each triennial zoological congress, so that resolutions and conclusions of general importance could, if deemed necessary, be brought up for discussion at the ensuing zoological congress. The first International Congress of Entomology will be held on August 1–6, 1910, at Brussels, during the International Exposition which will be taking place there at that time. The subjects to be brought before the general or sectional meetings will comprise systematics, nomenclature, anatomy, physiology, psychology, ontogeny, phylogeny, œcology, mimicry, etiology, bionomy, palæontology, zoogeography, museology, medical and economic entomology. The chairman of the local committee for Great Britain is Dr. G. B. Longstaff, Highlands, Putney Heath, London, S.W.

NOTES on Cornish Crustacea, by Mr. J. Clark, form the subject of the chief article in the August number of the *Zoologist*, the author directing attention to the great richness of the coasts of Cornwall in animals of this class, even such far-off species as the gulf-weed crab being occasionally drifted into these waters.

THE July number of the *Emu* is illustrated by a very interesting plate, reproduced from a photograph, showing the feeding-grounds of the laughing kingfisher, cat-bird, and noisy pitta in the Coolabunia pine-scrubs near Kingaroy, to the south-west of Maryborough, Queensland. Near the centre of the photograph is shown a large flat stone, around which is strewn an enormous mass of shells of *Helix cunninghami*, a large species in which the shell measures more than a couple of inches in diameter. The shells of these snails are broken by the birds on the boulder, and their luscious contents eaten.

WE have received a copy of the report of the directors of the various museums in Cape Colony, namely, the South African, the Port Elizabeth, the Kimberley, the Albany, and the King William's Town Museum, for 1908. In the case of the South African Museum, Dr. Peringuey complains of the want of sufficient space in the exhibition galleries, more especially in the anthropological and ethnological department, where it has been found impossible to find room for a series of life-like models of native races recently prepared under his direction. It is interesting to note that a number of skulls and skeletons of the Hottentot races have been recently acquired by this museum.

To the *Revue scientifique* for August 21 Dr. E. Trouessart communicates an article on African big game and big-game shooting, with special reference to the effects of the latter on the numbers of the animals in the country. Several paragraphs are devoted to the facilities for hunting expeditions from Nairobi, and to the fact that by obtaining licences for his wife and servant a sportsman is able to obtain more than the permitted number of specimens of the rarer species. Despite the effects of game reserves and shooting restrictions, Dr. Trouessart is inclined to take a pessimistic view of the prospects of the big game in East Africa, and hazards the prophecy that in less than half a century it will have vanished. To quote his words:—"Avant un demi-siècle, peut-être, de tout ce gros gibier si abondant à l'heure actuelle, il ne restera plus que souvenir." Special attention is devoted to the appalling destruction of elephants which still goes on in the heart of the continent, a statement of Mr. Schillings being quoted to the effect that the number of tusks annually imported into Antwerp alone represents the slaughter of no fewer than 18,500 elephants. The inaction of France in the matter of game-protection is strongly commented upon.

THE metamorphoses of the midges and gnats of the family Chironomidæ form the subject of an article, by Dr. A. Thienemann, in the second half of vol. lxv. of *Verhandlungen des Naturhistorischen Vereins der preussischen Rheinlande und Westfalens*. The developmental history of the Trichoptera has, according to the author, been well worked out, but that of the Chironomidæ is still imperfectly known. Although the greater number of chironomid larvæ, of which the so-called blood-worms are familiar examples, inhabit fresh water, it is pointed out that many are found in various situations on land, while a few dwell in brackish, and even in salt, water. Of the land-living forms, the larvæ of some species of Camptocladius are found in the droppings of animals, those of three kinds of Ceratopogon take up their quarters in ants' nests, while others of the same genus are nourished in the resin or beneath the bark of dead branches of pines, while another is found in decaying funguses. Larvæ of another genus select damp moss as their home. Larvæ and pupæ of several genera are figured.

PART iii. of the "Treasury of Human Inheritance," which forms No. 9 of the Memoirs published by the Francis Galton Laboratory for National Eugenics, furnishes a good example of the excellent work which is being done by that institution. The subjects here dealt with from the point of view of heredity are certain pathological conditions, such as angioneurotic œdema, insanity, and deaf-mutism. There are also sections devoted to the malformations of certain organs, and to the inheritance of special kinds of mental and physical ability. Cases available for the purpose in view have been collected and tabulated with great care, the respective pedigrees being clearly shown in diagrams, and the result is a mass of material which forms a valuable addition to the data now being rapidly accumulated under the guidance of Prof. Karl Pearson. The application of the principles deduced from such investigations will present special difficulties of its own, but whatever may be the practical outcome of the movement set on foot by Sir F. Galton, there can be no question as to the importance of the study of these and similar conditions in their bearing upon the racial qualities of future generations.

A NOTE by Dr. A. C. Hof on the action of iodo-eosin as a test for free alkalis in dried plant tissues is published in the *Bio-chemical Journal*, Liverpool. The substance required is a solution in ether of the dye-acid prepared by treating an alkaline solution of iodo-eosin with excess of acid. The presence of free alkali in a vegetable tissue is indicated by the red colour due to the formation of alkaline salts. Microscopic preparations can be permanently mounted in neutral Canada balsam.

OF the articles which appear in the Journal of the Royal Horticultural Society (vol. xxxv., part i.), the most generally interesting are the hints on French gardening, chiefly on the cultivation of lettuces, contributed by Mr. C. D. Mackay, and the note on *Solanum etuberosum* provided by the editor. It is observed that plants passing under the name of *Solanum etuberosum* do produce tubers about the size of walnuts, and also show a remarkable power of resistance to the potato disease induced by *Phytophthora infestans*. The latter property has suggested the possibility of raising disease-resistant hybrids with *etuberosum* as one parent; some experiments in crossing this species, the Chilian wild potato, *Solanum Maglia*, and cultivated forms of the ordinary potato are communicated by the Rev. J. A. Paton.

As a result of some months' botanical exploration in Sardinia, Dr. Th. Herzog presents in Engler's *Botanische Jahrbücher* (vol. xlii., part iv.) an attractive sketch of the vegetation on the island, accompanied by an illustrative map. The once extensive oak forests have been much reduced by ruthless cutting; *Quercus ilex* still flourishes in less accessible situations, notably round Mt. Gennargentu, where it is accompanied by *Paeonia officinalis*; *Quercus robur* also grows in the central districts, while the cork oak, *Quercus suber*, clothes the mountains in the north. A very wide area is covered by the formation known as "mâquis," where *Pistacia lentiscus*, *Rhamnus Alaternus*, *Myrtus communis*, and *Arbutus unedo*, with species of Cistus, form the dominant species. The solitary European palm, *Chamaerops humilis*, grows in the north-west, occasionally in pure stands.

AN important article dealing with the classification of the Scitamineæ, the monocotyledonous series comprising the Zingiberaceæ, Marantaceæ, Cannaceæ, and Musaceæ, as represented in the Philippine Islands, is contributed by Mr. H. N. Ridley to the botanical series of the *Philippine Journal of Science* (vol. iv., No. 2). The area of the Philippines is much poorer in species than the Malayan region, but four genera and five-sixths of the species are endemic. Alpinia, Globba, and Amomum furnish the majority of the Zingiberaceæ; Alpinia is typically eastern Asiatic, but ranges so far as Japan and Polynesia. A feature of the genus Globba is the preponderance of white over yellow flowers, this being the reverse of what occurs in India and Malaya. The Marantaceæ are represented by three genera, but no indigenous species of Cannaceæ or Musaceæ are noted, so that there is at present no record of any species of the curious tribe Lowioideæ.

PROF. BRÜCKNER returns to the vexed question of the development of the Rhine-Rhone divide in the *Zeitschrift* of the Berlin Gesellschaft für Erdkunde (1909, p. 387). His paper is a reply to that of Herr L. von Sawicki, published in the same journal early this year (p. 7), and deals in detail with the points on which the two authors differ.

PROF. J. CVIJIĆ contributes a further important contribution to our knowledge of the geology of the Dinaric coastal region in a memoir published in the June and July numbers of *Petermann's Mitteilungen* entitled "Bildung und Dislozierung der dinarischen Rumpffläche." Few parts of the earth's surface show a more complex and varied geological history than this, and the rapidly increasing literature dealing with it has scarcely reached a stage in which a short summary of results is possible. Dr. Cvijić's paper is accompanied by maps and sections and a number of excellent characteristic photographs.

WE have received the annual report of the Survey Department of British East Africa for the financial year 1907–8, by Major G. E. Smith, R.E., director of surveys. The report is divided into three sections, trigonometrical branch, cadastral branch, and Uasingishu Rapid Allotment, and each branch shows very good progress. The trigonometrical branch having completed the preliminary astronomical observations and base measurements on the Athi plains near Nairobi last year, has been able to make rapid progress with triangulation, 7320 square miles having been completed in 1907–8, as against 1375 in 1906–7. In the cadastral branch the arrears of farm surveys have been reduced to manageable proportions, and systematic mapping should get on rapidly next season.

THE director-general of Indian observatories reports that the monsoon appeared about a week before its normal date over the Bay of Bengal, and advanced inland with the usual rapidity; the Bombay current also arrived about the normal date, but did not penetrate inland in full strength until nearly the end of June. The aggregate rainfall of June and July in the plains of India was 13 per cent. in excess of the normal, excepting in the provinces of Central India, the Central Provinces, and Mysore, where there was a deficit, especially in the latter State. Abundant monsoon rainfall is, as a rule, preceded by high pressure in South America and low pressure in the Indian Ocean. These favourable conditions were fully maintained during June and July, and the director-general infers from this fact and other data that the total amount of rainfall in August and September will exceed the average.

MUCH useful information relating to aërial navigation and the physics of the upper air is contained in the reports of scientific lectures and papers published in the weekly review of the Frankfort Aëronautical Exhibition. The number for August 14, for instance, includes (1) an illustrated account of the use of pilot balloons by Mr. H. Bongards, which show the direction and velocity of the upper wind currents. Dr. de Quervain first constructed a special theodolite by which the motion of the balloons could be easily followed in clear weather up to an altitude of 15,000 metres. At Frankfort an apparatus by Dr. Assmann is used for the purpose. (2) A preliminary report of a lecture, by Dr. Pütter, on the development of flight in the animal kingdom, in which the different muscular motions are explained. The author stated that about 62 per cent. of some 420,000 objects, including insects, birds, bats, and fishes, were endowed with some means of flight, and his views of the future development of our present flying apparatus were very promising.

THE so-called Roman amphitheatre at Charterhouse-on-Mendip, about seven miles north-west of Wells, has recently been excavated by Mr. H. St. George Gray on behalf of the Somersetshire Archæological Society. It was certainly closely connected with the extensive Roman lead-mining operations in the Mendips, which, with the remains discovered from time to time, have been fully described by Prof. Haverfield in the "Victoria County History." So far as the discovery of relics goes, the present operations were disappointing. Flint implements are numerous, and when discovered associated with Roman remains it is safe to infer that the lead-miners found them on the surface and buried them in their excavations. The arena, according to Mr. Gray, may have been used by the Roman miners for games, combats, or cock-fighting, but it is ridiculous to style it an amphitheatre of the class of the Maumbury Rings at Dorchester. In fact, the use of such a term raises, as Prof. Haverfield says, "false ideas of space and grandeur"; and he goes on to say that "we cannot decide its precise use, but it is ill-suited to form a pond or water reservoir, and the notion of a tiny amphitheatre is not wholly absurd."

CONSIDERABLE progress towards the settlement of the ever-recurring controversy regarding the origin and date of the so-called dene-holes has been made in a paper contributed to the January–June number of the Journal of the Royal Anthropological Institute by the Rev. J. W. Hayes. This contribution is somewhat lacking in lucidity and logical arrangement, but the writer has pursued the investigation in a common-sense way, and has collected a mass of facts necessary to the settlement of the problem. It is essential to know the various qualities of chalk, and the uses to which it was put in ancient and modern times. The export of the material began in pre-Roman time, and the character of it varied. It was essential for the purposes of home and foreign trade that it should be excavated in solid blocks, and the occurrence of strata of this quality accounts for the grouping of a number of pits in the same neighbourhood. It was and is raised in buckets or baskets, and difficulties of carriage suggested the construction of fresh shafts in close proximity to each other. These considerations seem to dispose of the objection that excavation for the material was only one of the objects of the construction of the dene-holes as we find them. One of the strongest reasons against the theory that they were used as granaries or hiding places lies in the fact that they contain cores of sand, which could not have arisen from attrition of the sides of the pits or from collapse of the mouths of the excavations. These cones could only have resulted from the deposit in the worked-out pits of débris from those of later construction. Mr. Hayes has collected a mass of reports from persons engaged in the chalk trade in recent times which show the methods by which the material is excavated and utilised. These raise a strong presumption that the same considerations which now influence the workers prevailed also in the British and Roman periods.

IN the *Electrician* for August 20 Mr. Morris-Airey makes a suggestion which may prove the correct explanation of the discordant results obtained when two lights of different colours are compared together by photometers of the Bunsen and of the flicker type respectively. The three groups of nerve fibres in the retina, which respond respectively to red, green, and violet light, behave, according to Mr. Morris-Airey, in different ways when the stimulus is first applied, the red group, *e.g.*, responding more quickly than the violet, so that the true degree of excitation of the nerves corresponding to a stimulus is attained by the red nerves before it is by the violet. If the speed of the flicker photometer is such that the stimulus is not applied long enough to allow the three sets of nerves to attain the proper degrees of excitation, the results of comparisons of lights of different colours will vary with the speed, and will only agree with the Bunsen results when the speed is reduced sufficiently.

ACCORDING to the July *Bulletin de la Société d'Encouragement pour l'Industrie nationale* of France, the society is in a most flourishing condition. It has 650 members and an annual income of more than 100,000 francs, part of which is derived from the Department of Agriculture of the country. The society further possesses about thirty endowments, amounting together to more than a million francs, the income from which it utilises in various ways, as, for example, in prizes to inventors who benefit industry, in assisting inventors or artisans who have come down in the world, &c., all calculated to forward the object of the society. In addition, in its monthly bulletin, which is a quarto volume of two hundred pages, it gives its members well written and illustrated articles on industrial questions of the day. In the July number, leaving out of account the shorter articles, there are reports on the breweries and distilleries of the north of France, on recent girder bridge-work, on the position of the electrical industry in France, and, lastly, forty pages of a serial article on the economic situation in Great Britain.

THE *Engineer* for August 27 comments on the reasons for the success of the French in following up new lines of research, and says that it is probably to be found in the fact that they often allow themselves to be influenced by imagination rather than by the practical aspect of the problems they are trying to solve. The remark is called forth by the interest which is being taken on the other side of the Channel in the evolution of the aëroplane, as evidenced by the meeting at Rheims. We agree with our contemporary that, not only the possession of a healthy imagination, but also unbounded enthusiasm, are qualities which go to make a good inventor. Can the fact that this country is taking so small a part in the development of aërial machines be accounted for by the absence of inventive faculties? We prefer to believe that it is rather the lack of financial support which is causing the stagnation, a lack which may be explained by the well-known desire of British manufacturers to see commercial success and profit within reach before taking up any industrial development. Given funds, there is no doubt that we have men of ability sufficient to bring this country into line with our neighbours.

THE leading article in *Engineering* for August 27 is devoted to the address of the president of the British Association. Many of the statements in the address are of particular interest to engineers, and one appeals very forcibly. Sir Joseph Thomson quotes Helmholtz as saying that often in the course of a research more thought and energy are spent in reducing a refractory piece of brass to order than in devising the method or in planning the scheme of campaign. This is exactly in accord with engineering practice. For example, in developing a certain steam turbine, the thermodynamic and kinematic questions involved occupied not a tithe of the time and thought which had to be expended on such questions as the mere form of the casing. Should it, for instance, open at a transverse joint or a longitudinal one? Would the governor fit in better at one end or at the other? These and other apparently trivial, but really very important, details absorbed the greater part of the time at the designer's disposal. The mathematician seems often to have a difficulty in appreciating this matter, but the experimental physicist is nearer akin to the engineer, and has to face many of the same problems. Both suffer from a certain apparent perversity in the materials they use, to which, however, the engineer has commonly the added burden of often wayward and intractable human nature.

MESSRS. H. F. ANGUS AND CO., 83 Wigmore Street, London, W., have submitted to us a specimen of a very useful supplementary lens which they have placed on the market for attachment to a naturalist's telescope. The telescope sent with the lens is of the usual short-focus pattern made for observing birds or other objects, and by placing the supplementary lens over the objective the instrument can be used to watch insects or similar small forms of animal life at any convenient distance down to about 20 inches, at which distance the magnification is about five diameters. The combination thus provides the naturalist with a very handy means of studying the characteristics and movements of insects, spiders, and so on at a convenient distance, and without disturbing the creatures. Similar caps can be adapted to the ordinary tourist telescope and the monocular prismatic field-glass. The attachment is inexpensive—the price being 3*s*. 6*d*. for any size or power lens required—and it certainly increases the optical capacity of any instrument with which it is used. For the observation of minute forms of animal life in the open air, and for the examination of details of objects placed beyond the distance of distinct vision in museums, the additional lens will be found a great advantage. As, however, accessory parts of instruments are often misplaced or not at hand when desired, we suggest that the attachment should be fixed upon the telescope by a band or other means which would permit the lens to be brought in front of the objective or turned away from it as desired. A simple swivel arrangement would probably enable this to be done, and the naturalist could then immediately convert his glass into an instrument for the observation of objects near or far.

OUR ASTRONOMICAL COLUMN.

CHANGES ON MARS.—Further changes in the south polar regions of Mars are recorded by M. Jarry Desloges in No. 4350 of the *Astronomische Nachrichten* (p. 95, August 25). Observations, made at the observatory installed on the Revard plateau, on August 20, 11h., showed that the Mare Cimmerium was divided obliquely by a bright band between Eridania and Electris, whilst a large gulf was distinguished on Zephyria, and numerous changes were seen to have taken place on the northern plains. Since its separation, observed on August 11–12, the bright oval region in longitude 320° has become more and more separated, and the dark regions of the planet, so pale in June and July, are changing, and becoming darker, almost daily. A greyish region seen at the eastern side of the polar cap on August 13, 2h., is diminishing rapidly, and apparently disaggregating in all directions.

THE ABSORPTION OF LIGHT IN SPACE.—A suggestion recently made by Prof. Turner, in regard to M. Tikhoff's researches on the absorption of light in interstellar space, is discussed by Mr. J. A. Parkhurst in the July number of the *Astrophysical Journal* (vol. xxx., No. 1, p. 33). Prof. Turner's suggestion was that photographs of stars should be taken using only the visual rays, and then other photographs should be taken in the same way to determine the increase of exposure necessary to get stars of a definite number of magnitudes fainter. If these photographs were more in accordance with the theoretical law connecting exposure and intensity than are those where the violet rays are not excluded, they would afford evidence that the discordance between visual and ordinary photographic magnitudes is due rather to cosmical than to photographic causes. Evidence of this nature has already been adduced by M. Tikhoff.

Mr. Parkhurst shows, however, from a number of experiments carried out at the Yerkes Observatory, that his results are contradictory to those of M. Tikhoff, and suggests that the cause of the difference lies in the instruments and plates employed; probably, in the main, in the plates and light-filters, for the same effect has been obtained by him both with a reflecting telescope and a doublet camera. Thus it would appear that the proposed experiments with photographic colour-filters would furnish no definite evidence either for or against the cosmical absorption or scattering of the violet rays.

In the same journal Mr. Paul R. Heyl also discusses the question of the apparent dispersion in space, and, whilst preferring Nordmann's monochromatic-photometry method, suggests that too great an importance has been attached to the parallax values used in measuring the dispersion; this would possibly account for the considerable differences between the values obtained by Tikhoff and Nordmann. Mr. Heyl also indicates that the objections urged by M. Lebedew against the methods are not unanswerable.

PLANETS AND THEIR SATELLITES.—In a note appearing in No. 4351 of the *Astronomische Nachrichten* (p. 97, August 27), Prof. Lowell shows that throughout the solar system there exists a remarkable parallelism between the ratios obtained by comparing the speeds of the satellites, about their primaries, with the velocities of the latter in their own orbits. A table showing the ratios for the systems of Jupiter, Saturn, Uranus, and Neptune displays relations which are too systematic to be merely fortuitous. In a brief discussion as to the effect of the calculated speeds, during the time the systems were evolving, in determining the relations between the satellites and the interplanetary particles through which they were passing, Prof. Lowell shows that the total effect of the particles on the large satellites was to retard the latter and cause them to approach the primaries. For retrograde satellites the effect was greater than for the direct, which may account for the preservation of the latter. Incidentally, this is shown to be antagonistic to the planetesimal hypothesis, wherein it is reasoned that the impact of the interplanetary particles on a direct satellite would accelerate it and thus prevent it being drawn down on to the planet; this is exactly contrary to the fact with any of the major satellites.

METEOR OBSERVATIONS.—As in previous years, organised observations of the Perseids were carried out by the members of the Belgian Astronomical Society at seven different stations, and the results are briefly reported in No. 21 of the *Gazette astronomique*. Each observing party kept watch from 10h. to 14h., each night, from August 7 to August 15, and the detailed discussion of the collected observations should provide some very useful information concerning this important shower. At Antwerp two observers recorded 492 meteors, 129 of which were of the first magnitude, or brighter, and the maximum display, both there and at Uccle, appears to have taken place on August 11; the horary numbers were 51·4 and 44·2 respectively.

Observations of the Perseids in 1908, and the Lyrids in 1909, were made at the Kasan Observatory, and the results are published in detail in No. 4350 of the *Astronomische Nachrichten*. Altogether, the paths of 132 Perseids and 59 Lyrids, with notes on their appearances and the values determined for the radiants, are given.

NEW SPECTROSCOPIC BINARIES.—No. 19, vol. i., of the Publications of the Allegheny Observatory contains the preliminary announcement that spectrograms taken with the Mellon spectrograph show the following five stars to be spectroscopic binaries:—(1) 30 H. Ursæ Majoris; range of 100 km. and period of 11·6 days. (2) B.D. + 3·2867°; 134 km. range and short period. (3) B.D. + 6·2875°; range of 80 km. (4) 25 Serpentis; range of 90 km. and a short period. (5) ι Coronæ; range 40 km., period short.

OBSERVATIONS OF PERRINE'S COMET.—Photographic observations of Perrine's comet, 1909*b*, were made at Greenwich on August 14 and 16, and at the Königstuhl Observatory on August 12, 15, and 19; on the latter date the magnitude was 15·0.

These observations show that, between the extreme dates, the ephemeris published by Prof. Kobold was nearly correct, the corrections in R.A. varying from +5s. on August 12 to −6s. on August 19; those for declination increased from −10·8′ to −14′ (*Astronomische Nachrichten*, No. 4350, p. 96).

THE BRITISH ASSOCIATION AT WINNIPEG.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY A. E. SHIPLEY, M.A.CANTAB., HON. D.SC.PRINCETON, F.R.S., PRESIDENT OF THE SECTION.

I.

Charles Darwin.

THIS is the year of centenaries. Perhaps in no other year in history were so many men born destined to impress their genius on the literature, the politics, and the science of the world as in 1809. The number of literary men who first saw the light in that *annus mirabilis* is almost too long to mention—Mark Lemon, the genial editor and one of the founders of *Punch*; "Crimean" Kinglake; John Stuart Blackie, until lately a well-known figure in Edinburgh; Monckton Milnes, the first Lord Houghton, "poet, critic, legislator, the friend of authors" and the father of Lord Crewe, who at present presides over that most important of all Government offices—that of the Colonies. One could prolong the list; and one must at least mention the names of Louis Braille, the inventor of the Braille type for the blind, of Fanny Kemble and of Elizabeth Barrett Browning, before passing on to remind you that this year is also the centenary of Tennyson, who, with Browning, formed the twin stars of poetry during the reign of Queen Victoria, and who from his intimate knowledge of natural history and his keen power of observation was essentially the poet of Darwinism. Of his life-long friend, born the same year, Edward Fitzgerald, the translator—one feels almost inclined to say author—of Omar Khayyám, and of the gifted musician Mendelssohn there is no time to speak.

On this side of the Atlantic, and yet not wholly on this side, for he spent five impressionable school years at Stoke Newington, we have that "fantastic and romantic" genius Edgar Allan Poe.[1] Later he studied at West Point, where surely he must have been as incongruous a student as James Whistler himself. We have also that kindly, humorous physician Oliver Wendell Holmes, a nature "sloping towards the southern side" as Lowell has it. Amongst many recollections of literary men I cherish none more dearly than that I once entertained him in my Cambridge and once visited him in his.

Three other names stand out. William Ewart Gladstone, that leader of men, a politician and a statesman capable more than most men at once of arousing the warmest affection of his followers and the bitterest hatred of those who went the other way. Cultured as he was and widely read, he had his limitations, and although his tenacious memory was stored with the humanities of all the ages, he was singularly devoid of any knowledge of science. If we may paraphrase the words of Lord Morley in his estimate of Gladstone's writings, we would say that his place is not in science, "nor in critical history, but elsewhere."

Abraham Lincoln, the greatest man born on this continent since the War of Independence, was some ten months older than Gladstone. Both men were great statesmen, both men were liberators; for we must not forget that in many minds the help Gladstone gave to Italy in her struggle for freedom and union remains the most enduring thing he achieved.

Yet in externals how different! One the finished, cultured product of the most aristocratic of our public schools and the most ancient of our universities, the other little read in the classics or in mediæval and ecclesiastical lore, yet deeply versed in the knowledge of men and how to sway them. Rugged, a little rough if you like, humorous and yet sad, eminently capable, a strong man, and at heart "a very perfect gentleman."

On the same day, February 12, upon which Lincoln first saw the light, was born at the "Mount," Shrewsbury, a little child destined as he grew up to alter our conceptions of organic life perhaps more profoundly than

[1] Poe lived from his eighth to his thirteenth year at the "Manor House School," Stoke Newington, at that time a village, now swallowed up by the metropolis. Poe described the place as he knew it, and his schoolmaster, Dr. Bransby, in "William Wilson."

any other man has ever altered them, and this, not only in the subjects he made his own, but in every department of human knowledge and thought.

Being as I am a member of Charles Darwin's own college, coming as I do straight from the celebration in which the whole world united to do his memory honour, it would seem meet that I should in this year of the centenary of his birth devote this address to a consideration of his life and of his work, and of such confirmation and modification of his theories as the work of the last fifty years has revealed.

As to the man, I can but quote two estimates of his character, one by a college companion who lived on terms of close intimacy with Darwin when at Christ's, the other the considered judgment of one who knew and loved and fought for Darwin in later life.

Mr. Herbert says:—

"It would be idle for me to speak of his vast intellectual powers . . . but I cannot end this cursory and rambling sketch without testifying, and I doubt not all his surviving college friends would concur with me, that he was the most genial, warm-hearted, generous, and affectionate of friends; that his sympathies were with all that was good and true; and that he had a cordial hatred for everything false, or vile, or cruel, or mean, or dishonourable. He was not only great, but preeminently good, and just, and lovable."

Prof. Huxley, speaking of his name, says:—

"They think of him who bore it as a rare combination of genius, industry, and unswerving veracity, who earned his place among the most famous men of the age by sheer native power, in the teeth of a gale of popular prejudice, and uncheered by a sign of favour or appreciation from the official fountains of honour; as one who, in spite of an acute sensitiveness to praise and blame, and notwithstanding provocations which might have excused any outbreak, kept himself clear of all envy, hatred, malice, nor dealt otherwise than fairly and justly with the unfairness and injustice which was showered upon him; while, to the end of his days, he was ready to listen with patience and respect to the most insignificant of reasonable objectors."[1]

It has been somewhat shallowly said—said, in fact, on the day of the centenary of Darwin's birth—that "we are upon very unsafe ground when we speculate upon the manner in which organic evolution has proceeded without knowing in the least what was the variable organic basis from which the whole process started." Such statements show a certain misconception, not confined to the layman, as to the scope and limitations of scientific theories in general, and to the theory of organic evolution in particular. The idea that it is fruitless to speculate about the evolution of species without determining the origin of life is based on an erroneous conception of the true nature of scientific thought and of the methods of scientific procedure. For science the world of natural phenomena is a complex of procedure going on in time, and the sole function of natural science is to construct systematic schemes forming conceptual descriptions of actually observed processes. Of ultimate origins natural science has no knowledge and can give no account. The question whether living matter is continuous or not with what we call non-living matter is certainly one to which an attempted answer falls within the scope of scientific method. If, however, the final answer should be in the affirmative, we should then know that all matter is living; but we should be no nearer to the attainment of a notion of the origin of life. No body of scientific doctrine succeeds in describing in terms of laws of succession more than some limited set of stages of a natural process; the whole process—if, indeed, it can be regarded as a whole—must for ever be beyond the reach of scientific grasp. The earliest stage to which science has succeeded in tracing back any part of a sequence of phenomena constitutes a new problem for science, and that without end. There is always an earlier stage, and to an earliest we can never attain. The questions of origins concern the theologian, the metaphysician, perhaps the poet. The fact that Darwin did not concern himself with questions as to the origin of life nor with the apparent discontinuity between living and non-living matter in no way diminishes the value of his work. The broad, philosophic mind of the great master of inductive method saw too fully the nature of the task he had set before him to hamper himself with irrelevant views as to origins.

No well-instructed person imagines that Darwin spoke either the first or the last word about organic evolution. His ideas as to the precise mode of evolution may be, and are being, modified as time goes on. This is the fate of all scientific theories; none are stationary, none are final. The development of science is a continuous process of evolution, like the world of phenomena itself. It has, however, some few landmarks which stand out exceptional and prominent. None of these is greater or will be more enduring in the history of thought than the one associated with the name of Charles Darwin.

I cannot, indeed, attempt to weigh or estimate the influence and the far-reaching import of the work which all the world has been weighing and estimating during this year, the centenary of his birth and the jubilee of the "Origin of Species." I cannot, to my intense regret, give you any personal recollections of Darwin, for though I think I once saw him in the streets of Cambridge, I have to my sorrow never been absolutely sure that this was so.

But in reading his writings and his son's most admirable Life, one attains a very vivid impression of the man. One of his dominant characteristics was simplicity—simplicity and directness. In his style he was terse, but he managed to write so that even the most abstruse problems became clear to the public. The fascination of the story he had to tell was enhanced by the direct way he told it.

One more characteristic. Darwin's views excited at the time intense opposition and in many quarters intense hatred. They were criticised from every point of view, and seldom has a writer been more violently attacked and abused. Now what seemed to me so wonderful in Darwin was that—at any rate so far as we can know—he took both criticism and abuse with mild serenity. What he wanted to do was to find the truth, and he carefully considered any criticism, and if it helped him to his goal he thanked the critic and used his new facts. He never wasted time in replying to those who fulminated against him; he passed them by and went on with his search.

In the development of the theories associated with Darwin's work the New World played a prominent part. Darwin's "Wanderjahre" were spent on this side of the Atlantic. The central doctrine of evolution through natural selection was forced upon his mind by the studies and researches he made in South America during the voyage of the *Beagle*. The numerous observations in all departments of natural science and the varied forms of life he came across in this classical journey were the bricks with which he built many of his later theories. The storm of controversy which the "Origin of Species" awoke was at least as violent in America as in Great Britain, and we must not forget the parts played by men like Hyatt, Fiske, Osborn, and many others, and above all by Asa Gray and by Brooks of Baltimore, whose recent death has robbed America of perhaps her greatest Darwinian.

It is a somewhat remarkable fact that whilst the works of Darwin stimulated an immense amount of research in biology, this research did not at first take the line he himself had traced. With some exception the leading zoological work of the end of the last century took the form of embryology, morphology, and palæontology, and such subjects as cell-lineage, "Entwickelungsmechanik"; the minute structure of protoplasm, life-histories, teratology, have occupied the minds of those who interest themselves in the problems of life. Along all these lines of research man has been seeking for the solution of that secret of nature which at the bottom of his heart he knows he will never find, and yet the pursuit of which is his one abiding interest. Had Frank Balfour lived we should, I think, have sooner returned to the broader lines of research as practised by Darwin, for it was his intention to turn himself to the physiology—using the term in its widest sense—of the lower animals. Towards the end of the nineteenth century, stimulated by Galton, Weldon began those series of measurements and observations which have culminated in the establishment, under the guidance

[1] "Life and Letters of Charles Darwin," vol. ii., 1887, p. 179.

of his friend and fellow-worker, Karl Pearson, of a great school of eugenics and statistics in London. With the beginning of the twentieth century came the re-discovery of Mendel's facts, and with that an immediate and enormous outburst of enthusiasm and of work. Mendel has placed a new instrument in the hand of the breeder, an instrument which, when he has learnt to use it, will give him a power over all domesticated animals and cultivated crops undreamt of before. We are getting a new insight into the working of heredity, and we are acquiring a new conception of the individual. The few years which have elapsed since men's attention was re-directed to the principles first enunciated by the Abbot of Brünn have seen a great school of genetics arise at Cambridge under the stimulating energy of Bateson, and an immense amount of work has also been done in France, Holland, Austria, and especially in the United States. As the work has advanced, new ideas have arisen and earlier formed ones have had to be abandoned; this must be so with every advancing science; but it has now become clear that mutations occur and exist especially in cultivated species, and that they breed true seems now to be established. In wild species also they undoubtedly occur, but whether they are so common (in uncultivated species) remains to be seen. If they are not, in my opinion a most profitable line of research would be to endeavour to determine what factor exists in cultivation which stimulates mutation.

To what extent Darwin's writings would have been modified had Mendel's work come into his hands we can never know. He carefully considered the question of mutation, or, as they called it then, saltation, and as time went on he attached less and less importance to these variations as factors in the origin of species. Ray Lankester has recently reminded us that Darwin's disciple and expounder, Huxley, "clung to a little heresy of his own as to the occurrence of evolution by saltatory variation," and there must have been frequent and prolonged discussion on the point. That "little heresy" has now become the orthodoxy of a number of eager and thoughtful workers who are at times rather aggressive in their attacks on the supporters of the old creed. "That mutations occur and exist is obvious to everyone, but that they are of frequent occurrence under purely natural conditions is," Sir William Thiselton-Dyer thinks, "unsupported by evidence." The delicate adjustment between an organism and its natural surroundings suggests that sudden change of a marked kind would lead to the extinction of the mutating individual. So far as I can understand the matter in dispute, Darwin and his followers held that evolution had proceeded by small steps, for which we may accept de Vries's term fluctuations; whilst the Mutationists hold that it has advanced by large ones, or mutations. But it is acknowledged that mutations are not all of the same magnitude, some, *e.g.* albinism, brachydactyly in man, dwarf habit or glabrousness in plants, may be large; others, *e.g.* certain differences in shade of colour or in size, are insignificant, and indeed Punnett has suggested that under the head of fluctuating variation we are dealing with two distinct phenomena. He holds that "some of the so-called fluctuations are in reality mutations, whilst others are due to environmental influence." He thinks the evidence that these latter are transmitted is slender, and later states that "Evolution takes place through the action of selection on these mutations. Where there are no mutations there can be no evolution." The disagreement about the way in which evolution has proceeded has perhaps arisen from a misunderstanding as to the nature of the two kinds of variation described respectively as mutations and fluctuations. Mutations are variations arising in the germ-cells and due to causes of which we are wholly ignorant; fluctuations are variations arising in the body or "soma" owing to the action of external conditions. The former are undoubtedly inherited, the latter are very probably not. But since mutations (using the word in this sense) may be small and may *appear* similar in character to fluctuations, it is not always possible to separate the two things by inspection alone. The whole matter is well illustrated by the work of Johannsen on beans. He found that while the beans borne by any one plant vary largely in size, yet if a large and a small bean from the same plant are sown, the mean size and variability of the beans on the plants so produced will be the same. The differences in size are presumably due to differences of condition, and are not inherited. But if two beans are sown, one from a plant with beans of large average size, and one from a bean of small average size, the bean plant the parent of which had the high average will bear larger beans than the one from the parent with small average beans. The faculty of producing a high or low mean size is congenital, is a mutation in the sense used above, and is inherited. It is no doubt unfortunate that the word mutation has been used in several different senses, for it seems to have led to most regrettable confusion and misunderstanding.

As I have said, in such a year, and in my position, I ought perhaps to have devoted the whole of this address to the more philosophical side of our subject; but, in truth, I am no philosopher, and I can only say, as Mr. Oliver Edwards, "an old fellow-collegian" of Dr. Johnson's, said to the "great lexicographer" when they met after nearly half a century of separation: "I have tried too in my time to be a philosopher, but I don't know how, cheerfulness was always breaking in."

II.

Organising Zoology.

I now turn to a subject of the greatest moment and of the greatest difficulty, and one on which there is little general consensus of opinion. The question I wish to raise is this—are the zoologists of the world setting about their task in an economic and efficient way?

We live surrounded by a disappearing fauna. Species are disappearing from the globe at a greater rate than even the most ardent mutationist claims they are appearing. To mention but a few striking cases: The European beaver has almost gone, though a few linger on around the periphery of the Continent. Norway, the lower Danube, Eastern and Arctic Russia still harbour them, and a very few are said still to inhabit the Rhine and the Rhone. The European bison is now represented by a few wild specimens in the Caucasus. The American bison is reduced, and that by the deliberate and calculated action of man, to a few herds most carefully preserved by Government; the largest of these, containing some 600 heads, is now at the National Park at Wainwright. Equally deliberate and equally calculated is the destruction of the fur-seal, which threatens soon to be complete. The Greenland sealing is almost a thing of the past. In 1860 British vessels killed 68,278 seals; in 1866, 103,578; and this went on until 1895, when the pursuit was abandoned by the British, it being no longer found to pay them, though Norwegians still continue "sealing." In 1859 19 vessels sailing from British ports killed 148 whales; in 1881 12 vessels killed 48 whales; last year 6 Dundee vessels killed but 15, and the year before that but 3. The whalers sailing from Newfoundland ports killed 1275 whales in 1904, 892 in 1905, and only 429 in 1906.

At the present time certain Norwegian whaling companies have been for the last few years actively at work in the Shetlands, and are killing off as fast as they can the common rorqual (*Balaenoptera musculatus*, L.), the lesser rorqual (*B. rostrata*), Sibbald's rorqual (*B. sibbaldi*, Gray), the cachalot (*Physeter macrocephalus*, L.), the humped-back whale (*Megaptera boops*, L.), and, when they can reach him, the Atlantic right whale (*Balaena mysticetus*, L.). These are killed primarily for their blubber, but the economy of the factories rivals that of the Chicago pork-packing industries. Nothing is wasted; the flesh is made into sausages, which are readily eaten in Central Europe, and the bones are ground up to make manure. No animal which produces but few young can withstand such persistent and organised attacks on the part of man, and I fear, before many years are passed, many species of whale will be extinct. At the present moment the two right whales seem almost on the verge of extinction, and *Balaena mysticetus* will probably go before *B. australis*. Nothing shows this more clearly than the price of whalebone, which has gone up in the last eighty-four years from 56*l.* per ton to 2100*l.* per ton, or from 12 cents a pound to 4·90 dollars, and in some years to 5·80 dollars a pound. The number of pounds on sale in the United States has dropped from 2,916,500 in 1851 to 96,600 in 1906. With the whales will disappear the whale-lice and the whole of the very interesting parasitic fauna which inhabit their vast interiors.

The disappearance of the large game from enormous tracts of country in Africa is too well known to delay us. The elephant, except where preserved in the Litzikama Forest, near Mossel Bay, and in the Addo Bush, near Port Elizabeth, is exterminated south of the Limpopo. The price of ivory, again, is a measure of the nearness of its extinction. The best pieces, which are used for billiard balls, have risen in price from 55*l.* a cwt. in 1882 to an average of 100*l.* a cwt. in 1908. The common and the brindled gnu (*Connochoetes taurinus*) are fated to follow the extinct quagga. The blesbok (*Damaliscus albifrons*), formerly found in thousands in Cape Colony, the Transvaal, and Bechuanaland, is now very rare, and seems doomed. The giraffe has long been driven out from South Africa, though it still roams over large tracts of country in East and Central Africa.

Perhaps the most striking case of the disappearance of a mammalian fauna is that presented in Western Australia. Here many districts are now said to be entirely devoid of indigenous mammals, and this depletion is in the main an affair of only the last thirty years, and many of the local extinct forms are still remembered by the older natives and colonists. Mr. Shortridge, a collector who has worked for some years in South-west and Western Australia, writes in a letter: "The entire disappearance of so many species over such large tracts of country is generally considered to be due to some epidemic perhaps brought into the land by introduced animals. It is to be noted that they have died out chiefly in the dry regions, where, except for the introduction of sheep, there has been very little alteration in the natural conditions. Rabbits, although already very numerous in the Centre and South-east, have not as yet found their way to the North-west." Amongst the mammals which have almost, if not quite, disappeared from West Australia are the banded wallaby (*Lagostrophus fasciatus*), the hare wallaby (*Lagochestes hirsutus*), the rat-kangaroos (*Potorous gilberti* and *P. platyops*). The indigenous rats and mice of Australia are disappearing even faster than the marsupials, and it seems probable that many will not be heard of again.

A very few years ago the ship employed by the company which is exploiting the phosphates of Christmas Island introduced the brown rat (*M. decumanus*) there. Within a short time the two indigenous rats first collected by Mr. C. W. Andrews, of the British Museum, named *Mus macleari* and *Mus novitatis*, were wiped out of existence. The same animal having been introduced in North America is gradually spreading, and as it spreads the native fauna of Muridæ is slowly vanishing.

To adorn our ladies' heads some of the most beautiful of birds are being systematically exterminated. In the London market alone were sold last year some 50,000 sooty terns (*Sterna fuliginosa*, *S. anaestheta*, and *S. bonata*), 20,000 specimens of the crowned pigeon (Goura) from New Guinea, their sole habitat, immense numbers of "osprey" feathers, egret and heron, and more than 50,000 birds of paradise, or more than double the number of the year before.

I have no time to continue this melancholy record, but it could be prolonged almost indefinitely.

When we reflect how greatly we treasure every scrap of knowledge we can glean about such recently extinct animals as the Rhytina—Steller's sea-cow—the dodo, the great auk, we must see that if it be impossible to check the gradual disappearance of those animals doomed to extinction, we should at least monograph them and take every care that what can be permanently kept of their structure should be kept. In respect to the recording of the habits and physical features of a disappearing race, the anthropologists are setting an example which the zoologists would do well to follow.

We are living with a disappearing fauna around us, and numerous as the museums of the world are, and skilled and painstaking as the curators of these museums are, they are both wholly inadequate to deal with the material at hand. Some dozen years ago Dr. Günther made a very careful estimate of the number of species of animals which were known in the years 1830 and 1881. I summarise his table:—

Number of Species known in the years 1830 and 1881.

	1830	1881
Mammalia	1,200	2,300
Aves	3,600	11,000
Reptilia and Batrachia ...	543	3,400
Pisces	3,500	11,000
Mollusca	11,000	33,000
Bryozoa	(40)	120
Crustacea (year 1840) ...	(1,290)	7,500
Arachnida	1,408	8,070
Myriapoda	450	1,300
Insecta	49,100	220,150
Echinodermata (1838) ...	(230)	1,843
Vermes (1838)	(372)	6,070
Cœlenterata (1834)	500	2,200
Porifera (1835)	(50) *say*	400
Protozoa (1838–44) *say* ...	(305) ,,	3,300
	73,588	311,653

Taking an average year between 1881 and the present date, but rather nearer the latter, because each year the number of newly described species becomes larger, Dr. Sharp tells me that, according to the zoological record, 12,449—let us call it 12,450—new species were described in the year 1897.

Number of new Species described in the year 1897.

Mammalia	285
Aves	105
Reptilia and Batrachia	140
Pisces	148
Mollusca	1,077
Brachiopoda	7
Bryozoa	6
Crustacea	239
Arachnida	659
Myriapoda	275
Insecta	8,364
Echinodermata	491
Vermes	294
Cœlenterata	164
Porifera	95
Protozoa	100
	12,449

This number, however, includes fossils which I do not think were included by Dr. Günther. We might deduct 450 for them if we wish to confine our attention to living animals. This leaves us 12,000. If we multiply this by 27, the number of years which have elapsed since Dr. Günther made his estimate, we find a total of 324,000. This number is possibly too large, as it makes no allowance for synonyms; still, it is a rough indication that since 1881 the number of described species has been doubled. Isolated groups, such as the mammals, treated in the same way, give us fairly similar results, so that now we may, I think, say that there are more than 600,000 described species of living animals.

It thus appears that during the fifty-one years in the middle of the last century the number of known species grew by some 238,000, giving an average increase of a little less than 5000 per annum. At the present day there are far more workers in the field than there were thirty years ago, museums have multiplied, and there are many more zoologists, and it is now estimated that the number of species annually described and named amounts to some 12,000.

The number, large as it seems, is, however, but small in comparison with the number of species collected and deposited in museums where no one has time to work them out. It is still smaller in comparison with the vast numbers of species as yet uncaptured. Dr. Sharp, in 1895, calculated that there were a quarter of a million known and described insects. This was an increase of 30,000 over Günther's figures of fifteen years before, but he states that in his opinion this quarter of a million is but one-tenth of those which exist.

With the exception of the larger Mammalia—though the Okapi warns us the exception may yet prove the rule—there is no group of animals which may not yield us new surprises—no group which we can regard as well worked out, though naturally some are better known than others. What, then, are the zoologists of the world doing to record the animal life around them? One thing of late is certainly an improvement. During last century the great zoological collections were in the main increased and augmented by the chance gifts of hunters and sportsmen, whose chief object in their expeditions was not zoology, but what is termed "sport." Many valuable gifts are still received from such sources, but it is now recognised that we must not in these matters trust to the sportsman alone. The plan of attaching trained naturalists and experts in taxidermy to an expedition avowedly meant for other purposes is good, and is well exemplified by Mr. Roosevelt's "safari" in East Africa at the present time. We may hope that we may never again see an expedition without a single trained naturalist on its staff, such as the last Stanley led across Africa. A still better plan is to send out expeditions of trained naturalists to do definite pieces of work. Such expeditions as Andrews and Foster Cooper and Osborn to the Fayum for fossils, of Cunnington and Boulenger to the same region to investigate the fauna of the lake, or Wollaston and his companions to the Ruwenzori district, yield a harvest one hundred times more abundant than the best of other schemes.

Yet even here I would plead for a little more organisation. One must not suggest too rigid a scheme, and it is to be hoped that in the future, as in the past, there will always be found wealthy men willing to devote their energies to the advancement of zoology. Such work has been done by Mr. Godman on the fauna of Central America, one of the richest regions in the world, and now, owing to his munificence, one of the best known. The stately array of volumes embodying these results is paralleled by the magnificent monographs in which the results of the Prince of Monaco's marine researches are recorded, and by the monographs of the Princeton Expedition to the Argentine, financed by one of the richest of the millionaires of the United States. We trust that such enterprises will always continue.

With regard, however, to expeditions financed from public funds which are sent out officially, it might be possible to have more international cooperation. Just as the members of the Geodetic Survey meet from time to time and determine the next step to be taken in the triangulation of the world, so it seems to me might the members of the chief museums of the world meet, say, triennially, and draw up certain thought-out plans for the exploration of the zoological world.

With regard to working out the material when collected, the existing museums of the world are too few, and their staffs are too small to deal, not only with the huge collections which are constantly pouring into their buildings, but even with the accumulated stores already housed there. In our smaller State museums it is not uncommon to find men who are responsible for the whole of the Arthropoda. Only within the last few months I have had to try to find for a Metropolitan museum a curator who was expected to be a specialist in fishes, molluscs, and arachnids. Now is it possible to expect such men, able and zealous as they are, accurately to determine species in these vast and complex groups? My own feeling is—but I fear I shall carry no one with me—that we must specialise still further. I should like to see each of the great classes of the animal kingdom assigned to one of the great museums of the world. Just as an example—which is only an example, possibly a bad one—I suggest that all the type-specimens of Amphibia be sent to one museum, say, if you like, that of Berlin or St. Petersburg; in return for this that museum should distribute to others its types of fish, birds, &c. Then, at this museum there would arise a series of specialists capable of deciding swiftly and accurately on the validity of the claims of any new species of amphibian that may be advanced. Again, a student of Amphibia, instead of wandering round the museums of the world if he wishes to study species, would find all he wants within the four walls of one building. When once the type is described and deposited, it would be the duty of the museum to distribute co-types and accurately named specimens of the same species to other museums in some recognised order. Smaller groups might be allocated to smaller museums, *e.g.* the fleas to Tring and the ticks to Cambridge—at both these places there are now specialists working out world collections of these pests. What I want is a world's Clearing-House for animals. I know I shall be told that my suggestions can never be realised, that international jealousies would prevent such a scheme being adopted, that I am proposing to fetter research. I admit the difficulties, but do not regard them as insuperable. When you recall the international Clearing Houses for the Postal and Telegraphic service, for the banking of the world, and when we reflect what private enterprise does, under the name of Lloyd's, for the shipping of the world, how it registers and describes and certifies, with a minuteness not surpassed by any maker of species, each ship in the world; how, through its signal stations and by other means, it follows the daily course of each vessel, so that at any hour of any day it can state where, in normal circumstances, that vessel is, it does not seem to me impossible to come to some understanding as to dealing with the animals of the world. Only by some such means can we hope to cope with the problem before us.

One other fruitful source of "waste of time" I will mention. That is the debatable matter of zoological nomenclature, more especially the questions of synonymy. The British Association at their last meeting passed a resolution on the proposal of Mr. G. A. Boulenger in the following sense:—

"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."

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.

The International Congress of Zoology takes, I believe, a somewhat sterner view, but they are engaged in drawing up a list of names which they hope will be accepted for all time. I for one am prepared to accept them, and I am prepared to go further. I would ask the International Congress if, instead of drawing up a list of single species, or perhaps in addition to it, they would draw up a list of systematic monographs, the names in which may be regarded as final. After all, modern classification began with a book, and it would take no longer, or very little longer, to sanctify a book which may contain diagnoses of hundreds of species than to sanctify the single species. The idea is due to Mr. Cyril Crossland, and he suggests—he was working at Chætopods—that such works as Claparède's "Annelides Polychètes du Golfe de Naples," Ehler's "Die Borstenwürmer," McIntosh's "Monograph of the British Annelids" be accepted. Possibly whole categories of books might be considered, such as the "*Challenger* Reports," and especially "Das Tierreich," the admirable volumes of which we owe to the enterprise of the Berlin Zoological Society. Such a scheme would certainly cause some minor injustices, but every scheme does that. The immense advantage of allowing a researcher readily to determine and give an accepted name to an animal he is investigating without waiting weary days in struggling through a vast and scattered literature for the sake of synonymy would surely far out-balance any temporary injustice.

One last phase of my subject and I have finished with what I want to say on the subject of organising zoology. In Europe the great museums of our metropolitan towns are State museums, endowed by the State, managed by the State, and in Great Britain and Ireland staffed and curated by the State; that is to say, the officials at the museums are Civil Servants. Let us consider for a moment what that means, and let us take the British Museum, which, in its entirety, is second to none in the world as an example of a State museum.

The British Museum was established by an Act of Parliament in the year 1753 (26 Geo. II. cap. xxii). This Act sanctioned the purchase of collections and library of Sir Hans Sloane, that prince of collectors, for the comparatively insignificant sum of 20,000*l*. In fact, Sir Hans left his magnificent collection of natural objects, which, twenty years before his death, amounted to just under 70,000 specimens, his library of 40,000 printed volumes and 4100 manuscripts, to the nation, on condition that 20,000*l*., about one-fourth of the estimated value of the collections, be paid to his executors. Under the above-mentioned Act 10,000*l*. were paid to each of Sir Hans Sloane's daughters, Mrs. Stanley and Lady Cadogan. The same Act provided 10,000*l*. for the purchase from the Duchess of Portland, heiress of the second Earl of Oxford, of the Harley collection of charters and manuscripts, which were then in the market, and other moneys for the purchase and repair of Montagu House, Bloomsbury, and for maintenance. The Act incorporated with the Museum the Cottonian Library at Westminster, which, by an Act of Parliament of William III.'s reign, was under the care of trustees, chief amongst whom were the Archbishop of Canterbury, the Lord Chancellor, and the Speaker; the money was raised by a lottery, and the museum was opened in January, 1759, just 150 years ago.

Now it will be noticed that at its formal birth the museum consisted of about two equal parts—on the one hand books and manuscripts, and on the other what used to be called "natural objects."

The "General Repository," as the Act of George II. called it, was placed in the hands of a body of trustees, now forty-nine in number, three of them relics of William III.—namely, the Archbishop of Canterbury, the Lord Chancellor, and the Speaker of the House of Commons, are trustees by virtue of office. These three are known as the principal trustees; there are twenty-one other trustees in virtue of their office—*e.g.* the Bishop of London, the Presidents of the Royal Society and Royal Academy, and so on—one is appointed by the Crown, nine represent the families of donors, and fifteen are co-opted. So large and unwieldy a body cannot, as a whole, transact the business of a great museum, and they have largely delegated their functions to a standing committee of the three principal trustees and fifteen annually appointed representatives.

Now the manner of appointing to the museum is this. The junior members of the staff are selected as the result of examination, and when appointed they become Civil Servants. Not a bad thing in itself, but bad for a man of science. He, through no fault of his own, becomes entangled in red tape; above all, he must not make himself a nuisance; *trop de zèle* must be avoided, his enthusiasms tend to become checked, he is perpetually observing what is called "official reticence," and he perforce spends his days in performing routine work during routine hours. No amount of skill and ability—and the staff at the museum is both skilled and able—hastens his promotion. This is a matter almost entirely of seniority. In fact, the conditions of the Civil Service are incompatible with that freedom to research in any line that proves most suggestive, and with that absence of outside control which alone makes scientific research on a large scale possible.

The appointment to the senior staff, the keepers or heads of departments, the Director of the Natural History Museum, and the chief librarian, are vested in the three chief principal trustees. This takes us back to the reign of William III. and the Cotton Library at Westminster. No doubt the then Archbishop, the then Lord Chancellor, and the then Speaker, both from propinquity and from their abilities and training, were quite the best men who could be found for this position of trust towards this library. Probably the present holders of these exalted positions—positions which they most worthily fill and which give two of them precedence after royalty in all Britain—are most fully endowed with the qualities which fit them to elect the senior staff for the library and for the collections of works of art and of antiquities at Bloomsbury. I doubt if the same eminent qualities enable them to deal equally satisfactorily with the higher posts in the Natural History Museum. If Parliament, or indeed any other body, were framing a scheme for the management of a great museum of science at the present time, I do not think it would occur to anyone that the holders of the exalted offices I have mentioned were specially fitted, either by the knowledge of the pressing scientific needs and problems of the moment or by their intimacy with the men of science of to-day, to be the most competent electoral body to choose keepers in geology, mineralogy, botany, and zoology. And, indeed, the existing arrangement has broken down. I do not know how long before Sir E. Ray Lankester's resignation of the joint posts of Director and Keeper in Zoology, in December, 1907, it became known to the trustees that that resignation was imminent, but I do know that it was talked about and written about months before that date. Yet after the resignation took effect one whole year elapsed before the trustees appointed a Keeper in Zoology; for twelve months there was no head of a department which contains collections unrivalled in the world. It took the trustees about six months longer to find a Director, and for about eighteen months the charge of this great museum of natural history was vested, under the trustees, in the Chief Librarian at Bloomsbury.

As Prof. Ronald Ross could testify, after scientific research has placed it within the power of man to exterminate so deadly a disease as malaria, the real fight begins; and the real fight is to persuade the authorities to adopt and enforce the measures which are offered them gratis. There is a case in point, if I am not misinformed, on this continent at the present time. It has been known since the time of the making of the St. Gothard Tunnel that lasting and often fatal disease is caused by a small intestinal worm, known as the tunnel-worm or hook-worm. Within the last few years Dr. Wardell Stiles has shown quite clearly that the unhappy condition of "poor white" of the Southern United States is due largely to their being affected by this hook-worm. Their bodies and their intellects are arrested in their development, and the adults amongst them are unable to understand the prophylactic measures he advocates, but the children could be taught if the proper organisation existed for teaching them. Many of the Southern States are friendly to the movement, and I know of no greater service that the central Government of the United States could confer upon the inhabitants of these southern States, in which, as is well known, President Taft takes the deepest interest, than that of detailing Dr. Stiles for several months a year to organise and control this movement. If this could be done, I believe—and I am here speaking of those things that I do know—the United States Government would confer on their own people a benefit as great as they conferred on other nations when they freed Havana of yellow fever and Panama of malaria.

In concluding this part of my address I wish to say as emphatically as I can that if science is to take its proper place in the polity of the nation we must endeavour to have men of scientific training, or at least of scientific sympathies, in the Government and also in the Government offices.

I cannot recollect the name of one single Minister trained in natural or physical science amongst the numerous members of His Majesty's Governments of the last thirty-five years. It is not so very long ago—I am glad to say that one of the actors of my little story is still with us—that Sir Joseph Hooker, then Director of the Royal Gardens at Kew, was walking through the grounds with Mr. Ayrton, President of the Board of Works, which in those days was the Government Department responsible for Kew.

They happened to run across Mr. Bentham, the great authority upon the classification of plants. Sir Joseph introduced him to the President, adding, "he works in our herbarium." "Dear me," said the President, "I hope you don't get your feet wet." Now I do not want for a moment to suggest that our present genial President of the Board of Works—whose official connection with Kew has been long severed—would not readily distinguish between an herbarium and an aquarium, but what I do wish to emphasise is that this ignorance of some of the most elementary details of scientific method exists in many of our rulers and in many of our permanent officials—not in all by any means; I know of some most notable exceptions—but in many. It is but human to distrust what we cannot understand, and it is this lack of understanding which is largely retarding progress at the present day.

III.

International Ocean Research.

As an example of international cooperation in scientific research I may take the investigations which have been going on for the last seven years in the Baltic Sea, in the North Sea, and in that greater Norwegian Sea which stretches from the western coast of Norway north to Spitsbergen and westward beyond Iceland and the Færöes. In this inquiry no fewer than ten nations—in fact, all those the shores of which touch these seas—have had a share —England, Scotland, Norway, Sweden, Finland, Russia, Germany, Denmark, Holland, and Belgium—and since most of these countries have a special steamer equipped for research and under the command of men trained in scientific methods, it has been possible to collect a mass of facts connected with the seas of Northern Europe such as has never been got together before for any similar area of the ocean.

The aim of those responsible for the scheme of work was to obtain as complete a survey as possible of the physical and biological conditions of the seas in question. They wanted to know the direction of ocean currents, both superficial and along the bottom; the variations in the degree of salinity of the water in time and in space; the nature of the sea-bottom, and whether this could be correlated with the fauna, sessile or moving, found upon it, and whether this fauna reacted on the prevalence or absence of food-fishes; the influence of depth, salinity, and temperature on the fauna; the seasonal variations and fluctuations of the small floating organisms often called the plankton; the life-history of our food-fishes, where and when they deposited their ova; what became of the ova; the distribution of the larval stages; the age at which the fish become mature, and their average length of life.

Then, again, it was hoped that much could be learned about the influence of man's activity on the sea. The relative depletion of the fish population caused by different modes of fishing; the intensity of trawling; how often does the trawl pass over the same ground in a given time? The question whether or no the seas are being over-fished, and, if so, what measures can be taken to lessen this evil, either by close time, limiting the size of fish captured, or by artificial fish-breeding. Many of these last-named problems concern the legislator as much as the man of science. The function of the latter is to provide facts upon which the administrator may act.

Such a vast task as was set out by the International Council in 1902 has necessitated an immense organisation. Some eight or ten steamers are employed making periodic voyages, under the direction of trained men of science. Enormous numbers of temperature-readings, investigations into the speed and direction of currents, and chemical analyses of sea-water have been recorded, and thousands of samples of the bottom, of the animals and plants living thereon, of fish in all stages, millions of fish ova, have been collected and accurately determined. To work up such an amount of material has occupied the attention of a large number of naturalists. Each country has at least one large laboratory devoted to this work, and their results are coordinated and generalised by the central bureau. The English part of the work was entrusted by the Lords of the Treasury to the Marine Biological Association, and has been carried out under the direction of Dr. E. J. Allen and Prof. Walter Garstang at our laboratories at Plymouth and Lowestoft.

Although all the ten countries are working upon what is, broadly speaking, a common plan, each has had its own special problems. In addition to carrying out the broad outlines of an international scheme, they have specialised along lines indicated by their own needs, and have attacked problems the solution of which affected their own special food supply. Thus Norway, where the old open fishing-boat is being replaced by the modern, decked trawler, has especially studied the cod and the saithe, the haddock and the herring, and has devoted much time and labour to the discovery of new fishing grounds, and has successfully done this along the Norse coast, in the Arctic circle, and on the banks between the Færöe Islands and Iceland. They have further established a trade in *Pandalus borealis*, allied to the prawns, which are taken in the deep waters off Norway, and are now to be bought in most fishmongers' shops in Great Britain.

In a similar way the Danes have tracked the eels as they leave the estuaries of the great rivers of Central Europe across the North Sea to the deep Atlantic off the West of Ireland, just beyond the 1000-fathom line. In these depths they spawn, and the resulting larval form, the Leptocephalus, long thought to be a separate genus, lives there for a while, until, gradually changing into an elver, it retraces by some mysterious instinct its parents' path across the ocean and regains the fresh-water rivers which those parents had left.

The English share of the investigation is limited to that part of the North Sea which lies south of the latitude of Berwick, and for the most part to the western half of these seas and to the English Channel; the latter, as we shall see, is a very important area. The work, so far as it has been specialised, deals, in the North Sea, largely with the plaice, with the food of fishes generally, and with the character of the deposits forming the sea-floor, with the creatures growing thereon. In the Channel the English worker is entirely responsible for the study of the hydrography of the water, which, entering the North Sea through the Straits of Dover, contributes greatly to its mass.

As a result of Prof. Garstang's investigations, an important spawning ground of the plaice has been located in the southern bight of the North Sea; the migration of both sexes has been traced to these grounds on the advent of the spawning season, and their return to their feeding grounds in the spring has been followed. During the spawning season it is usual to catch more males than females on the spawning grounds, possibly because at this time the female is inert and elusive, whilst the male is unusually active.

The course of the ova has been traced, chiefly by the Dutch investigators, as they drift towards the shallow fringe of coastal water, by far the greater number along the continental coast. Here the young fry grow up, and after attaining a certain size they leave the shallow coastal waters for the deeper seas off shore. Comparatively few of these, however, reach the feeding ground of the Dogger Bank, and Garstang has been able to show that by carrying the young plaice in steamers and transplanting them at the proper time on to this rich feeding ground, their rate of growth can be greatly accelerated and thus their market value largely increased, just as Dr. Petersen has done in the case of plaice on Thisted Bredning.

A few years ago there was no trustworthy method of determining the age of fish. Petersen's method of arranging the measurements of a large number of specimens in a scale according to size, when they resolved themselves into certain groups, which were considered to coincide with age-classes, has been superseded by the discovery of Reibisch, Heincke, and others, that many of the bones, the scales, and the otoliths of fishes show annual age-rings, like those found in the trunk of a tree or in the horns of cattle. By laboriously counting the rings on the otoliths of thousands of plaice, Dr. Wallace and others have been able to determine their rate of growth, and to show that some specimens attain the age of twenty-five and even twenty-nine years. Similar investigations have shown that the sexes have a different rate of growth. The age at maturity is found to differ in different regions, but in the majority of cases Wallace found that the males are sexually mature (four to five years) a year before the female is capable of spawning (five to six years). We can now correlate age with size and with weight.

The migrations of the plaice and of other fish and their rate of growth depend, amongst many other factors, upon their food supply. And the nature of the food of fishes has recently been re-investigated in the North Sea. I give some of Todd's results, which were made by the examination of some thousands of fish of thirty-one species. Of these I select three—the cod, the plaice, and the dab.

Percentages of stomachs containing various kinds of food.

Cod.

Size of fish in cm.	0–15	15–30	30–60	60+
Pisces ...	0 p.c.	11 p.c.	52 p.c.	67 p.c.
Mollusca ...	0	2	16	4
Crustacea ...	100	95	67	63
Polychæta ...	0	9	9	26

Plaice.

Size of fish in cm.	0–10	10–20	20–30	30+
Pisces ...	0 p.c.	1 p.c.	5 p.c.	5 p.c.
Mollusca ...	17	66	76	84
Crustacea ...	57	16	13	11
Polychæta ...	38	37	51	42
Echinoderma.	0	20	13	6

Dabs.

Size of fish in cm.	0–10	10–20	20–30	30+
Cœlenterata..	0 p.c.	18 p.c.	18 p.c.	20 p.c.
Echinoderma.	0	26	25	2
Polychæta ...	30	22	20	10
Crustacea ...	70	30	35	61
Mollusca ...	2	48	57	65

These tables show what, of course, was more or less known before, that as a rule the young fry live very largely, and in many cases solely, on crustacea. To a great extent the supply of suitable food dominates the movement of the young fry, for nowhere is the truth of the Frenchman's definition of life, "I eat, thou eatest, he eats," with its terrible correlative, "I am eaten, thou art eaten, he is eaten," more true than in the sea. Later in life the fishes' taste alters, and with increased size they can tackle animals the calcareous deposits of which would seem to render them highly indigestible.

Very careful investigations have been made, and are being made, by Mr. Borley and Mr. Todd as to the distribution of the fauna of the middle and southern parts of the North Sea, and its relation to the depth of water, the varying degree of salinity, and to the texture of the bottom deposits. These results, however, have not been published, but I may go so far as to say that the inquiry shows that within the area investigated the texture of the sea floor has, on the whole, more influence on the distribution of the invertebrates of the bottom fauna than has depth, and that depth in the area in question seems to have more influence than salinity.

With regard to the character of the bottom deposits, it has been found by Mr. Borley that off shore and on the gently shelving continental coast the sea bottom is of a uniform character over wide areas, though on the western side it is more patchy; and it has proved possible to divide the samples taken into some nineteen main types, each characteristic of one or more of the areas into which the region has been split up. Only one or two details of this laborious work can be mentioned. One is that the texture or degree of coarseness of the ground in various parts of the sea is such as to suggest that the distribution of the finer grades of material, the finer sands and silts, is greatly influenced by the joint action of currents and tides. It is, for instance, known that in the southern part of the North Sea the main direction of the bottom current is to the north and then to the east; and examination of the deposits shows a regular diminution in the proportion of the coarser sands, a regular increase in the proportion of finer material, as we proceed from the Straits of Dover in a north-easterly direction. A remarkable fact in this connection is the complete absence of silt from the sandy bottom west of the mouths of the great rivers Rhine and Maas. There can be no doubt that the presence of broad and shallow stretches of sand on the Continental, but not on the English, side of the North Sea is one of the factors which has determined the distribution of the small plaice, which on the Continental shores are so extraordinarily abundant, and on the English shores are relatively so scarce.

By means of bottles weighted with shot, so as to have about the same specific gravity as the surrounding sea water, Mr. G. P. Bidder has been able to trace slow currents moving over the bottom of the sea The bottles are closed, and contain a postcard in many languages offering a reward to whosoever returns the postcard, recording the latitude and longitude of the place it was trawled at, to our laboratory at Lowestoft. Attached to the neck of the bottle is a copper wire 1½ feet long. This wire trails along the bottom, the bottle itself floating about 1¼ feet above the level of the ground. Slowly as the bottles are swept along yet the distance they cover is sufficient to sharpen the free end of the wire to a needle point.

By these and by other methods it has been possible to trace the almost imperceptible but steady flow of waters along the bed of the sea. Without doubt these currents influence the distribution of the larval and young forms of all the creatures which live near the bottom, and especially influence the migration of food-fishes in their younger and less active stages, when they are swept helplessly along.

But these bottles have a double lesson to teach us: not only do they enable us to chart the slow streaming of the bottom water, but they give us to some extent a measure of the intensity of trawling in the North Sea. They have been re-fished in really surprising numbers. Commercial trawlers have re-taken them at the rate of 58 per cent. per annum. In one area these bottles cast upon the waters were re-taken, not after many days, but after very few. Out of 300, eighty-five were recovered in six weeks, and fifty out of 270 were trawled in five weeks, representing a local intensity of fishing which, if continued, would give us between 80 per cent. and 90 per cent. of recaptures in a year.

Marked fish which have been liberated and re-captured tell the same story of intensity of fishing.

The intensity of fishing as indicated by the percentage of re-captures within twelve months of liberation is shown by the following table[1]:—

Off shore	Percentage Fish under 25 cm.	Over 25 cm.
Dutch coast...	23·7	20·3
Deep water, Southern Bight	13·0	26·6
Leman Ground (liberated April and May)	18·7	17·4
Leman Ground (liberated December) ...	—	21·0
Horn Reef outer ground	33·3	23·0

Obviously, since some fish are known to have been captured but not returned to the laboratory, the method gives a minimum estimate.

By applying the same method to the marking experiments of other countries as well as our own, Garstang[2] gave the percentage recovered within twelve months of liberation of fish more than 25 cm. in length as from 4 per cent. on the Fisher Bank to 56 per cent. in the Skager Rak.

When we reflect on the chances of these marked fish dying or being eaten or losing their labels, it is surely a most remarkable fact, full of significance to the practical man, that in the North Sea marked fish of marketable size are recaptured at the rate of between 20 and 30 per cent. each year, and sometimes at a greater rate. It would seem that each square yard of the fishing grounds is swept by the trawl, not once, but again and again each year.

Mr. Borley has conducted a large series of experiments to determine the vitality of fish after they have been captured by both the beam and the otter-trawl. It was necessary to determine the degree of injury caused by the actual trawling, the raising of the trawl, and the subsequent exposure on deck. The larger fish of both sexes

[1] Garstang, "North Sea Fisheries Investigation Committee Southern Area," Report No. 1.

[2] "Provisional Report on the Natural History of the Plaice" (Committee B). *Procès verbaux*, vol. iii.

were capable of resisting the damage to a greater extent than those of smaller size, and the relative resistance of the two sexes varied at different sizes, the male showing a decline in the increase of its vigour as it approaches maturity. One factor which is very deleterious to the fish is the presence of jellyfish in the trawl; these either smother the fish or possibly sting them to death; at any rate, the mortality of the fish is enormously increased when medusæ are present in any numbers. The otter-trawl is also far more harmful than the beam-trawl, and exposure on deck to a hot sun is another constant source of death, one hour's such exposure in one series of experiments killing 99 per cent. of the smaller fish. In the ordinary commercial operation of trawling, whilst the fish are being sorted those that have no market value lie about on the deck of the vessel for at least an average period of one hour; hence it is extremely probable that when shovelled overboard practically all are dead or dying.

The work which has been done by our own special steamer has been supplemented by records carefully kept by certain selected captains of commercial trawlers, which sail from Grimsby or from Lowestoft. In this way the details of some 20,000 hauls have been examined, and their results tabulated by Miss Lee.

I have left myself no time to describe the important hydrographical investigations carried on by Mr. Mathews into salinity, temperature, &c., which show us the conflicting currents at the mouth of the English Channel and how the North Sea in its southern part is supplied with water from the Atlantic through the Channel. The curious ebb and flow of the Gulf Stream, its periodic welling up and subsidence, closely connected as they seem to be with the migrations of the herring, cod, and haddock shoals, is another most important matter of investigation.

Neither can I tell you in detail of the immense amount of work which is being done by the other countries which share in the international scheme, by the Scottish Fishery Board, the pioneer in Great Britain of this sort of research. To the west our Channel work is beginning to get into touch with the more recently established Irish Fishery Board, and with the work carried on under the direction of Prof. Herdman in the Irish seas.

The outcome of all this minute and continuous investigation will, in time, tell us whether or no the North Sea fisheries are being exploited in the most profitable way—a very important question for our country, for with a fishing fleet of 27,000 vessels, manned by 90,000 fishermen, who land 900,000 tons of fish a year, valued at 10,000,000*l.*, Great Britain takes 90 per cent. of what is caught in the North Sea. Some statistics indicate that there is a falling off. The steam trawlers in 1905 landed 25,000 tons of fish less than in 1904, and in 1904 there was a similar shortage on the total of 1903. And yet 1903 was a year in which some crisis took place; the growth of the haddocks and the number of young haddocks were far less than normal, the Norwegian cod fisheries sank to a minimum, the French statistics showed the same feature in their fisheries off Iceland. In 1903, however, there were unusually large numbers of small plaice. The polar ice-field pressed down south, and seals, cetacea, and arctic birds left their usual quarters, and came south in some cases so far as Shetland. The gigantic climatic changes indicated by the above undoubtedly disturbed for a time the rate of increase and the rate of growth of the fish population of the North Sea, but they soon returned to their normal state. Compared with such mighty influences the fishing activity of man seems almost negligible, and Dr. Hjort for one thinks that "the productiveness of fish" "may be regarded as independent of the interference or fisheries of man." I am not sure that this is so. Taking large areas and all fish into consideration, it may be true; especially it would seem to be so of some species, such as the herring, the saithe, and the cod; but in certain areas and with certain fish, such as the sole and the plaice, man's activity has undoubtedly decreased the number.

Although the researches of the last few years have immensely increased our knowledge of what is going on in the sea, they have, like an ever-widening circle, but increased the number of problems which await solution. It is earnestly to be hoped that the work may go on on at least its present basis. The business man, always on the outlook for a dividend, has sometimes complained that some of our inquiries do not seem to him practical, but he must have patience and faith. A few years ago no knowledge could seem so useless to the practical man, no research more futile than that which sought to distinguish between one species of a gnat or tick and another; yet to-day we know that this knowledge has rendered it possible to open up Africa and to cut the Panama Canal.

And here, if I may quote the words of the author of the Maccabees:

"And here will I make an end."

"And if I have done well, as is fitting the story, it is that which I desired; and if slenderly and meanly, it is that which I could attain unto. . . . And as wine mingled with water is pleasant and delighteth the taste: even so speech, finely framed, delighteth the ears of them that read the story."

"And here shall be an end."

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY COLONEL SIR DUNCAN JOHNSTON, K.C.M.G., C.B., R.E., F.R.G.S., F.G.S., PRESIDENT OF THE SECTION.

It has been usual for Presidents of this Section to make some allusion in their addresses to the principal matters of geographical interest which have occurred during the preceding year, and I propose to follow this custom before proceeding with the rest of my address, which would hardly be complete without some allusion to the great geographical achievements of the past year.

I doubt if there has ever been a year in which more important additions to geographical knowledge have been made than those resulting from the journeys of Dr. Sven Hedin, Dr. Stein and Lieut. Shackleton.

Dr. Sven Hedin's previous explorations had deservedly gained him such a high reputation as an explorer that it seemed almost impossible for him to increase it, yet his recent expedition in Tibet, extending over two years, has enhanced his already great reputation.

Refused permission to enter Tibet from India, he was not to be deterred. Travelling round to Leh and making that place his starting point, he entered Tibet and traversed in various directions a considerable tract, previously unexplored, of that country, making a good reconnaissance survey of the country he passed through.

A large part of his journey was through a bleak and inhospitable region, where he encountered intense cold and very great privations. At one time he went for eighty-three days without meeting a living soul, and the cold and hardships were such that out of ninety-seven ponies and mules with which he started only six came through. Yet in the following year, in the depth of winter, Dr. Sven Hedin again traversed this terrible country. In doing so he ran imminent risk of starvation, as his last sheep was killed a considerable time before he got through to country where he could obtain fresh supplies.

Dr. Sven Hedin's tact and resource were as great as his fortitude and courage. He made friends wherever he went, and, although the Tibetan Government sent orders over and over again that he should be turned back, he succeeded in spending two years in exploring the country, maintaining the most friendly relations with the Government officials and others whom he met. Besides exploring and surveying a large tract of previously unexplored country, he investigated the sources of the Brahmaputra, the Indus, and the Sutlej, and in the course of his journeys he accumulated a mass of geographical and other scientific information.

Next comes Dr. Stein's expedition to Chinese Turkestan, by which he has made a most noteworthy contribution to geographical knowledge and antiquarian research.

Dr. Stein, accompanied by that capable surveyor Rai Ram Singh, who was later on relieved by that equally skilful and energetic surveyor Rai Sahib Lal Singh, travelled from India *viâ* Chitral and Kashgar. He commenced survey work in the eastern part of the Mustagh-ata range, and carried it along the Kun Lun Mountains, skirting the southern side of the Takla Makan Desert and the Lob Nor Desert to Suchou and Kan-chou. He surveyed a large area of the mountainous region lying westward of Kan-chou, then crossing the desert from Anshi to Hami he returned north of the Tarim River, skirting the southern slopes of the Tian Shan range, to Kashgar. During this very long journey Dr. Stein came across the ancient frontier wall, built about the second century B.C. He traced it west of Suchou, until lost in the desert, for some 250 miles, and he made various incursions into and across the desert, making discoveries of the greatest antiquarian interest.

After his return to Kashgar he surveyed the last unexplored portion of the Kun Lun Mountains and the country containing the sources of the Khotan or Yurungkash River, which proved to be flanked on the south by a magnificent range of snowy peaks rising to more than 23,000 feet; thence passing the sources of the Keriya River he skirted the southern slopes of this snowy range and finished by connecting this survey with that to the north of this range. The privations and hardships undergone by Dr. Stein and his party were very great, and, just as he completed his last bit of survey, he was unfortunate enough to get his foot badly frost-bitten, and had to hasten to more civilised parts for medical treatment.

Dr. Stein, during his expedition, displayed all the best qualities of an explorer—enthusiasm, determination, skill, and tact. The modest account he has so far given us of his travels, which gives a mere outline of his work, shows that the geographical as well as the archæological results of his expedition are of the greatest value.

The last completed exploration I propose to mention is Lieut. Shackleton's great journey in the Antarctic Circle, which has raised him to a high position among the gallant explorers of the Polar regions.

Lieut. Shackleton personally arranged and supervised all arrangements for the expedition, his experience in the British Antarctic expedition under Captain Scott standing him in good stead.

Having landed in McMurdo Sound, a party consisting of Lieut. Adams, Prof. David, and others ascended Mount Erebus, which is more than 13,000 feet high, all above snow-level.

Later on Lieut. Shackleton and a sledge-party set off southward, and after an arduous journey succeeded in reaching 88° 33′ south latitude, more than six degrees nearer the Pole than any previous explorer. His party travelled altogether about 1700 miles, including relays, in 126 days, a splendid performance in a rough and difficult country under very trying climatic conditions. Soon after passing 83° 33′ south latitude they lost their last pony, and from this point they had to drag their sledges themselves, although their journey involved the ascent of a plateau 10,000 feet high. They only turned back when their diminishing stock of provisions rendered it imperatively necessary to do so. They were for a considerable time on short rations, and found several times that they had expended their food supplies before reaching their next depôt. Had they missed one of these depôts—no unlikely contingency in such a country—they must have perished by starvation. Altogether the sledge journey was a great feat of pluck and endurance.

Lastly, Lieut. Shackleton's colleague, Prof. David, with others, made a sledge journey to the north-west, reaching the South Magnetic Pole. A good deal of triangulation was carried out, many geological specimens were collected and much scientific information was obtained.

Whether we consider Lieut. Shackleton's skill and energy in organising the expedition, the courage and determination displayed in carrying it out, or the results obtained, his expedition will stand out as one of the greatest of the many great efforts to reach the Poles, and as a British expedition it is one that specially appeals to us.

At first sight it would seem that these great journeys belie the opinion so often expressed of late years that the days of the explorer are numbered, and that in future geographers will have to deal with surveys rather than exploration; but, in fact, these splendid achievements only strengthen this opinion. These explorers have considerably reduced the comparatively small area still unexplored, and other expeditions are helping to diminish the unexplored area.

Among those which are in progress I may mention the following:—Colonel Kozlof's expedition to Mongolia, which has already visited Kuku Nor and which is exploring the upper course of the Huang Ho and other parts of Mongolia. Lieut. Boyd Alexander is exploring in West Africa. The Duke of the Abruzzi is investigating part of the mountainous region across our Indian frontier; Dr. Longstaff is exploring another part of that mountain system; Captain R. E. Peary, U.S.A., and Captain E. Mikkelsen are leading expeditions in different parts of the Arctic regions, and M. Charcot is exploring in the Antarctic Circle. Lastly, an important British expedition will start before long to explore part of the Island of New Guinea, one of the largest still unexplored land areas. There are other expeditions, either in progress or projected, too numerous to mention.

The best modern explorers are not now content with exploration or even with a rough route traverse and an occasional observation for latitude; they either themselves make careful reconnaissance surveys of the country adjoining their route or they are accompanied by trained surveyors, who make such surveys.

Again, every year the area surveyed on correct scientific principles is extended. The interesting address of my predecessor, Major Hills, will have told you what is being done in this way in the British Crown colonies. In the British self-governing colonies and in the colonies and dependencies of other Powers the area of regular survey is being continually extended, and in more remote regions surveys are being carried out by Boundary Commissions or for railways or other purposes. Along with the increasing appreciation of the value of geography which has taken place of late years, there has been an increasing recognition of the need for regular surveys, and it is probable that the next generation will find that not only is no considerable area of the earth's surface unexplored, but that the area not yet surveyed at least geographically, or for which a regular survey has not been projected, is getting limited.

I propose in the rest of my address to deal with the regular survey and mapping of new areas, and to discuss various questions connected therewith; if I am right in believing that large areas will be regularly surveyed in the near future, such questions merit careful consideration. I shall state on these points the practice of some of the great national surveys, because their experience seems the best guide for future work; but I recognise that methods suitable for rich and populous countries, such as Germany, France, or Great Britain, may be too costly for many countries and provinces the survey of which has still to be made, and mention will be made of less expensive methods which are likely to be much in demand in future.

It would be difficult to say anything new on the subject I propose to deal with, and I lay no claim to do so, still less do I wish to dogmatise as to the best methods. When I express opinions I shall also state the practice of some of the principal surveys of the world, and my hearers having weighed the matter can accept my opinions or not according to their judgment. In either case my object will have been attained if careful consideration is given to the points raised.

Maps may be roughly divided into three classes:—

(1) Geographical maps—*i.e.* those on very small scales.

(2) Topographical maps. The dividing line between these and geographical maps is not very clearly defined. For the purpose of this address maps between the scales of 4 miles to the inch and $\frac{1}{25000}$ scale will be considered as topographical.

(3) Cadastral maps—*i.e.* maps on large scales mainly for property purposes.

As the time at my disposal will not admit of my discussing all three classes of maps, and as I have on a previous occasion read a paper to this Association on "Cadastral Surveying," I propose to limit my remarks to topographical surveys and maps.

In most of the older countries topographical surveys have originally been made to meet military needs, and as a rule they are carried out under military supervision.

In order that they may be useful in case of war such surveys must have been made before war breaks out. The use, however, of topographical maps is not limited to military purposes; on the contrary, they have invariably proved of great value for civil requirements. In one respect they are more useful for civil than for military purposes, as a state of war occurs rarely, and hence while the maps are only occasionally used in connection with war, they are constantly used in connection with civil administration and with public and private business of all kinds. The topographical maps of the Ordnance Survey, prepared originally solely for military requirements, have proved extremely useful for civil purposes. Directly or indirectly all the numerous maps prepared by the trade in Great Britain for civil use are based on them. I believe the experience of all other countries is similar to that of the Ordnance Survey. In most countries in which land is of any value, a cadastral survey for land transfer purposes is needed, as well as a topographical survey. In some cases indeed, the need for a property survey has first made itself felt; thus in the Transvaal and in the Cape Colony, neither of which yet has a topographical survey, there has for many years been a Government Survey Department for making property surveys. The question arises whether there should be two separate surveys, one for topographical and one for cadastral maps, or whether there should be only one survey, the topographical maps being prepared by reducing the cadastral survey. Incidentally the further question arises whether, if two separate surveys are made, they should be under one head.

In most countries—the Ordnance Survey of the United Kingdom being an exception—not only are entirely separate surveys made for these two classes of maps, but these surveys are generally under different departments. In some cases the cadastral surveys are isolated farm surveys, showing little detail except property boundaries. Such surveys would, of course, not answer as a basis for topographical maps. In other cases, however, the cadastral surveys show all necessary detail except ground forms, which can be added by a separate survey. The only cadastral survey, so far as I know, which shows ground forms is the Ordnance Survey, the 6-inch maps of which are contoured.

A difficulty in the way of utilising the cadastral survey for the smaller scale maps arises from the fact that a cadastral survey is, from its large size, much slower than a topographical survey. It is often found advisable to take up the survey of the former somewhat irregularly, while it is important for the proper progress of the latter that it should be taken up regularly and methodically. The Ordnance Survey 1-inch map has, since 1824, not had a separate survey of its own, but has been based on the cadastral survey. Ordnance Survey experience has shown that the delays in completing the topographical map, due to this course, have been much greater than one would have expected, and that there are grave disadvantages in having the scale of survey very much larger than that of the finished map. These objections do not apply, or can be overcome, if the cadastral survey of any locality is completed before the topographical map is taken up. This is a condition not likely to be often fulfilled in the case of future topographical surveys. I advocate therefore that, following the general practice, there should be entirely separate topographical and cadastral surveys. I should advocate this even where it is essential to keep the expense as low as possible. More economy would probably result from the adoption of a fairly small scale for the topographical map, from curtailing the small detail to be shown on it, and from showing on the cadastral maps only such detail as is needed for property purposes, than would result from making one survey do for both classes of maps.

On the other hand I consider that, even when separate surveys are made for the two classes of maps, it is advantageous that both should be made under the same head. The more usual course is, however, to have the two surveys independent, and in some cases local circumstances may make the course I advocate inadvisable.

Triangulation.

The first preliminary to any survey should be a triangulation. It is the most satisfactory course, and the best economy in the long run, to carry out with the greatest accuracy possible the primary triangulation on which the survey is to be based. Such a triangulation will remain good for a very long period. For example, the primary triangulation of the Ordnance Survey was commenced in 1791; while some doubts have been expressed whether it is accurate enough to combine with other more recent work for the purpose of investigating the figure of the earth, no one has questioned that even the earliest part of this triangulation is amply accurate enough for map-making purposes.

On the other hand I do not advocate carrying out a primary triangulation until arrangements have been made for basing a survey on it. In South Africa an excellent and very accurate primary triangulation has been carried out. This triangulation was undertaken largely no doubt for scientific purposes. While answering its purpose in that respect it has so far had no surveys of any great extent based on it. An accurate triangulation is now a much quicker and less expensive operation than it used to be. The introduction of Invar tapes and wires has largely expedited and simplified the accurate measurement of base lines, while the improvements effected in theodolites enable equal or greater accuracy to be obtained with the comparatively small and handy instruments now made than could be got formerly with large and cumbrous instruments, such as the 36-inch theodolites, with which most of the primary triangulation of Great Britain and Ireland was carried out. Unless observations are rendered difficult by numerous buildings, by trees or by a hazy or smoky atmosphere, a good primary triangulation should not now be very expensive. It is usual to base on the primary triangulation a minor triangulation of several orders, the object being to have an accurate framework of trigonometrical points on which to base the survey. If it is important to keep the expense low, the trigonometrical points may be rather far apart, intermediate points being fixed by plane table; but it should be remembered that it is the truest economy to make the best triangulation which funds admit of. In forests or in wooded and rather flat country, where triangulation would be very expensive, lines of traverse made with every possible accuracy, and starting and closing on trigonometrical points, may be used instead of minor triangulation.

Detail Survey.

Provided the detail survey is based on triangulation, it may be made by any recognised method. Plane tabling is now almost universally resorted to, and is probably as cheap and convenient as any other method. The vertical heights of the trigonometrical points will have been fixed by vertical angles with reference to some datum. The height of intermediate points can be fixed by clinometer lines, especially down spurs and valleys, and even by aneroid, and from these heights the contour lines can be sketched in. Altitudes can be more accurately fixed by spirit-levelling, but this is an expensive method not likely to be much used in the case of topographical surveys. It is possible that in exceptional cases photographic surveying may be resorted to with advantage, and undoubtedly photographic methods sometimes enable work to be done which would not otherwise be feasible. The photographic method suggested by Captain F. V. Thompson, R.E., is an advance on previous methods. In Canada, I understand that a good deal of photographic surveying has been done, and presumably the conditions in Canada have been found suitable for this method. It has been little used elsewhere.

Scale of Map.

The next point for consideration is the scale on which the map is to be published, and it is an important one. Speaking generally, the cost increases with the scale, and cost is therefore one of the main determining considerations. The physical and artificial character of the country, the amount of detail it may be decided to show on the map, the method adopted for representing hills and other detail, and the method of reproduction to be used, all affect the question.

Clearness and legibility are among the first essentials of a good map, and it is desirable that the scale should be such that all detail it may be decided to show on the map can be inserted without overcrowding, or conversely, if the scale is fixed, the amount of detail and method of showing it should be such as to avoid the common fault of overcrowding the map.

In populous countries, such as Belgium, France, and Germany, where buildings, roads, railways, &c., are numerous, a larger scale is, *caeteris paribus*, desirable, than in less populous countries.

All important detail such as roads, railways, canals, forests, woods, &c., should appear on the map, as should the more important names, but it is a matter for consideration how far minor detail such as orchards, marshes, rough pasture, state of cultivation, &c., should be inserted on the map, and to what extent the less important names should be omitted.

In hilly country hachures and contours, especially if in black, tend to obscure the detail and names, and the smaller the scale the greater this tendency.

Methods of reproduction will be dealt with later, but I may here say that more detail and names can be shown clearly on a given scale if the map is engraved on copper than if reproduced in any other way. The scales adopted by different countries vary very much—I give below the scales adopted by some of the principal surveys.

$\frac{1}{25000}$ scale—Switzerland (the more populous parts), Prussia, Baden, Saxony, Bavaria, and Würtemberg (these German maps, although called maps of position, are practically topographical).

$\frac{1}{40000}$ scale—Belgium and Denmark.

$\frac{1}{50000}$ scale—France (the new topographical map), Algeria, Tunis, Holland, Japan, Spain, Switzerland (the less populous parts).

$\frac{1}{62500}$ scale—the United States (the more populous parts).

$\frac{1}{63360}$ scale (1 inch to a mile)—Great Britain and Ireland, and Canada.

$\frac{1}{75000}$ scale—the Austrian Empire.

$\frac{1}{80000}$ scale—the old staff map of France.

$\frac{1}{100000}$ scale—the German Empire, Italy, Norway, Portugal, Sweden, and Switzerland (Dufour atlas).

$\frac{1}{125000}$ scale—the United States (the less populous parts).

$\frac{1}{126000}$ scale—Russia.

$\frac{1}{250000}$ scale—the United States (barren districts).

The introduction of cycles, motors, and other rapid means of locomotion has led to a demand for a scale which will show a considerable tract of country on a sheet of moderate size. If the standard map is already on rather a large scale, this demand is best met by publishing a reduction of the standard map. This course is followed by Great Britain and Ireland and by Canada, the 1-inch map of which is reduced to and published on the ½-inch scale; but if only one scale is used a compromise must be arrived at which will meet the reasonable requirements of rapid locomotion, as well as the other essentials of a topographical map.

If I may venture an opinion in a matter in which practice varies so much, it is that for countries using British measures in which, owing to dense population, the detail is close the 1-inch scale ($\frac{1}{63360}$) is a very good one, and that for more open parts the ½-inch scale may with advantage be adopted. For countries using metrical measures I should advocate $\frac{1}{62500}$ and $\frac{1}{125000}$ respectively. These scales do not differ largely from those adopted by most of the principal countries, the majority of which use scales between $\frac{1}{50000}$ and $\frac{1}{100000}$ for fairly close countries.

Where it is important to keep the cost down I should advocate a half-inch to the mile or a $\frac{1}{125000}$ scale. All except the most closely populated country can be shown clearly on such scales provided the maps do not show too many names or too much small detail.

The United States have scales of $\frac{1}{62500}$, $\frac{1}{125000}$, and $\frac{1}{250000}$, the general closeness of detail in any area determining which of these three scales is adopted. This arrangement is a good one, and would be still better if the areas published on the $\frac{1}{62500}$ scale were also reduced to and published on the $\frac{1}{125000}$ scale, and if the whole country were published on the $\frac{1}{250000}$ scale. The principle here advocated of having each scale so far as possible complete for the whole country has been carried out by Great Britain, where the whole country, except some uncultivated areas, is published on the 25-inch ($\frac{1}{2500}$) scale, and the whole country on the 6-inch, the 1-inch, the ½-inch, the ¼-inch, and other smaller scales.

Scale of Field Survey.

It is usual to make the field survey for small scale maps on a larger scale than that on which the map is to be published with the view of securing greater accuracy of detail, but this should not be overdone. If the field survey is on too large a scale it entails needless expense, also when the surveyor is working on too large a scale he is apt not to realise the effect of reduction on his survey, and is likely to survey so much detail as to overcrowd the map, thus increasing the cost of the work and injuring the map.

When the map is reproduced by photographic methods the fair drawing is usually on a larger scale than the finished map, so as to get finer results on reduction; but in this case also, for somewhat similar reasons to those stated above, there are limits to the amount of reduction which can be made with advantage.

In these respects the practice of different countries varies considerably.

In Austria the field survey is on the $\frac{1}{25000}$ scale; this is reduced to and drawn on the $\frac{1}{60000}$ scale, and this drawing is reproduced by heliogravure on the $\frac{1}{75000}$ scale.

In France the field survey is on the $\frac{1}{10000}$ or $\frac{1}{20000}$ scale. The survey is reduced to and drawn on the $\frac{1}{40000}$ scale. In Algeria and Tunis, both field survey and drawing are on the $\frac{1}{40000}$ scale. In all cases the French maps are now reproduced by heliogravure on the $\frac{1}{50000}$ scale from the $\frac{1}{40000}$-scale drawings.

In Germany the field survey is on the $\frac{1}{25000}$ scale. This is reduced to the $\frac{1}{100000}$, on which scale the maps are engraved on copper.

In Great Britain the 1-inch map is based on the 25-inch and 6-inch survey. These were reduced, and a fair drawing was made on the 2-inch scale in a manner suitable for reduction to the 1-inch scale—*i.e.* the detail lettering, &c., were drawn so that when reduced to the 1-inch scale they should be in proper proportion. This drawing was reduced and printed by heliozincography on the 1-inch scale, and from these prints was engraved on copper.

In America the field surveys are on the scales of $\frac{1}{45000}$, $\frac{1}{90000}$, and $\frac{1}{192000}$ for the $\frac{1}{62500}$, the $\frac{1}{125000}$, and the $\frac{1}{250000}$-scale maps respectively. The drawings, on the same scale as the field survey, are reduced by photography and engraved on copper.

I consider that the best results are obtained when the field survey is made on double the scale of the finished map; that if reproduction is to be by engraving, the fair drawing should be on the same scale as the finished map; that if, on the other hand, reproduction is to be by photographic methods, the fair drawing should be on the same scale as the survey, *i.e.* double that of the finished map. The reduction I advocate should conduce to accuracy of detail and, if reproduced photographically, to fineness of detail, while it is not so great that the surveyor and draughtsman should be unable to realise the effect of reduction.

Detail.

The need of considering the amount of detail, &c., to be shown is not always sufficiently realised. The way in which detail is to be represented also needs consideration, as on small scale maps much detail has to be represented conventionally.

Railways have to be shown conventionally, and should be so marked that they catch the eye without being too heavy.

Roads also should be clearly marked. Where different classes of roads exist they should be distinctively shown, main roads being more prominent than others. It is important to know what roads are fit for fast wheeled traffic in all weathers, and which are fit only for slow traffic. The exact classification of roads must depend on the conditions obtaining in the country. The most elaborate classification is that shown on the French maps, and next that shown on the maps of Great Britain. Provided that important distinctions are represented, the simpler the classification the better.

Forests, woods, marshes, and in some cases pasture, rough pasture, orchards, vineyards, gardens, &c., are shown by conventional signs. While forests, woods, and marshes should certainly be distinguished on the maps, I incline to the opinion that the state of cultivation is better omitted, and that the less small detail shown the better. Such small detail increases the cost and often overcrowds the map. The German $\frac{1}{100000}$ scale shows much small detail, and although the maps are beautifully and delicately engraved on copper, the detail is rather crowded on some sheets. The French Carte Vicinale is, in my opinion, rather crowded with names.

The most difficult question, and that on which opinions differ most, is the method of representing ground forms. Methods which answer well on steep ground are less satisfactory on gentle slopes, and *vice versâ*, and each method is open to some objection.

Ground forms may be indicated by contours, hill shading in stipple, vertical hachures, horizontal hachures, the layer system, or by a combination of some of these.

Ground forms are represented by contours on the $\frac{1}{25000}$-scale maps of the German States, the Swiss Siegfried Atlas, the maps of the United States, the 1-inch map of Canada, the $\frac{1}{40000}$-scale map of Denmark, and the maps of Japan. Where the slopes are steep the contours give almost the effect of hill-shading. Some of these maps give a very good representation of the ground, the best being those in which the contours are in colour.

Hill features are shown by stipple shading on the French Carte Vicinale and the Ordnance Survey four-mile map. In mountainous country stipple shading gives a good pictorial representation of the ground, but it fails in flatter country, and it is often difficult to tell from it which way slopes run.

The Swiss Dufour Atlas ($\frac{1}{100000}$ scale) is a good example of vertical hachuring, as are some of the German $\frac{1}{100000}$-scale maps. Vertical hachures are also used on the Austrian and Swedish maps, and in conjunction with contours on the maps of several other countries.

Vertical hachures when well executed give an artistic and graphic representation of the hills. In the Swiss and British maps the pictorial effect is enhanced by assuming a light from the left-hand top corner. In steep ground, especially when the hachures are in black, these are apt to obscure detail and names. I think hachures are better when printed in colour, but many will disagree with me on this point.

Horizontal hachuring, while having some advantages, is less effective and is little used.

The system generally known as the layer system has been used in Great Britain by the well-known Scotch firm of J. Bartholomew and Co., has recently been adopted by the Ordnance Survey for its $\frac{1}{2}$-inch maps, and is used in the $\frac{1}{2}$-inch maps of Canada. It consists in indicating by various shades of colour the area lying between certain contours; thus one shade may be given to all ground below the 50-feet contour, another shade to ground between the 50-feet and 100-feet contour, and so on. This system gives a general indication of ground form and enables the contour lines to be followed more easily. Its shades of colour enable the eye to pick out more easily all land lying at about the same level. It is most effective in ground with a small range of vertical height, as the vertical depth of layers can then be small and the distinction in colour between successive layers marked. In hilly ground the depth of the layer must be increased, which means that many ground features are ignored on the map, or the number of layers on the map must be large, in which case the distinction in shade between successive layers will be less marked. This method is popular in Great Britain, and enables those who are not versed in reading contours and hachures to realise something of the nature of the ground forms.

A combination of these methods has been used as follows:—

France on her $\frac{1}{50000}$-scale maps shows ground forms by contour lines and stipple shading. This gives a very fair representation of the ground, but where the contours are very close together the effect of the coloured contours on the stipple is not pleasant. Nor does the stipple always look well when it falls on colour.

The German coloured $\frac{1}{100000}$-scale map, the Italian $\frac{1}{100000}$, and the British 1-inch show both contours and vertical hachures.

The Norwegian $\frac{1}{100000}$-scale map shows the features by contours, vertical hachures and shading.

The new British $\frac{1}{2}$-inch scale map has both contours, layers and stipple shading.

Opinions differ so much on this subject, and there is so much to be said for and against each method, that I will confine myself to the opinion that contours reasonably close together should form the principal feature of any method of representing ground forms; that contours by themselves give a very fair representation of the ground; that vertical hachures, if printed so as not to obscure the detail and names, or stipple shading when there is not too much colour on the maps, increase the pictorial effect and are useful additions to contours; that ground forms should preferably be in colour, and that where hachures or stipple are used as well as contours both should be in the same colour.

The German coloured $\frac{1}{100000}$-scale map (brown hachures and contours), the British 1-inch scale copper-plate printed map (brown hachures and black contours), the British 1-inch coloured map (brown hachures and red contours), and the French $\frac{1}{50000}$-scale (grey stipple and brown contours), all give a good representation of the ground, and there are other maps which might be named almost, if not quite, as good.

Vertical Interval of Contours.

The vertical interval between contours should depend partly on the scale, partly on the steepness of the ground. Practice varies considerably in this matter.

The $\frac{1}{25000}$-scale maps of Switzerland and of Germany, except Prussia, are contoured at 10-metre intervals.

The $\frac{1}{50000}$-scale maps of France are contoured at 10-metre intervals.

The $\frac{1}{50000}$-scale maps of Japan and Spain are contoured at 20-metre intervals.

On the Swiss $\frac{1}{50000}$ scale contours are 30 metres apart.

On the United States $\frac{1}{62500}$ scale the contour interval varies from 20 to 100 feet.

On the British 1-inch map there are contours at 50 feet, at every 100 feet up to 1000 feet, and thence at 250-feet intervals.

On the Canadian 1-inch and $\frac{1}{2}$-inch maps the contour interval is only 25 feet, but the sheets published have been in ground with only moderate elevations.

On the German $\frac{1}{100000}$-scale the contour interval is 50 metres.

I consider that if the contours are printed in colour the vertical interval may with advantage be such that on steep ground the contours are reasonably close together, every fourth or fifth contour being printed heavier so as to be more easily followed. If the contours are in black they cannot with advantage be so close.

It is, in my opinion, best if the contour interval is uniform all over a country. Failing this, it seems desirable that it should be uniform over considerable areas and at least throughout a sheet; but this view is not universally held. I do not like the varying interval adopted by the Ordnance Survey. The contours on the Ordnance Survey maps are surveyed with great accuracy and at great expense. For topographical maps much cheaper and more rapid methods will suffice.

Cartography.

I have, with a view to clearness, kept the question of the method of reproduction separate, but it has a bearing on some of the points already considered. Thus the fine engraving of the German $\frac{1}{100000}$-scale map enables an amount of small detail and ornament to be shown on that map which could not have been clearly shown if any other method of reproduction had been used.

The older maps were generally engraved on copper, or sometimes on stone, and printed in black and white. Subsequently photographic methods, such as the photogravure of the Austrian and the more recent $\frac{1}{50000}$-scale French maps, were used, and colour printing is now largely resorted to.

In some cases the colour-plates are prepared by engraving on copper, stone, or zinc. The maps of the United States and Switzerland are engraved on copper. In other cases, for instance, the 1-inch Ordnance Survey, colour-plates are prepared on stone by transfers and offsets from the engraved copper plate. In other cases—*e.g.* the $\frac{1}{80000}$-scale map of France—the colour-plates are prepared by photographic methods.

For clearness, delicacy of outline, and artistic effect nothing equals engraving on copper. It forms also the best basis for colour-printing. Unfortunately it is very slow and costly.

Engraving on stone is quicker and less expensive than copper engraving. It is inferior in delicacy to the latter, but some of the best stone engraving is very good.

Photographic methods are the most rapid and the cheapest, and with care give very fair results. As good examples I may quote the $\frac{1}{75000}$-scale maps of Austria, prepared by heliogravure, and the 6-inch maps of the Ordnance Survey, prepared by heliozincography, both black and white maps.

Of colour-printed maps I may instance the new $\frac{1}{50000}$-scale map of France prepared by heliogravure, and the $\frac{1}{2}$-inch Ordnance Survey map hitherto prepared by photo-etching, although I understand that in future the outline will be engraved on copper.

When rapid reproduction and moderate cost are desired I do not hesitate to recommend photographic methods which, although not so good as engraving, give, when carefully executed, reasonably good results.

Opinions differ as to the extent to which colour should be used, the modern tendency being to use it very freely. I can hardly be accused of prejudice against colour, as during my tenure of office at the Ordnance Survey colour-printing was largely developed, but I think it is often overdone. I consider that a moderate amount of colour is a great improvement to a map. Ground forms, however indicated, can, in my opinion, be better shown by colour than in black; it is advantageous also to distinguish water by colour, to give prominence to main roads by colouring them, and to colour woods and forests, but I do not advocate going much beyond this. It is difficult to choose colours which are suitable, distinctive, and harmonious, and the more numerous the colours used the greater the difficulty of doing so.

Colour-printing introduces possible sources of error. Colour maps are based on a drawing on which all detail to appear on the map is shown. A plate is prepared for each colour on which there should be only such detail as shall be printed in its particular colour. In preparing this plate there is a risk that detail which should appear may be omitted, or that detail be inserted which should be on another plate, or that the detail may be slightly out of position. Again, owing to change of temperature and to the varying amount of moisture in the air, paper contracts or expands. Registration can rarely be mathematically correct, and with every care may sometimes be appreciably out. While with care errors such as I have indicated can be minimised so as not appreciably to affect the map, it is difficult to ensure that they should be altogether absent.

To recapitulate my views, I advocate for a topographical map a scale between $\frac{1}{62500}$ and $\frac{1}{126720}$ ($\frac{1}{2}$ inch to a mile), according to circumstances. The scale of survey to be double that of the finished map; ground forms to be shown by contours reasonably close together, the exact interval depending on the scale of the map and the nature of the country, also, if funds are available, by vertical hachures; both contours and hachures, if shown, to be in colour, the same colour being used for both. If considerations of time and cost do not admit of reproduction by engraving on copper, the map to be reproduced by some photographic method and printed in not more than five colours. I put forward these opinions rather as a basis for consideration than as having special weight in themselves. With the increasing recognition of the importance of geography an increasing demand for maps is sure to come, and good maps can only be satisfactorily designed after considering the points here discussed.

It is not yet, I think, generally recognised that a really good topographical map, based on triangulation, may be produced on a scale of about $\frac{1}{2}$ inch to the mile at very moderate expense if unimportant detail is left out and survey and reproduction carried out as economically as possible. Such a survey has recently been carried out in the Orange River Colony, a country mainly agricultural with generally poor land. There must be few parts, other than barren and mountainous regions, under settled government where such a survey would not be of value. I believe that in future still further economy in surveying and mapping will be attained, and this will stimulate the undertaking of fresh surveys.

Meeting, as we are privileged to do this year, in Canada, I should like to say a few words on the surveying and mapping of the Dominion. Until recently the only maps published have been on very small scales and have shown no ground forms. During the last few years, however, a regular topographical survey has been undertaken by the Militia Department. I am glad that for this topographical survey the scales of 1 inch and $\frac{1}{2}$ inch to the mile, both standard scales in Great Britain and Ireland, have been adopted. They are, in my opinion, suitable scales for Canada, and it is to be hoped that for any new mapping within the British Empire these or similar scales may be adopted as they have been in many parts. Uniformity in scales is very desirable.

Without committing myself to praise in every respect of the maps prepared by the Militia Department, I may say that they appear to me excellent, well-executed maps. Not many sheets have yet been issued, and they are probably not yet well known even in Canada; but I have little doubt that when known their value will be appreciated, and that the area mapped will be rapidly extended. There are no doubt large areas in Canada for which a smaller scale than 1 inch will suffice, but there can be few, except waste and barren regions, for which maps on some scale will not be needed. To a country like Canada, which has made wonderful progress already, and which has a great future before it, adequate mapping must be of importance, specially so in view of the vast area of the country. I have misread the character of the Canadian people if they will be content with any except first-rate maps for the whole settled area of the Dominion.

I should like to have said a few words on the aid which good maps give to geographical education, but my address is already too long. I will only say that while good maps and geographical education are of use to all countries, they are of special value to the British Empire, the different parts of which are geographically so scattered, but which are so closely bound together by common ties of kinship, interest, sentiment, and loyalty.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE issues of the *Lancet* for August 28 and *British Medical Journal* for September 4 are "educational" numbers, and give full information for those desirous of entering the medical profession and of the various services with medical officers attached.

A NEW mathematical professorship has been created, we learn from the *Revue scientifique*, in the University of Paris with the title of the Chair of the Theory of Functions. Prof. E. Borel has been appointed to the new post, which brings the number of mathematical professors in the University up to twelve.

A CIRCULAR from Principal Miers announces that an Appointments Board has been constituted by the University of London. The terms of reference to the Board are "to assist graduates and students of the University in obtaining appointments, and to coordinate and supplement the work done by the schools and institutions of the University with this object." The aim is to encourage the selection of university men for all posts in the work of which the possession of a university training on scientific methods is an advantage. The Board wishes to assist graduates to find employment, and to assist employers to find, in the university ranks, suitable men for vacancies.

AMONG the names of the distinguished persons upon whom the University of Birmingham has decided to confer the honorary degree of Doctor of Laws by way of commemorating the recent Royal visit, we notice the following:—Mr. W. N. Atkinson, H.M. Superintendent Inspector of Mines, South Wales; the president of the Royal College of Surgeons; Sir William Crookes, F.R.S.; Mr. Maurice P. Fitzmaurice, C.M.G., chief engineer to the London County Council; Sir Archibald Geikie, K.C.B., P.R.S.; Mr. Haldane, F.R.S.; Dr. J. S. Haldane, F.R.S., reader in physiology at the University of Oxford; Sir A. B. W. Kennedy, F.R.S.; Sir Joseph Larmor, F.R.S., Lucasian professor of mathematics in the University of Cambridge; Sir R. D. Powell; Sir William Ramsay, K.C.B., F.R.S.; Lord Rayleigh, F.R.S.; Prof. E. Rutherford, F.R.S., professor of physics in the University of Manchester; Prof. Silvanus P. Thompson, F.R.S.; Dr. W. A. Tilden, F.R.S.; Sir J. J. Thomson, F.R.S.; Mr. C. S. Tomes, F.R.S.; Dr. T. Herbert Warren, Vice-Chancellor of Oxford University; and Dr. B. C. A. Windle, F.R.S., president of Queen's College, Cork. The degrees are to be conferred on October 20.

THE calendar for the session 1909–10 of the Manchester Municipal School of Technology shows how thoroughly the education committee of the city has, by the courses of instruction sanctioned in the school, met the requirements of the industries of south-east Lancashire, of which Manchester is the commercial centre. A prefatory statement to the calendar points out that the object of the school is to provide instruction and training in the principles of science in their application to the industrial arts, with the view of a right understanding of the foundations upon which these arts rest, and to promote their effective development. The essential aim of the instruction is the training of faculty through a systematic course of sound theoretical study, and the development of resourcefulness and habits of self-reliance by means of an exact, thorough, and progressive course of laboratory and shop work, so as to prepare the student after due experience for positions of responsibility. Courses of three years' duration have been arranged, for day students of sixteen years of age and upwards, in each of the following branches of technology:—mechanical engineering; electrical engineering and technical physics; municipal and sanitary engineering; applied chemistry in each of the six aspects—general chemical technology, chemistry of textiles, manufacture of paper, metallurgy and assaying, brewing, and electrochemistry; manufacture of textiles; photography and the printing crafts; and architecture and the building trades. It is interesting, in view of the distinguished success with which the work of the school has been crowned, to direct attention to the fact that the subcommittee which administers the school consists of three classes of members, viz. representatives from the city council, members representative of educational and other institutions of various grades, and co-opted members consisting of men distinguished in the district for their knowledge of manufactures or science.

ATTENTION has often been directed in these columns to the amount of State aid provided for the purposes of university and other higher education in this country. It has been pointed out repeatedly that the financial assistance forthcoming from the Treasury in this direction compares very unfavourably with the sums of money provided for similar purposes by the Governments of other great countries. An examination of the Civil Services Estimates for the past eleven years shows, however, that there has been a steady increase year by year in the annual amounts voted by Parliament for higher education. The total amount for this purpose for the financial year 1899–1900 was 108,338*l.*, made up as follows:—universities and university colleges of Great Britain, 85,000*l.*; the Royal College of Science, London, 18,388*l.*; and Queen's Colleges in Ireland, 4950*l.* In 1905–6 the total amount had increased to 201,773*l.*, allocated thus:—universities and university colleges of Great Britain, 174,000*l.*; the Royal College of Science, London, 22,723*l.*; and the Queen's Colleges in Ireland, 5050*l.* For the present year the total amount has grown to 215,700*l.*, the items under the respective headings being 191,000*l.*, 20,000*l.*, and 4700*l.* The grant in aid of *Scottish* universities (included under Great Britain) is 42,000*l.*, which is in addition to an annual sum of 30,000*l.* payable to these universities from the Local Taxation (Scottish) Account. The local education authorities in England and Wales give grants amounting to about 100,000*l.* annually to universities and university colleges. It may be said, therefore, that roughly the State grants in aid of universities and colleges in Great Britain amount now to nearly 220,000*l.* annually, and the local taxation grants to about 130,000*l.*, making an annual sum of about 350,000*l.* It is instructive to point out in connection with the amount thus arrived at that the total for grants in respect of public elementary schools in England and Wales in connection with the Board of Education amounts for the present year to 11,162,405*l.*, and that 555,000*l.* is paid for the training of teachers, 791,800*l.* to secondary schools, and 537,505*l.* in connection with technical institutions, schools of art, and evening schools.

IN an article on the position of higher education published in the issue of NATURE for July 22 (vol. lxxxi., p. 113), attention was directed to an article by Prof. Guido H. Marx on the remarkable growth and spread of interest in higher education in various countries. The opportunity was taken on that occasion to point out that Prof. Marx's figures, so far as the numbers of students in institutions of university standing in Great Britain are concerned, were not quite trustworthy. Referring to this article by Prof. G. H. Marx, Prof. B. Menschutkin, of St. Petersburg, writes to correct the statistics given in respect of Russia. He says:—"The statistics with regard to Russia (23,000 students) are very antiquated. This number of students was reached some fifteen years ago, but at present the students of the higher colleges number at least about 77,000, as can be seen from the following data, showing how many students there were in the different institutions in 1908 (in some cases, as for St. Petersburg, the numbers refer to the present year):—

St. Petersburg (University 9800, Academy of Law 350, Philological Institute 150, Medical Academy 800, Technological Institute 2000, Polytechnik Institute 4200, Institute of Ways of Communication 1200, Institute for Engineers 700, Electrotechnical Institute 650, Mining Institute 650, Institute of Forestry 550, the three higher colleges for women 6000, Lyceum and three Military and two Nautical Academies 1200, Academy of Theology 300), 28,550; *Moscow* (University 9000, Institute of Oriental Languages 150, Academy of Theology 200, Technical Institute 2500, Agricultural Institute 850, Engineering Institute 550), 13,250; *Kharkov* (University 5300, Technological Institute 1200, Veterinary Institute 500), 7000; *Kiev* (University 3200, Academy of Theology 200, Polytechnic Institute 2500), 5900; *Kazan* (University 3000, Academy of Theology 170, Veterinary Institute 430), 3600; *Tomsk* (University 800, Technological Institute 1900), 2700; *Warsaw* (University and Polytechnic Institute), 1500; *Odessa* (University), 3300; *Novocherkask* (Polytechnic Institute), 700; *Yuryev* (Dorpat) (University 3000, Veterinary Institute 350), 3350; *Helsingfors* (University 2400, Technical College 350), 2750; *Riga* (Polytechnicum), 1700; *Novaya Alexandria* (Agricultural Institute), 400; *Yaroslavl* (Lyceum), 1050; *Yekaterinoslav* (Mining Institute), 500; *Nĕžin* (Philological Institute), 150; *Saratov* (University, established this year), 200; *Vladivostok* (Institute of Oriental Languages), 300. The total number is therefore 76,900. There are also many *private* higher colleges in different towns, the number of students of which it was impossible to ascertain; it is surmised that this number is about 20,000."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 30.—M. Bouchard in the chair.—The improvement of the theory of partial equations of the first order: N. **Saltykow**.—A demonstration of the phase rule: M. **Boulouch**. A criticism of the demonstration of the phase rule by M. Müller, in which thermodynamical considerations are excluded. The author regards some of M. Müller's assumptions as unjustifiable.—The hydrolytic dissociation of bismuth iodide: René **Dubrisay**. The effects of temperature and dilution have been studied. Two oxyiodides have been shown to exist, the red compound being BiOI; the second black oxyiodide gives a ratio of bismuth to iodine corresponding to $Bi_2O_3 : 5HI$.—A simplified method and apparatus for determining the calorific power of gaseous combustibles: P. **Lemoult**. The method is based on the fact that the combustion of molecular proportions of hydrogen and oxygen or carbon monoxide and oxygen gives nearly the same heat evolution, and after absorption of carbon dioxide formed in the latter case, the contractions are the same. If carbon monoxide, hydrogen and methane are present, the contraction (*a*) after combustion and absorption of CO_2 is measured, and also the oxygen consumed (*b*). The approximate calorific value is $P=0{\cdot}914a+3{\cdot}405b$.—The pseudopolychroïsm of sphærolites: Paul **Gaubert**.—The extension and retrogression of the virgin forest of tropical Africa: Aug. **Chevalier**.—The Mesoplodon of la-Hougue (November 2, 1908): R. **Anthony**.—The proof of experimental ammoniuria in epilepsy: J. E. **Florence** and P. **Clément**. Ammonium acetate, administered in 4-gram to 6-gram doses, is in healthy individuals excreted mainly as urea. In epileptics under the influence of bromides the method of elimination is similar; in epileptics not under bromide treatment a marked elimination of ammonia coincides with the very frequent attacks.—Alcoholic fermentation in presence of sulphurous acid: P. **Martinand**.—The specificity of oxydases: J. **Wolff**.

NEW SOUTH WALES.

Royal Society, June 2.—Mr. H. D. Walsh, president, in the chair.—A pitchblende probably occurring in New South Wales: T. H. **Laby**.—The viscosity of water: R. **Hosking**.—A contribution to the experimental study of the large ions in the air: S. G. **Lusby**.—The mobility of the large ions in the air: Prof. J. A. **Pollock**.—"Lope de Vega": L. **Hargrave**.—Note on the determination of the free acid in superphosphates: F. B. **Guthrie** and A. A. **Ramsay**.

July 7.—Mr. H. D. Walsh, president, in the chair.—Description of a new hæmoprotozoa from birds in N.S. Wales: Dr. J. B. **Cleland** and T. H. **Johnston**.—A new melanin-producing hæmatozoon from an Australian tortoise: T. H. **Johnston** and Dr. J. B. **Cleland**.—A new reptilian cestode: T. H. **Johnston**.—The discrepancy between the results obtained by experiments in manuring, &c., in pots and in the field: L. **Cohen**.

Linnean Society, July 28.—Mr. C. Hedley, president, in the chair.—New Australian Lepidoptera belonging to the family Noctuidæ: Dr. A. J. **Turner**. One genus, and twenty-five species referable to twenty-two genera, are described as new, and new habitats are recorded for a number of species previously known.—Notes from the botanic gardens, No. 14: J. H. **Maiden** and E. **Betche**. Three species, referable to the genera Halorrhagis, Bæckea, and Olearia, are described as new; *Rutidosis leiolepsis*, F. v. M., *Ageratum conyzoides*, L., *Prunella vulgaris*, L., var. *laciniata*, Benth., *Gleichenia flagellaris*, Spreng., *Angiopteris erecta*, Hoffm., and *Cassytha filiformis*, L., are recorded as new for New South Wales; it is suggested that *Acacia Dorothea*, Maiden, should be transferred from the Uninerves to the Julifloræ; and notes on, or new records for, certain rare or interesting plants are appended.—Studies of the life-histories of Australian Odonata. No. 2. The life-history of *Diphlebia lestoïdes*, Selys: R. J. **Tillyard**. The genus Diphlebia contains the only Australian representatives of the family Calopterygidæ. The discovery of the larva is of great importance to ontogenists. The ova were found in the tissue of water-weed one foot below water, the female having deposited them by descending the reed under protection of an air-film. Larvæ were successfully hatched out in October, and some of them were kept until March. In November four exuviæ were found clinging to rocks in the stream-bed of the Rodriguez Pass, at Blackheath. The larva is of most remarkable form, quite unlike any other calopterygid larva known, and having some points in common with agrionid larvæ. It must be regarded, not as a synthetic type, but as a highly specialised and successful development from the main calopterygid stock, such development having taken place on lines parallel to that of the agrionid type.—Some hæmogregarines from Australian reptiles: T. H. **Johnston**. Four Australian species of Hæmogregarina have been described. Three additional species, from snakes or from a tortoise (Chelodina), are described as new, and some observations on *H. shattocki*, Samb. and Seligm., are offered.—The influence of the dilution of serum upon the phagocytic index: Dr. R. **Greig-Smith**. Several factors have each an influence in modifying the nature of the curve representing the opsonic and phagocytic effects obtained upon progressively diluting normal serum. It would be possible to obtain the phagocytic indices so that their ratios lie upon a straight line, by using a 1·0 per cent. to 1·1 per cent. solution of sodium chloride for making the dilutions and suspensions. With weaker strengths of normal saline the curve rises above, and with increased strengths it falls below, the straight line. The thickness of the bacterial suspension, the nature of the phagocytes, and the time of incubation influence the results, and have to be taken into account.

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THURSDAY, SEPTEMBER 16, 1909.

PRINCIPLES OF IGNEOUS PETROLOGY.

The Natural History of Igneous Rocks. By A. Harker, F.R.S. Pp. xvi+384. (London: Methuen, 1909.) Price 12s. 6d. net.

FOR some time the need of a text-book of general petrology in English has been acutely felt, owing to the rapid progress which the science has made in theoretical subjects and the inaccessibility of many of the original memoirs to students and teachers. Most text-books treat the subject from a purely descriptive point of view, and the speculative developments are kept in the background. In fact the literature of descriptive petrology is now so large that an attempt to extract the general conclusions to be deduced from the observations becomes of greater importance than merely to add to the number of ascertained facts. In a book of about four hundred pages Mr. Harker endeavours to meet this demand, and has covered so wide a range and compressed so much information into this brief space that he has achieved a very large measure of success.

The work is confined to the investigation of the principles of igneous petrology, and the metamorphic and sedimentary rocks are excluded from its scope. The title fairly expresses the aims of the book; it is an attempt to treat of igneous rocks in the manner of natural history, taking account not only of their minute anatomy and structure, but also of their distribution, their range in time, and their genetic associations. Of late years there has been a plethora of unnatural systems of petrology, based on purely arbitrary lines. On the best known of these (the "quantitative classification") the author passes severe judgment, and returns to the broader treatment followed by Rosenbusch, Brögger, Judd, and Teall. That combination of geological reasoning with petrological analysis which has always characterised the English school of petrologists finds able expression in the pages of this treatise.

The geographical distribution of recent volcanic rocks is considered in the introductory chapters, and the remarkable association of "Atlantic" and "Pacific" rock types with certain classes of tectonic developments is made the foundation of an appeal for a natural classification. Undoubtedly the facts are most impressive, though we are entirely in the dark regarding their causes; and they afford the clearest indication that in time we shall be in possession of natural systems of petrography. We learn incidentally that the first sketch of this grouping was presented by Mr. Harker, though it has become more generally known through the treatment of Dr. Prior and Prof. Becke. The Tertiary volcanic rocks of the Inner Hebrides are placed among the Pacific types, a conclusion by no means easy to accept, and one which may need to be revised at some future date.

The application of physical chemistry to the crystallisation of magmas is taken up in considerable detail. This part of the book is practically a summary of Prof. Vogt's papers, and leaves nothing to be desired in lucidity of exposition and accuracy of statement. For students it will be of the greatest value, as the original memoirs are loaded with detail, and much too voluminous for their use, and no satisfactory account of them has hitherto appeared in English. We must confess, however, to a certain feeling of disappointment in reading them, a sense of incompleteness. The *a priori* principles are laid down in a very satisfactory fashion, but the applicability of these principles to the actual concrete facts of rock structure and history, which we had a right to expect from a geologist of Mr. Harker's wide experience, is dismissed with scant treatment. The difficulty of interpreting the history of crystallisation in the commonest rocks in terms of the theoretical principles laid down is sure to face the student at an early stage in his studies. We miss in particular any reference to the work of Schreinemaker, who has proved by analytical investigations that in a solution of three minerals in one another, of which two can form mixed crystals, while the third is independent, there are many possible schemes of crystallisation; one mineral may separate out completely at an early stage, and the crystallisation of any substance may be interrupted or repeated. If there are more components, or if we allow for the influence of dissolved gases in the magma, the problem becomes much more complicated; but it is a relief to find that as the theory is better understood the discrepancies between it and the observed facts seem to diminish.

The subject of "hybridism," or mixed rocks, is discussed in a brief chapter, which sums up in admirable fashion the results of the author's work in this difficult field. He takes a middle position between the schools of petrology which deny that igneous rocks dissolve sediments or older rocks with which they come into contact, and those which hold that such processes go on on a large scale, and that many rocks generally regarded as of normal types are thus produced. Mr. Harker's field work enables him to speak on this subject with great authority, and his conclusions are so moderate and so firmly based on sound evidence that he carries us with him in all that he says. There is also a chapter on magmatic differentiation, a subject on which it does not seem possible to say anything that is new, and a very interesting account of the mutual relations of associated igneous rocks which, in our opinion, is the best in the volume. The curves drawn on a very simple graphic system show the variation in the components of allied rock types, and are convincing that some general principles must underlie the facts, though as yet we have been unable to grasp them. The final chapter on classification is unexpectedly brief, and contains an admission that existing systems are merely temporary stop-gaps, and a satisfactory classification must traverse the lines of all current groupings, and will require an entirely new nomenclature. To us this appears unduly pessimistic, and we believe rather that in petrology as in other sciences the future will be the child of the past, and that real progress will not involve the demolition of the older systems, but will include them while giving them a sounder basis to rest upon. The book contains two beautiful photographic plates of active volcanoes, and a large number of useful illustrations; in print, paper, and binding it will meet the approval of every book-lover. J. S. F.

A POPULAR MAMMAL BOOK.

Wild Beasts of the World. By Frank Finn. Pp. viii+188; illustrated. (London and Edinburgh: T. C. and E. C. Jack, 1908–9.) Price 17*s.* net.

THE favourable opinion we formed of Mr. Finn's work when the first part was noticed last year in NATURE we are pleased to be able to endorse now that the complete volume is before us. The book is confessedly a thoroughly popular one, and, therefore, ought to be judged solely from that standard; and from that point of view it may be pronounced a decided success. The author's style of writing is bright and attractive; and in the main his descriptions appear correct and up to date. Mr. Finn has not overloaded his text with names of naturalists and observers about whom the public knows little or nothing; and he has, in our opinion for the most part rightly, altogether ignored subspecies. As regards nomenclature, the author will have nothing to do with modern innovations and changes, and we accordingly find the baboons (and not the flying-lemur) appearing under their old title of Cynocephalus, and the fox as *Canis vulpes.* The fact that such names still dominate in popular literature suggests that they should not, as is now too much the fashion, be ignored in our museums, which are primarily popular institutions.

Mr. Finn appears to take as his texts the hundred mammals represented in the coloured plates, as the descriptions of all these are printed in larger type than is conceded to many of the others noticed. Personally we are not enamoured of this plan, as it suggests that the species to which large type is accorded are of more importance than the rest; but this point is not one affecting the character of the work as a whole.

The coloured plates form, of course, the characteristic of the volume which will appeal most strongly to the general public; and for these illustrations—the only ones in the book—we have in the main nothing but commendation, although some appear rather too brilliantly coloured. A few, moreover, do not indicate important details—notably the one of the hamster, in which the dorsal gland-patch is not shown. The one serious error in the illustrations occurs in part xii., where the plate lettered Marco Polo's wild sheep really represents the true argali (*Ovis ammon*); and there is no excuse for this, as the figures, if we mistake not, have been drawn from the mounted specimens in the British Museum. Nor is this all, for, whereas the figure in the foreground depicts, as we have said, the true Altai argali, the one in the middle distance is taken from its Tian Shan representative. In the concluding part we notice that the plate of the platypus shows the web of the forefoot fully extended when the animal is on land, in place of being folded beneath the palm, as it must be in order that the creature should get a foothold.

Misprints and other errors in the text appear to be few, but we notice on p. 47 *Mipsiprymnus* for *hypsiprymnus.* In the account of the Derbian eland no mention is made of the fact that the species occurs in the Bahr el Ghazal; while the occurrence of the water-chevrotain in East Central Africa is ignored. The old error as to female takin-horns differing in form from those of the male is also repeated.

Most of these are, however, but trifling errors, which detract but little from a work worthy in the main of high praise. R. L.

APPLIED MECHANICS.

(1) *Applied Mechanics for Engineers.* A Text-book for Engineering Students. By E. L. Hancock. Pp. xi+385. (New York: The Macmillan Co., 1909; London: Macmillan and Co., Ltd.) Price 8*s.* 6*d.* net.

(2) *Machines—Outils, Outillage, Vérificateurs.* By P. Gorgeu. Pp. 232. (Paris: Gauthier-Villars, 1909.) Price 7 francs, 50 centimes.

(1) THIS book is intended to be a text-book for engineering students during the first year of their course, and the examples selected to illustrate the principles discussed are, therefore, mainly such as are likely to be met with in practical engineering work. To facilitate the working out of the numerical problems, of which there are nearly 300 scattered through the book, the author has printed in the form of five appendices a series of tables including hyperbolic functions, logarithms of numbers, trigonometrical functions, squares, cubes, square roots, conversion tables, &c.; it is very problematic as to how often such tables incorporated in a text-book are of use to the student—it is much more convenient for him to have a small thin book of mathematical tables, and there are several such books now available, which he can carry about with him in his pocket, and refer to whenever calculations have to be made.

Two very complete chapters are those devoted to centre of gravity and moment of inertia; the application of Simpson's rule to the finding of the area and centre of gravity of rail and similar sections is fully discussed, and the whole subject of the determination of moments of inertia of various standard sections is treated very fully, both by analytical and graphical methods: this is a matter of considerable interest to engineers engaged in structural design work. Another chapter which will be found of use by the engineer in practice as well as by the young student is that dealing with the dynamics of machinery: after dealing with such usual problems as those of the flywheel and connecting-rod in a reciprocating engine, a number of sections is devoted to the gyroscope, and to its application to the mono-rail and similar devices.

The last chapter in the book treats of impact in a more satisfactory manner than is usually the case in text-books on mechanics. The book is certain to prove a useful one to all those who are engaged in teaching the subject of mechanics to engineering students, and the number of well-selected examples makes it a particularly satisfactory book for the student himself. Many young engineers are far away from help in matters of this nature, and have to depend upon their own resources—it is essential in such a case that they should have a large number of practical problems to work through in order to familiarise themselves with the principles underlying each branch of the subject.

(2) This book has been written specially for artillery officers detailed for duty in ordnance factories; it is copiously illustrated, and special attention has been given to the relative advantages and disadvantages of different types of machine tools, and to different methods of transmitting motion to the tools.

The first section is devoted to such details as the transmission of motion from one shaft to another by belting and gearing, quick return motions, cams, sliding pairs, turning pairs, and screw pairs, and in each case brief notes are given as to the important points to which attention should be paid in order to secure good results and to maintain all working parts in good order.

The second section deals with all the more important machine tools which are to be found in a modern workshop; in each case a regular order of treatment is followed—first the parts exterior to the machine itself and transmitting motion to it are discussed, and then in order the links in the machine receiving this motion, the links of the machine transmitting movement to the work, the links of the machine transmitting movement to the cutting tool, and lastly any other specialised link, and the frame. This is a method of treatment suitable not only for the non-technical student, but also for students who are just beginning the study of machines and machine tools, and the illustrations, which form a special feature of the book, are so arranged that the reader has no difficulty in finding at once in any of the figures the link of the machine which is described in any particular paragraph of the written description of the machine.

The third section deals with the cutting tools used in the various types of machine tools, methods of tempering, angles for the cutting edge for different classes of work, methods of lubrication, and speed of cutting are all discussed in detail, and a few paragraphs are devoted to the employment of the new high-speed steels.

In view of the fact that interchangeability of parts is now so important in all cases where large numbers of similar machines are constructed, the fourth section is entirely given up to an account of the construction and use of various types of gauges, with a series of useful notes on the precautions which must be adopted to ensure that their employment shall secure the desired result. The book should be consulted by all those who are engaged in the design of machine tools.

T. H. B.

A BELGIAN BOTANIST.

Notice sur Léo Errera. By L. Fredericq and J. Massart. Pp. 153. (Bruxelles: H. Lamertin; London: Williams and Norgate, 1908.)

Recueil d'Œuvres de Léo Errera. Vols. i. and ii. Botanique générale. Pp. iv+318 and v+341. Vol. iii. Mélanges Vers et Prose. Pp. xiv+222. (Bruxelles: H. Lamertin; London: Williams and Norgate, 1908–9.)

It would be difficult to overestimate the influence of the two great German professors, Anton De Bary and Julius Sachs, on the progress of botany. At a time when many fundamental ideas were only beginning to take shape, these advanced workers and leaders of thought attracted a succession of brilliant students from many European countries, who absorbed in Strassburg and Würzburg the doctrines and inspirations of their masters, and eventually spread abroad the new theories and conceptions that are now regarded as the foundations of botanical science. Amongst this band of eager students was the Belgian, Léo Errera, who entered first De Bary's laboratory in 1897, and subsequently sought further experience under the tutelage of Sachs. Two important results can be traced to these courses of foreign study. In the first place, intercourse with such gifted teachers and with brilliant colleagues helped to stimulate the energies of an already keen enthusiast, and to pave the way for future friendships and associations. In the second place, his interests were diverted from systematic to chemico-physiological botany, which became one of the chief lines of research at the University of Brussels.

The first of his primary contributions to science was the paper on glycogen in the Mucorineæ; this was the outcome of research in De Bary and Hoppe-Seyler's laboratories, and required a profound knowledge of the two sciences of botany and chemistry. It was followed by other papers on the same and other physiological subjects published by himself or his students. Prof. Errera was also well versed in mathematics and physics, evidence of which is furnished by the course of molecular physiology prepared for his advanced students. The researches connected with glycogen and the localisation of alkaloids, the papers on the application of physical chemistry to the elementary phenomena of cells, the relations of flowers and insects, and the defensive structures of plants, may be regarded as his chief contributions to botany.

As a professor, Errera took the keenest interest in his students, and spared no pains to stimulate their energies towards the acquirement of knowledge and the prosecution of research. At the time when practical courses were not yet customary he initiated a course which was first held in two small rooms in the gardens, and later in a more spacious laboratory provided at his own expense in a neighbouring building. The biography compiled by two of his former students bears testimony to the enthusiasm he inspired, and provides a realistic picture of his varied talents. He was an accomplished linguist, an excellent lecturer, and an entertaining companion.

The papers on general botany collected in the two volumes noted above are of a popular nature, as his more technical contributions have been published in the *Recueil de l'Institut botanique de l'Université de Bruxelles.* The first is a letter describing the vegetation in the neighbourhood of Nice, written when he was sixteen years old. The article on the structure and methods of fertilisation of flowers appeared four years later; it was inspired by Charles Darwin's work, and the introductory quotation from the "Origin of Species," taken in conjunction with his essay on Darwinism, is worth reproducing:—"Whoever is led to believe that species are mutable will do good service by conscientiously expressing his convictions." The article is, to a large extent, an account of contemporary investigation, but includes original notes on the oxlip and the genus Pentstemon. The essay entitled "Une Leçon élémentaire sur le Darwinisme" was revised in 1903, after the publication of de Vries's book. Errera fully accepts the mutation theory, regarding it as an amplification, and not a contradiction, of the selection theory. The references in this paper to Dr. Scott's work on Cheirostrobus and the joint communication by Drs. Scott and Oliver on Lagenostoma will serve to indicate how the author incorporated the very latest results into his teaching.

The most interesting part of the third volume, containing miscellaneous verse and prose, will be found in the collection of extracts and aphorisms. Here is an epigram that will be appreciated by philosophers generally:—"La vérité est sur une courbe dont notre ésprit suit eternellement l'asymptote." The authors of the biography are to be congratulated on presenting such an interesting account of the brilliant alumnus of Brussels University. The papers are worthy of consultation, not alone for the facts contained, but also for style and arrangement.

OUR BOOK SHELF.

An Atlas of Skiagrams, illustrating the Development of the Teeth, with Explanatory Text. By Dr. J. Symington, F.R.S., and Dr. J. C. Rankin. Pp. 47; pl. xii. (London: Longmans, Green and Co., 1908.) Price 10s. 6d. net.

THE difficulty of cutting sections comprising both soft and highly calcified parts without causing displacements, and the further trouble of piecing together the disposition of parts in a large number of serial sections so as to reconstruct a model in the solid, gives to skiagrams an especial value, as being a representation of the relations of the developing teeth to one another and to the jaws which is beyond suspicion of disturbance. Certain difficulties arising from the teeth being disposed in an arch were very successfully met by the authors, who resorted to tipping the back of the skull upwards to a uniform extent in all cases, namely, raising the back about 30 degrees, and by this method the shadows of the front teeth were separately projected and the overlapping of the shadows to a great extent avoided. The skulls used were divided into halves, and the right and left sides both presented in nearly every case where the skulls used were more than seven years of age; but in the younger ones, no difference being found between the two sides, only one is presented.

The ages of the subjects used range from birth to adult life, and twenty-three skiagrams are given which illustrate the calcification of the temporary teeth and their change to the successional set; amongst other points clearly shown, the extent of calcification in each tooth, at each age, a point sometimes of medicolegal importance, is well seen. Some points in the relation of the growth of the jaws to the development of the teeth can be advantageously studied in these skiagrams, as well as the relation of the developing teeth to the antrum. Inasmuch, however, as the walls of the antrum cannot always be very clearly traced in the midst of shadows cast by other parts of the upper jaws, the anatomy of the antrum is also illustrated by drawings made subsequently from the same specimens, the technique adopted being to harden the tissues in formol, and then to chip away as much of the bone as could be removed without destroying all support. The lining membrane so treated becomes sufficiently firm to stand alone and retain its shape, and the dissections made were carefully drawn. These figures include also the accessory sinuses. The authors may be congratulated upon having produced an atlas which is of the greatest service in adding to the accuracy of our knowledge of the development of the teeth and of their relations to the parts about them.

Mineralogie und Geologie für schweizerische Mittelschulen. By Dr. Hans Frey. Dritte Auflage. Pp. iv+234. (Vienna: F. Tempsky; Leipzig: G. Freytag, 1909.) Price 2.75 marks.

THIS work, which has evidently been successful, is of the type commonly used in German-speaking schools, and makes no special appeal to the beginner's interest in field-observation, or to the splendid object-lessons ranged around him in his native land of Switzerland. A number of Swiss illustrations are, however, inserted, and the passages on mountain-building and the Alpine lakes embody considerations raised in recent times. To a British mind the mineralogical section will seem to contain far too much in a small compass, if the course is to be gone through systematically before the pupil enters on his collegiate years. It occupies half the book, and is followed by a petrographic chapter, which similarly bears traces of having been brought somewhat hesitatingly towards modern modes of statement and classification.

The section on historical geology, perhaps in accordance with a settled syllabus, is limited to thirty-four pages, and the illustrations of fossils are given without any explanation as to the nature of the organisms. In these circumstances, the generic and specific names are worse than useless; they need, moreover, some revision and press correction. A great opportunity still remains for making the mineralogy and geology of Switzerland serve as an introduction to these sciences, and for letting the land itself speak to the pupil, before he becomes entangled in the strings of facts which are supposed to be inseparable from a scientific education. G. A. J. C.

Gilbert White and Selborne. By Henry C. Shelley. Illustrated from photographs by the author. Pp. xvi+226. (London: T. Werner Laurie, 1909.) Price 6s. net.

THIS little book is not badly done so far as it goes, but there is nothing in it that has not often been said before; the photographs are good, but of quite familiar objects. The one innovation consists in eking out a volume offered at six shillings by "Cameos from the Natural History of Selborne," which occupy fifty of these meagre pages: a serious literary blunder, to use a mild word. The six shillings might be much better spent in the purchase of an edition of the famous book, which is much talked of but probably little read.

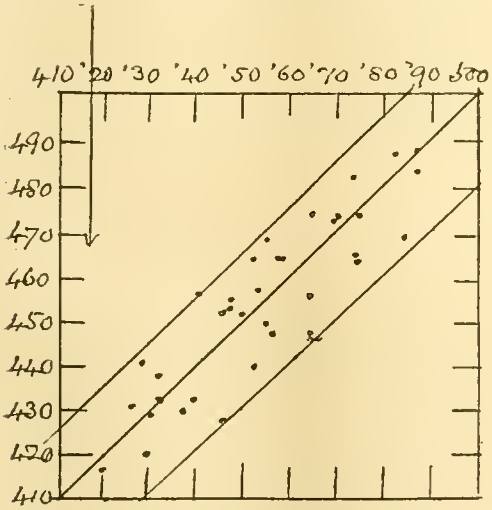
LETTERS TO THE EDITOR.

[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 Summer Season of 1909.

IN endeavouring to estimate the character of a coming season, the following method is, I think, often serviceable. Let us take, as a concrete case, the annual numbers of very hot days at Greenwich (80° or more) from 1841 to 1908. Add these in the thirty years ending 1870, 1871, 1872, &c. Then compare each sum with the next by the dot method; where each dot represents one value by the horizontal scale, and the next by the vertical. A line may be drawn connecting points of intersection of lines (horizontal and vertical) from equal numbers in the two scales, and two others roughly parallel with it (as shown).

Now the last value, previous to this summer—the sum, that is, of the thirty years ending 1908—is 417. Find this in the horizontal scale, and consider where the next dot is likely to go. It would hardly be higher than (say) the level of 433. Now we know the numbers of those days in twenty-nine out of the thirty summers ending 1909; their sum is 416. Deducting 416 from 433 leaves 17; and we infer that this season would probably not have more than seventeen of those hot days (which is only two more than the average). The season has, so far, proved a very cool one (August 4). This method is obviously capable of wide application.



A similar conclusion seems to be arrived at by a comparison of Greenwich and Rothesay weather. It appears (whatever the explanation) that when the year's rainfall at Rothesay has exceeded 55 inches (last year had 56), the following summer at Greenwich has never been very warm. We may tabulate the cases (eleven in number, 1841–1907) as follows:—

	Rothesay Rf. in.	Greenwich days with 80° or more following summer	Relation to av. (15)
(1) 1872	70·2	16	+ 1
(2) 1877	68·6	11	− 4
(3) 1841	65·9	17	+ 2
(4) 1903	61·6	16	+ 1
(5) 1882	59·6	7	− 8
(6) 1862	59·5	13	− 2
(7) 1866	58·7	9	− 6
(8) 1907	58·5	8	− 7
(9) 1868	57·2	14	− 1
(10) 1861	56·3	1	− 14
(11) 1906	56·3	2	− 13
		Av. 10·4	

That is, eight cool summers, three slightly warm, and the hottest with seventeen of those days. It seemed not unreasonable to apply this "rule-of-thumb" (if it is to be so called) to the present season, following on a Rothesay year, which would fall to be added to the above list.

Once more; the summer season of 1879 is well remembered as a singularly cold one. There were only thirty days with 70° or more, and one with 80° or more (the averages being 77 and 15 respectively); and now, at thirty years' interval, we have another very cold summer.

Suppose we compare each summer with the thirtieth after, in respect of those very hot days (80° or more). We can carry the comparison obviously up to 1878 (that year compared with 1908).

It would appear that, in the case of very cold and very warm summers, there is some tendency for the thirtieth after to be of like sign in relation to the average.

Thus the six coldest, in ascending order (0 to 6 hot days), are 1860, 1862, 1841, 1853, 1855, 1845; in each case but one the thirtieth season after was cold, and that one was average.

The six hottest, in descending order (40 to 27 hot days), are 1868, 1857, 1859, 1846, 1876, 1870; in each case but one (again average) the thirtieth season after was hot. The season of 1909 seems likely to conform to this.

ALEX. B. MACDOWALL.

P.S. (September 13).—There have been, so far, nine of those very hot days (three in May, six in August), which is probably the year's total, or near it.

A New Mineral from a Gold-washing Locality in the Ural Mountains.

SOME time ago I acquired through a friend two small glass tubes, together containing about 5 grams of a bright greyish-yellow crystalline powder.

The manager of the gold workings in question noticed several years ago in his troughs minute quantities of the dust referred to, and commenced to collect it, but in spite of the greatest care he was not able to find more than about 10 grams during the subsequent years.

The separation of the dust has been made easier through the specific gravity of the microscopic crystals being =9. Various analyses made proved the dust to consist of about 98·5 per cent. tantalum and about 1·5 per cent. niobium, with 0·001 per cent. manganese. We have therefore a new mineral, namely, native tantalum.

During the last six months no more traces of the mineral have been found, notwithstanding the greatest possible care taken to find more. It seems to have been here an instance of an isolated formation, but it is not impossible that the same mineral may be found elsewhere, associated with gold and platinum, but is overlooked owing to the small quantity and the fact that it has a lower specific gravity than gold or platinum.

Perhaps this information may be of interest to those associated with gold or platinum workings, and may induce them to look out for this new mineral, when it is not improbable there may be found other native metals as well.

Newcastle-upon-Tyne. P. WALTHER.

The Benham Top.

IN confirmation of Mr. F. Peake Sexton's contention in NATURE of September 2 (p. 275), that irradiation plays no appreciable part in the necessity for thin lines on the Benham top, I may add that the colours are equally well seen when the top is viewed (1) through a narrow diaphragm held close to the eye; (2) through a magnifying lens; (3) in the monochromatic light of the sodium flame.

My only objection to Mr. Sexton's theory was at first the brilliancy of the colours in the light of the sodium flame, but this difficulty at once disappeared when Mr. Sexton pointed out that though blue objects cannot be seen as such in that light (because there are no blue rays present for them to reflect), it by no means follows that the nerve centre for blue cannot be stimulated by the light of a sodium flame. It will be seen, on reflection, that quite different phenomena are involved in the two cases, and, this understood, there seems to be no difficulty in accepting Mr. Peake Sexton's theory, which is substantially similar to that of Prof. Liveing, made at the time the top first appeared, though Prof. Liveing did not seem to realise that the case of the sodium flame presented no real difficulty, and he suggested that the colours seen in that light were due to the fact that it is not absolutely monochromatic—a quite unnecessary contention.

Colchester, September 8. CHARLES E. BENHAM.

THE APPROACHING OPPOSITION OF MARS.

THE planet Mars is now a conspicuous object in the evening sky, its ruddy, brilliant disc appearing just below the great square of Pegasus, and astronomers the world over are once more seizing the opportunities presented by a favourable opposition for the further solution of the Martian enigma. The actual opposition will not take place until September 23d. 22h., or 10 a.m. on September 24, civil date.

FIG. 1.

As Prof. Lowell says in his classical memoir on Mars, "Study of Mars at one opposition is material to its study at the next. . . . At any one opposition we may scan Mars but for a few months through only a fraction of its circuit round the sun." Therefore, no opportunities may be missed by the students of the ruddy planet, whenever, and under whatever conditions, an opposition takes place. But only at one opposition in every seven, or about once every fifteen years, are the conditions so favourable as at present; Figs. 1 and 2 show this diagrammatically. The orbits of the earth and Mars are drawn to scale, but as eccentric circles, and from Fig. 1 it will be seen that the opposition of this month will be, as regards the distance separating the two planets, the most favourable we have experienced since 1892. Owing to the eccentricity of the planet's orbit, the distance between the earth and Mars, when at an opposition, may range from 61,000,000 to 35,000,000 miles, the corresponding range of the apparent diameter being 13″ to 25″. The most favourable oppositions occur when Mars is near its perihelion (Π, Figs. 1 and 2), with the earth near its aphelion (α), point. The ideal condition would be for opposition to take place about the last week in August, whilst the most unfavourable conditions would obtain if it occurred about the third week in February; thus the opposition of 1877 was the most favourable during last century, except that of 1845, whilst that of 1901, February 21, was about as unfavourable as is possible.

The advantage of proximity was well illustrated in 1877, when Asaph Hall discovered the two Laputan satellites, and Schiaparelli first observed the much-discussed *canali*.

On September 23, when at opposition, Mars will be about 36·4 million miles from the earth, but the nearest approach of the two bodies will take place on September 18, when the distance separating them (E_2–M_2, Fig. 2) will be about 160,000 miles less. After the opposition, as the planet lags behind the earth, as shown in Fig. 2, the distance will continue to increase, and the apparent diameter of the planet will, of course, decrease, as shown by the circles drawn on the right of the diagram. These circles show the relative apparent diameter of the planet on August 13, when Mars is at perihelion, on September 18, when at least distance from the earth, and on November 1, when a substantial increase in the distance separating the two bodies will have taken place. The following are the apparent diameters of the planet at different epochs during the present opposition:—September 1, 22·8″; September 18, 24″; September 23

FIG. 2.

(opposition), 23·9″; October 1, 23·3″; November 1, 17·8″; December 1, 12·7″. This means that on September 18, an observer using a power of ×80 would see Mars on the same scale as a naked-eye observer sees the moon; the conditions of "seeing" would be worse. Taking another illustration, a land area of about the size of Ireland would, roughly speaking, appear as a spot of 1·3″ diameter, or a little longer than 1/1500th of the apparent diameter of the full moon.

Whilst the distance of the planet is an important factor in determining the value of the observing conditions at an opposition, it is by no means the sole factor; the altitude of the planet above the horizon makes or mars the conditions for the users of large instruments searching for minute detail. Thus, although the opposition of 1892 produced a more favourable distance-condition than that of 1894 (see Fig. 1), the observing conditions at the latter were not inferior, because of the higher culmination of the planet. At the present opposition, the declination of Mars is 4° S., and this means that for observers in our latitude (51° 30′) the meridian altitude will not exceed 35°; but this is a great improvement on the conditions in 1907, when the corresponding altitude was only 10°, and when, even from Flagstaff, Prof. Lowell found it desirable to send an expedition to the Andes for the observation of the planet. During the present opposition the meridian altitude at Flagstaff will be more than 50°.

As at all favourable oppositions, taking place about August, the south pole of Mars is now tilted earthwards, the earth, at the date of opposition, being about 20° below the plane of the planet's equator. Therefore the southern hemisphere will be observed, and as the summer solstice of this hemisphere, as shown in Fig. 2, occurs but a few days before opposition, the southern snowcap is in the process of dissolution, and changes due to the melting of the snow are taking place. Already such phenomena have been recorded by MM. Desloges and Jonckheere, among others. As the rotation-periods of the earth and Mars are approximately equal, the same regions can be observed on consecutive nights. On September 19 the Syrtis Major region will be in view, and on September 27 the region of the Mare Cimmerium.

Probably at no opposition since the time that Fontana suspected markings on the ruddy planet, in 1636, has the status of areographers been so critical as at the present juncture. Thanks to the persistent labours and unswerving faith of a few observers, of whom Prof. Lowell is the foremost, the question as to the subjective reality of the *canali* discovered by Schiaparelli in 1877 may be considered as settled. Whether one follows Prof. Lowell's lead in the matter of "artificial, irrigating waterways" or not, there can remain but little, if any, doubt that these long, straight channels do exist. In describing his observations, made at Trincomali, Ceylon, during the unfavourable opposition of 1903 (see Fig. 1), when the apparent diameter of the planet was but 14·6″, the late Major Molesworth said[1]:—"Personally, I am quite convinced of the reality of the great majority of the so-called canals: I think I could convince the most sceptical on this point if they could only have spent an hour or two at my telescope on some of the perfect nights in March and April this year." Major Molesworth used a 12¾-inch Calver reflector, with a power of 450. Numerous observers, and the Flagstaff photographs, have also testified as to the gemination of these features. Not only do these canals exist, but, in the opinion of many experienced observers, they also suffer changes which show a dependence on the seasonal changes of the planet.

Having settled the existence of the "canals," it became necessary to account for the changes, and, in one essential, this question remained more or less open until the opposition of 1907. With regard to the polar caps, Herschel's observations enforced the natural conclusion that their changes were due to the accumulation and dissipation of "snow" as the Martian winters waxed and waned. This coincidence of snowcap and season was not to be denied, and in the Martian spring, at the opposition of 1892, Prof. W. H. Pickering observed the disappearance of some 1,600,000 square miles of the southern snowcap, an area about the size of India, in a period of thirty-three days. But there still remained the one essential factor, that was the proof that this "snow" was really frozen water; that the Martian atmosphere contained water-vapour sufficient to produce these effects. On this point the different observers were at issue.

Beer and Mädler, during 1830–9, found that occasionally certain permanent features of the planet's landscape were blurred, as though by passing cloud and mist. During the favourable opposition of 1862, Lockyer's observations led to the definite conclusion that "the daily—nay, *hourly*—changes in the detail and in the tones of the different parts of the planet"[1] were caused by the transit of clouds over the various features.

"Clouds and mists" and "polar snows" inevitably suggest to the terrestrian the presence of water, hence a *raison d'être* for the canals, and the spectroscopic evidence adduced by Huggins and Vogel went to confirm the suggestion. But with the spectroscopic equipment of the Lick Observatory at their disposal, Campbell and Keeler could find no evidence for water-vapour in the planet's atmosphere, and the critics of a "terrestrial" Mars suggested that the snowcaps might be caused by the solidification and deposition of some other compound, such as carbon dioxide.

However, the spectrograms obtained by Mr. Slipher at the last opposition, 1907, afford, according to our present view, incontrovertible evidence that the atmosphere of Mars does contain a detectable quantity of water-vapour (see NATURE, vol. lxxvii., p. 442, March 12, 1908). Prof. Very estimates that at the time the spectrograms were taken, the Martian atmosphere contained sufficient precipitable water to give an average layer 14 mm. deep, or about one-third or one-fourth that in the earth's atmosphere. Nor is water-vapour the only familiar atmospheric constituent which has been shown to be present by the Lowell Observatory spectra. When Mr. Slipher described[2] the 1907 spectra, he explained the difficulty of detecting the free oxygen constituent of the Martian atmosphere, viz., the probable relatively slight increase in intensity, of the oxygen bands, produced by adding the absorption of a thin (Martian) atmosphere to that of a dense (terrestrial) atmosphere, but expressed the opinion that "its detection need not be considered impossible."

A recent message from the Kiel Centralstelle, dated September 10, informs us that Prof. Very's measures of the Lowell Observatory spectrograms—which show the spectra of the moon and Mars photographed side by side when the respective objects are at equal altitudes—show that oxygen is present in the atmosphere of Mars; the relative intensification of the oxygen band *b*, in the planet's spectrum, is stated to be eight times the probable error of the measures. Therefore, although the details are yet to come, it appears fairly

[1] Monthly Notices, vol. lxv., No. 8, p. 839, 1905.

[1] Memoirs R.A.S., vol. xxxii., p. 179, 1863.

[2] *Astrophysical Journal*, vol. xxviii., p. 404, 1908.

safe to assume that not only water-vapour, but oxygen also, exists in the Martian atmosphere.

Thus we arrive at the present opposition with the knowledge that a familiar compound, capable of forming snowcaps, of filling canals, and of being pumped in order to irrigate the pastures of a thirsty landscape, exists on Mars, and is accompanied by that element which we terrestrians look upon as another essential for the existence of animal life; and crucial difficulties in the "habitability" theory have been removed. Close, persistent, and world-wide scrutiny, at this favourable epoch, should lead to further elucidation of the enigma, and enable us to "reconstruct" a being and a vegetation capable of existing there.

An idea which has caught the popular fancy is that of signalling to Mars, but as the earth, from the planet, would be in the glare of the sun and would subtend, even at the impossible moment of opposition, an angle of less than 50″—of the same order as the apparent diameter of Jupiter at his recent opposition—to say nothing of the questionable transparency of our thicker atmosphere, this problem has not yet entered the province of practical astronomy.

WILLIAM E. ROLSTON.

POLAR EXPEDITIONS AND OBSERVATIONS.

THE position and prospects of polar exploration have been given great attention in the daily Press during the last few days. No precise information as to Dr. Cook's journey to the North Pole has yet been published, but the general narrative of Commander Peary's expedition leaves little room for doubt that Commander Peary reached the neighbourhood of the pole, and probably the pole itself, though an element of uncertainty must exist until his observations for latitude are examined critically. The Berlin correspondent of the *Times* reports that an executive committee for a Zeppelin polar expedition has been formed, the object of the expedition being defined as "the scientific investigation by means of the dirigible airship of the unknown Polar Arctic Sea and the development of the dirigible airship for the carrying out of scientific labours." Announcement has also just been made that a British Antarctic expedition will start next August under Captain R. F. Scott, who commanded the National Antarctic Expedition of 1900–4, with the object of reaching the South Pole.

As all the world knows, Mr. Shackleton's record of this year has given Great Britain the premier position in Antarctic exploration, and an earnest desire is felt by British explorers to place to the credit of this country the feat of first reaching the South Pole. McMurdo Sound has in the past been used as the base for British South Polar expeditions, but it is proposed on the next journey to establish a second base in King Edward VII. Land, 400 miles to the east of McMurdo Sound. The track to the pole from the new base may be expected to include phases similar to those met with in travelling from McMurdo Sound, but it is anticipated it will continue longer on the sea-level, meet the mountains nearer the pole, and consequently leave a shorter journey on the high inland plateau. The distance to be covered is in all some 1500 miles, for which 150 days are available. The plan for the journey to the pole from King Edward VII. Land includes the use of three means of sledge traction: ponies, a dog team with a relay of men, and motor sledges.

The scientific objects of Captain Scott's expedition are stated to be as follows:—(1) Geographical.—To explore King Edward VII. Land, to throw further light on the nature and extent of the great Barrier ice formation, and to continue the survey of the high mountainous region of Victoria Land. (2) Geological.—To examine the entirely unknown region of King Edward VII. Land and continue the survey of the rocks of Victoria Land. (3) Meteorological.—To obtain synchronous observations at two fixed stations, as well as the weather records of sledge journeys. (4) Magnetic.—To duplicate the records of the elements made by the *Discovery* expedition with magnetographs. The comparison should throw most important light on secular changes. (5) Miscellaneous.—In addition, attention will be paid to the study of marine biology at both stations and in the ship, and the examination of physical phenomena will be continued.

It is estimated that an expedition of the kind projected will cost at least 40,000*l*., and towards this sum considerable amounts have been given already. An appeal has been made to the public, and it is hoped that no difficulty will be experienced in raising the necessary money for the accomplishment of what will in any case include valuable scientific work.

The full narrative of Commander Peary's expedition to the North Pole appeared in the *Times* of September 11 and 13, and occupied six columns. By permission of the editor we are able to give a summary of this account of the journey and the observations made. The expedition left Etah, Greenland, on August 18, 1908, in the *Roosevelt*, having on board 22 Eskimo men, 17 women, 236 dogs, and about 40 walrus. Cape Sheridan was reached on September 5 and winter quarters were established there. Sledge loads of supplies were then taken to Cape Belknap, Porter Bay and other stages up to Cape Columbia, where Prof. McMillan obtained a month of tidal observations during November and December. Tidal and meteorological observations were also made at Cape Bryant, and explorations were carried on.

The expedition started for the north from Cape Columbia in several divisions at the end of February of this year. Latitude 83° 20′ was passed on March 2, and on March 5 "the sun, red and shaped like a football by refraction, just raised itself above the horizon for a few minutes and then disappeared again." The lead, or creek of open water, which was then reached, prevented further movement until March 11, when it was frozen and a start became practicable. The depth of the lead was determined by soundings to be 110 fathoms. On March 14 the lead had been passed, and the temperature was $-58°$ (?) F. Two days later Prof. McMillan had to be sent back to Cape Columbia at once on account of frostbite. "Sounding gave a depth of 825 fathoms. We were over the Continental Shelf, and as I had surmised, the successive leads crossed in the fifth and sixth marches composed the big lead and marked the Continental Shelf."

By an admirable system of advance, main and supporting parties, the expedition moved rapidly north, covering no fewer than fifty minutes of latitude (about 57 miles) in three marches. The fourth supporting party started on the back trail from about latitude 88°, and on April 2 Commander Peary, with his party of Eskimos, moved towards the pole.

In a march of about ten hours the party travelled twenty-five miles and was well beyond the 88th parallel, "with the sun now practically horizontal." Several long marches were accomplished, and one of forty miles in twelve hours. In four days, two degrees of latitude were covered, that is, a distance of about 138 miles. On the last stage of the journey Commander Peary's only companion was an Eskimo. An observation made on April 6 showed that the latitude was 89° 57′, so that the pole had been practically reached. Thirty hours were spent in making observations there and ten miles beyond the camp, and in taking photographs. No land could be seen. The minimum temperature recorded during the thirty hours was -33° and the maximum -12° (?) F. A sounding was made five miles from the camp, but bottom was not touched at 1500 fathoms. The party returned to Cape Columbia on April 23, and to the *Roosevelt* four days later. On July 18 the ship left Cape Sheridan and arrived in Indian Harbour on September 6.

The record of the expedition is a triumph for good organisation and persistent endeavour, and though details of the scientific observations are not yet available, the narrative gives good reason for believing that, so far as the time permitted, some valuable work was accomplished. Commander Peary states that Prof. Marvin and Prof. McMillan both secured numerous observations of tidal and meteorological conditions, as well as other data of scientific interest, while Dr. Goodsell gave special attention to microscopic work.

Commander Peary's achievement has rendered unnecessary any further expedition to reach the North Pole, so that attention may now be concentrated upon systematic scientific work in the region of which a preliminary view has just been taken. Whatever may be the ultimate decision as to relative claims to have been the first to reach the pole, there can be no doubt that the work carried on by the members of Commander Peary's expedition will be of greater value to science than mere observations of latitude taken during a "dash" to the pole. The success of the expedition is associated, however, with a fatal mishap to one of the scientific members. Prof. R. G. Marvin, of Cornell University, was drowned on April 10, forty-five miles north of Cape Columbia, while returning from latitude 86° N. in command of a supporting party. Prof. Marvin was only thirty years of age, and his death has caused great regret.

Though Commander Peary refers in his narrative to observations for latitude made at various points, no particulars are given, but that may be because the narrative was written for the general public. The explorer has had a unique experience in Arctic regions, and when his observations are published they will, it is hoped, show that the instruments used and corrections applied enabled him to determine position with reasonable accuracy. The determination of latitude by observations of the sun is, however, very difficult in latitudes near the poles. Without suggesting that Commander Peary's results may be found to require correction, it is of interest to indicate the conditions of observation in polar regions and the instruments used by some explorers.

LATITUDE OBSERVATIONS IN POLAR REGIONS.

To an explorer situated at one of the poles of the earth, the stars and all other heavenly bodies appear to pass round him in circles parallel to the horizon once in twenty-four hours, and the altitude of any one star is the same at whatever time it might be taken, provided the atmospheric conditions remain unchanged. If an explorer could be at either pole during the winter months, the best proof he could have that he had really reached 90° latitude would be by observations of stars. Should he be able to measure the altitude of a star with a theodolite or sextant and artificial horizon, at not less than 35° above the horizon, and repeat his measurement at regular intervals, say, of three hours, during one complete rotation of the earth, and find the altitude to be the same at every observation, he would certainly be at an extremity of the earth's axis. Should time be pressing, instead of this somewhat lengthy operation he could take observations of different stars one after the other around the horizon, and then if, after applying corrections for refraction and instrumental errors, he found in each case the altitude to be the same as the declination of the star given in the Nautical Almanac or similar publication, he could conclude that he was exactly on a pole of the earth. The former of these two would be the more satisfactory method, because effects of refraction, which is very uncertain in high latitudes, would be eliminated.

But it is usually daylight when the explorer reaches his highest latitude, and the stars are not visible, so here is a practical difficulty in the way of either of these methods. Still, much the same plan could be followed with the sun. If an explorer is exactly at the pole the sun will pass round him in a circle in twenty-four hours, and the only change in its altitude will be due to the change in declination, which is given in the Nautical Almanac for every hour. Should it be found, then, during a series of observations of the sun extending throughout twenty-four hours, or over a number of hours, that the observations changed just the amount of the sun's change in declination for every hour, the only place where the observer could be would be at the pole.

If, instead of the altitude remaining the same, it should, during one rotation of the earth, be found to decrease for twelve hours and then increase for the other twelve, or *vice versa*, it is clear that the latitude would not be 90°, but its value could easily be computed from the observations.

As regards observations for time taken at or near the poles, the ordinary method of taking sets of altitude of east and west stars fails altogether, for the simple reason that the altitude remains practically the same at all times, and it is impossible to state the *exact* instant of time corresponding to a certain altitude. The only satisfactory method of rating a chronometer would be by taking transits of the sun or stars by a theodolite firmly fixed and left in position on a stand. Since all the meridians converge at the poles, there can be no difference of longitude, and another remarkable fact would be that an observer exactly over the North Pole would be facing south whichever way he turned, and this would interfere with his ordinary idea of bearings considerably.

There can be no doubt that the best instrument to take for accurate observations at or near a pole is a good transit theodolite, and altitudes below 30° or so should, if possible, be avoided. With a sextant and artificial horizon, a low altitude, such as 10° or 11° or below, is very satisfactory. In the first place, it is extremely difficult to make a contact at all, and then the image in the artificial horizon is usually greatly distorted, specially when a glass plate artificial horizon is used, silvered only on the back. But whether the observations are taken with a theodolite or sextant and artificial horizon, it is naturally impossible to expect any result that can be depended on unless a solid foundation exists upon which to level up the theodolite or place the artificial horizon.

To take advantage of the best conditions of the ice and ensure a safe return, a polar explorer endeavours to reach his highest latitude at an early date when the sun's declination is only a few degrees. Thus it was April 7, 1895, when Dr. Nansen arrived at 86° 12·3′ N., and April 25, 1900, when Captain Cagni, of the Duke of the Abruzzi's expedition, reached latitude 86° 34′ N., his farthest north; whilst the two explorers whose names are just now so prominent both announce that they discovered the North Pole in this month.

Although doubtless unavoidable for the reasons stated, these comparatively early dates of reaching high latitudes have great disadvantages so far as observations are concerned. The stars have disappeared, to be seen no more for five or six months, and the sun is so near the horizon, owing to its low declination, that the meridian altitude, upon the measurement of which the latitude usually depends, is not high enough to give a satisfactory result, owing to the uncertainties of the refraction correction, and, if a sextant and artificial horizon are used, to the great difficulty in making the observation at such a low altitude, and unavoidable distortion of the sun's image. For good results it is a maxim with geographical surveyors that no altitude should be taken that is less than 25° or 30°.

A meridian altitude of the sun only a little above 6°, which is what would be observed at the poles on April 6, or between 11° and 12°, which would be the amount for April 21, would not be likely to furnish a very exact latitude, even if taken with a first-rate instrument under favourable climatic conditions, much less so when these are not favourable and when the observations are made with the small portable instruments which alone can be carried by the explorer on a rapid dash to the pole, when every ounce of weight is a serious consideration.

Dr. Nansen, after leaving the *Fram*, took with him on his famous sledge journey a small altazimuth, with 4-inch circles, and a pocket sextant with an arc of $1\frac{3}{4}$ inches radius, both of which, by means of verniers, read to single minutes. It was with the pocket sextant, however, that his farthest north latitude observation was made, using the natural horizon, and he admits that the result cannot be depended upon to a minute or two

Captain Cagni observed with a sextant, and in referring to his farthest north latitude, which depended upon an altitude of about 12°, states that he used both the artificial horizon and the natural horizon, which latter was very distinct.

Coming now to the Antarctic regions, Captain Scott's expedition was well provided with instruments, but his highest latitudes on the southern journey were taken with a small theodolite. In the case of this expedition, the dates when the high latitudes were reached were later on in the summer, so that the sun's southern declination, and consequently its meridian altitude, was higher.

This same remark also applies to Mr. Shackleton's recent expedition, for on January 3, when the last observation on his long journey to the south was made, the sun's meridian altitude was about 25° 33′, which resulted in a latitude of 87° 22′, the further distance travelled south of this depending for its measurement chiefly on the sledgeometer, which throughout the journey had been found to agree well with the latitudes observed. On his journey Mr. Shackleton used a 3-inch transit theodolite, reading to single minutes, and the adjustment of which had been thoroughly tested. He also had the advantage of observing on *terra firma* instead of moving ice, so altogether his resulting latitudes doubtless compare very favourably, as regards accuracy, with those of other polar explorers.

As regards the effect of extreme cold on the refraction correction of the altitude, it may be interesting to note that, for an altitude of 11°, there is a difference of just above 1′ for a change of temperature from +50° to −60° F.

Sextant observations taken with a glass plate artificial on moving ice would be most untrustworthy, for, in addition to the probable sources of error already referred to, there may be slow oscillations of the water, tidal or other, that may affect the level of the reflecting surface considerably.

CHEMISTRY IN THE SERVICE OF THE STATE.

IT is generally known in chemical circles that Sir Edward Thorpe is relinquishing the post of principal chemist at the Government laboratory, which he has so ably held for the last fifteen years. In the closing paragraphs of the present report[1] he notes that it is the last document of the kind he will have the honour of submitting to the Treasury, and takes the opportunity of directing attention to the great increase which has occurred in the work of the laboratory during the period in question. It appears that the number of samples examined yearly is now more than double what it was fifteen years ago, the actual figures being 76,513 in the year 1894, and 176,935 in 1908–9.

Naturally there is not much of strictly scientific importance to be found in the record of an establishment devoted to "the daily round, the common task" of acting as chemical Abigail to all and sundry Government offices. Yet in its applications of chemical science to civic requirements Sir Edward's department touches the public welfare at many points; and in illustration of this some gleanings from the pages before us are not without interest. For statistics, in which the report abounds, the reader may be referred to the publication itself.

The business of the laboratory is subdivided into three main classes. Articles examined for the two great revenue departments, Customs and Excise, form by far the largest number of samples. A considerable amount of work, however, is submitted by other branches of the executive, especially the Board of Agriculture, the India Office, the Admiralty, the Board of Trade, and the Office of Works. Finally, samples, relatively few in number, but important as being objects of dispute in legal proceedings, are referred to the laboratory for examination under the provisions of the Sale of Food and Drugs Act and the Fertilisers and Feeding Stuffs Act.

In its *rôle* of revenue chemist, the laboratory is required to hold the balance fairly between the Exchequer on the one hand and the maker or importer of taxable commodities on the other. Alcoholic liquors, sugar, tobacco, tea, coffee, and chicory naturally furnish the greater number of samples for analysis, since they are the chief dutiable articles in this country. But in safeguarding the revenue derived from these products it is also necessary to analyse numerous other articles; thus the principal chemist remarks that "the duty on chicory involves the examination of many substances botanically allied to it, such as dandelion and burdock roots." Genuine cider, again, is not liable to import duty, but samples are analysed nevertheless; for "if evidence is found that spirit has been added," the cider comes under the tariff as a preparation containing spirit, and is taxed accordingly. It is noted that a large proportion —more than 13 per cent.—of certain beverages sold as temperance drinks contained an excess of alcohol, the quantity ranging from 3 to 11 per cent. of proof spirit.

Among other miscellaneous matters, an investigation into the character of the spirits usually sold to the labouring populace was undertaken. Such phrases as "adulterated, maddening liquor" are common in the mouth of the well-meaning but uninformed temperance enthusiast. The results of an impartial inquiry, however, lend no support to the charge of adulteration. Samples of whiskey, gin, rum, and brandy were purchased in the ordinary way

[1] Report of the Principal Chemist upon the work of the Government Laboratory for the Year ended March 31, 1909. Cd. 4771. Price 3*d*.

at public-house bars and retail counters in working-class neighbourhoods of London and the principal towns of the United Kingdom, as well as from the booths at fairs and markets in West of Ireland districts. "There was no evidence of any deleterious substance or adulteration of any kind," remarks the principal chemist.

The work done for "other Government departments" covered a very wide range of products. From gold-braid to African coinage; from cordite-jelly to poisoned trout, almost every conceivable variety of article was submitted for analysis. There is an account of feeding-stuffs sold by a firm of millers, and found to consist wholly of sawdust and gypsum; wherefore the millers were mulcted in heavy penalties. There is a story of "a firm of traders doing a considerable business" who were found practising extensive frauds with postage stamps. "Proof of the fraud was given by one of the chemists of the department, first at the Mansion House, and afterwards at the Old Bailey, where the accused persons were duly convicted and sentenced."

Glimpses of tragedy also appear here and there. Thus we read about the analysis of the air from an underground chamber in which a post-office employé had been asphyxiated; and about the examination of a paint which gave off certain fumes, and apparently brought about, indirectly, the electrocution of a workman.

Foodstuffs, of course, figure largely in the report. As regards imported butter, it would appear that the legal proceedings taken three or four years ago have had a beneficial effect in eliminating much of the adulteration that was then practised. A similar result is also recorded in respect of preservatives in cream.

The foregoing are a few examples indicating the nature of the year's work, though not altogether its scope. Questions of brewing and distilling, the use of duty-free alcohol in manufactures, the purity of tobacco, the sale of patent medicines, the efficacy of sheep-dips, the trustworthiness of disinfectants, the materials used in dangerous industries, water supply, and many similar matters were also dealt with, and are duly chronicled in the report.

In relinquishing his post, Sir Edward Thorpe can look back upon fifteen years of eminently useful service to the State. Large and conflicting interests are involved in the duties of his department; and to have held the scales evenly between the claims of the public services on the one hand, and the various sections of the trading community on the other, is no mean achievement. One question, however, suggests itself at this juncture. Is it any longer of public utility to retain the present grouping of what are really several laboratories under one head? Looking at what is done in other countries, should not the Board of Agriculture, for example, have its own separate chemical establishment, with a freer hand for investigation and development than is readily practicable under the present conditions?

C. S.

THE BRITISH ASSOCIATION AT WINNIPEG.

SUBJOINED is a synopsis of grants of money appropriated for scientific purposes by the general committee at the Winnipeg meeting. The names of members entitled to call on the general treasurer for the grants are prefixed to the respective research committees.

	£
Recommended by Council.	
Gill, Sir D.—Measurement of Arc in South Africa	100
Glazebrook, Dr. R. T.—Electrical Standards Report	100
Section A.—Mathematical and Physical Science.	
Turner, Prof. H. H.—Seismological Observations	60
Shaw, Dr. W. N.—Upper Atmosphere	25
Preece, Sir W. H.—Magnetic Observations at Falmouth	25
Gill, Sir David—Establishing a Solar Observatory in Australia	50
Section B.—Chemistry.	
Divers, Prof. E.—Study of Hydro-aromatic Substances	25
Armstrong, Prof. H. E.—Dynamic Isomerism	35
Kipping, Prof. F. S.—Transformation of Aromatic Nitramines	15
Kipping, Prof. F. S.—Electro-analysis	10
Section C.—Geology.	
Harker, Dr. A.—Crystalline Rocks of Anglesey	1
Gregory, Prof. J. W.—Faunal Succession in the Carboniferous Limestone in British Isles	10
Tiddeman, R. H.—Erratic Blocks	10
Lapworth, Prof. C.—Palæozoic Rocks	10
Watts, Prof. W. W.—Composition of Charnwood Rocks	2
Watts, Prof. W. W.—Igneous and Associated Sedimentary Rocks of Glensaul	15
Gregory, Prof. J. W.—South African Strata	5
Geikie, Prof.—Geological Photographs	10
Strahan, Dr. A.—Fossils of Midland Counties	25
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	15
Shipley, A. E.—Feeding Habits of British Birds	5
Vincent, Dr. Swale—Prairie Fauna	15
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
Ridgeway, Prof. W.—Neolithic Sites in Greece	5
Section I.—Physiology.	
Schafer, Prof. E. A.—The Ductless Glands	40
Sherrington, Prof. C. S.—Body Metabolism in Cancer	20
Hickson, Prof. S. J.—Table at the Zoological Station at Naples	25
Waller, Dr. A. D.—Electromotive Phenomena in Plants	10
Waller, Dr. A. D.—Anæsthetics	25
Starling, Prof. E. H.—Tissue Metabolism	25
Sherrington, Prof. C. S.—Mental and Muscular Fatigue	20
Starling, Prof. E. H.—Dissociation of Oxy-hæmoglobin	15
Section K.—Botany.	
Scott, Dr. D. H.—Structure of Fossil Plants	10
Darwin, Dr. F.—Experimental Study of Heredity	30
Blackman, Dr. F. F.—Symbiosis between Turbellarian Worms and Algæ	5
Johnson, Prof. T.—Survey of Clare Island	30
Section L.—Education.	
Magnus, Sir P.—Studies suitable for Elementary Schools	5
Corresponding Societies Committee.	
Whitaker, W.—For Preparation of Report	20
Total	1249

SECTION G.

ENGINEERING.

OPENING ADDRESS BY SIR W. H. WHITE, K.C.B., SC.D., LL.D., F.R.S., PRESIDENT OF THE SECTION.

ON the present occasion, when the meetings of the British Association for the Advancement of Science are held in the heart of this great Dominion, it is natural that the proceedings of Section G (Engineering) should be largely concerned with the consideration of great engineering enterprises by means of which the resources of Canada have been and are being developed and the needs of its rapidly increasing population met. It will not be inappropriate, therefore, if the Presidential Address is mainly devoted to an illustration of the close connection which exists between the work of civil engineers and the foundation as well as the development of British Colonies and Dominions beyond the seas.

British colonies and possessions have started from the sea-front and have gradually pushed inland. Apart from maritime enterprise, therefore, and the possession of shipping, the British Empire could never have been created. An old English toast, once familiar, but which has of late years unfortunately fallen into comparative desuetude, wished success to "Ships, Colonies and Commerce." A great truth lies behind the phrase: these three interests are interdependent, and their prosperity means much for both the Mother Country and its offspring. As colonies have been multiplied, their resources developed, and their populations increased, over-sea commerce between them and the Mother Country has been enlarged; greater demands have been made upon shipping for the over-sea transport of passengers, produce and manufactures; there has been a growing necessity for free and uninterrupted communication between widely scattered portions of the Empire, the maintenance of which has depended primarily and still depends on the possession of a supreme war-fleet, under the protection of which peaceful operations of the mercantile marine can proceed in safety, unchecked by foreign interference, but ever ready to meet foreign competition.

Now that our colonies have become the homes of new nations it is as true as ever that the maintenance of British supremacy at sea in both the mercantile marine and the war-fleet is essential to the continued existence and prosperity of the Empire. The trackless ocean supplies the cheapest and most convenient means of transport and intercommunication; continuous improvements in shipbuilding and marine engineering have abridged distances and given to sea-passages a regularity and certainty formerly unknown. It is a literal fact that in the British Empire the "seas but join the nations they divide." Every triumph of engineering draws closer the links which bind together its several parts. Greater facilities for frequent and rapid interchange of information of what is happening in all sections of the Empire and of knowing each other better should lead, and have led, to increased sympathy and a fuller realisation of common interest in all that affects the well-being of the Empire. Within the last few years the events of the Boer War have given remarkable proofs of the practical interest of the colonies in Imperial concerns and their readiness to share its burdens. The present year will always be remembered as that in which generous offers of assistance from the colonies in the task of strengthening the Royal Navy at a critical period have led to a conference the labours of which should produce important practical results and make our future secure. Organised cooperation between the Mother Country and the Dominions beyond the seas in the maintenance of an Imperial Navy adequate for the protection of vital interests is essential to that security; and, at last, there is a prospect that this end will be attained.

While claiming for the shipbuilder and marine engineer an important place in the creation and maintenance of the Empire, it is recognised that the work of other branches of civil engineering has been equally important. The profession of the civil engineer was described in the Charter granted to the parent institution in 1828 as "the art of directing the Great Sources of Power in Nature for the use and convenience of man; as the means of production and of traffic in States both for internal and external trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange; and in the construction of ports, harbours, moles, breakwaters and lighthouses; and in the art of navigation by artificial power for the purposes of commerce; and in the construction and adaptation of machinery and in the drainage of cities and towns." Since this description was penned there have been great and unforeseen developments in many directions, including those relating to improvements in the use of steam, the generation and practical applications of electrical power, the manufacture and extended employment of steel. The main ideas expressed eighty years ago, however, still remain applicable to the beneficent work of the civil engineer. His skill and enterprise, backed by adequate financial provision, are continuously being applied to improve and extend means of production, internal and external means of communication, inland and over-sea navigation, the use of mechanical power and appliances, the acceleration and cheapening of transport, the development and utilisation of natural resources, and the direction of the sources of power in nature for the use and convenience of man. One of the chief fields of engineering operations at the present time is to be found in the Dominion of Canada, the governing authorities of which have appreciated the fact that bold enterprise and generous financial provision for the execution of great engineering works are essential to the progress and prosperity of the country. Its vast extent, its magnificent lakes and rivers, its agricultural and mineral riches, its forests, its unrivalled water-power, and many other potential sources of future wealth and progress, furnish exceptional incentives and opportunities to the engineer. From an early period in the history of Canada this fact has been realised, and attempts have been made to utilise natural advantages; while the same policy has been energetically adopted since the Dominion was established forty-two years ago. It is impossible in this Address even to enumerate the great engineering works which have been accomplished or are in process of execution; and it might be thought impertinent if the attempt were made by one who has only an outside knowledge of the facts. On the other hand, it may be of interest to illustrate by means of Canadian examples the truth of the general statement that civil engineering has exercised and must continue to exercise great influence upon the well-being and development of the British Empire.

By the kindness of the High Commissioner of Canada, Lord Strathcona—who has himself done so much for the development of the Dominion, including a great part in the construction of the Canadian Pacific Railway—the writer has been favoured with official reports and statistics bearing on the subject. These have been freely used in the statement which follows.

The subject is so extensive and the time available for this Address so short that it will be necessary to omit detailed reference to important applications of engineering which are necessarily made, under modern conditions, in all great centres of population. Amongst these may be mentioned building construction, sanitation, water supply, heating, lighting, telegraphy, telephony, tramways, electric generating stations and their plant, and gas manufacture. No attempt will be made to deal with the important assistance given by engineers to the operations of agriculture, mining and manufacture, or to the utilisation of the splendid forests of the Dominion, although the demands for machinery and mechanical power are in these respects exceptionally great, owing to the sparseness of the population and the magnitude of the work to be done. Notwithstanding the large immigration and rapid increase of population, these demands will certainly continue and will probably become greater as the area under cultivation is increased, as manufactures are developed, and the natural resources of the country more largely utilised. The example of the United States places this anticipation beyond doubt, and demonstrates the great part which the engineer must continue to play in the development of Canada.

Even when the limitations described have been imposed upon the scope of this Address, the field to be traversed is a wide one: and without further preface an endeavour will be made to describe a few of the most important services which the engineer has already rendered to the Dominion and will render in the immediate future.

Railways.

It has well been said that the great problem of to-day in Canada is that of providing ample and cheap transport for her agricultural, mineral, and forest products from the interior to the sea, and so to the markets of the world. Important as inland navigation may be as an aid to this enterprise, it cannot possibly compare with railway development in actual and potential results. Apart from that development the one united Dominion must have remained a dream; thanks to the rapid and efficient intercommunication furnished by railways, widely scattered provinces are knit together in friendly and helpful union, literally by "bonds of steel" which stretch from the Atlantic to the Pacific, and reach farther and farther north each year. Regions which would otherwise have remained inaccessible and unproductive have been turned into new provinces, the fertility and future development of which it is not easy to forecast, and practically impossible to exaggerate.

In this department successive administrations (both Federal and provincial) have realised the facts and possibilities of the position, and have given substantial assistance to private enterprise in the execution of great engineering works. Progress in railway development has been remarkable since Federation was accomplished forty-two years ago. During the preceding thirty years the total railway mileage in operation had been raised to 2278 miles; in 1887 it was 12,184 miles; in 1897, 16,550 miles; in 1907, 22,452 miles. The number of miles of railway actually under construction in 1907 was officially estimated at 3000, exclusive of lines projected but not yet under contract. In 1906, when the lines in operation were 21,353 miles, it was estimated by competent authorities that the railways under construction, and projects for extensions likely to be carried into effect in the immediate future, reached a total of at least 10,000 miles, while probable further extensions of about 3500 miles were under consideration. Further, it was estimated that the capital expenditure required to complete these schemes would be about 60 millions sterling. These figures may need amendment, but there are others representing ascertained facts which equally well illustrate the magnitude of the railway interests of the Dominion.[1] The total capital invested in Canadian railways in 1907 was officially reported to be about 234,390,000*l.*; the aid given to railways up to that date by Dominion and Provincial Governments, and by municipalities, considerably exceeded 36,000,000*l.* sterling in money; the land grants from the Dominion Government approached 32 million acres, while the Provincial Governments of Quebec, British Columbia, New Brunswick, and Nova Scotia had granted about 20½ million acres. The Governments have also guaranteed the bonds of railway companies to the extent of many millions of dollars. The capitalisation per mile of railway lines owned by the Governments (amounting to 1890 miles) is reported as being 11,400*l.*; this is practically the same amount as that for Indian railways, that for the United States being 13,600*l.*, and for New South Wales and Victoria about 12,600*l.* For British railways the figure given is 54,700*l.* per mile. The freight carried by Canadian railways in 1907 amounted to nearly 63,900,000 tons (of 2000 lb.), which included about 14,000,000 tons of coal and coke, nearly 4,500,000 tons of ores and minerals, 10,250,000 tons of lumber and other forest products, nearly 7,900,000 tons of manufactures, and 2,309,000 tons of merchandise. In 1875, when 4800 miles of railway were in operation, the corresponding freight-tonnage was 5,670,000 tons; so that while the length of railway increased nearly 4·7 times, the tonnage increased nearly 11·3 times. During the same period passengers increased from 5,190,000 to 32,137,000. For twenty-eight railways making returns the average revenue per passenger per mile was 2·232 cents, and for the four principal railways was 2·07 cents. For freight fifty-nine railways showed an average rate of 2·328 cents per ton-mile, and for the five principal railways it was 0·702 cent per ton-mile. The average distance travelled by a passenger was 64 miles, the corresponding figure for the United States being 30·3 miles. The average distance a ton of freight was hauled was 183 miles, as against 132 miles for the United States. In Canada, as the official reporter remarks, there is a small amount of suburban railway traffic and a low density of population. The following table is taken from the official Canadian Railway Statistics for 1907:—

	For each mile of Railway	
	Population	Square miles of Territory
United States	381	13·61
United Kingdom	1,821	5·29
France	1,590	8·46
New South Wales	686	146·09
New Zealand	358	43·42
Victoria	360	25·89
India	10,119	61·09
Canada	289	161·8

Canada has therefore the highest mileage measured against population, and the lowest against territory.

The earliest great railway system of Canada, the Grand Trunk, had its beginnings in 1845; in 1907 it was working about 3600 miles within the Dominion. In association with the Government it is now engaged on the construction of the Grand Trunk Pacific Line, which will cross the Continent wholly in Canadian territory, and have a length of 3600 miles, exclusive of branches.

The story of the Canadian Pacific Railway is well known, and need not be repeated; the influence which its existence and working have had upon the prosperity of the Dominion has been enormous and beneficial since its opening in 1885, and experience of its effect has led to the promotion of other Trans-Continental lines. In June, 1907, the total length in operation was nearly 9000 miles, and the company owned in addition great lines of steamships employed on Atlantic and Pacific services.

The Canadian Northern Railway system represents one of the most striking examples of recent railway development in the Dominion. In 1907 it was working nearly 2600 miles in the North-Western provinces, about 150 miles in Ontario, 500 miles in the Province of Quebec, and 430 miles in Nova Scotia and Cape Breton, making a total of nearly 3700 miles. In 1908 its mileage on the main system was reported to have increased to nearly 3400 miles, and the total length in operation had become 4800 miles. The North-Western Provinces have given substantial assistance to this great system, and its promoters are said to aim at a complete Trans-Continental route, as well as the development of railway communication to Hudson's Bay and the establishment of a line of steamships therefrom to Great Britain.

Besides these three great railway organisations, which in 1907 controlled about 75 per cent. of the mileage in operation, there are a large number of smaller companies, making up a total of about 80. Their total earnings in 1907 amounted to 29,350,000*l.*, the total working expenses being 20,750,000*l.* Earnings from freight service were (in round figures) 19,000,000*l.*; from passenger service, 7,837,000*l.*; from express services, 655,000*l.*; from mails, 325,000*l.*, the balance coming from miscellaneous items. The total number of persons employed by the railways was 124,000; their salaries and wages amounted to 11,750,000*l.* It was officially estimated that if to the railway employees were added persons employed in factories for rolling stock and railway materials, as well as those engaged in the casual service and shipping, with an allowance for their families, "quite 25 per cent. of the population win their daily bread from the carrying trade" of the Dominion.

The equipment of the Canadian railways in 1907 included 3504 locomotives, 3642 passenger cars, and 113,514 freight cars. In the opinion of the official reporter on railway statistics, based chiefly on a comparison of the proportion of rolling stock to mileage in Canada and the United States, a considerable increase of rolling stock is required, and there is a possibility of greater efficiency being obtained in the utilisation of existing freight cars. The manufacturing resources of the Dominion are declared to be fully capable of meeting all requirements, as in 1907 they produced 227 locomotives, 397 passenger cars, and 13,350

[1] Most of these statistics are taken from the valuable Report for 1907, presented to the Minister of Railways and Canals by Mr. Butler, Deputy Minister and Chief Engineer of the Department.

freight cars. A reduction of grades and curvatures has been carried out on the principal railways in recent years, and this has permitted the hauling of heavier loads. It is estimated that in 1907 the average earnings per ton of freight hauled were 1·472 dollars, and the average earnings per passenger carried were 1·219 dollars. The earnings per train mile were 1·953 dollars, and the working expenses 1·381 dollars. The total earnings per mile of railway were 6535·64 dollars, and the working expenses were 4620·9 dollars. The working expenses were divided as follows in the official report:—

	Per cent.
Maintenance of way and structures ...	20·13
,, ,, equipment ...	20·88
Conducting transportation ...	55·25
General expenses ...	3·74

Allowing two cords of wood fuel to be equal to one ton, 5,609,000 tons of fuel—of which 5,578,000 tons were coal—were consumed by Canadian railway locomotives in 1907 in running 100,155,000 miles. The total cost was about 3,027,500*l.*, equal to 14·59 per cent. of the working expenses.

From this brief summary of facts some idea may be gained of the rapid development of Canadian railways, their immense capital value and traffic, and the remarkable influence they have had upon the progress and population of the Dominion. It is a matter for satisfaction that British capital and engineering skill have contributed in no small measure to produce this development, and it may be hoped that in the future they may render even greater service.

Inland Navigation.

The most important system of inland navigation which Canada possesses is primarily due to the existence of the Great Lakes and the St. Lawrence River; but the utilisation of these natural advantages and the construction of a continuous navigable channel from the sea to the head of Lake Superior is due to the work of engineers. The importance of such a navigable waterway leading to the heart of the Dominion was recognised long ago by the Government. The first canal is said to have been opened in 1821, and from that time onwards the canal system has been developed, but the greatest progress has been made during the last forty years under successive Administrations. Up to March 31, 1907, the capital expenditure on Canadian canals, exclusive of outlay by the Imperial Government, has approached 18,350,000*l.* sterling, of which more than ten millions have been spent on enlargements. Besides minor canal systems, many of which are important, a great "trunk system" of water-transit has been created from Montreal to Port Arthur, at the head of Lake Superior, this all-water route being nearly 1300 miles in length, having a minimum depth of water of 14 feet and effecting a total vertical rise of about 600 feet from tidal water in the St. Lawrence to Lake Superior. In order to effect this rise forty-nine locks are provided, most of which are 270 feet long and 45 feet wide, enabling vessels 255 feet long to be accommodated. Out of the total length of more than 1200 miles, only 73½ miles consist of artificial channels. The Welland Canal, connecting Lakes Erie and Ontario—with a total rise from lake to lake of 327 feet, effected in twenty-five locks—is 26¾ miles long. This canal dates from 1824; its enlargement to present dimensions was begun in 1872, and occupied fifteen years; the total expenditure on the canal has been nearly five and a half millions sterling. Another important section of the waterway is the Sault Ste. Marie Canal—about 6000 feet in length and from 142 to 150 feet wide between the pier-ends, with a lock 900 feet long, 60 feet wide, having 20¼ feet of water over the sills. The difference of level between Lakes Superior and Huron is 18 feet. Commenced in 1888, the Sault Ste. Marie Canal was opened for traffic in 1895, the cost being about 930,000*l.* Like its predecessor on the United States side of St. Mary's River—the so-called "Soo" Canal affords *free passage* for the ships of both countries. In 1898 about two and three-quarter millions represented the tonnage of vessels passing through the Canadian Canal, and of this total about 403,000 tons was in Canadian vessels. In 1907 the total tonnage had risen to 12,176,000 tons, of which 2,288,000 was in Canadian vessels. The Soulanges Canal is fourteen miles long, with a rise of 84 feet effected in four locks. Commenced in 1892, it was opened for traffic in 1899, and cost nearly 1,400,000*l.* The Lachine Canal was commenced in 1821, enlarged in 1843 and 1873, and, as completed in 1901, is 8½ miles long, has 45 feet rise, effected in five locks, and has cost from first to last about 2,300,000*l.*

In the construction of this great waterway many difficult engineering problems have been solved, and every modern improvement has been introduced; electricity has been utilised in its equipment, both for power and lighting, so that navigation can proceed by night as well as by day. For the years 1903–7 the canals were declared *free of tolls*; but it is estimated officially that if tolls on the ordinary scale had been collected the revenue for 1907 would have exceeded 91,000*l.* In these five years the water-borne traffic of the Dominion increased from 9,204,000 tons in 1903 to 20,544,000 tons in 1907; in the same period the increase in Canadian railway traffic was from 47,373,000 tons to 63,866,000 tons. The official reporter justly remarks that "these results are exceedingly encouraging."

It was recognised long ago that the utilisation of the waterways of Canada from the Great Lakes to the sea would yield considerable advantages by facilitating cheap transport of agricultural products of the fertile regions from the great North-West, but the Canadian portions of that territory were then regarded as "a great lone land." Subsequent developments of the corn-growing regions of Canada have emphasised the value of the water route and its great potentialities. In his "History of Merchant Shipping" (published 1876) Lindsay dwelt upon this point, and foresaw that if the waterways of Canada were made continuously navigable a struggle for supremacy in oversea trade must arise between New York and the Canadian ports of Montreal and Quebec. This struggle is now in full force, so far as the grain trade is concerned, and it is likely to grow keener. The quantity of grain passed down the whole length of the St. Lawrence navigation to Montreal increased from about 450,000 tons in 1906 to 685,000 tons in 1907, while the quantity carried to Montreal by the Canadian Pacific Railway was about 387,000 tons for 1906 and 384,000 tons for 1907. On the other hand, the quantity carried by canals in the United States to New York fell from 294,500 tons in 1906 to 230,800 tons in 1907.

An important addition to the Canadian canal system has been proposed, and its execution will probably be undertaken when great works now in progress have been completed. This route extends from Georgian Bay on Lake Huron to the St. Lawrence, and would utilise Lake Nipissing as well as the French and Ottawa rivers. The distance to be traversed would be 450 miles, less than that of the present all-water route. On the basis of careful surveys it has been estimated that a canal having 20 feet depth of water could be constructed at a cost of twelve millions sterling, upon which capital a reasonable dividend could be paid, even if the charges made for transport were one-third less than the lowest rates of freight possible on United States routes to New York. It would, of course, be most advantageous to have the available depth of water increased from 14 to 20 feet, thus making possible the employment of larger and deeper draught vessels between the Lakes and Montreal. Considerable economies in the ratio of working expenses to freight earnings would be effected, break of bulk in transit to the sea would be avoided, and the cost of transport greatly reduced.

The magnitude of the grain trade and its growth may be illustrated by the following figures for recent years:—In 1897 the grain cargoes passed down the Welland Canal to the ports of Kingston and Prescott numbered 377, and represented 515,000 tons; for 1907 the corresponding figures were 518 cargoes, weighing 841,000 tons. As to the elevators and mechanical appliances for handling economically these huge quantities of grain, nothing can be said here, although they involve the solution of many difficult engineering problems and have been greatly simplified and improved as experience has been gained.

The bulk of the canal traffic, of course, moves eastwards and outwards from the interior provinces. For example, of the total quantity of freight (1,604,321 tons) passed through the whole length of the Welland Canal in 1907, about 75 per cent. moved eastwards, and more than 62 per cent. of the 2,100,000 tons which passed through the St. Lawrence canals moved in the same direction.

Shipping on the Great Lakes.

Canadian shipping and shipbuilding on the Lakes have made considerable progress in recent years, although they do not rival those of the United States. According to authoritative statements there were not twenty Canadian steamers engaged in the transport of grain fifteen years ago; only three of these were steel-built, and the largest carried only 90,000 bushels. The total carrying capacity of Canadian grain-carriers at the present time has been estimated at ten million bushels, and the capital invested in the fleet is said to be about three millions sterling. Between the harvest and the close of navigation in winter it is estimated that no fewer than sixty million bushels of grain can be moved from port to port in Canadian steamers.

Many special engineering features have been introduced into the structures and equipment of these Lake grain-carriers. They are really huge steel barges of full form, of uniform cross-section for a considerable portion of their length; and they possess enormous cargo capacity, moderate engine power and speed, with structures of a simple nature which can be largely standardised and made to resemble bridge-construction rather than ordinary shipbuilding. They can be built in a short time, the largest vessels occupying about four months in construction. In this way the cost of construction is cheapened, but the rates for labour and materials prevailing in the Lake shipyards are so high relatively to British costs that at present these grain-carriers are said to cost about 40 per cent. more (per ton dead weight carried) than the cost of ordinary "tramp" steamers built in Great Britain. Their holds and hatchways are arranged so as to facilitate the rapid shipment and discharge of cargoes. At their ports of call special mechanical appliances are provided for dealing with cargoes, most of which consist of grain, ore, or coal.

In the design and construction of these cargo-handling appliances the mechanical engineer has displayed great ingenuity, and the results obtained in rate of shipment and discharge of cargoes of grain, ore, and coal are remarkable. Cases are on record where vessels carrying 7000 tons dead weight have been loaded in four hours and discharged in ten hours; more than 5000 tons of ore have been discharged in about four hours. The draught of water of the steamers must be kept within moderate limits and the breadths of the locks are moderate, so that increase in carrying power must be chiefly obtained by increase in length; consequently, as individual cargoes are increased, a greater number of lifting appliances can be brought to bear simultaneously, and the rate of loading or discharge can be maintained or accelerated.

The season of navigation extends over only seven or eight months in the year; consequently, "quick despatch" is essential to success. A large vessel of this class has the following approximate dimensions:—Length, about 600 feet; breadth, 58 to 60 feet; depth, 32 feet; draught of water, 19 to $19\frac{1}{2}$ feet when carrying 10,000 to 11,000 tons of cargo; corresponding displacement, 16,000 tons. The engines of such a ship develop about 2000 horse-power, and drive her at eleven to twelve statute miles per hour in fair weather. The large size and moderate speed result in very economical conditions of working, and the freight rates are exceedingly low. From official returns it appears that for these dead-weight cargoes the freight per ton mile across the Lakes is from 0·04 to 0·05 of a penny per ton mile, the corresponding railway rate being about ten times that amount. The multiplication of this type of vessel on the great Lakes is a proof that it satisfactorily fulfils the conditions of service. Similar vessels would not be well adapted for ocean work, which demands greater structural strength, different proportions, and a more liberal equipment; but shipbuilders generally may benefit from a study of the Lake steamers.

The greater portion of the traffic on the Lakes passes through the "Soo" canals. The voyages are comparatively short, the average length of the trip being about 840 miles. Consequently, individual vessels make several passages during the season when navigation is open, and the total number of passages as well as the total aggregate tonnage of the ships reaches very high figures. In the season of 1907, for example, when the canals were open less than 240 days, 20,440 vessels (counting as a vessel each passage), with an aggregate registered tonnage exceeding 44 million tons, passed through the United States and Canadian canals at the Soo. The aggregate freight tonnage carried exceeded 58 million tons; the weight of coal approached $11\frac{1}{2}$ million tons; the iron ore carried weighed 39,600,000 tons; and the grain transported amounted to 136 million bushels. The conditions of the Suez Canal are, of course, entirely different, as vessels passing through are engaged on long voyages, and individual ships make few passages in the year. On the other hand, Suez Canal traffic proceeds uninterruptedly throughout the year, while the Soo canals are closed during the winter months. Subject to these differences in working conditions, it may be of interest to state that in 1907 4267 vessels of 14,728,000 tons passed through the Suez Canal, and paid transit dues which amounted to 4,460,000*l.*; whereas the passage of the "Soo" canals was free.

The St. Lawrence Ship Channel.

Closely allied with the waterway from Montreal to Lake Superior is the improvement of the channel of the St. Lawrence from Montreal to Quebec and beyond towards the sea. From the Straits of Belleisle to Montreal the distance is 986 miles; from Quebec to Montreal it is 160 miles. Formerly the minimum depth of water between Quebec and Montreal prevented the passage of vessels drawing more than 10 to 12 feet during the greater part of the season of navigation. In 1826 the question of deepening the river channel was raised; in 1844 the work was begun, but was abandoned three years later; in 1851 it was resumed, and has since been continued. In 1869 the minimum depth of the channel at low water was increased to 20 feet, in 1882 it was 25 feet; in 1888 $27\frac{1}{2}$ feet for 108 miles from Montreal to a point within tidal influence. A channel having a minimum width of 450 feet, and 550 to 750 feet wide at the bends, with a minimum depth of 30 feet, was completed in 1906 from Montreal to tide water at Batiscan. Certain work remains to be done between this point and Quebec in order to complete the project adopted in 1889 and amended in 1906, but it is anticipated this will be finished in about four years. Below Quebec the channel is 1000 feet wide. When once dredged it is stated that the channel remains permanent. Accidents in the channel are few. The Superintending Engineer in his Report of July, 1908, indicates the magnitude of the work done by comparisons with the Suez and Panama Canals, the figures standing as follow:—

	Length Miles	Minimum depth Feet	Minimum breadth Feet	Estimated excavation Cubic yards
Suez Canal	100 ...	$29\frac{1}{2}$	100 (bottom)	—
Panama Canal	49 ...	41	200 (min.) 500 (max.)	80,000,000
St. Lawrence Channel.	220[1] ...	30	450 (min.) 1000 (max.)	70,000,000

In 1844 the largest vessels navigating the St. Lawrence to Montreal were of 500 tons; now the *Virginian* and *Victorian* of the Allan Line (12,000 tons), and the *Laurentic* and *Megantic* of the White Star Line (15,000 tons), proceed to that port, and have made the passage from Quebec in less than ten hours. Ordinarily, this passage occupies eleven to twelve hours, the return passage being made in nine to ten hours.

In the execution of these great works a specially designed dredging plant, including several types, has been employed, and works about seven months in the year; and the rock dredging and blasting in the section below Quebec has involved great difficulty. The total amount of rock to be removed amounted to 1,700,000 cubic yards, extending over nearly three miles, and the whole bottom was covered with huge boulders, some of which were 30 to 40 tons in weight. These great masses had to be lifted before blasting and dredging was done. During the fiscal

[1] Length of channel requiring improvement demands dredging and excavation over a length of about 70 miles.

year 1907–8 the expenditure on dredging plant and dredging was nearly 132,000*l.*, and 4,832,000 cubic yards of material were removed. At the close of that year 56 millions of cubic yards out of the estimated total of 70 millions had been dredged; the length completed to 30 feet minimum depth was 59 miles out of 70 miles. These facts indicate the advanced condition of the undertaking and the prospect of its completion at an early date.

In order to secure the safe and continuous navigation of this channel by night as well as by day, under all conditions of weather, during the season when the river is open every precaution and aid which engineering skill and invention can provide has been laid under contribution. A marine signal service with telephonic equipment has been provided; submarine bells have been established for use in foggy weather; a complete system of buoys and lighting has been installed; the channel is periodically examined and swept to ensure that there are no obstructions; the question of prolongation of the season for navigation by the use of ice-breakers is being studied. The harbour of Montreal has been greatly improved in accommodation and equipment, and the aggregate tonnage as well as average size of sea-going vessels using the port have been much increased. In 1898, 868 such vessels aggregating 1,584,000 tons arrived at Montreal; in 1907, 742 vessels aggregating 1,926,000 tons arrived. Of the latter, 522 vessels aggregating 1,525,000 tons were British. At the St. Charles Docks and Wharves, Quebec, in the season of 1907, 235 vessels of 1,009,000 tons were entered inwards, and 67 vessels of 249,000 tons outwards, the first outward steamer leaving on April 7, and the first ocean steamer arriving on April 26. The last arrival from the sea was on December 9, and the ice formed in the tidal basin on December 12.

Still further improvements of the St. Lawrence navigation are now proposed, and the work was commenced in 1907. It is intended to increase the depth of the channel to a minimum of 35 feet from the sea to Montreal, and the Superintending Engineer reported in 1908 that, with certain moderate additions to the dredging and steam plant, this work could be completed in six seasons. The widths and curves of the existing channel will not require any important changes, as they were designed from the first for the largest classes of steamships. When this increased depth has been obtained Montreal as a port will have an approach channel comparing favourably with that of other ports available for Transatlantic traffic. At Southampton the existing depth at low water in the approach channel is about 32 feet, and it is proposed to obtain 34 feet. At Liverpool the minimum depth at low water over the bar and in the approach channel in the Mersey is about 28 feet. The Ambrose Channel leading to New York is to have 40 feet depth at low water when the works are completed. Ample depth of water is of the first importance in the economical working of the largest and swiftest ships, and the Canadian Government has been well advised in deciding to carry out the great scheme above described.

Water-power.

Canada has unrivalled resources in water-power, and its extent and possible utilisation have been made the subject of investigation by engineers for many years past. One of the most important memoirs on the subject was presented to the Royal Society of Canada in his Presidential Address of 1899 by Mr. Keefer, C.M.G. In recent times many other engineers have studied the subject and carried out important works. Exact knowledge of the total power represented by the waterfalls and rapids of the Dominion is not available, nor can any close estimate be made of the power which may be employed hereafter in factories, mills, or industrial processes, because profitable employment obviously depends upon commercial considerations, which must be governed largely by the localities in which water-power may be found, and the cost of works and of transmission of energy to places where it can be utilised. It has been estimated that on the line from Lake Superior through the chain of lakes and rivers leading to Niagara and thence through the St. Lawrence to the sea eleven millions horse-power may be developed.[1] Mr. Langelier has estimated that in the Province of Quebec the water-power aggregates more than eighteen millions horse-power; other provinces all possess large resources of the same kind as yet untouched. The most striking example of the utilisation of water-power is that on the Niagara River, which I had the good fortune to visit in 1904, during my Presidency of the Institution of Civil Engineers; the works on the Canadian side were then in full progress, and at a stage which enabled one to realise completely their great difficulty and immense scale. The three companies the works of which are near the Falls on the Canadian side have provided for a total ultimate development of more than 400,000 horse-power, and a fourth establishment lower down the river, intended chiefly for the use of Hamilton, is to develop 40,000 horse-power. In the construction of the works, in the electric generating plant, the arrangements for transmitting power over long distances, and other features of importance remarkable engineering skill and daring have been displayed. American capital and enterprise have had much to do with these undertakings, as they have with many other important Canadian enterprises; but it may be hoped that British capital will keep its lead and be freely employed in the development and utilisation of all the resources of the Dominion, including that magnificent asset its water-power. The applications of water-power are already very numerous, including, not merely the creation of electrical energy and its use for lighting and power in towns and factories situated at considerable distances from the Falls, but for manufactures and industrial processes carried on near the Falls. Amongst these manufactures, that of aluminium and carbide of calcium may be mentioned, while paper- and pulp-mills and saw-mills constitute important industries. Great advances have been made in the transmission of electrical power over long distances, and very high pressures are being used. Electric traction on railways and tramways also derives its power from the same sources, and is being rapidly developed. In 1901 there were 553 miles of electric railways, and in 1907 815 miles.

[1] The *Times Financial Supplement*, April 2, 1906, contains a valuable article on this subject, from which many of the above figures are taken.

Over-sea Trade and Transport.

It was remarked at the outset that a great truth is embodied in the old toast of "Ships, Colonies, and Commerce," and the efficient and economical transport of passengers, produce, and manufactured goods between the Dominions beyond the Seas and the Mother Country is essential both for the development of Colonial resources and for the continued prosperity of the United Kingdom. The British mercantile marine commands the larger portion of the carrying trade of the world; its earnings constitute a valuable item in the national income; it forms one of the strongest bonds of union between the various parts of the Empire. This general statement may be illustrated by reference to the over-sea trade of Canada and to the shipping engaged therein.

The total value of the Imports and Exports of the Dominion in 1898 was close upon 61 millions sterling; in 1908 it exceeded 130 millions sterling, having more than doubled within ten years. During the year ending March 31, 1908, the vessels which were entered at Canadian ports (*inwards from the sea*) carrying cargoes were classified as follows in the official returns:—

Ships		Tons register	Freight carried: Tons weight	Freight carried: Tons measurement	Crews
British ...	2,603	4,539,256	1,306,822	254,373	165,078
Canadian..	2,803	718,490	202,939	1,449,054	44,594
Foreign ...	2,878	1,758,549	887,154	36,618	86,293
Totals......	8,284	7,016,295	2,396,915	1,740,045	295,965

The corresponding figures for ships entered outwards for sea carrying cargoes were:—

Ships		Tons register	Freight carried: Tons weight	Freight carried: Tons measurement	Crews
British ...	2,533	4,258,960	2,706,334	714,085	136,614
Canadian..	3,557	1,041,053	616,248	291,480	45,658
Foreign ...	4,132	2,211,605	1,454,787	538,499	88,093
Totals......	10,222	7,511,618	4,777,369	1,544,064	270,365

Taking the combined over-sea traffic inwards and outwards, it employed 18,506 ships of 14,528,000 tons, the cargoes of which aggregated 7,174,000 tons dead-weight and 3,284,000 measurement tons, the crews exceeding 576,000 officers and men.

Of the 2603 British ships entered inwards, there came from Great Britain 852 ships of 3,392,000 tons, carrying as cargoes more than 860,000 tons dead-weight and 153,000 tons measurement; while there came from British Colonies 399 ships of nearly 381,000 tons, carrying cargoes of 236,000 tons dead-weight and 44,000 tons measurement. Of the 2533 British ships entered outwards, there proceeded to Great Britain 732 ships of 2,529,000 tons, carrying cargoes of 1,635,000 tons dead-weight and 509,000 tons measurement; while there sailed for British Colonies 648 ships of nearly 400,000 tons, carrying cargoes of 259,000 tons dead-weight and 76,500 tons measurement.

It will be seen, therefore, that the British ships entered inwards carried more than 54 per cent. of the total dead-weight cargoes and 14½ per cent. of the measurement goods, while foreign ships carried about 37 per cent. of the dead-weight and rather more than 2 per cent. of the measurement goods. British ships entered outwards carried more than 56 per cent. of the total dead-weight, and more than 46 per cent. of the measurement; whereas foreign ships carried only about 30 per cent. of the dead-weight, and not quite 35 per cent. of the measurement.

The trade from and to ports in the British Empire amounted to 45 per cent. of the grand total dead-weight freight; and ships carrying the British flag—excluding Canadian vessels—carried about 56 per cent. of the grand total dead-weight, and nearly 30 per cent. of the measurement goods. Including Canadian vessels, the British Empire can claim possession of 67½ per cent. of the total dead-weight trade, and 82½ per cent. of the measurement goods. The average tonnage per ship for the British was about 1700 tons; for the Canadian vessels less than 300 tons; for the foreign ships a little more than 900 tons.

It may be interesting to add a few figures showing the magnitude of the *coasting trade* of the Dominion. In 1908 there arrived and departed 104,527 steamers aggregating nearly 42,857,000 tons, and 50,710 sailing ships aggregating 7,673,000 tons. The sailing ships included nearly 50,200 small schooners, sloops, barges, canal boats, &c., averaging about 150 tons each. The grand totals for the coasting trade were 155,237 ships of 50,530,000 tons, and of these 151,873 ships of 47,356,000 tons were classed as British in the official returns. It will be obvious that great importance must attach to every detail of the business involved in carrying on a shipping trade of the magnitude indicated by the foregoing figures, and still more is this the case in regard to the immensely greater transactions of British shipping considered as a whole. No pains must be spared in promoting economy or improving procedure, and even minute savings on particular items must be secured, since their aggregate effect may be of vast amount.

Since the introduction of iron for the structures of ships and of steam as the propelling power marvellous economies have been effected in the cost of over-sea transport. The chief causes contributing to this result have been (1) improvements in steam machinery, leading to great reductions in coal consumption; (2) considerable enlargement in the dimensions of ships; and (3) the supersession of iron by steel for structures and machinery. It is unnecessary, and would be impossible on this occasion, to deal in any detail with these matters, which have been illustrated repeatedly by many writers, including the speaker. On the other hand, it would be improper to leave altogether without illustration the remarkably low cost of sea transport under existing conditions, since it has great influence on the commerce of the British Empire and of the world.

Rates of freight, of course, vary greatly as the conditions of trade and the stress of competition change. At the present time these conditions remain unfavourable, although it may be hoped that there are signs of improvement, after long and severe depression. It will be preferable, therefore, to give facts for more normal circumstances, such as prevailed five or six years ago. Coal was then carried from the Tyne to London (315 miles) for 3*s.* 3*d.* a ton; to Genoa (2388 miles) for 5*s.* a ton; to Bombay (6358 miles) for 8*s.* 6*d.* a ton, including Suez Canal dues. The corresponding rates of freight were 0·111, 0·025, and 0·016 of a penny per ton-mile.

Grain was brought across the Atlantic for 9*d.* per quarter in large cargo steamers, whereas in former times, when it was carried in small vessels, the charge was 9*s.* 6*d.* Goods were carried 6400 miles eastward *viâ* the Suez Canal in tramp steamers at an inclusive charge of 25*s.* to 30*s.* a ton, the freight rate averaging about 0·05 of a penny per ton-mile. It was estimated at that time that the average railway rate per ton-mile in Great Britain for cost of transport and delivery of goods was about thirty times as great; but the moderate distances travelled, local and national taxation, high terminal charges, and the immense outlay involved in the construction, equipment, and maintenance of railways account for much of the great difference in cost of transport. The ocean furnishes a free highway for the commerce of the world.

Economy of fuel-consumption has played a great part in the reduction of working expenses in steamships. Fifty years ago from 4 to 5 lb. of coal per indicated horse-power represented good practice in marine engineering for screw steamships. At present, with quadruple expansion engines, high-steam pressures, and more efficient reciprocating engines from 1¼ to 1½ lb. is common practice, and better results are claimed in some cases. A cargo steamer of the tramp type, carrying 6500 tons dead-weight, can cover about 265 knots in twenty-four hours in fair weather for a coal consumption of 27 tons per day, representing an expenditure on fuel of 20*l.* to 25*l.* A larger vessel carrying about 12,000 tons dead-weight, driven by engines of similar type, would consume about 45 tons in covering the same distance at the same speed. This increased economy in fuel per ton-mile is the result of an increase in dimensions from 365 feet length, 47 feet breadth, and 24½ feet draught of water to a length of 470 feet, a breadth of 56 feet, and a draught of 27½ feet. The first cost of cargo steamers is small in relation to their carrying capacity and possible earnings, varying, of course, with the current demand for new steamships. In the present depressed condition of shipping, about 5*l.* 10*s.* per ton dead-weight is named as a current rate; in busy times the price may be 40 to 45 per cent. higher; even then it is small in proportion to earning power. Working expenses are kept down also by the use of efficient appliances for rapidly shipping or discharging cargoes, and so shortening the stay of ships in port. As an example a case may be mentioned when a ship of 12,000 tons dead-weight and 800,000 cubic feet measurement capacity had her full cargo discharged at an average rate of 300 tons an hour, a fresh cargo put on board at the rate of 250 tons an hour, and 1600 tons of coal shipped between 7 a.m. on Monday and noon on the following Friday—that is, in 101 hours. In another case a cargo weighing 11,000 tons was discharged in 66 hours. "Quick dispatch" in dealing with cargo is now universally recognised as essential, and it has been asserted that a saving of one day in discharging or loading a tramp steamer when she finds full employment may involve an expense equal to 1 per cent. on her first cost.

The "intermediate" type of steamer—in which large carrying capacity is combined with provision for a considerable number of passengers and moderate speed—is of comparatively recent date, but it has been developed rapidly and is subject to the universal laws to which all classes of shipping conform. Increase of size is adopted in order to favour economy in working and greater earning power, while increase in speed is made in some cases. Vessels like the *Adriatic* or *Baltic* of the White Star Line, the *Carmania* and *Caronia* of the Cunard Line, and the *George Washington* of the Hamburg-American Line illustrate this statement; while its latest and greatest examples are found in the two steamers now building for the White Star Line by Messrs. Harland and Wolff, which are said to be of 45,000 tons, to be intended to steam twenty to twenty-one knots, to provide accommodation for a great number of passengers, and to have large capacity for cargoes. In mail and passenger steamers of the highest speed increase in dimensions is devoted chiefly to provision for more powerful propelling apparatus and for a correspondingly large quantity of fuel, and the cargo-carrying capacity is relatively small; but the law of increase in size and cost is obeyed, and will be followed up to the limit which may be fixed by the vast outlay necessary in order to provide suitable harbours and dock accommodation with an adequate depth of water, or by commercial considerations and the possibility of securing a suitable return on the large capital expenditure. Growth in dimensions of ships will not be determined by the naval architect and marine engineer finding it impossible to go further, for there are even now in view possibilities of further progress if the shipowner so desires. Invention and improvement have not reached their ultimate limits.

The wonderful progress made during the last seventy years is well illustrated by the history of shipping trading between Canada and Great Britain, and it may be of interest to recall a few of the principal facts. For a long period trade and communications were carried on by wood-built sailing ships, many of the finest being Canadian built; but at a very early period Canadians had under consideration the use of steamships. One of the first steamers to cross the Atlantic was the *Royal William* paddle-steamer, built near Quebec in 1831. She was 160 feet long, 44 feet broad, of 363 tons burden, sailed from Quebec on August 5, 1833, and reached Gravesend on September 16, a passage of more than forty days, in the course of which sail-power was largely used. Cabot, in 1497, crossed in the good ship *Matthew*, of 200 tons burden, which was probably from 90 to 100 feet in length; so that three centuries of progress had not made very great changes in size of the ships employed. Wood was still the material of construction, and sails were still used as a motive power, although the steam-engine was installed. In 1839 it was a Canadian, Samuel Cunard, who secured—in association with two British shipowners, Burns and McIver—the contract for a monthly Transatlantic service from Liverpool to Halifax and Boston. The four steamers built were wood-hulled, driven by paddle-wheels, had good sail-power, and were of the following dimensions:—207 feet long, $34\frac{1}{2}$ feet broad, 1150 tons burden, and about eight knots speed. A rapid passage to Boston then occupied about fourteen days.

Another Canadian enterprise, the Allan Line, started about fifty-six years ago. The first steamer built for the company was appropriately named the *Canadian*. At the time of her construction she ranked among the most important mercantile steamers in existence, and was quite up to date. Her dimensions were:—length, 278 feet; breadth, 34 feet; burden, 1873 tons. She had inverted direct-acting engines, driving a screw propeller, and a full sail equipment.

The Transatlantic service to New York, as was natural, rapidly surpassed that to Canadian ports, but the latter has been continuously improved, and its development has been marked by many notable events. For example, the Allan Line was amongst the first to use steel instead of iron for hulls, and in their two largest steamers now on service, dating from 1903, they were the first to adopt steam turbines for ocean-going ships, although their lead of the Cunard Company was not long. The *Virginian* and *Victorian* are 520 feet long, 60 feet broad, of 10,750 tons, and their maximum speed is 18 knots. The Canadian Pacific Railway authorities added shipowning to their great land enterprises at an early period in their career by building for the Pacific service in 1891 three important steamers, each 456 feet long, 51 feet broad, of 5950 tons, and 17 knots speed. These vessels continue on service, and have done splendid work as a link in the "all red" route. Since this step was taken the Canadian Pacific Railway has become possessed of a large fleet of Atlantic steamships, and quite recently has placed on the service from Liverpool to Quebec passenger steamships nearly 550 feet in length, 66 feet in breadth, of 14,200 tons, with a maximum speed of 20 knots.

The latest addition to the Canadian service has been made by the White Star Line in the form of two steamers, the *Laurentic* and *Megantic*, of 15,000 tons, 550 feet long, about 67 feet broad, and 17 knots speed. In the *Laurentic* an interesting experiment has been made—Messrs. Harland and Wolff having introduced a combination of reciprocating engines and a low-pressure turbine. This system was patented as long ago as 1894 by Mr. Charles Parsons, to whom the invention of the modern steam turbine and its application to marine propulsion are due. Mr. Parsons foresaw that while the turbine system would prove superior to reciprocating engines in ships of high speed and with a high rate of revolution, there would be a possibility of getting better results by combining reciprocating engines with low-pressure turbines in ships of comparatively slow speed, where a low rate of revolution for the screw-propellers was necessary to efficient propulsion. His main object, as set forth fifteen years ago, was "to increase the power obtainable by the expansion of the steam beyond the limits possible with reciprocating engines," and subsequent investigations led Mr. Parsons to the conclusion that it would be possible to secure an economy of 15 to 20 per cent. by using the combination system as compared with that obtainable with efficient types of reciprocating engines. Many alternative arrangements have been designed for combining reciprocating engines with low-pressure turbines; that now under trial associates twin-screw reciprocating engines, in which the expansion of the steam is carried down to a pressure of 9 to 10 lb. per square inch when working at maximum power, and then completed to the condenser pressure in a turbine. Triple screws are employed, the central screw—driven by the turbine—running at a higher rate of revolution than the side screws, which are driven by the reciprocating engines. The *Laurentic* has been but a short time on service, and few particulars are available of her performances as compared with those of her sister ship, fitted with reciprocating engines. It has, however, been reported that the results have proved so satisfactory that the combination system will probably be adopted in the two large White Star steamers of 45,000 tons now building at Belfast. This favourable view is fully confirmed by the performances of the *Otaki*, built by Messrs. Denny, of Dumbarton, for the New Zealand Shipping Company, and completed last year. That firm, as is well known, have taken a leading part in the application of the Parsons type of steam turbine to the propulsion of mercantile and passenger steamers, and they possess exceptional experience as well as special facilities for the analysis of the results of trials of steamships, having been the first private firm to establish an experimental tank for testing models of ships and propellers on the model of that designed by Mr. W. Froude and adopted by the Admiralty. Messrs. Denny have generously placed at the disposal of their fellow-shipbuilders the principal results obtained on the official trials and earliest voyages of the *Otaki*, and have compared them with similar results obtained in sister ships fitted with reciprocating engines.[1] The *Otaki* is the first completed ship fitted with the combination system and subjected to trial on service, and as the successful application of that system to cargo steamers and steamers of the intermediate type would result in a considerable economy in the cost of over-sea transport, it may be of interest to give some details of her recorded performance. She is 465 feet long, about 60 feet broad, and of 7420 tons (gross). Her dead-weight capability is about 9900 tons on a draught of 27 feet 6 inches, and the corresponding displacement (total weight) is 16,500 tons. The vessel was designed for a continuous sea-speed of 12 knots when fully laden, and the contract provided for a trial speed of 14 knots with 5000 tons of dead-weight on board. The trials were accordingly made at a displacement of about 11,700 tons. Her installation of boilers is identical with that of her sister ship, the reciprocating-engined twin-screw steamer *Orari*, which is 4 feet 6 inches shorter than the *Otaki*, but generally of the same form. On the measured mile the *Otaki* obtained a speed of 15 knots, while the *Orari* reached 14·6 knots. In order to drive the *Orari* at 15 knots about 12 per cent. more horse-power would have been required, and this is a practical measure of the superiority of the combination system over the reciprocating twin-screw arrangement in the *Orari*. The total water consumption per hour of the *Otaki* at 15 knots was 6 per cent. less than that of the *Orari* at 14·6 knots. If the *Otaki* also ran at 14·6 knots, the water consumption would have been 17 per cent. less than that of the *Orari* at the same speed. On the voyage from Liverpool to New Zealand the *Otaki* averaged about

[1] See a paper by Engineer Commander Wisnom, R.N., in the Proceedings of the Institution of Engineers and Shipbuilders in Scotland for 1909.

11 knots, which would have required on the measured mile only about 40 per cent. of the power developed when running 14·6 knots. With the ship laden more deeply, the average development of power on the voyage was about one-half the maximum developed on the measured mile, and this was disadvantageous to economy in the combination. Even in these unfavourable conditions the *Otaki* realised an economy in coal consumption of 8 per cent. on the voyage from Liverpool to New Zealand and back as compared with her reciprocating-engined sister ship; this represents a saving of about 500 tons of coal. Ordinarily the ship would leave England with sufficient coal on board for the outward passage, so that 250 tons less coal need be carried and a corresponding addition could be made to cargo and freight-earning. Probably as experience is gained the actual economy will prove greater than that realised on the maiden voyage; but even as matters stand there is a substantial gain, and a prospect of the extended application of the steam turbine to vessels of moderate and low speed. In view of results already obtained, the New Zealand Shipping Company have decided to apply the combination system to another vessel just ordered from Messrs. Denny.

In designing turbine machinery for vessels of moderate or low speed there must necessarily be conflicting claims. For maximum efficiency in steam turbines a high rate of revolution is necessary, whereas at moderate or low speeds it is antagonistic to propeller efficiency to run at this high rate of revolution. Engineers are at present much occupied with the study of arrangements by means of which these conflicting claims may be harmonised and greater total efficiency of propulsion obtained. Having regard to the enormous capital invested in cargo steamers of moderate speed, and the importance attaching to their economic working as influencing the cost of over-sea transport, it will be obvious that it is most desirable to find an arrangement in which the high speed of the rotor may be reduced by means of some form of gearing or its equivalent, so as to enable the screw shaft and its propeller to be run at a speed which will secure maximum propeller efficiency. Many proposals have been made, including mechanical gearing and hydraulic or electric apparatus, for transforming the rate of motion. Some of these are actually undergoing experimental trials, and are said to have given very promising results. One of the most important trials is that undertaken by the Parsons Marine Steam Turbine Company, which has purchased a typical tramp steamer, and is carrying out on her a series of trials in order first to ascertain accurately what are the actual conditions of steam and coal consumption with the present reciprocating engines, and then to, ascertain the corresponding facts when those engines have been removed and a steam turbine with its associated gearing has been fitted. It is interesting to note in passing that in the earliest days of screw propulsion with slow-running engines it was found necessary to adoot gearing in order to increase the rate of revolution of the propellers, whereas at present interest is centred in the converse operation. Furthermore, if any system of gearing-down proves successful, it may be anticipated that its application will be extended to swift turbine-driven steamships, since it would enable good propulsive efficiency to be secured in association with rapidly running turbines of smaller size and less weight than have been employed hitherto.

The Marine Steam Turbine.

The rapid development of the marine steam turbine during the last seven years constitutes one of the romances of engineering, and the magnitude of the work done and the revolution initiated by Mr. Charles Parsons will be more justly appreciated hereafter than it can be at present. In some quarters there is a tendency to deal critically with details and to disregard broader views of the situation as it stands to-day. In May, 1909, there were 273 vessels built and under construction in which steam turbines of the Parsons type are employed, the total horse-power being more than three and a half millions. In the Royal Navy every new warship, from the torpedo-boat up to the largest battleships and armoured cruisers, is fitted with turbine engines; and the performances of vessels which have been tested on service have been completely satisfactory, in many instances surpassing all records for powers developed and speeds attained. In the war-fleets of the world this example is being imitated, although in some cases it was at first criticised or condemned. In the mercantile marine as a whole, while the new system has not made equal advance, many notable examples can be found of what can be accomplished by its adoption. It is now admitted that steam turbines enable higher speeds to be attained in vessels of given dimensions; and in steamers built for cross-channel and special services, where high speed is essential and coal consumption relatively unimportant, turbines have already ousted reciprocating engines. For over-sea service and long voyages an impression has existed that the coal consumption of turbine-engined ships would considerably exceed that of ships driven by triple or quadruple expansion reciprocating engines. Critics have dwelt on the reticence in regard to actual rates of coal consumption practised by owners of turbine steamships. Naturally there are other reasons for reticence than those which would arise if the coal consumption were excessive; but pioneers in the use of turbine machinery may reasonably claim the right of non-publication of results of trials in the making of which they have incurred large expenditure and taken considerable risks if they think that silence is beneficial to their business interests. Even if it were true that in the earliest applications of the new system economic results had not been obtained equal to those realised in reciprocating engines which have been gradually improved during half a century, that circumstance should not be regarded as a bar to acceptance of a type of engine that admittedly possesses very great advantages in other ways, but should be regarded as an incentive to improvements that would secure greater economy of coal. The evidence available, however, does not confirm the adverse view, and those familiar with the facts do not admit its truth. One example may be cited as it affects the Canadian service. In June, 1907, it was authoritatively stated that in the Allan liner *Virginian* the reports which had been circulated respecting the excessive coal consumption were unfounded, that the vessel was making passages at speeds of $17\frac{1}{2}$ to $17\frac{3}{4}$ knots, as against the 17 knots estimated, and the rate of coal consumption was really about 1·4 lb. per indicated horse-power which would have been required to attain this speed if the vessel had been fitted with reciprocating engines. This result compares well with the consumption in ordinary passenger steamers running at high speeds in proportion to their dimensions, although in large cargo steamers and vessels of the intermediate type, working under much easier conditions and at very low speeds in proportion to dimensions, lower rates of consumption may be obtained. With these latter vessels the fair comparison is the combination system and not the pure turbine type which is adapted for high speeds.

The crowning triumph of the marine steam turbine up to the present time is to be found in the great Cunard steamships *Lusitania* and *Mauretania*. The passages made this year by the latter ship since she was refitted have been marvellously regular, and the 25 knots average across the Atlantic, which was the maximum contemplated in the agreement between the Government and the Cunard Company, has been continuously exceeded. As one intimately concerned with the design of the *Mauretania*, who has had large experience in ship design, has made a life-long study of the laws of steamship performance, and had the honour of serving on the committee which recommended the employment of turbines in these great ships, the writer ventures to assert that equal results could not possibly have been obtained with reciprocating engines in vessels of the same form and dimensions. Contrary opinions have been expressed, but they have been either based upon incorrect data or have omitted consideration of the fact that in vessels of such great engine-power it was necessary to have time to perfect the organisation of the staff in order to secure uniform conditions of stoking and steam production, and to bring the "human element" into a condition which would ensure the highest degree of efficiency in working the propelling apparatus. This necessity for time and training has been illustrated again and again in the case of new types of Transatlantic steamers, including some which held the record for speed prior to the appearance of the Cunarders. In the *Lusitania* and *Mauretania* the engine-power is fully 60 per cent. greater than that of their swiftest predecessors, yet no similar allowance appears to have been thought necessary by some critics, who assumed that performances on the earlier voyages represented the maximum capabilities of the vessels. Subsequent events have shown this view to be fallacious, and have justified the recommendation of the Turbine Committee and the action of the Cunard directors. Allegations made in regard to excessive coal consumption have also been disproved by experience, and in this respect the anticipations of the committee and of Mr. Parsons have been fully realised.

The marvellous regularity maintained by the *Mauretania* on a long sequence of consecutive Transatlantic passages—made under varying and in many cases very adverse conditions of wind, weather, and sea—illustrates once more, and on an unprecedented scale, the influence which large dimensions have upon the power of maintaining speed at sea. Starting from the eastward passage, beginning on February 3 last, and taking twelve passages (westward and eastward) which followed, the average speed for the thirteen passages, approaching 40,000 sea miles in length, has been $25\frac{1}{2}$ knots; the lowest average speed in the series has been 25·2 knots, the highest average speed 25·88 knots. Many of the winter passages in this series were made in winter weather against strong winds and high seas, which would have considerably reduced the speed of her predecessors, but had small influence on the *Mauretania*. In many instances delays have been caused by fogs.

On seven consecutive passages made since the beginning of last May the average speed of the *Mauretania* in covering about 20,000 sea-miles has been 25·68 knots, the minimum speed for the passage having been 25·62 knots and the maximum 25·88 knots. On her contract trials the *Mauretania* maintained an average speed of 26·04 knots for a distance somewhat exceeding 1200 knots, the steaming time being rather less than forty-eight hours. On the passage when she averaged 25·88 knots, she ran 1215 knots from noon on June 17 to noon on June 19 (about forty-six hours), at an average speed of 26·23 knots, and by noon on June 20 had covered 1817 knots at an average speed of 26·18 knots for sixty-nine hours. The ship has, therefore, surpassed on service her performance on the contract trial.

In view of the foregoing facts and of others of a similar nature, it is reasonable to assume that as experience is enlarged and information is accumulated in regard to forms of propellers likely to prove most efficient in association with quick-running turbines, sensibly improved performances will be obtained. At present, in comparisons made between the efficiency of reciprocating-engined ships and turbine-engined ships, the former have the great advantage attaching to long use and extended experiment; but this is not a permanent advantage, and it may be expected that, good as the position is to which the marine steam turbine has attained in the brief period it has been in practical use, that position will be gradually improved. Whether or not other forms of propelling apparatus in their turn will surpass the steam turbine it would be unwise to predict. Internal-combustion engines are regarded in some quarters as dangerous and probably successful rivals to steam turbines in the near future. Within certain limits of size, internal-combustion engines no doubt answer admirably; but as dimensions and individual power of the engines are increased, the difficulties to be overcome also rapidly increase, and the fact is fully recognised by those having the best knowledge of those types of prime movers. On the whole, therefore, it seems probable that the turbine will not soon be displaced, whatever may happen eventually.

An Imperial Navy.

Three centuries ago a great English seamen and coloniser wrote these words:—

> "Whomsoever commands the sea commands the trade; Whomsoever commands the trade of the world commands the riches of the world, and consequently the world itself."

In these words Sir Walter Raleigh clearly expressed the doctrine of "sea-power," which in recent times has been emphasised by Admiral Mahan of the United States Navy and other writers. Twenty years ago when the movement began which has been followed by an unprecedented series of shipbuilding programmes, great additions to the *personnel* of the Royal Navy and large expenditure on improvements of existing naval bases and the creation of others at important strategical points, the same truth was expressed in a report made by three distinguished Admirals, one of whom, Admiral of the Fleet Sir Frederick Richards, subsequently became First Naval Lord of the Admiralty, and did much to give effect to the policy he had joined in recommending. One passage in this report may be quoted:—"No other nation has any such interest in the maintenance of an undoubted superiority at sea as has England, whose seaboard is her frontier." "England ranks amongst the great Powers of the world by virtue of the naval position she has acquired in the past, and which has never been seriously challenged since the close of the last great war. The defeat of her Navy means to her the loss of India and her Colonies, and of her place amongst the nations."

The "maintenance of an undoubted superiority at sea" in existing circumstances and in face of foreign competition is no easy task, and it is good to know that the Dominions beyond the Seas are ready to take a share of the heavy burden of Empire. In what way effect can best be given to this fundamental idea it is not easy to decide. It is necessarily a matter in which the views of all concerned must be considered, and a policy determined on which shall command hearty support from all portions of the Empire. It may be presumed that the arrangement of such a policy has been the chief object of this year's Defence Conference. The decision which may be reached and the action taken must exercise momentous influence upon the destiny of the Empire. Universal approval has been given to the arrangement for that Conference, and this is a happy augury of its ultimate success in framing a satisfactory scheme for the construction and maintenance of an Imperial Navy. Many valuable suggestions have been made by British and Colonial authorities as to the great lines on which such a scheme should be drawn, but this is not the place to enter upon a discussion of the subject. It may be permitted, however, as a sequence to the preceding remarks on over-sea transport, to remark that the protection of trade routes between the Mother Country and the Dominions beyond the Seas constitutes an essential duty; in the performance of which duty, especially in portions of trade routes adjacent to the Colonies, naval forces maintained by the Colonies may render valuable service. Such a policy in no way infringes the fundamental condition that supremacy at sea ultimately depends upon battle-fleets; while it recognises the fact, which past struggles have demonstrated, that behind and beyond the work of battle-fleets lies the need for adequate protection of commerce and communications. Moreover, it leaves Colonial Governments unfettered in making arrangements for the execution of that portion of the general scheme of defence which they may undertake; and there can be no inconvenience or loss from such independent action provided the scheme of Imperial defence has been considered as a whole, and an understanding reached in regard to the distribution of the work. At present the Mother Country alone possesses experience and means of manufacturing warships and armaments, so that gradual developments, requiring time and experience, will be necessary before the Colonies can become self-supporting in these respects should they desire to do so. On the side of *personnel* and its training also the Royal Navy must be the great school for all parts of the Empire. Finally, the full utilisation of Imperial defensive forces demands the existence of a complete understanding and the pre-arrangement of a common plan of campaign. In order to meet this essential condition there must be an Imperial staff.

The burden of naval defence has hitherto been borne almost entirely by the Mother Country. What the weight has been is hardly realised until the figures for expenditure are examined. As indications of what is involved in creating and maintaining a modern navy of the first class, it may be mentioned that in the ten financial years of the present century (including the current year 1909–10) the total expenditure on the Royal Navy amounts to 328 millions sterling. From 1885 to 1902, during the period the writer occupied the position of Director of Naval Construction and Assistant Controller of the Navy, the total outlay on the 245 ships for the designs of which he was responsible amounted to about 100 millions sterling. The stress of foreign competition and the growth in dimensions and cost of warships is leading to still greater expenditure on the Navy, and it is good to know that Canada, Australia, New Zealand, and South Africa are ready and willing to bear their share of the inevitable burden.

All branches of engineering have been and will be drawn upon freely in the execution of this great task. Mining and metallurgy assist by the production of materials of construction; mechanical and electrical engineers contribute machines and appliances required in shipyards and engine factories, as well as guns, gun-mountings, and mechanical apparatus of all kinds required in modern warships in order to supplement and economise manual power; marine engineers design and construct the propelling apparatus, and constantly endeavour to reduce the proportion of weight and space to power developed; naval architects design and build the ships; constructional engineers are occupied in the provision of docks, harbours, and bases adapted to the requirements of the fleet; and other branches of engineering play important, if less prominent, parts. The progress of invention and discovery is increasing, rapid changes occur unceasingly, the outlay is enormous, the task is never ending, but its performance is essential to the continued well-being of the Empire, and it must and will be performed.

NOTES.

The International Geodetic Association will meet in London on September 21 and following days at the rooms of the Institution of Civil Engineers, Great George Street, Westminster. The permanent commission of the association, consisting of one representative from each contributing country, is constituted as follows:—Belgium, Lieut.-Colonel Gillis; Chile, M. Bertrand; Denmark, Major-General Madsen; France, General Bassot (president); Germany, Prof. Foerster; Great Britain, Sir George Darwin (vice-president); Holland, Prof. H. G. van de Sande Bakhuyzen (perpetual secretary); Hungary, Prof. L. de Bodola von Zagon; Italy, Prof. Celoria; Japan, Dr. Hisashi Terao; Mexico, Sen. Angel Anguiano; Norway, Major-General Per Nissen; Portugal, General the Marquis d'Avila et de Bolama; Russia, General Artomonoff; Spain, Sen. Arrillaga; Sweden, Prof. Rosen; Switzerland, Prof. Gautier; United States, Mr. Tittmann. The Argentine Republic will be represented by Prof. Porro de Somenzi, Roumania by Colonel Rimniceano, India by Colonel Burrard, Egypt by Mr. Keeling, Australia by Mr. G. H. Knibbs. Among the seventy or eighty delegates, other than members of the permanent commission, are Prof. Helmert, chief of the Central Bureau, Potsdam, Prof. Albrecht and Prof. von Seeliger (Germany); Vice-Admiral Ritter v. Kalmar and Major-General von Sterneck (Austria), Lieut-Colonel Bourgeois and M. H. Poincaré (France), Baron Roland Eötvös (Hungary), Prof. Kapteyn (Holland), and Dr. Backlund (Russia). Among the representatives of Great Britain are the Astronomer Royal, Colonel Close, Major Leonard Darwin, Rear-Admiral Field, Sir Archibald Geikie, Sir David Gill, Dr. Glazebrook, Colonel Grant, Major Hills, Captain Lyons, and Colonel Sir William Morris. By command of the King, the delegates are invited to visit Windsor Castle on Saturday, September 25. On Monday, September 27, the meeting will be transferred to Cambridge, where the concluding sessions will be held.

The seventeenth annual exhibition of the Photographic Salon is now open at the Gallery of the Royal Society of Painters in Water Colours, 5A Pall Mall East. As the promoters of this exhibition are interested only in pictorial work, the technician expects to find among the works they have selected for presentation expressions of the most recent ideas as to approved methods, and the finest examples that these methods can furnish. Last year's Photographic Salon included a large number of colour photographs on autochrome plates, but this year there is not a single colour photograph of any kind. This must mean that, in spite of the improvements in the manufacture and in the methods of using plates for colour photography, the results obtained are not generally satisfactory from the artistic point of view. The shortcomings of these plates are well known and appreciated by those who have studied them, but they do offer possibilities of a certain measure of success in the rendering of colour, and we were not prepared for their total exclusion. The one hundred and thirteen pictures hung, selected, presumably, from many hundreds submitted, include examples of many styles and all degrees of merit. They range from a fuzziness that leaves the subject hardly recognisable to the keenest sharpness of definition, from the darkest to the lightest possible, and from those that have large flat patches of an even tint to those that show the most delicate and perfect modelling that can be desired. It is the possibilities of these great varieties of style that are of technical interest. The catalogue is defective in not giving the methods by which the various examples are produced, but we believe that we are correct in saying that the portraits by Mr. E. O. Hoppe are all unsophisticated platinum prints. These, and some of Mr. Frederick H. Evans's exhibits, and the portrait by Mr. Furley Lewis, will be specially instructive to those who print in platinum as showing the rich results obtainable by this method. In addition to the new work, there are nearly thirty examples of photographs by the late David Octavius Hill, made more than sixty years ago. These demonstrate that the vast strides photography has made during the last half-century have tended rather to increase the output and multiply diversity of method than to raise the quality of the work from a pictorial point of view.

By the death of Mr. Thomas Southwell, which took place at his residence in Norwich on September 5, science has lost an amateur naturalist of the very best type, and one who, by the extremely careful and painstaking nature of his work, set an example even to his professional brethren. Moreover, his natural-history studies were not undertaken for the purpose of filling up the time of an idle man, for during the best years of his life Mr. Southwell was in the employ of Gurney's (Barclay's) bank at Norwich, and could study his favourite subject only in the intervals of his professional work. In addition to possessing a great knowledge of the ornithology of his county, Mr. Southwell devoted special attention to whales and whaling, and for a long series of years his annual report in the *Zoologist* on the product of the season's whaling and sealing expedition afforded a mine of valuable information which could be obtained nowhere else. The great value of these reports consists in the fact that the information relating to the British portion of these industries was always at first hand, Mr. Southwell having got in touch with the whaling captains of Peterhead and Dundee. In addition to giving statistics concerning the annual catch of whales and seals, Mr. Southwell studied and collated all the information he could acquire concerning the distribution and migrations of the Greenland right-whale, and was thus enabled to formulate certain important theories on these points. In 1881 he published a small volume on the "Seals and Whales of the British Seas"; and his other writings include the third volume of Stevenson's "Birds of Norfolk," a revised second edition (1890) of Lubbock's "Fauna of Norfolk," Sir Thomas Browne's "Notes and Letters on the Natural History of Norfolk," a "Guide to Norwich Castle Museum," and a paper on the former breeding of the crane in East Anglia. At the time of his death Mr. Southwell was in his seventy-ninth year.

M. SANTOS-DUMONT has accomplished several successful flights with an aëroplane having a supporting surface of only nine square metres. On September 13 he travelled a cross-country distance of about five miles in five minutes upon this machine.

Science announces that the President of the United States has issued a proclamation setting aside the Oregon caves in the Siskiyou National Forest, in the State of Oregon, as a national monument. The area of the reservation is about 480 acres.

THE Paris correspondent of the *Times* announces that the fourth International Aëronautical Congress will be held at Nancy on September 18–23. Major Renard (France) will read a paper on the units of aëronautics and their nomenclature, and will submit a report on the results and lessons of the recent aviation week at Rheims.

MR. F. C. CONSTABLE, Wick Court, near Bristol, sends notes of observations of a remarkable pink glow observed in the direction of the sun between 6.40 p.m. and 6.58 p.m. on September 12. The pink colour seemed to be the same as that observed by him on a steamer journeying from Bombay to Karachi in 1883, a few days after the Krakatoa eruption.

PROF. SILVANUS P. THOMPSON, F.R.S., has consented to become the first president of the Illuminating Engineering Society, and influential support has been received from many distinguished authorities on matters of illumination in this country, on the Continent, and in America. The society will enter upon its opening session in November, and has every reason to hope for a long and prosperous existence. Anyone interested in the objects of the society and desiring to become a member should apply to Mr. L. Gaster, hon. secretary, 32 Victoria Street, London, S.W.

AT the autumn meeting of the Institute of Metals, which will be held at Manchester on October 14 and 15, it is expected that the following papers will be presented:—the constitution and properties of the ternary alloys aluminium-copper-tin, J. H. Andrew and C. A. Edwards; the surface appearance of solders, C. O. Bannister and H. J. Tabor; the technical assay of zinc, H. W. Greenwood; notes on the production of pure spelter, J. S. Glen Primrose; some causes of the corrosion of copper and brass, E. L. Rhead; the elastic breakdown of ductile materials, Prof. C. A. Smith; the copper-zinc alloys—a study of volume changes during solidification, Prof. T. Turner and M. T. Murray.

THE Reale Accademia dei Lincei makes the following announcements:—The royal prize for mathematics is divided equally between Profs. Enriques and Levi-Civita, and that for social and economic sciences is similarly divided between Prof. Rodolfo Benini and Dr. G. Mazzarella. From the Santoro foundation the academy has awarded a prize of 10,000 lire to Prof. Quirino Majorana, for his researches on wireless telephony, which have resulted in communication being established up to distances of 300–400 kilometres or more; in addition, minor awards to Prof. Gabbi, for researches on Malta fever, and Dr. Canovetti, to enable him to continue his experiments on air resistance. From the same benefaction grants have also been made to Profs. Vinassy de Regny and Gortani, for Alpine studies; Prof. Gorini, for investigating diseases of cheese; Prof. Silvestri, noxious insects; Prof. Almagià, study of precipices; the Lombardy commission for seiches on Laghi di Garda and Maggiore; Dr. Abetti, solar physics, in Prof. Hale's observatory. The Carpi prize for experimental physiology is divided between Drs. Baglioni and Lombroso. The late Prof. Sella has bequeathed to the academy a prize of 1000 lire, to be awarded annually to some assistant in an Italian physical laboratory, this being the second gift that the academy has received during the year.

THE seventh annual meeting of the South African Association for the Advancement of Science will be held in Bloemfontein on September 27 to October 2 inclusive, under the presidency of Sir Hamilton Goold-Adams, G.C.M.G. The business of the meeting will be held in three sections as follows:—Section I., astronomy, mathematics, physics, meteorology, geodesy, surveying, engineering, architecture, and geography: president, Prof. W. A. Douglas Rudge, Bloemfontein; Section II., chemistry, bacteriology, geology, botany, mineralogy, zoology, agriculture, forestry, sanitary science: president, Dr. C. F. Juritz, Cape Town; Section III., anthropology, ethnology, education, history, mental science, philology, political economy, sociology, and statistics: president, Mr. Hugh Gunn, Bloemfontein. The second award of the South Africa medal and grant will be made to Dr. Harry Bolus at this meeting. The South African Ornithologists' Union will meet in Bloemfontein at the same time and in the same buildings as the association. A series of lectures, under the auspices of the association, on Darwinism and human life, by Prof. J. Arthur Thomson, is being delivered in South Africa by way of celebrating the Darwin centenary. The honorary general secretaries of the meeting are Dr. J. D. F. Gilchrist, South African College, Cape Town, and Mr. R. T. A. Innes, Government Observatory, Johannesburg.

A LARGE portion of the August number of the *Museums Journal* is taken up by the report of the meeting of the Museums Association held at Maidstone in July. The programme of the meeting included a visit to Ightham to inspect the collection of flint implements brought together by Mr. B. Harrison.

IN the September number of Witherby's *British Birds* Mr. P. H. Barr appears to have disposed effectually of the remarkable idea that the black-headed gull acquires the feature to which it owes its name by means of a mysterious colour-change in the feathers of the head. He has proved that a moult takes place early in the year, usually in February, which embraces, not only the head, but the breast and back, and that at the conclusion of the process, which takes about a week, the black skull-cap is acquired. Occasionally young birds assume the black cap of the breeding plumage while they are still in the immature dress elsewhere.

ACCORDING to Bulletin No. 33 of the Biological Survey of the U.S. Department of Agriculture, which is devoted to the brown rat in the States, serious efforts are being made in North America and Japan to reduce the numbers of this rodent, which is regarded as the worst mammalian pest in the world. So far, however, the campaign has not been crowned with success, the annual destruction of from several hundred thousand to a million head in Japan making no appreciable diminution in its numbers. In the paper before us Mr. D. E. Lantz has given a very full account of the morphology, distribution, migration, and ethology of the rat, with suggestions as to the best means of hunting and trapping, and the elimination of conditions conducive to its rapid increase.

THE Belfast Naturalists' Field Club, the oldest club of the kind in Ireland, has always possessed a strong geological section. An interesting excursion was recently undertaken to the eskers at Dromfane and near Broughshane. The accompanying illustration shows the fine sections that occur in these glacial ridges in co. Antrim. We learn from a report in the *Northern Whig* for August 24 that determinations were made of the source of the material, which proved to be mainly derived from local rocks. The Cainozoic rhyolites of Cloughwater and Ballycloughan were visited later in the day. Rhyolitic lavas are not so limited in the British Isles as the report before us would suggest, since the enormous outpourings in the Snowdon area and in Borrowdale must be borne in mind; but those of Antrim have a thoroughly modern

Gravel Pit, Drumfane, near Ballymena, County Antrim. Photographed by Mr. J. L. S. Jackson.

aspect, and may be compared with types in Hungary or in Mexico. Naturalists in the north of Ireland are fortunate in having established a tradition for good observational work, in which amateurs have played a most important part.

A NICE little question in nomenclature is raised by Dr. Ameghino in a paper published in the *An. Mus. Nat. de Buenos Aires*, vol. xix., pp. 107–209, under the title of "Le *Diprothomo platensis*, un précurseu. de l'homme du Pliocène inférieur de Buénos Aires." It appears that in 1884 the author proposed the generic term Diprothomo for one of the hypothetical ancestors of *Homo sapiens*. Recently Dr. Ameghino obtained from a superficial stratum in Buenos Aires, regarded as of Lower Pliocene age, a calvarium of apparently low type, which in his opinion is generically distinct from Homo. For this supposed new genus he proposes to adopt the name Diprothomo with the new affix platensis. As having no tangible type, "Diprothomo" will probably be regarded as a *nomen nudum*, and if this be so many naturalists will be likely to say that it cannot be employed in a new sense. After restoring the skull to his own satisfaction, Dr. Ameghino concludes that it affords further evidence of his view as to the South American origin of the human race. Additional testimony in favour of this opinion is stated to be afforded by the lower jaw of a child with the angle inflected in marsupial fashion. The extinct South American genus Microbiotherium is regarded as the *fons et origo* of most mammals, and from this sprang Clenialites, the ancestor of the Primates.

THE *West Australian* newspaper of July 7 contains the report of an address, by Dr. J. B. Cleland, read before the West Australian Natural History Society at its annual meeting held at Perth. The subject was the Australian fauna and flora, and especially the effects produced on these by foreign invaders. After alluding to the rabbit-pest, the author stated that the inexcusable introduction of the fox for sporting purposes has led to its rapid multiplication in parts of Victoria, South Australia, &c., and the loss of many sheep. Cats have become wild, and near Perth, for instance, fierce and powerful in build, feeding on the native birds and smaller animals and rabbits where these are present. The Norway rat and the black rat seem not to have extended beyond man's more immediate surroundings. The dominant rat in Perth is the sociable black rat, the larger Norway rat being hitherto obtained only from the neighbourhood of the wharves at Fremantle and Perth. It is otherwise in Sydney, where both are found together in the town. These rats have brought with them several species of fleas, of which some will bite man when their original host is absent (*e.g.* has died). By this means plague, introduced by rats, is communicated to man. The sparrow, the starling, the goldfinch, the blackbird, and the Indian minah have all come to stay. Some of these eat much grain and fruit, while all tend to drive away and usurp the place of the beautiful, interesting, and useful native birds.

DR. E. JANCZEWSKI contributes to the *Bulletin international de l'Académie des Sciences de Cracovie* (No. 6) a short supplement to his monograph on the genus Ribes. In the same part Mr. C. Rouppert presents a revision of the discomycetous fungus Sphærosoma. This genus, of which a new species was discovered by the author, has been variously classed under the Pezizaceæ, Helvellaceæ, and Tuberaceæ. It is here referred to the Helvellaceæ, but is regarded as a connecting link with the other two families.

THE latest issue of the *Kew Bulletin* (No. 7) opens with a review of the known species of Impatiens from the Philippine Islands, communicated by Sir J. D. Hooker, which forms a continuation of the extensive survey of the genus, based on collections from India, China, and the Malayan region. Out of twenty-five species, collected chiefly in the neighbourhood of Luzon, only two agree with previously determined species. The author is of opinion that further exploration will lead to the discovery of many more species. In the same number there is published a decade of Diagnoses Africanæ (No. xxx.), which includes the type of a new liliaceous genus, Neodregea, allied to Dipidax.

IT will add to the general estimation of the common cruciferous plant, the shepherd's purse, when it is realised that the species can be segregated into several elementary species or biotypes. The latest investigation, undertaken by Mr. G. H. Shull at the Station for Experimental Evolution of the Carnegie Institution of Washington, and described in Publication No. 112 of the institution, bears evidence with regard to the existence of at least four biotypes which breed true under ordinary conditions and can readily be crossed; they are distinguished by characteristic lobings of the leaf. The author has also investigated the type known as *Bursa* (*Capsella*) *Heegeri*, which bears round seed capsules; this plant was found in the market-place at Landau, Germany, but has been lost except under cultivation.

BLACK spots varying in size from 1/10-inch to 3/8-inch in diameter are occasionally noticed on chilled beef. Dr. Klein has investigated their nature, and finds them to be caused by the mycelium of a fungus, an oidium, which is quite harmless and does not alter the meat beyond their limits (Report to the Frozen Meat Trade Association).

AN interesting contribution to the September number of *Travel and Exploration* is an account, by a writer calling himself "Pousse Caillou," of the region known as Changchenmo, the home of the Tibetan antelope (*Pantholops hodgsoni*) and the *Ovis ammon*, which lies north-east of Leh, on the Kashmir-Turkestan frontier. Here we find seventy or eighty miles of the most utterly forsaken country which can be imagined. The lower volcanic hills, broken into Gothic pinnacles, are backed by a coal-black precipice, featureless and rigid in outline, while the intervening valleys of pure sand are swept by bitterly cold winds. Game preservation is more rigidly enforced even than in Ladakh, only six licences for shooting being granted annually, and the bag of antelope is limited to six specimens. The writer vividly describes the difficulty of shooting this shy animal, the success of the stalk being often interfered with by the appearance of the kyang, half-wild horse or ass, which roams wild on these plateaux.

THE report of the committee on ancient earthworks and fortified enclosures, prepared for presentation to the Congress of Archæological Societies for the current year, presents no features of startling novelty. Measures for protection of sites have been successful in the cases of Maiden Castle, Dorset; Thetford Castle Meadow and Hill, Norfolk; Stokeleigh Camp, on the Somerset side of the Avon; White Barrow, Wilts; the earthwork at Selsea; the old landmarks of Epping Forest; and Pendina's Camp, Cardiganshire. On the other hand, the committee has to report that in many cases the laying out of golf courses has caused the mutilation of ancient ramparts and ditches. The discovery of a portion of the Roman Wall of London on the site of Christ's Hospital; excavations at Caerwent and Caerleon, Caersws, in Montgomeryshire, and Elslack, near Skipton, in Yorkshire, were the most important operations of the year. The bibliography of current literature on the subject is a useful addition to the report of this committee.

IT very rarely happens that three well-developed typhoons occur within the space of ten days; in the Bulletin of the Manila Weather Bureau for October, 1908, Señor Coronas gives an excellent discussion, with charts, of three such cyclonic storms which reached the central and northern parts of Luzon on October 4, 8, and 13, accompanied by photographs of the destruction caused. They all appear to have originated in the vicinity of the Western Caroline Islands, and to have travelled in a W.N.W. direction; on reaching the archipelago they were considerably modified in shape and extent, and crossed the China Sea in a somewhat more northerly direction. The rates of translation, during which the wind at times reached hurricane force, varied considerably, in one instance attaining the unusual speed of twenty-one miles an hour, but on reaching the China Sea the velocity of translation considerably diminished in all cases. The barometric fall was very rapid, the minimum at one station being 27·99 inches, although it was some fifteen miles from the vortex. Forewarned by valuable observations from Guam (Ladrone Islands) and Yap (Western Caroline Islands), the Manila Observatory was able to give timely notice in each case to its own stations and to foreign services.

SOME interesting results are described and illustrated by Dr. A. S. King in No. 1, vol. xxx., of the *Astrophysical Journal*, where he publishes a paper on the Zeeman effect in the spectrum of titanium. The experiments were carried out at the Mount Wilson Observatory, field strengths of 12,500, 13,800, and 18,400 gausses being employed between the poles of a Du Bois electromagnet; the dispersion used was, generally, such that there were 0·93 Angströms per mm., the spectrograph being the 13 feet vertical Littrow. A table, containing nearly 300 lines, between λ 3904 and λ 6556, gives a summary of the results, and shows that the great majority of titanium lines are resolved into triplets. Notable among the exceptions are the lines at λ 4527·49 and λ 4544·86, each of which is resolved into seven components, and shows a regularity of structure identical in both; the line at λ 4281·53 has eight components. Two sextets and three quintuplets also show a certain regularity in their separations, which is not shown, however, by the lines having four components. Special attention was paid to the forty-four lines given in Lockyer's list of "enhanced" titanium lines, which do not appear to fall in any special class; thirty-five are triple, six are quadruple, one quintuple, and two sextuple. Two plates, which accompany the paper, beautifully illustrate some of the more interesting separations.

ATTENTION is directed by Mr. G. N. Huntly, in a brief paper in the Journal of the Society of Chemical Industry, to a curious case of corrosion occurring in a stand-by boiler at the generating station of the London Electric Supply Corporation. The corrosion had been noticed two years previously, but attempts to check it by the addition of caustic soda to the boiler-water had proved unavailing. The interior of the boiler showed numerous blisters up to 30 mm. in diameter, most of them near the water-level; each blister contained a clear liquid with a black powder in suspension, and a pit was observed to be forming in the centre of each blister. Analysis showed the presence of ferrous sulphate and free sulphuric acid in the liquid contents, although the boiler fluid was alkaline and contained little sulphur. The action was traced to manganese sulphide in the steel, which had become oxidised with formation of sulphuric acid; as the water in the boiler was quiet, the acid remained trapped behind a film of rust, and acid corrosion could thus take place in an alkaline medium, the oxygen required to convert the sulphur into acid penetrating the blister more readily than the alkali of the water. Addition of sodium arsenite to the boiler-water in place of caustic soda completely stopped the trouble, perhaps by eliminating the dissolved oxygen. These experiments confirm the growing impression that the injurious effects of sulphur in steel cannot be wholly removed by the addition of manganese; so far from being harmless, the manganese sulphide appears to be a dangerous constituent, leading to fractures as well as to corrosion.

PROF. O. LEHMANN, of Carlsruhe, who is so well known for his work on liquid crystals, has done a great service to those wishing to repeat any of the beautiful experiments which can be performed with these bodies by giving, in the *Physikalische Zeitschrift* for August 15, detailed descriptions of thirty-two of the most convenient and suitable experiments to perform during a lecture on the subject.

THE *Physical Review* for July contains the second of a series of communications from Mr. G. W. Pierce, of the Jefferson Physical Laboratory of Harvard, on the behaviour of rectifiers of alternating electric currents such as are used as detectors of electric waves. In the present case electrolytic rectifiers have been studied by the aid of the Braun tube oscillograph, and the author finds that the theory of electrolytic polarisation is capable of explaining all the facts observed, if the slight polarisation capacity of the small platinum electrode of the rectifier is taken into account. The detector, when polarised by the superposition of a direct current, is almost perfect, that is, the current it produces is nearly all in one direction. It may therefore be compared with the crystal rectifiers dealt with in the author's first paper. The author proposes to examine the behaviour of vacuum-tube rectifiers before giving definite shape to any theory of crystal rectifiers.

THE *Century Magazine* for September contains two interesting engineering articles. The first of these deals with the great aqueduct now being constructed for bringing water from the Catskill Mountains to the City of New York. This aqueduct will be ninety-two miles long, and, to supply the 500,000,000 gallons required daily, more than 600 square miles of collection area must be utilised and several large reservoirs constructed. The article is well illustrated with photographs, sections, and maps. The second article is a first instalment giving an account of Fulton's invention of the steam-boat. While many engineers in this and other countries experimented towards the end of the eighteenth century, Fulton was the first to secure real success. However, it may comfort some of our British patriots to be reminded that the American vessel was fitted with one of Watt's engines, constructed in Birmingham and shipped to America. The article contains many original documents and drawings, and is of interest as showing that the modern troubles which many inventors have to face in working out their schemes and in overcoming red tape had their counterpart more than a century ago.

THE results of some experiments on solid steel bars under combined stress are given in an article in *Engineering* for August 20. The author, Mr. C. A. Smith, of the East London College, University of London, has already presented useful work in confirmation of Guest's law, and in this series has loaded solid specimens in compression and torsion, and also in tension and torsion. The necessity for doing this will be evident when it is remembered that Lord Kelvin suggested that, as a tension load lowers the torsional yield point, a compression load would raise it. Four different grades of steel were experimented on, of carbon content ranging from 0·09 per cent. to 0·48 per cent. Under combined compression and torsion, the maximum principal stress at yielding varied from 19,800 lb. to 36,500 lb. per square inch, while the maximum shear stress varied from 18,900 lb. to 20,400 lb. per square inch, the average variation from the mean of the latter stress being 2·16 per cent. Another series shows an average variation of the maximum shear stress from the mean of 1·87 per cent. only, this series including tests in tension, compression, torsion, and combined stress. Taking all the results given, the average variation from the mean of the maximum shear stress is about 2 per cent. The importance of these tests will be understood when the difficulties of testing solid specimens under combined stress are remembered, difficulties which seem to have been overcome successfully by use of the author's sphingometer, by means of which the tension and compression measurements are taken in three planes.

REFERRING to the letters published in NATURE of July 22 and 29 in regard to sonorous or musical sands, Prof. J. C. Branner, Stanford University, California, writes to direct attention to articles on this subject by Profs. H. C. Bolton and Alexis A. Julien, published in the Proceedings of the American Association for the Advancement of Science (vol. xxxii., pp. 251–2; vol. xxxiii., pp. 408–13; vol. xxxviii., pp. 137–40). We may remind Prof. Branner that the subject was discussed in NATURE by Prof. Bolton and Mr. Carus-Wilson twenty years ago (vols. xxxix.–xlvi.).

A NEW edition of Mr. P. H. L'Estrange's "Junior Course of Comparative Geography" has been published by Messrs. George Philip and Son, Ltd. Part v. of this book, too, has now been issued separately at the price of 10*d*. In the new edition all the maps of the original work have been reproduced in black and white, the names and symbols required for this course only being retained. The book has been revised throughout, and additional matter added, for example, on local geography.

OUR ASTRONOMICAL COLUMN.

HALLEY'S COMET RE-DISCOVERED.—To Prof. Max Wolf belongs the honour of re-discovering Halley's comet after an absence of more than seventy years. A telegram from the Kiel Centralstelle announces that the comet was discovered at the Königstuhl Observatory on September 11. Its position at 14h. 7·3m. (Königstuhl M.T.) was

R.A. = 6h. 18m. 12s., dec. = +17° 11′,

and its magnitude 16·0.

Mr. Crommelin's ephemeris position for September 11·9 was

R.A. = 6h. 18m. 4s., dec. +17° 16′,

so to the Greenwich calculators, Messrs. Cowell and Crommelin, must be given the credit of having prepared an ephemeris which agrees remarkably well with the observation. At present the comet is approaching the northern limit of Orion from the south-western region of Gemini, forming nearly a straight line with the stars γ Geminorum and 143 OΣ, the three objects being about equally spaced in the order γ—143 OΣ—comet. The following is an extract from Mr. Crommelin's ephemeris:—September 25·7, 6h. 18·5m., +17° 11′; October 9·1, 6h. 14·6m., +17° 8′; October 22·0, 6h. 4·9m., +17° 2′.

OBSERVATIONS OF MARS.—Some interesting observations of changes, during August, in the areas surrounding the southern ice-cap of Mars are reported by MM. Antoniadi, Quénisset, and Jarry-Desloges in the September number of the *Bulletin de la Société astronomique de France* (pp. 385–94). M. Antoniadi, observing at Juvisy on August 12, 14, and 16, found the planetary features so pale as to be almost unrecognisable. On August 15 the Orontes was suspected to be, and the Euphrates was certainly, double, whilst, later, the Amenthes was seen to be broad and diffuse. M. Antoniadi suggests that the pale greyness of the darker regions may be due to the interposition of very light clouds or of a mist in the Martian atmosphere. Both MM. Quénisset and Jarry-Desloges also direct attention to the unusual paleness of the dark regions of the planet during the past few weeks, and each account is illustrated by reproductions from the original drawings showing various aspects of the planet.

A LARGE GROUP OF SUN-SPOTS.—Despite the fact that we are now drawing near to a sun-spot minimum, the solar disc has, during the past fortnight, exhibited an extensive group of spots. An observation on August 28 showed a bright patch of faculæ some distance south of the equator on the eastern limb, and on the following day a small spot was observed near the limb to the north of this. Observations on September 6 showed that there was a group of small spots in about the latitude of the previously observed faculæ, and this developed until, on September 11, it was a diamond-shaped group, of medium-sized spots, of which the longest diagonal was about one-sixth the length of the sun's diameter; each of the four main spots was surrounded by a number of smaller nuclei.

THE TRANSVAAL OBSERVATORY.—From a note in the *Observatory* (No. 413, p. 369) we learn that the Transvaal Government, on behalf of the Government observatory, has accepted the gift of a photographic astronomical telescope from Mr. Franklin Adams. The triple-objective is of 10 inches aperture, and made by Messrs. Cooke and Sons. Two guiding telescopes, each of 6 inches diameter, accompany the main instrument. The telescope is erected, and is to be employed mainly in assisting Prof. Kapteyn, in his studies of the construction of the sidereal universe, by securing photographs of the southern heavens.

ARTIFICIAL IMITATION OF LUNAR LANDSCAPE.—By cooling the slag from an iron-ore, smelted in a furnace and run off at a temperature of about 1100° C., Mr. Paul Fuchs succeeded in obtaining a surface structure which appears to be a very good imitation, in miniature, of a typical lunar landscape. The cooling was done with water applied in various ways, and produced craters, mountains, and plains according to the conditions of the slag and of the cooling. Photographs of the results are reproduced on a plate accompanying No. 4348 of the *Astronomische Nachrichten*, wherein Mr. Fuchs describes his experiments.

TEMPERATURE AND PRESSURE CONDITIONS IN THE SOLAR ATMOSPHERE.—Two interesting letters dealing with the conditions obtaining in the solar atmospheres appear in No. 413 of the *Observatory* (September, pp. 359–63).

In the first, Mr. Buss returns to the question of the radial motions in sun-spots exhibited by Mr. Evershed's spectrograms, and shows how they may be interpreted to indicate that the visible umbral area of a spot is caused by the efflux of material from within rather than the influx of cooler matter from above. The facts that spots often endure for months, and that Mr. Evershed finds that the radial motions are confined to the "reversing layer," *i.e.* to the lower levels of the sun's general atmosphere, are quoted as supporting this view; the vortices are effects of the outrush. This idea of the spots being produced by effluence leads to the sequel that the vapours of the actual spot must be at a higher temperature, whereas the observations of Sir Norman Lockyer and others show the reverse. To overcome this difficulty Mr. Buss suggests that the spectrum observed is that of the vapours high above the visual umbral level, and that, could we but observe the unveiled spectrum of the umbra itself, we would find it to be a bright-line spectrum.

In the second letter Mr. Evershed continues the discussion with Prof. Whittaker regarding pressure in the "reversing layer." After quoting experimental evidence to show that pressure-shifts are apparently independent of the manner in which luminosity is produced, Mr. Evershed points to the fact that the spectrum of the "reversing layer" consists of bright lines, as demonstrating that there is no enormous pressure on the emitting vapours; otherwise one would expect a more continuous spectrum. Finally, he states that measures of spot spectra, made at Kodaikánal, do exhibit small, differential pressure-shifts; the most affected lines are slightly displaced, relatively, towards the violet, thus indicating a pressure in the umbræ of about one-third of an atmosphere less than in the surrounding regions. Further details of these results are to be published shortly.

PARALLAX OF THE DOUBLE STAR Σ 2398.—In No. 4348 of the *Astronomische Nachrichten* (p. 63), Dr. Karl Bohlin announces that the reduction of photographic observations, made at the Stockholm Observatory during 1907–8, shows that the parallax of the double star Σ 2398 is 0·484″. This star thus becomes the nearest known neighbour, in the northern sky, to the solar system, its distance being 426,000 astronomical units, or 6·7 light-years. A previous observation by Lamp, at Kiel in 1883–7, gave the parallax as 0·353″.

OUR FOOD FROM THE WATERS.[1]

AT the last meeting of the British Association in Canada (Toronto, 1897) I was able to lay before Section D a preliminary account of the results of running sea-water through four silk tow-nets of different degrees of fineness continuously day and night during the voyage from Liverpool to Quebec. During the eight days' traverse of the North Atlantic, the nets were emptied and the contents examined morning and evening, so that each such gathering was approximately a twelve-hours' catch, and each day and each night of the voyage was represented by four gatherings. This method of collecting samples of the surface fauna of the sea in any required quantity per day or hour from an ocean liner going at full speed was suggested to me by Sir John Murray of the *Challenger* Expedition, and was first practised, I believe, by Murray himself in crossing the Atlantic. I have since been able to make similar traverses of several of the great oceans, in addition to the North Atlantic, namely, twice across the equator and through the South Atlantic, between England and South Africa, and four times through the Mediterranean, the Red Sea, and the Indian Ocean to Ceylon; and no doubt other naturalists have done much the same. The method is simple, effective, and inexpensive; and the gatherings, if taken continuously, give a series of samples amounting to a section through the surface layer of the sea, a certain volume of water being pumped in continuously through the bottom of the ship, and strained through the fine silk nets, the mesh of which may be one two-hundredth of an inch across, before passing out into the sea again. In examining with a microscope such a series of gatherings across an ocean, two facts are brought prominently before the mind: (1) the constant presence of a certain amount of minute living things; (2) the very great variation in the quantity and in the nature of these organisms.

Such gatherings taken continuously from an ocean liner give, however, information only in regard to the surface fauna and flora of the sea, including many organisms of fundamental importance to man as the immediate or the ultimate food of fishes and whales and other useful animals.

It was therefore a great advance in planktology when Prof. Victor Hensen (1887) introduced his vertical, quantitative nets, which could be lowered down and drawn up through any required zones of the water. The highly original ideas and the ingenious methods of Hensen and his colleagues of the Kiel School of Planktology—whether all the conclusions which have been drawn from their results be accepted or not—have at the least inaugurated a new epoch in such oceanographic work, and have inspired a large number of disciples, critics, and workers in most civilised countries, with the result that the distribution of minute organisms in the oceans and the fresh waters of the globe is now much more fully known than was the case twenty, or even ten, years ago. But perhaps the dominant feeling on the part of those engaged in this work is that, notwithstanding all this activity in research and the mass of published literature which it has given rise to, much still remains to be done, and that the planktologist is still face to face with some of the most important unsolved problems of biology.

It is only possible in an address such as this to select a few points for demonstration and for criticism—the latter not with any intention of disparaging the stimulating work that has been done, but rather with the view of emphasising the difficulties, of deprecating premature conclusions, and of advocating more minute and more constant observations.

The fundamental ideas of Hensen were that the plankton, or assemblage of more or less minute drifting

[1] Evening discourse delivered before the British Association at Winnipeg on August 31 by Prof. W. A. Herdman, F.R.S.

organisms (both animals and plants) in the sea, is uniformly distributed over an area where the physical conditions are approximately the same, and that by taking a comparatively small number of samples it would be possible to calculate the quantity of plankton contained at the time of observation in a given sea area, and to trace the changes of this plankton both in space and time. This was a sufficiently grand conception, and it has been of great service to science by stimulating many workers to further research. In order to obtain answers to the problems before him, Hensen devised nets of the finest silk of about 6000 meshes in the square centimetre, to be hauled up from the bottom to the surface, and having their constants determined so that it is known what volume of water passes through the net under certain conditions, and yields a certain quantity of plankton.

Now if this constancy of distribution postulated by Hensen could be relied upon over considerable areas of the sea, far-reaching conclusions, having important bearings upon fisheries questions, might be arrived at; and such have, in fact, been put forward by the Kiel planktologists and their followers—such as the calculation by Hensen and Apstein that the North Sea in the spring of 1895 contained at least 157 billions of the eggs and larvæ of certain edible fish; and from this figure and the average numbers of eggs produced by the fish, their further computation of the total number of the mature fish population which produced the eggs—a grand conclusion, but one based upon only 158 samples, taken in the proportion of one square metre sampled for each 3,465,968 square metres of sea. Or, again, Hensen's estimation, from 120 samples, of the number of certain kinds of fish eggs in a part of the West Baltic, from which, by comparing with the number[1] of such eggs that would normally be produced by the fish captured in that area, he arrived at the conclusion that the fisherman catches about one-fourth of the total fish population—possibly a correct approximation, though differing considerably from estimates that have been made for the North Sea.

Such generalisations are most attractive, and if it can be established that they are based upon sufficiently trustworthy data, their practical utility to man in connection with sea-fishery legislation may be very great. But the comparatively small number of the samples, and the observed irregularity in the distribution of the plankton (containing, for example, the fish eggs) over wide areas, such as the North Sea, leave the impression that further observations are required before such conclusions can be accepted as established.

Of the criticisms that have appeared in Germany, in the United States and elsewhere, the two most fundamental are:—(1) that the samples are inadequate; and (2) that there is no such constancy and regularity in distribution as Hensen and some others have supposed. It has been shown by Kofoid, by Lohmann, and by others that there are imperfections in the methods which were not at first realised, and that in some circumstances anything from 50 to 98 per cent. of the more minute organisms of the plankton may escape capture by the finest silk quantitative nets. The mesh of the silk is 1/200th inch across, but many of the organisms are only 1/3000th inch in diameter, and so can readily escape.

Other methods have been devised to supplement the Hensen nets, such as the filtering of water pumped up through hose-pipes let down to known depths, and also the microscopic examination in the laboratory of the centrifuged contents of comparatively small samples of water obtained by means of closing water-bottles from various zones in the ocean. But even if deficiencies in the nets be thus made good by supplementary methods, and be allowed for in the calculations, there still remains the second and more fundamental source of error, namely, unequal distribution of the organisms in the water; and in regard to this a large amount of evidence has now been accumulated, since the time when Darwin, during the voyage of the *Beagle* on March 18, 1832, noticed off the coast of South America vast tracts of water discoloured by the minute floating alga *Trichodesmium erythraeum*, which is said to have given its name to the Red Sea, and which Captain Cook's sailors in the previous century called "sea-sawdust." Many other naturalists since have seen the same phenomenon, caused both by this and by other organisms. It must be of common occurrence, and is widespread in the oceans, and it will be admitted that a quantitative net hauled vertically through such a trichodesmium bank would give entirely different results from a haul taken, it might be, only a mile or two away, in water under, so far as can be determined, the same physical conditions, but free from Trichodesmium.

[1] It is probable that too high a figure was taken for this.

Nine nations bordering the north-west seas of Europe, some seven or eight years ago, engaged in a joint scheme of biological and hydrographical investigation, mainly in the North Sea, with the declared object of throwing light upon fundamental facts bearing on the economic problems of the fisheries. One important part of their programme was to test the quantity, distribution, and variation of the plankton by means of periodic observations undertaken four times in the year (February, May, August, and November) at certain fixed points in the sea. Many biologists considered that these periods were too few and the chosen stations too far apart to give trustworthy results. It is possible that even the original promoters of the scheme would now share that view, and the opinion has recently been published by the American planktologist, C. A. Kofoid—than whom no one is better entitled, from his own detailed and exact work, to express an authoritative verdict—that certain recent observations "can but reveal the futility of the plankton programme of the International Commission for the investigation of the sea. The quarterly examinations of this programme will, doubtless, yield some facts of value, but they are truly inadequate to give any trustworthy view of the amount and course of plankton production in the sea."[1] That is the latest pronouncement on the subject, made by a neighbour of yours to the south, who has probably devoted more time and care to detailed plankton studies than anyone else on this continent.

It is evident that before we can base far-reaching generalisations upon our plankton samples, a minute study of the distribution of life in both marine and fresh waters at very frequent intervals throughout the year should be undertaken. Kofoid has made such a minute study of the lakes and streams of Illinois, and similar intensive work is now being carried out at several localities in Europe.

Too little attention has been paid in the past to the distribution of many animals *in swarms*, some parts of the sea being crowded and neighbouring parts being destitute of such forms, and this not merely round coasts and in the narrow seas, but also in the open ocean. For example, some species of Copepoda and other small crustacea occur notably in dense crowds, and are not universally distributed. This is true also of some of the diatoms, and also of larger organisms. Many naturalists have remarked upon the banks of Trichodesmium, of Medusæ and Siphonophora, of Salpæ, of Pteropods, of Peridinians, and of other common constituents of the plankton. Cleve's classification into Tricho-Plankton (Arctic), Styli-Plankton (temperate), and Desmo-Plankton (tropical) depends upon the existence of such vast swarms of particular organisms in masses of water coming into the North Atlantic from different sources.

It is possible that in some parts of the ocean, far from land, the plankton may be distributed with the uniformity supposed by Hensen. It is important to recognise that at least three classes of locality exist in the sea in relation to distribution of plankton:—

(1) There are estuaries and coastal waters where there are usually strong tidal and other local currents, with rapid changes of conditions, and where the plankton is largely influenced by its proximity to land.

(2) There are considerable sea areas, such as the centre of the North Sea and the centre of the Irish Sea, where the plankton is removed from coastal conditions, but is influenced by various factors which cause great irregularity in its distribution. These are the localities[2] of the greatest economic importance to man, and to which attention should especially be directed.

(3) There are large oceanic areas in which there may

[1] "Internationale Revue der Hydrobiologie und Hydrographie," vol. i. p. 846, December, 1908.

[2] See Dakin, Trans. Biol. Soc. Liverpool, xxii., p. 514.

be uniformity of conditions, but it ought to be recognised that such regions are not those in which the plankton is of most importance to men. The great fisheries of the world, such as those of the North Sea, the cod fishery in Norway, and those on the Newfoundland Banks, are not in mid-ocean, but are in areas round the continents, where the plankton is irregular in its distribution.

As an example of a locality of the second type, showing seasonal, horizontal, and vertical differences in the distribution of the plankton, we may take the centre of the Irish Sea, off the south end of the Isle of Man. Here, as in other localities which have been investigated, the Phyto-Plankton is found to increase greatly about the time of the vernal equinox, so as to cause a maximum, largely composed of Diatoms, at a period ranging from the end of March to some time in May—this year to May 28, in the Irish Sea. Towards the end of this period the eggs of most of the edible fishes are hatching as larvæ.

This Diatom maximum is followed by an increase in the Copepoda (minute crustacea), which lasts for a considerable time during the early summer, and as the fish larvæ and the Copepoda increase there is a rapid falling off in Diatoms. Less marked maxima of both Diatoms and Copepoda may occur again about the time of the autumnal equinox. These two groups—the Diatoms and the Copepoda—are the most important economic constituents in the plankton. A few examples showing their importance to man may be given:—Man eats the oyster and the American clam, and these shell-fish feed upon Diatoms. Man feeds upon the cod, which in its turn may feed on the whiting, and that on the sprat, and the sprat on Copepoda, while the Copepoda feed upon Peridinians and Diatoms; or the cod may feed upon crabs, which in turn eat "worms," and these feed upon smaller forms which are nourished by the Diatoms. Or, again, man eats the mackerel, which may feed upon young herring, and these upon Copepoda, and the Copepoda again upon Diatoms. All such chains of food matters from the sea seem to bring one through the Copepoda to the Diatoms, which may be regarded as the ultimate "producers" of food in the ocean. Thus our living food from the waters of the globe may be said to be the Diatoms and other microscopic organisms as much as the fishes.

Two years ago, at the Leicester meeting of the British Association, I showed that if an intensive study of a small area be made, hauls being taken, not once a quarter or once a month, but at the rate of ten or twelve a day, abundant evidence will be obtained as to (1) variations in the distribution of the organisms, and (2) irregularities in the action of the nets. Great care is necessary in order to ensure that hauls intended for comparison are really comparable. Two years' additional work since in the same locality, off the south end of the Isle of Man, has only confirmed these results, viz. that the plankton is liable to be very unequally distributed over the depths, the localities, and the dates. One net may encounter a swarm of organisms which a neighbouring net escapes, and a sample taken on one day may be very different in quantity from a sample taken under the same conditions next day. If an observer were to take quarterly, or even monthly, samples of the plankton, he might obtain very different results according to the date of his visit. For example, on three successive weeks about the end of September he might find evidence for as many different far-reaching views as to the composition of the plankton in that part of the Irish Sea. Consequently, hauls taken many miles apart and repeated only at intervals of months can scarcely give any sure foundation for calculations as to the population of wide sea areas. It seems, from our present knowledge, that uniform hydrographic conditions do not determine a uniform distribution of plankton.

These conclusions need not lead us to be discouraged as to the ultimate success of scientific methods in solving world-wide plankton and fisheries problems, but they suggest that it might be wise to secure by detailed local work a firm foundation upon which to build, and to ascertain more accurately the representative value of our samples before we base conclusions upon them.

I do not doubt that in limited, circumscribed areas of water, in the case of organisms that reproduce with great rapidity, the plankton becomes more uniformly distributed, and a comparatively small number of samples may then be fairly representative of the whole. That is probably more or less the case with fresh-water lakes, and I have noticed it in Port Erin Bay in the case of Diatoms. In spring, and again in autumn, when suitable weather occurs, as it did two years ago at the end of September, the Diatoms may increase enormously, and in such circumstances they seem to be very evenly spread over all parts and to pervade the water to some depth; but that is emphatically *not* the case with the Copepoda and other constituents of the plankton, and it was not the case even with the Diatoms during the succeeding year.

I have published elsewhere an observation that showed very definite limitation of a large swarm of crab Zoëas, so that none were present in one net while in another adjacent haul they multiplied several times the bulk of the catch and introduced a new animal in enormous numbers. Had two expeditions taken samples that evening at what might well be considered as the same station, but a few hundred yards apart, they might have arrived at very different conclusions as to the constitution of the plankton in that part of the ocean.

It is possible to obtain a great deal of interesting information in regard to the "hylokinesis" of the sea without attempting a numerical accuracy which is not yet attainable. The details of measurement of catches and of computations of organisms become useless, and the exact figures are non-significant, if the hauls from which they are derived are not really comparable with one another and the samples obtained are not adequately representative of nature. If the stations are so far apart and the dates are so distant that the samples represent little more than themselves, if the observations are liable to be affected by any incidental factor which does not apply to the entire area, then the results may be so erroneous as to be useless, or worse than useless, since they may lead to deceptive conclusions. It is obvious that we must make an intensive study of small areas before we draw conclusions in regard to relatively large regions, such as the North Sea or the Atlantic Ocean. Our plankton methods are not yet accurate enough to permit of conclusions being drawn as to the number of any species in the sea.

The factors causing the seasonal and other variations in the plankton already pointed out may be grouped under three heads, as follows:—

(1) The sequence of the stages in the normal life-history of the different organisms.

(2) Irregularities introduced by the interactions of the different organisms.

(3) More or less periodic abnormalities in either time or abundance caused by the physical changes in the sea, which may be grouped together as "weather."

These are all obvious factors in the problem, and the constitution of the plankton from time to time throughout the year must be due to their interaction. The difficulty is to disengage them from one another, so as to determine the action of each separately.

Amongst the physical conditions coming under the third heading, the temperature of the sea is usually given a very prominent place. There is only time to allude here to one aspect of this matter.

It is often said that tropical and sub-tropical seas are relatively poor in plankton, while the colder Polar regions are rich. In fishing plankton continuously across the Atlantic it is easy from the collections alone to tell when the ship passes from the warmer Gulf Stream area into the colder Labrador current. This is the reverse of what we find on land, where luxuriant vegetation and abundance of animal life are characteristic of the tropics in contrast to the bare and comparatively lifeless condition of the Arctic regions. Brandt has made the ingenious suggestion that the explanation of this phenomenon is that the higher temperature in tropical seas favours the action of denitrifying bacteria, which therefore flourish to such an extent in tropical waters as seriously to diminish the supply of nitrogen food and so limit the production of plankton. Loeb,[1] on the other hand, has recently revived the view of Murray, that the low temperature in Arctic waters so

[1] "Darwin and Modern Science" (Cambridge, 1909), p. 247.

reduces the rate of all metabolic processes, and increases the length of life, that we have in the more abundant plankton of the colder waters several generations living on side by side, whereas in the tropics with more rapid metabolism they would have died and disappeared. The temperature of the sea-water, however, appears to have little or no effect in determining the great vernal maximum of Phyto-Plankton.

Considering the facts of photosynthesis, there is much to be said in favour of the view that the development, and possibly also the larger movements of the plankton, are influenced by the amount of sunlight, quite apart from any temperature effect.

Bullen[1] showed the correlation in 1903–7 between the mackerel catches in May and the amount of Copepod plankton in the same sea. The food of these Copepoda has been shown by Dakin to be largely Phyto-Plankton, and Allen has lately[2] correlated the average mackerel catch per boat in May with the hours of sunshine in the previous quarter of the year, thus establishing the following connection between the food of man and the weather:—Mackerel—Copepoda—Diatoms—Sunshine. One more example of the influence of light may be given. Kofoid has shown that the plankton of the Illinois River has certain twenty-nine-day pulses, which are apparently related to the lunar phases, the plankton maxima lagging about six days behind the times of full moon. The light from the sun is said to be 618,000 times as bright as that from the full moon; but the amount of solar energy derived from the moon is sufficient, we are told, appreciably to affect photosynthesis in the Phyto-Plankton. The effectiveness of the moon in this photosynthesis to that of the sun is said to be as two to nine, and if that is so Kofoid is probably justified in his contention that at the time of full moon the additional light available has a marked effect upon the development of the Phyto-Plankton.

As on land, so in the sea, all animals ultimately depend upon plants for their food. The plants are the producers and the animals the consumers in nature, and the pastures of the sea, as Sir John Murray pointed out long ago, are no less real and no less necessary than those of the land. Most of the fish which man uses as food spawn in the sea at such a time that the young fry are hatched when the spring Diatoms abound, and the Phyto-Plankton is followed in summer by the Zoo-Plankton (such as Copepoda), upon which the rather larger but still immature food fishes subsist. Consequently, the cause of the great vernal maximum of Diatoms is one of the most practical of world problems, and many investigators have dealt with it in recent years. Murray first suggested that the meadows of the sea, like the meadows of the land, start to grow in spring simply as a result of the longer days and the notable increase in sunlight. Brandt has put forward the view that the quantity of Phyto-Plankton in a given layer of surface water is in direct relation to the quantity of nutritive matters dissolved in that layer. Thus the actual quantity present of the substance—carbon, nitrogen, silica, or whatever it may be—that is first used up determines the quantity of the Phyto-Plankton. Nathansohn in a recent paper[3] contends that what Brandt supposes never really happens; that the Phyto-Plankton never exhausts any food constituent, and that it develops just such a rate of reproduction as will compensate for the destruction to which it is subjected. This destruction he holds is due to two causes: currents carrying the Diatoms to unfavourable zones or localities, and the animals of the plankton which feed on them. The quantity of Phyto-Plankton present in a sea will then depend upon the balancing of the two antagonistic processes—the reproduction of the Diatoms and their destruction. We still require to know their rate of reproduction and the amount of the destruction. It has been calculated that one of these minute forms, less than the head of a pin, dividing into two at its normal rate of five times in the day, would at the end of a month form a mass of living matter a million times as big as the sun. The destruction that keeps such a rate of reproduction in check must be equally astonishing. It is claimed that the *Valdivia* results, and observations made since, show that the most abundant plankton is where the surface water is mixed with deeper layers by rising currents. Nathansohn, while finding that the hour of the day has no effect on his results, considers that the development of the Phyto-Plankton corresponds closely with evidence of vertical circulation. Like some other workers, he emphasises the necessity of continuous intensive work in one locality: such work might well be carried on both at some point on your great lakes and also on your Atlantic coast. The *Challenger* and other great exploring expeditions forty years ago opened up problems of oceanography, but such work from vessels passing rapidly from place to place could not solve our present problems—the future lies with the naturalists at biological stations working continuously in the same locality the year round.

The problems are most complex, and may vary in different localities—for example, there seem to be two kinds of Diatom maxima found by Nathansohn in the Mediterranean, one of Chætoceros due to the afflux of water from the coast, and one of *Rhizosolenia calcaravis*, due to a vertical circulation bringing up deeper layers of water. As a local example of the importance of the Diatoms in the plankton to man, let me remind you that they form the main food of your very estimable American clam. The figures I now show, and some of the examples I am taking, are from the excellent work done on your own coasts in connection with fisheries and plankton by Prof. Edward Prince and Prof. Ramsay Wright and their fellow-workers at the Canadian biological station, on your eastern seaboard.

The same principles and series of facts could be illustrated from the inland waters. Your great lakes periodically show plankton maxima, which must be of vast importance in nourishing animals and eventually the fishes used by man. Your geologists have shown that Manitoba was in post-Glacial times occupied by the vast lake Agassiz, with an estimated area of 110,000 square miles; and while the sediments of the extinct lake form your celebrated wheat fields, supplying food to the nations, the shrunken remains of the water still yield, it is said, the greatest fresh-water fisheries in the world. See to it that nothing is done to reduce further this valuable source of food! Quoting from your neighbours to the south, we find that the Illinois fisheries yield at the rate of a pound a day throughout the year of cheap and desirable food to about 80,000 people—equivalent to one meal of fish a day for a quarter of a million people.

Your excellent "whitefish" alone has yielded, I see, in recent years more than 5,000,000 lb. in a year; and all scientific men who have considered fishery questions will note with approval that all your fishing operations are now carried on under regulations of the Dominion Government, and that fish hatcheries have been established on several of your great lakes, which will, along with the necessary restrictions, form, it may be hoped, an effective safeguard against depletion. Much still remains to be done, however, in the way of detailed investigation and scientific exploitation. The German institutes for pond-culture show what can be done by scientific methods to increase the supply of food-fishes from fresh waters. It has been shown in European seas that the mass of living food matters produced from the uncultivated water may equal that yielded by cultivated land. When aquiculture is as scientific as agriculture, your regulated and cultivated waters, both inland and marine, may prove to be more productive even than the great wheat lands of Manitoba.

Inland waters may be put to many uses: sometimes they are utilised as sewage outlets for great cities, sometimes they are converted into commercial highways, or they may become restricted because of the reclamation of fertile bottom lands. All these may be good and necessary developments, or any one of them may be obviously best in the circumstances; but, in promoting any such schemes, due regard should always be paid to the importance and promise of natural waters as a perpetual source of cheap and healthful food for the people of the country.

[1] M. B. A. Journ., viii., 269.
[2] *Ibid.*, viii., 394.
[3] Monaco Bulletin, No. 140.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A NUMBER of resolutions concerned with education were adopted last week at the Trade Union Congress held at Ipswich. Some called for the State maintenance of school children, for scientific physical education, and the development of the medical department of the Board of Education. Others demanded that secondary and technical education be an integral part of every child's education, and be secured by such a reform and extension of the scholarship system as would place a maintenance scholarship within the reach of every child, and thus make it possible for all children to be full-time day pupils up to the age of sixteen; and that the best intellectual and technical training be provided for the teachers of the children, that each educational district be required to train the number of pupil teachers demanded by local needs and to establish training colleges, preferably in connection with universities or university colleges. The interest in education thus manifested by the leaders of our working men may be regarded as a gratifying sign of the times. All who desire the welfare of the nation would welcome any real improvement in our system of educating suitably the men upon whom the success of our industries largely depends; but many competent persons will doubt the wisdom of the great extension of our scholarship system demanded by the Trade Union Congress. In any system of awarding scholarships every care must be taken to ensure that each scholarship holder has shown by his previous record that he is mentally qualified to benefit by the secondary and technical education which the scholarship makes possible, and will complete the course at the school. It is important to educate every person to the full extent of his capabilities, but it is folly to imagine that every boy or girl who is made to attend a technical school must of necessity be able to benefit from such attendance.

THE technical colleges throughout the country are now issuing their programmes of work for the coming session. We have received the educational announcements of the Northampton Polytechnic Institute, Clerkenwell, the syllabus of classes at the Sir John Cass Technical Institute, Aldgate, London, and the prospectus of the East Ham Technical College evening classes. The educational aim of the Northampton Institute is to provide classes in technological and trade subjects, attention being first paid to the immediate requirements of Clerkenwell, the district of London in which the institute stands. The day courses are for students willing to give the whole of their time for one, two, or more years to a systematic training in technology. Day courses are provided in mechanical engineering, electrical engineering, watch-making, and horological engineering. In horology, a very large amount of time is given to workshop practice. There are also day courses in technical optics, electrochemistry, and other subjects. Evening classes are held in a very great variety of subjects. At the Aldgate institution graded courses of study extending over several years are provided in the various departments, and also special lectures, with accompanying laboratory practice, are given to meet the needs of persons holding responsible positions in the manufacturing establishments in the neighbourhood who desire to keep in touch with modern developments in applied science. Among the announcements of such special work may be mentioned the course on liquid, gaseous, and solid fuel arranged for the benefit of workers in chemical and engineering establishments and others concerned with the use of fuel as a motive power; that on the fermentation industries, with particular attention to microbiology; and that concerned with metallurgical problems. The evening classes at East Ham are under the general supervision of a responsible principal, and it is consequently possible for a student to obtain advice in the direction of securing a properly coordinated course of study continuing from year to year. The numerous classes are adapted particularly to meet the requirements of young men and women engaged in the manual and other industrial trades of the locality.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 6.—M. Bouchard in the chair.—The theoretical tides of the geoïd, on the hypothesis of an absolute rigidity of the earth: Ch. **Lallemand.** Defining the geoïd as the surface of mean level confining a volume equal to that of the globe, the mean tides at the equator are worked out for both the solar and lunar waves.—The Brownian movement and molecular constants: Jean **Perrin** and M. **Dabrowski.** Experiments have been made on two emulsions of different substances containing minute particles in suspension. The results are applied to determine the constant N of Avogadro in Einstein's formula, and also in a formula based on the distribution of the particles under the action of gravity. The former leads to a value of 70×10^{22}, and the latter to 70.5×10^{22}. The close accord of these results is a striking confirmation of the kinetic theory on which the formulæ are based. The most probable value of the charge of the electron e from these values is 4.1×10^{-10}.—Calorimetric and cryoscopic constants of mercuric bromide: M. **Guinchant.** The measured latent heat of fusion gives a cryoscopic constant according to van 't Hoff's formula of 403; actual cryoscopic determinations in various solvents furnished a constant of 283 to 407, the average value being 340.—The life of fungi in fatty media: A. **Roussy.** For various moulds it was found that fatty substances were capable of replacing carbohydrates in culture media. The concentrations of fat most favourable for growth of the moulds were determined.—Some wild yams of Madagascar: Henri **Jumelle** and H. Perrier **de la Bathie.**—The experimental transmission of exanthematic typhus by the body louse: Charles **Nicolle,** C. **Comte,** and E. **Conseil.**—The geological structure of the peninsula of Cape Bon, Tunis: A. **Allemand-Martin.**

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THURSDAY, SEPTEMBER 23, 1909.

PHILOSOPHY AND HISTORY OF SCIENCE.

(1) *Das Prinzip der Erhaltung der Energie.* By Dr. Max Planck. Zweite Auflage. Pp. xvi+278. (Leipzig: B. G. Teubner, 1908.) Price 6 marks.

(2) *Vererbung, Gedächtnis und Transzendentale Erinnerungen vom Standpunkte des Physikers.* By Dr. Gustav Eichhorn. Pp. x+116. (Stuttgart: Julius Hoffmann, 1909.) Price 2.50 marks.

(3) *De la Méthode dans les Sciences.* By Profs. H. Bouasse, &c. Pp. 412. (Paris: Félix Alcan, 1909.)

(4) *Materialistische Epoche und monistische Bewegung.* By Paul Volkmann. Pp. 30. (Leipzig: B. G. Teubner, 1909.) Price 1 mark.

(5) *Das Theorem des Pythagoras.* By Dr. H. A. Naber. Pp. xii+240. (Haarlem: P. Visser, 1908.) Price 7s.

(6) *Essai sur la notion de Théorie physique de Platon à Galilée.* By Pierre Duhem. Pp. 144. (Paris: A. Hermann and Son, 1908.) Price 5 francs.

(7) *Il passato ed il presente delle principali Teorie geometriche.* Terza editione. By Prof. Gino Loria. Pp. xxiv+476. (Torino: Carlo Clausen, Hans Rinck Succ, 1907.)

(1) IN 1887 the Göttingen Faculty of Philosophy offered a prize for the best essay, historical and critical, on the physical concept of energy, and the principle of conservation of energy. The prize was awarded to Dr. Max Planck, and his essay now, in its second edition, finds a fitting place in the series which the Teubner Press are issuing bearing the title of the first volume by Poincaré, "Science and Hypothesis."

The volume is divided into three sections. The first is historical; the second deals with statements and proofs of the principle; while the third discusses the various forms of energy and their symbolic representations.

"The Principle of Conservation of Energy" is a somewhat elastic title for a thesis. Had Prof. Planck included every application of the principle or every investigation in which the principle plays an important part, his work would have swelled out into a treatise containing pretty well the whole of physics and a large part of chemistry. The author has been wise in restricting his inquiries to a narrow field. He excludes all reference to the less easily understood second law or principle of degradation of energy. That principle is far more difficult to understand than the first law, and it is doubtful whether at the time of writing the essay Prof. Planck could have been in a position to give a satisfying account of it. It teaches us that a community of molecules tends towards a state of socialism in which wealth in the form of energy is evenly distributed among the molecules, but that as the change takes place, this energy becomes less and less available for useful purposes, until the system comes to a deadlock, when all progress and activity ceases, and no further work is done by the system. The first law, which tells us that wealth in the form of energy cannot be created or destroyed, so that one molecule cannot grow richer without making another poorer, is much easier of comprehension, and gave Prof. Planck abundant material for discussion.

While the treatment can scarcely be described as exhaustive, this impression may be to a large extent attributed to the changes which have taken place in our knowledge of physical phenomena since the thesis was written. It would have been next to impossible for the author to have brought the book up to date by the inclusion of this later work; and, after all, what has happened in the interval? Have we not, as a general rule, taken the principle of conservation of energy for granted, and merely investigated fresh applications of it? Even in connection with the phenomena of radio-activity, no one has cast any very serious doubts on the validity of the principle. For critical writings on the subject, we must go back to the time of Clausius, Mayer, Joule, and the earlier works of Helmholtz and Lord Kelvin; and these are discussed in the first section. An attempt to draw in recent applications might have confused the issue rather than otherwise.

(2) While many attempts have been made to formulate a physical basis for the phenomena of life—for example, by Loeb in Germany and Dr. F. J. Allen in this country—considerable difficulty is experienced in explaining thought, memory, and the hereditary transmission of characters, none of which concepts appears easily reconcilable with the ordinary properties of matter, at any rate in its inert state. Dr. Gustav Eichhorn would now maintain that electric theories of matter open up new possibilities. For the discovery of electrons, the theory that matter is a complicated aggregate of electrons, and the existence of mutual relations between matter and æther, are fully consistent with the view that the phenomena of thought and heredity are caused by particular states of the æther associated with the molecules of the material organism. Part of the book, dealing with hallucinations and "transcendental memories," was written ten years ago. The author does not profess to give an exhaustive or complete study of the problems with which the book deals, and in view of the fact that the electron theory is comparatively recent, his claims to have treated the subject from a new standpoint are not without foundation; but isn't all this the old notion of spiritualism and "animal magnetism" merely served up under a different name? If not, the resemblance is very striking, and the difference not very obvious.

(3) The collection of articles edited by Dr. Thomas under the designation of "Method in the Sciences" owes its publication to the growing importance attached to philosophy of science, and in particular to methodology in French educational curricula following Auguste Comte. It is pointed out that both textbooks and original articles leave a gap in such literature of the subject as is available for students, and this gap it has been the object of the present volume to assist in filling. In reviewing this book, one is tempted to enlarge on the fact that an educational system which tries to mould all teachers or students according to a common pattern can never be efficient. No better preventive against this deadly uniformity can be suggested than the publication of a book representing the combined experience of all sorts and con-

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ditions of men each a specialist in his own particular department of science; and if it is found that doctors disagree on points of detail, it is claimed that an examination of their views will have the beneficial effect of making the student think for himself instead of merely taking what is written for granted. The mere learning machine, who is frequently devoid of powers of clear exposition, probably exists in every country, but he is not the kind of man to be encouraged. This volume consists of articles on science, by Émile Picard; pure mathematics, by Jules Tannéry; mechanics, by P. Painlevé; general physics, by H. Bouasse; chemistry, by A. Job; morphology, by A. Giard; physiology, by F. Le Dantec; medical sciences, by Pierre Delbet; psychology, by Th. Ribot; sociology and social science, by E. Durkheim; morale, by L. Lévy Bruhl; and history, by G. Monod, all under the editorship of Dr. P. F. Thomas.

(4) Prof. Volkmann's pamphlet is an address delivered at the graduation ceremony of the Albertus University on January 18. It deals with the materialistic philosophy of the nineteenth century, with phenomenology and monism, and with the idealism of Kant, whose connection with the university in question is too well known to require mention.

(5) Dr. Naber deals in a pleasant and chatty way with many points in the history of Greek and Egyptian geometry. The discussion is in no way confined to the proposition now more generally known as "One Forty-Seven," which forms the title of the book, but we have sections dealing with "Pi" and its supposed value $\sqrt{10}$, with spirals and limaçons and their applications to angle-trisection and cube-duplication, with the history of the "Golden" or median section, and finally with the "pentalpha," or pentagonal star, and the dodecahedron. "Spirals in nature and in art" receive considerable attention, and are illustrated by numerous figures. It would be impossible to dwell at length on the historic side of the book. If it has one fault, that fault is a certain diffuseness and lack of definiteness. By this we mean that in some places it is not very certain what conclusions the author is seeking to prove. But possibly that is because the author is endeavouring to give a general idea of what mathematical thought was like in the Pythagorean times, and to do this he reasons largely from conjecture where historic evidence is wanting. He cannot certainly be accused of being long-winded, his sections being very short and concise, and his language terse.

(6) "To save appearances" (σωζειν τα φαινομενα or to account for observed facts was the object of Greek philosophy, which forms the motto of Prof. Duhem's book. Not less is it the object of the modern physicist. In tracing the development of physics from the time of Plato to that of Galileo a good many points may be observed which have left their traces on modern physical theory. We notice, in Prof. Duhem's words, that where we now speak of physics, the Greek and Mussulman philosophers and the men of science of the Middle Age spoke of astronomy; that the laws of motion of celestial bodies were studied ages before anyone thought of applying similar methods to terrestrial (or "sublunary") bodies; that the first discussions of the phenomena of the material world were metaphysical, and that optics and statics were the earliest subjects to form the basis of mathematical theories. We observe with interest the division of physics into two branches, one dealing with celestial and the other with sublunary bodies, of which the first was regarded as infinitely more perfect than the second, and was for this reason wrongly supposed to be only accessible to divine intelligence, while the latter or terrestrial physics was supposed to be summed up in the work of Aristotle. And we reflect that even nowadays the once supposed easier task of "saving the phenomena" of sublunary matter is the one which physicists as a rule shirk. It is true that electricity and not astronomy is the subject now usually under investigation, but in either case the philosopher turns his thoughts to the ether as the seat of the phenomena under investigation, and finds that the hypotheses necessary to "save" these phenomena are greatly simplified owing to the omission of irreversible effects. It is not claimed by Prof. Duhem that his is the first attempt at a history of physics as distinct from mathematics, but as a general account of the subject in a moderate compass it would be difficult to write a better book.

(7) Prof. Gino Loria's book needs little comment. Its merits can be summed up in a few words. It is a book with which no geometer can afford to dispense. It is a bibliography of geometry classified under such headings as "Geometry up to 1850," "Algebraic Curves," "Differential Geometry," "Non-Euclidian Geometry," "Geometry of Multi-dimensional Space." Every page is filled with references, and the number of papers and memoirs which have been consulted in the preparation of the book must be counted by thousands; indeed, if we mistake not, the mere names of authors contained in the index number well into the four figures. The second edition appeared in 1896, and in this third edition the author has added an appendix of about 120 pages dealing with the progress of geometry during the last ten years. In the epilogue, the author compares geometry to a fertile region the vegetation of which still offers numerous prizes in the form of flowers and fruits to the explorer and cultivator. If this analogy be pursued a little further, the need had arisen for a flora of the new territory, and no better botanist could be found for the purpose than Prof. Gino Loria.

THE FLUIDS OF THE BODY IN HEALTH AND DISEASE.

(1) *The Mercers' Company Lectures on the Fluids of the Body.* By Prof. Ernest H. Starling, F.R.S. Pp. viii+186. (London: Archibald Constable and Co., Ltd., 1909.) Price 6s. net.

(2) *Studies on Immunisation and their Application to the Diagnosis and Treatment of Bacterial Infections.* By Sir A. E. Wright, F.R.S. Pp. xv+490. (London: Archibald Constable and Co., Ltd., 1909.) Price 16s. net.

ALL important as the cells and cellular tissues of the body are, the fluids of the body may claim an equal importance, both in physiological or normal and in pathological or abnormal processes. In fact the one is a supplement to the other, and probably neither is able to exert its full activity without the simultaneous cooperation of the other.

(1) The first book under review comprises courses of lectures delivered by Prof. Starling at University College under the auspices of the Mercers' Company, at the Bellevue Hospital, New York, under the foundation of Dr. Herter, and at the Royal College of Surgeons. It is written in a simple and attractive style, and gives an admirable description of such subjects as the physical properties of protoplasm, the osmotic relationships of cells, the intake, exchange, absorption, and output of fluids in the body, and the production of lymph (the fluid which bathes the tissues), and the relationship of these normal processes to disease processes, such as dropsy. Many important physical and chemical conceptions, such as osmotic pressure, adsorption, the nature of colloids, surface tension, and the like, are here brought together and explained, and their relation to vital processes is examined. In the discussions of the connection between normal and pathological processes many suggestions of value to the medical practitioner are made. Thus the regeneration of the constituents of the blood after bleeding is considered to be due to the stimulus of lack of oxygen, and the value of occasional blood-letting is compared to that of a sojourn at high altitudes, the beneficial and recuperative effects of which are well recognised, and it is suggested that the practice of *occasional* blood-letting may be restored to the position of honour it once held in medical practice.

(2) The second book includes numerous papers contributed by Sir Almroth Wright, his co-workers, and friends to various journals and societies, and deals more or less directly with the problems of immunisation against disease-producing micro-organisms. The first part of the book deals primarily with the protective elements of the blood, agglutinins, bactericidins, and opsonins; in the second part the problem of fighting bacterial infections by those defensive agencies which the organism itself employs when it contends with microbic invasions, is discussed. The formation of a book by a collection of separate papers, collated together though they be to some extent by numerous foot-notes, necessarily leads to a certain amount of repetition, and to a somewhat irritating use of cross-references. Nevertheless, all workers in this field of research cannot but be grateful to Sir Almroth Wright for thus bringing together and rendering accessible a number of scattered papers.

Opsonins and vaccine therapy necessarily occupy a prominent place. Opsonins are substances present in the blood which act upon invading microbes, and render these susceptible to phagocytosis, that is, to ingestion by certain amœboid, wandering, and other cells, which brings about their destruction. By the injection of a certain quantum of a killed bacterial culture the production of opsonins specific for the particular organism injected tends to be increased; phagocytosis of the organism in question therefore is also rendered more active, and if an infection with the organism exists, it tends to be got rid of. The use of bacterial vaccines has been successful or useful in many infections; this is vaccine therapy. The present-day employment of vaccine therapy must in the main be ascribed to the work of Sir Almroth Wright, his co-workers and pupils, and to them all honour is due. At the same time we cannot help thinking that to some extent a balanced perspective is wanting in some of the statements. Thus the condemnations of the antiseptic system, and of the value of surgical extirpation of infective foci, are too wide and sweeping (pp. 280 and 318). The same criticism applies to the remarks on serum therapy (pp. 300 and 321).

Whatever be the failures of serum therapy, we cannot help thinking that neutralisation of the existing "poison" *at the moment* is a goal to be aimed at, however much we strive to reinforce the defensive powers of the body and render it later able to take care of itself. In very acute infections, such as some forms of septicæmia, which may prove fatal in twenty-four to forty-eight hours, or in cholera, in which the patient may be dead in a few hours after the commencement of the attack, the direct neutralisation of the "poison" would seem to be the only treatment that affords hope of success. The comparative failure of serum therapy should therefore be a stimulus to the elaboration of new methods of preparation of therapeutic serums rather than an argument for considering serum therapy futile.

TEXT-BOOKS OF PHYSICS.

(1) *Heat and other Forces.* By Colonel W. F. Badgley. Part i.: "Heat"; part ii.: "Physical Forces." Pp. 221+vi. (London: King, Sell and Olding, Ltd., 1907.) Price 5s. net.

(2) *An Elementary Course in Practical Science.* By C. Foxcraft and T. Samuel. Part i. Pp. 48. Part ii. Pp. 58. (London: G. Philip and Son, Ltd., n.d.) Price 6d. net each.

(3) *Horbare, Sichtbare, Elektrische und Rontgen-Strahlen.* By Dr. Friedrich Neesen. Pp. 132. (Leipzig: Quelle and Meyer, 1909.) Price 1.25 marks.

(4) *An Elementary Text-book of Physics.* By Dr. R. W. Stewart. Part ii.: "Sound," pp. iii+141. Part iii.: "Light," pp. vii+219. (London: C. Griffin and Co., Ltd., 1909.) Price, part ii., 2s. 6d. net; part iii., 3s. 6d. net.

(1) COLONEL BADGLEY'S book is an extraordinary production. The contents might be guessed from the title, which implies that heat is a force. The author has evidently read a great deal of current scientific work, to which he frequently refers, but has not the exact knowledge necessary for writing on the subject. Indeed, he suggests that the differences between work, energy, power, force, and motion are only mythical, and that the terms are really interchangeable. Typical, also, is the statement that "the heat given off by the spontaneous decomposition of radium is, perhaps, about a degree and a half centigrade." The preface is very cynical. It is questioned whether men of science believe in one

another's discoveries, and hinted that few of the latter are worthy of acceptance. The main object of the book is said to be to try to prove that "heat is not a vibration of material, not even of aether," but we search in vain for a clear alternative definition. It is a difficult book to follow because of the entire lack of order. The whole is an intricate mixture of simple experimental facts, quotations from books on many subjects, some of which are very remotely connected with heat, and a large amount of astounding new theory. Most of the ordinary phenomena in heat are dealt with, and a chapter in defence of the British systems of measurement is included. We can neither recommend the book to beginners—for it would confuse them—nor to those conversant with the subject—for it would waste their time.

(2) The two little books on practical science are for use in elementary schools, and the authors claim that the scheme has already been thoroughly tested with success. Part i. consists of a series of exercises in measurements of length, area, volume, weight, and density. Part ii. contains rather more advanced exercises on the same subjects, together with some on atmospheric pressure and heat, and a suggested course of woodwork. The exercises do not consist of detailed instructions of what to do and expect, but require some initiative on the part of the student. This is, indeed, the intention of the authors, who hold the view that the pupil should discover facts for himself. Thus, some of the exercises simply consist of a series of questions to be answered by making experiments. The books, although cheap, are clearly printed, and will probably be found to serve their purpose.

(3) Dr. Neesen has undertaken a difficult task in dealing with such a large subject in so small a volume. Nevertheless, most of the phenomena proper to the various subjects are referred to, although briefly. With a few exceptions, the book is non-mathematical, and deals rather with the experimental side. The reader, therefore, has no need of an advanced knowledge of physics, and it is doubtless advantageous for such to study the different kinds of wave motion together. Besides the subjects mentioned in the title, there are several paragraphs on radioactivity, in which the properties of the α, β, and γ rays are dealt with. Many of the diagrams are poorly drawn and printed. This is particularly unfortunate in a book dealing with wave motion and geometrical optics.

(4) Quite otherwise in this respect are the two text-books of physics by Dr. Stewart. That on sound especially should supply the much-felt need of an elementary treatment of that subject. Exception may be taken to the definition of simple harmonic motion as the projection on a diameter of the uniform circular motion of a point, because it leads students to believe in the existence of such a point in all cases of simple harmonic motion. It is rather surprising, also, to find Doppler's principle and the production of beats not referred to, especially as the latter is so commonly used as a method of estimating frequencies. Omissions are the chief fault in these volumes, and they are even more frequent in the part on light. There is no treatment of microscopes and telescopes, nor the methods of measuring the velocity of light. These are surely not out of place even in an elementary text-book. In reading this part alone it is noticeable that the undulatory theory is not sufficiently insisted upon, but this is compensated for by the fact that the laws of refraction and reflection are proved according to this theory in the volume on sound. On the whole, however, the books are distinctly good, and the large number of experiments suggested will no doubt serve to demonstrate the principles involved.

VOLUMETRIC CHEMICAL ANALYSIS.

A Manual of Volumetric Analysis. For the Use of Pharmacists, Sanitary and Food Chemists, as well as for Students in these Branches. By Dr. H. W. Schimpf. Fifth edition, revised and enlarged. Pp. xx+725 (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 21*s.* net.

THE plan of this work is as follows:—First, the general principles of volumetric chemical analysis are explained and illustrated. Next, the knowledge thus gained is applied to practice-work upon the commoner inorganic elements and their chief compounds, and upon certain organic acids. Finally, two branches of specialised work are taken up—namely, the analysis of various food-stuffs and pharmaceutical products—and the book concludes with a few examples of gasometric analysis applied to articles met with in pharmacy and medicine.

The treatment is generally fairly exhaustive, and the descriptions lucid. Often, indeed, the author gives almost a superabundance of detail in explaining the principles of the methods used. For example, he supplies not only the equations involved, but frequently the arithmetic as well. In the early part of the book he appears to have in mind the very elementary student, and is at some pains to explain such matters as the law of definite proportions. This seems hardly necessary in a book of this character. Knowledge of the elementary principles on the part of the student might well be taken for granted. In fact, the author is scarcely consistent; a page or two later on we find ourselves talking of univalent and divalent compounds, monobasic and dibasic acids, without previous explanation of the terms. A reader who knows what they mean would not be likely to want an exposition of the law of definite proportions.

A very useful description of the properties of indicators is contained in the fourth chapter. The reactions involved are dealt with mainly as ionisation phenomena, but a brief explanation is given of the chromophoric theory also.

The special feature of the volume, however, is the amount of attention devoted to the assaying of pharmaceutical preparations, particularly alkaloidal drugs. No fewer than a hundred and fourteen pages are taken up with these, and the sections appear to have been brought well abreast of modern practice. One division treats of the general volumetric estimation of alkaloids, explaining the principles, and describing some of the newer methods, as well as those which are older and better known. Afterwards comes a chapter dealing with the extraction of alkaloids from the various crude drugs—seeds, leaves, roots—in which they occur, and the determination of the proportion present. This is followed by sections which treat of the individual drugs and the galenical preparations containing them. The alkaloids of gelsemium, hyoscyamus, stramonium, coca, colchicum, conium, hydrastis, ipecacuanha, physostigma, pilocarpus, tobacco, strophanthus, and veratrum are included, as well as the commoner alkaloids, and this part of the work should be a boon to chemists or students interested in the examination of these products.

The space allotted to the analysis of water and food-stuffs does not allow of the articles being discussed at any length. Milk, butter, oils and fats, starch, and sugar are dealt with, and the outlines of principles and processes given are trustworthy as far as they go.

For the sake of the numerous references which the author supplies, one can readily forgive him his occasional lapses into slipshod English. The book contains a wealth of information, and considered as a whole is an excellent production. C. S.

OUR BOOK SHELF.

Geologischer Führer durch Dalmatien. By Dr. R. Schubert. Pp. xxiv+176. (Berlin: Borntraeger, 1909.) Price 5.60 marks.

THERE are few portions of the map of Europe more attractive to the eye of the geographer and the geologist than the coast of the northern Adriatic. On the one hand we have the coast of deposition, starting from the Apennine foothills north of Pesaro, and more and more emphasised in the swampy flats of Ravenna and Venice, until we reach the jungle-like woods of Monfalcone. Beyond this we come against steeply descending limestone hills, with a "karst" character already manifest. The blue water at Trieste speaks of the coast of subsidence that stretches to the south-east, with chains of islands parallel with the tectonic features of the land.

Dr. Schubert sums up the geological features of Dalmatia in a work intended for the instructed traveller. Cretaceous limestones play a large part in the country, but are concealed over much of the north by fresh-water and marine Eocene strata. The marine limestones of Middle Eocene age are here overlapped by the brackish-water marls and fluviatile conglomerates of the Promina series, which were laid down in Upper Eocene, and possibly finally in Oligocene, times, after a general uplift of the area (p. xvii). The Eocene sea itself had represented a return to marine conditions after a terrestrial and lagoon stage which closed the local Cretaceous system. The folding from north-east to south-west, which has determined the salient features of modern Dalmatia, took place in Oligocene times (p. 173).

While the corresponding depression of the Adriatic may have begun, through the production of faults, soon after the Oligocene period, the sea did not invade the northern part of its present basin until what we may call human times. The Po and its tributaries, dependent on the growth of the Alpine chain, carried detritus across this area, and the sinking that has separated the alluvial Italian region from the rocky shore of Istria began in the Glacial and continued into the Roman epoch. The chains of islands off the Dalmatian coast have thus a very modern origin.

Dr. Schubert guides the traveller on a series of excursions, with useful notes as to the accommodation on the way. He wisely points out that a knowledge of either Italian or Croatian, preferably the latter, is essential for those who go beyond the tourist routes. The price of his compact volume, with its numerous references to other literature, will not seem high, when one considers how long it will be before any large number of visitors will venture far from the comfortable steamers on the coast. The desire for luxury during travel fortunately leaves many European districts, like Dalmatia, free for those who prefer to study and observe at their own leisure.

G. A. J. C.

Entwickelung und Untergang des Kopernikanischen Weltsystems bei den Alten. By O. T. Schulz. Pp. 143. (Stuttgart, Verlag: Neue Weltanschauung, 1909.)

THIS essay is the first of a series entitled "Weltanschauungs-Fragen." It deals with the ideas of the Greeks about the construction of the world, but, notwithstanding the title, the standpoint of the author is that of an historian of geography, and not that of an historian of astronomy. He is evidently quite at home when sketching the gradual rise of geographical knowledge and illustrating it by maps. But when he comes to the astronomical part of his subject he has apparently only Zeller's "Philosophie der Griechen" and Schiaparelli's memoir on the precursors of Copernicus to build on, while Schiaparelli's later paper on the very subject indicated by the title of the present essay, as well as the writings of Tannery, Hultsch, and others, are unknown to him.

The author makes no attempt to point out how Aristarchus may have been led to the idea of the earth's motion round the sun, and tells the reader nothing about the systems of movable excentrics or epicycles. He states that Aristarchus at first believed in the motion of the sun round the earth, and that he says so in his little book on the distances of the sun and moon. But there is not a word in this book as to whether the sun or the earth is in motion. As regards the failure of the heliocentric idea to secure acceptance, the only reason given by the author is that Hipparchus considered it not to be based on sufficiently lengthy observations. We cannot imagine where the author got this piece of information from, as there is no allusion to the system of Aristarchus in the preserved writings of Hipparchus and Ptolemy. What Hipparchus did say was that he did not himself possess sufficient observations to work out the theory of the orbital inequalities of the five planets. But these have nothing to do with the motion of the earth. The author adds that there is no original research in the Almagest!

When dealing with the views of Plato, the author repeats the statements current sixty years ago about Plato's doctrine respecting the rotation of the earth and about his change of opinion in his old age as to which body was in the centre of the world. One cannot help wondering whether it really is of any use to try to kill historical errors. They seem to be immortal. At least, popular writers on the history of science are generally not aware that they are dead and buried long ago. J. L. E. D.

Excursionsbuch zum Studium der Vogelstimmen. By Prof. Voigt. Pp. 326. (Leipzig: Quelle und Meyer, n.d.) Price 3 marks.

THIS is the fifth edition of an excellent manual of the songs and other notes of birds, suitable for carrying in the pocket during walks and excursions. As a matter of fact, it is better for the learner to find out for himself what bird it is to the voice of which he is listening, for in the process, even if it be a long one, he will learn a good deal about the bird and its habits. But some learners are less gifted than others with a capacity for listening carefully, and have little or no musical ear, and a book like this may be of good service to these. Dr. Voigt's method is a very sensible one; he makes no great use of musical notation, but has invented a notation of his own which is likely to be much more useful to the ordinary observer. By a series of dots and dashes, inclining or curving up or down if necessary, he contrives to give a very fair idea of the character of the notes he wishes to represent, and also of their tendency to rise and fall. In some cases, *e.g.* in that of the swallow, he does not make use of either kind of notation, simply because neither would be any real help. His descriptions of the songs seem remarkably accurate. We have tested them in the case of many of the small warblers, which are among the most difficult to describe, and have invariably found them excellent, and the tendency of particular individuals of a species to vary the utterance is also duly noted. Thus of the marsh warbler (*Acrocephalus palustris*), Dr. Voigt says that it has troubled him more in the way of variation than any other species. In writing of this species he seems to have omitted the peculiar alarm-note uttered when an intruder is near the nest, but as a rule something is said of alarm- and call-notes. On the whole, we consider this book the most useful practical manual we have met.

W. W. F.

The Force of the Wind. By Prof. Herbert Chatley. Pp. viii+83; illustrated. (London: C. Griffin and Co., Ltd., 1909.) Price 3*s.* net.

PROF. CHATLEY has evidently devoted himself to a study of hydrodynamics and of its literature. He has attempted to boil down into an inordinately small compass, so as to be useful to engineers, an exposition of one of the most difficult and elusive subjects with which either the engineer or the mathematician has to deal. Explanation of principles which might be useful to a novice is replaced by a multiplicity of formulæ, which are flung at the reader with but little regard to dimensions or units. Numerical examples which, even in the case of clear exposition, always assist the student who wishes to apply a formula to any case in which he is interested are entirely absent.

Much information is collected, and numerous authorities are cited, but the result can hardly be considered satisfactory.

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.*]

Stability of Aëroplanes.

I HAVE recently been occupied with a comparative study of the theories of stability of aëroplanes deduced by Prof. Bryan, Captain Ferber, and Mr. F. W. Lanchester, and have just noticed a parallelism between the formulæ of Ferber and Lanchester which is strongly corroborative of the practical application of both.

In Ferber's "Les Progrès de l'Aviation par le vol Plane" (*Revue d'Artillérie*, November, 1905) he deduces from an extension of Prof. Bryan's analysis a formula for the conditions of longitudinal stability

$$\frac{P^2 b}{2Bg^2 kS} > 0{\cdot}8,$$

where P is the total mass of the machine, B is the moment of inertia about a transverse axis through the *cg*, S is the area of the supporting surfaces, *b* is the distance of the centre of pressure from the centre of area of the supporting surfaces, and K is an aërodynamic constant (0·7) kilometre-second system.

Lanchester's equation for longitudinal stability is

$$\Phi = \frac{4lH_n^2 \tan\gamma}{I\left(\frac{1}{K} + \frac{1}{\iota C\rho a\beta}\right)} > 1,$$

where l is the distance from the centre of pressure on a tail plane to the Cg, H_n is the kinetic head of the machine corresponding to its normal velocity, γ is the normal gliding angle, I is the moment of inertia about a transverse axis through the Cg, $K = \frac{\text{weight}}{(\text{normal velocity})^2}$, and the denominator of the second term in the expression within brackets is the lift on the tail plane (ft.-lbs.-sec.-units) divided by the square of the velocity.

Now the mass varies as the lifting force, which again varies as the square of the velocity, so that $P^2 \propto H_n^2$.

The torque which restores the machine to equilibrium depends in the case of a machine without a tail plane on b, and with a tail plane on l, so that if Lanchester's form is to refer to a machine without a tail plane b must be substituted for l.

B and I are identical in kind.

K varies as the lift ÷ square of the normal velocity, and since the lift varies as the product of the area and the square of the velocity, $K \propto S$.

The term relating to the tail plane is peculiar to that type studied by Lanchester, so that it can be omitted from our comparison.

Tan γ is a constant for any one type of surface.

Hence it will be seen that the two formulæ are exactly of the same form, and it only remains exactly to determine the appropriate constants to discover if the two expressions can be made identical.

As has been pointed out by Prof. Bryan, everything (except for a machine with a tail) depends on b, and unless $db/d\alpha$, where α is the angle of attack, is negative, the torque will not produce equilibrium. The Government's committee is, I believe, giving this attention.

I would further point out that the variations in velocity leading to Lanchester's "phugoid oscillations," and the oscillations due to the variation of b with α, will serve to explain the two types of oscillation, respectively of long and short periods, observed by Prof. Bryan and Mr. W. E. Williams, and shown by the former to be deducible from the equations of motion.

HERBERT CHATLEY.

Imperial Railways of North China, Engineering and Mining College, August 24.

IT is dangerous to draw conclusions from half-finished investigations, and anything I may now say must be subject to confirmation or modification when I have completely disposed of the mathematical theory of stability, both longitudinal and lateral, as I hope to do in a very few months unless any further pressure of professorial duties necessitates again hanging the matter up indefinitely. But results which I have recently obtained seem rather to corroborate instead of contradicting Lanchester's equation as holding good, subject to suitable assumptions and for the types of machine to which such a formula is applicable. I may state that I have already obtained expressions for the conditions that the quick or slow small motions may be subsident or oscillatory, and for their coefficients of subsidence in the first case and their periods and moduli of decay in the second. This applies to longitudinal stability, and a similar investigation is in progress regarding lateral stability.

It will, I believe, be easy to explain also *why* Lanchester's method, which to a mathematician certainly appears wanting in rigour, may lead to a correct result. But the matter will, I hope, be cleared up very shortly.

In the meanwhile, Prof. Chatley's comparative studies appear to indicate that we are within measurable distance of obtaining consistent results from widely differing methods.

G. H. BRYAN.

Chinese Names of Colours.

The correspondence on the above subject, started by Mr. A. H. Crook in Nature of January 11, 1906 (p. 246), was lately recalled to me when I heard, for the first time, the phrase "hsüeh ch'ing" (Cantonese sut$_0$ ts'eng)—snow-blue—used in conversation. It was used in this case in naming the colour of a flower, and struck me as particularly appropriate; the colour might well be described as one of those termed "ch'ing" diluted to a pale shade with white snow.

It hardly seems likely that any natural colour of snow itself should be the origin of the phrase, or how would one account for "shui hung"—water-red? The latter means pink, or, as one might say, a watery and "washed-out" red. Natural water of a pink colour is scarcely common.

Independently of the foregoing, though perhaps bearing on it, I should like to point out how the origin of some Chinese phrases may well have been obscured; this is by the substitution of one character for another nearly like it in sound, but not in sense. This may be illustrated by a case in which the change appears to be now taking place.

"Wang^4 pa^1"—forget eight—is a term denoting a person of infamous occupation, and also a kind of tortoise. This looks already sufficiently obscure, but is fully accounted for to the satisfaction of dictionary-makers and their kind.

It happens, however, that illiterate persons frequently wish to write this name. In many cases they may not know the character for "forget," but they well know that for "king" (wang^2), and the slight difference in sound is easily overlooked. The practice is being copied among the more literate, and it seems likely that in the end "wang^2 pa^1"—king eight—will entirely supplant the original (and now less common) form, and when this process is complete a sensible derivation will be impossible without reference to an older literature.

The process is almost parallel to some changes of spelling in English, but results in more complete obscurity.

Alfred Tingle.

Pei Yang Mint, Tientsin.

Percentages in School Marks.

Mr. Cunningham's inquiry (August 5) is aimed, apparently, at obtaining a kind of *index mark* for each candidate in an examination containing several papers. In getting a boy's percentage mark in any one paper there is no trouble; but the question is, By what law are percentages in different papers to be combined in order to get an index mark? Percentages may be combined in an infinite number of ways; which is the way Mr. Cunningham desires?

Consider three papers:—(1) looking at all the questions in the three papers as a whole, if marks have been assigned to each question with due relativity to all the other questions, (2) if the boys have each been properly prepared for all these questions, and (3) if fair time has been allowed for each of the papers, then each boy's index mark is clearly his total marks gained in the three papers divided by the total maximum marks of the three papers. The whole matter may be expressed more easily thus:—Let a boy gain marks x, y, z in three papers the maximum marks of which are a, b, c; his index mark may be expressed by $px+qy+rz$, and will depend on the constants p, q, r. For example, if $p=1/a$, $q=1/b$, $r=1/c$, the index mark is $x/a+y/b+z/c$ (or this divided by 3, the mean of the averages). Again, let $p=l/(la+mb+nc)$, $q=$&c., $r=$&c., then the index mark will be $(lx+my+nz)/(la+mb+nc)$, which reduces to the first example when $l=m=n$. In this case we have still the ratios $l:m:n$ in our power. For example, suppose papers set in Latin, French, and Greek, and take Mr. Cunningham's numbers for them respectively, namely, 37 out of 50, 50 out of 50, 71 out of 100, and suppose, on comparing the papers, that Latin is reckoned half as hard again as French, and Greek a quarter harder than Latin, then their difficulties would be Latin, French, Greek as 12 : 8 : 15, and it would seem fair to take these values for $l:m:n$. Thus the index mark for this boy would be $(12.37+8.50+15.71)/(12.50+8.50+15.100)$, or 1909/2500, or 0·7636 (per cent. 76·36). If, however, each one of the questions has had marks assigned to it relatively fair when compared with the marks of all the other questions of the three papers, and if the time allowed for each paper is proportionate to the work required by an average boy to answer the paper, then would $l=m=n=1$, and the index mark would be 158/200 (or per cent. 79·00). Thus, Mr. Cunningham must settle for himself, *in accordance with the circumstances of each case*, the values of the ratios $l:m:n$. The above includes the cases of Mr. Whalley and Mr. Abegg, and, I believe, will cover Mr. Pickering's case too, but I have tried unsuccessfully to understand his numerical table.

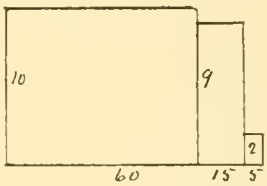
A kindred question is sometimes asked, What is the master-average of a set of averages? For example, thirty schools send in candidates for a paper; each school gets its own average of the marks gained by its pupils in the paper (this is the mark of value for the school); but the examining body wants some information as to how the paper has been done in general, for the sake of comparison with similar papers in other years, hence a master-average, or some equivalent, has to be determined. Assuming all the candidates from the whole thirty schools to be equally prepared for the paper, obviously the examining body will obtain its desired result by dividing the total sum of all gained marks by 100 N, if N be the total number of candidates and 100 be the maximum marks of the paper. This amounts to putting

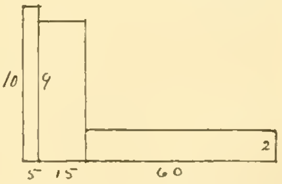
$$l=m=n= \ldots =1;$$

but if it be known that very bad work has come from a certain school, and if in fairness its marks should be valued at (say) one-third of the general run of the schools, then in this case we should put

$$l=m= \ldots =3$$

for twenty-nine of the schools, and $n=1$ for the school in question. To add the thirty averages and take one-thirtieth of the result is of no value at all. This is easily seen from the adjacent diagrams; in the first, sixty boys have an average of 10 marks, fifteen an average of 9, and five an average of 2; the mean of the averages is $(10+9+2)/3$, or 7; in the second case, five boys have an average of 10 marks, fifteen of 9 marks, and sixty of 2 marks; the mean of the averages is still only 7. Hence the same mean of averages is derived from two obviously different and even independent cases. Is it not fairer, in the absence of any other information, to take





$$(600+135+10)/80=9{\cdot}31 \quad\text{and}\quad (50+135+120)/80=3{\cdot}81$$

as the means of the averages, or rather as the representative index marks of the two groups of candidates? In other words, is not one group about two and a half times better than the other? Hence, for a single paper in a number of schools, the apparently easiest plan is to treat all candidates as equally well prepared, and to take the index mark required by the examining body as equal to the total marks gained by all the candidates in the thirty schools divided by 100 N as before; and this seems also fair. This index mark may be got as the quotient $(fu+gv+hw+\ldots)/100(f+g+h\ldots)$, where u, $v \ldots$ are school averages, and f, g, $h \ldots$ are the numbers at each school, so that $f+g+h+\ldots=$N. The same problem is presented to the headmaster of a school who wants to get an index mark either of a form, or of the work of a master, or of the whole school, for comparison from year to year.

J. D. Hamilton Dickson.

Peterhouse, Cambridge.

EXPLORATIONS IN CENTRAL ASIA.

THE detailed results of Dr. Stein's latest achievement in the world of scientific exploration are awaited with the deepest interest by all who concern themselves with the problems of Asiatic research, and it seems probable that we may sit expectant for many months yet before the extraordinary mass of information contained in his collections can be reduced to concrete form. Meanwhile, the Royal Geographical Society has published the text of the lecture (considerably amplified) which he delivered before it last March, and has issued a neat little map which is in itself a most necessary illustration to the story of his adventures.

FIG. 1.—Hall of Ancient Dwelling (Third Century A.D.) after Excavation, Niya Site.

The particular field of exploration which Dr. Stein has made his own is the Tarim basin of Chinese Turkestan. It was here at the very beginning of the century that he unearthed the first relics of an ancient civilisation, which, under the joint influence of India and China, had flourished in the oases of the Takla Makan desert and surrounded the shores of that elusive lake, Lop-nor, some fifteen or twenty centuries ago. It has been usual to think and to write of these buried Buddhist cities of the past as if the gradual encroachment of a great sand-sea, sweeping in huge progressive waves from the westward, had in the course of ages irresistibly engulfed them, and driven forth their ancient population to seek for more profitable fields elsewhere. To a certain extent this is true, but the movement of the sand-drifts was frequently the result rather than the cause of the desertion of these ancient sites. It was the failure of the water supply, the universal process of desiccation which now almost ranks as a geological feature recognisable throughout the world, that permitted the sand-waves. Yet there are points in Dr. Stein's systematic investigation of cause and effect which might lead us to believe in a return swing of the climatic pendulum; another beat in the "pulse of Asia" of which Mr. Huntington writes so convincingly. Here and there were found a people pushing gradually outward from the narrow ring of cultivation which borders the desert back again towards the old-world sites, although, in Dr. Stein's opinion, the sources of water supply once dried up will never again reopen.

However that may be, the important part of Dr. Stein's work in the field was the collection of those archæological relics of the past, including miscellaneous records (some of which are far older than any which have as yet come to light in Central Asia or China), bearing inscriptions in Indian Kharosthi and Brahmi, and specimens of early Buddhist art in moulding and in painting, the classification and interpretation of which will certainly prove to be the work of several years. Undoubtedly Dr. Stein has added a new chapter to Indian history, a chapter which deals with the period of Indo-Chinese religious affinity, when Buddhism, still rooted in the land of its birth, had spread outwards to the older civilisations of Central Asia and a never-resting tide of pilgrims passed to and fro, seeking inspiration at every wayside fount of knowledge that marked the weary road from the Chinese frontier through Khotan to Kashmir, or, striking farther west, refreshed the devotee in Badakshan and Kabul.

FIG. 2.—Southern Series of Cave Temples at the "Halls of the Thousand Buddhas."

The bourne of pilgrimage was ever the same. It was northern India and the cradle of Buddha on the borders of Nepal that was the end of all endeavour; and the marvel of our present knowledge (derived chiefly from the results of Dr. Stein's researches) is that the way was made so plain and the facilities for travel were so great in the early centuries of our era. We read of regular posts and connected lines of open route which must have been furrowed by the feet of thousands where never a soul passes in these later days.

With new history we have also to welcome a broad expanse of new geography. Dr. Stein's methods are nothing if not thorough. We have no uncertainty as to whereabouts he found this or that most ancient site; and when he records his remarkable discovery of a long extension of the time-worn wall of China he is able to define, not only its exact position, but its geographical significance as a defensive work with regard to surrounding topography. He does ample justice to the ability of his geographical assistant, Rai Sahib Ram Singh, but Ram Singh would never have effected such results without Dr. Stein's effective guidance and active help. One hundred and thirty sheets of the standard degree size, on the scale of four miles to the inch (which is what has been secured for the records of the Indian Survey), is a solid addition to our geographical knowledge which ranks well even with his vast store of accumulated archæological lore. Perhaps the most noteworthy discovery made by Dr. Stein during his investigations was the extension of the Turkestan basin eastwards to a point some seven degrees farther east than had been previously recorded. From the Chinese frontier town of Suchau a clearly defined line of drainage follows a course parallel to the extension of the Great Wall towards the central depression at Lop-nor; nor can there be much doubt that in the early days of Buddhist settlements in this region this now partially desiccated line of drainage marked the main trade-route from China to Turkestan. That route now hugs the foothills of the Altyn Tagh to the south between Anshi and Lop-nor, but it is a desolate and forsaken route, untrodden by the trader and unsanctified by the pilgrim.

FIG. 3.—Frescoed Wall in Cave Temple at "The Ten-thousand Buddhas."

It may be long yet ere we are able to appreciate as they deserve the discoveries and collections of Dr. Stein in relation to their bearing on the history of India; for the mass of raw material which has yet to be classified is so great as to have proved almost an embarrassment to its owner. In the meantime the short and instructive booklet on the subject now issued by the Geographical Society is well worth careful study.

THE SIXTEENTH INTERNATIONAL CONGRESS OF MEDICINE.

MEDICINE is so self-centred, and its practice is conducted so largely in private, that an international congress, where men meet on a level, rub shoulders, and part again once in three or four years, is an excellent corrective. It serves the same function in the profession as is answered by a public school for the only son of wealthy parents. It is not so much what is taught as what is seen and heard. The knowledge which is obtained by conversing with men brought up in different schools of thought, under various forms of civilisation, and often with wholly divergent ideals, is in itself remarkable, and is sufficient to start new trains of thought in many lines of research. In a great gathering like the International Congress of Medicine, where five or six thousand medical men are gathered together at fixed intervals, old friendships are cemented, new ones are formed, and whilst the scientific reputation of some falls to the ground, others are exalted. The quack is taken at his true value, for his work is judged by those who know the truth, whilst the humble and earnest worker in the difficult paths of research goes home strengthened by the encouragement which he has received from fellow toilers.

The sixteenth International Congress of Medicine was held at Budapest during the first week of September. The seventeenth congress will be held in 1913 at some town in Great Britain. Budapest lends itself especially to a large gathering of foreigners. It is a splendid city, magnificently placed on the Danube, easy of access both to the northern and eastern races of Europe. The inhabitants are active, intensely patriotic, eager to show the progress that has been made, and to prove that the youngest civilised State in Europe has not much to learn, and is in some respects already ahead of the older civilisations the best points of which it has endeavoured to copy. It is, indeed, very difficult to realise that Budapest was a Turkish possession little more than two hundred years ago, though the vigilant observer will notice the very faintest trace of orientalism as he walks amongst the people and through the smaller streets of the town. For a medical congress, Budapest is ideal, because it is full of springs and baths which would in themselves have brought it fame, the Hunyadi and Apenta springs being known throughout the world.

The congress was excellently organised, and the greatest credit is due to the president, Prof. Kálmán Müller, and the general secretary, Prof. Emil de Grósz, for the manner in which they brought things to a successful issue. His Royal and Imperial Highness the Archduke Joseph, acting on behalf of the King of Hungary, was indefatigable in the cause of the congress, for he not only attended the inaugural meeting in the municipal buildings, where 5000 persons were gathered together on one of the hottest days in the year, and remained throughout the whole sitting of three hours, but later in the week he welcomed the members to the palace and spoke personally to a very large number of the more important official delegates. He was ably assisted throughout by Count Albert Apponyi, the Hungarian Minister of Education, who made several important and statesmanlike speeches showing that he was in touch and in full sympathy with the work of the medical profession throughout the world.

The work of the congress was divided into official, sectional, and general. The official work was of unusual importance. It was decided that in future a meeting should be held once in four years instead of once in three years, as has been the case hitherto; that a permanent committee should be formed, with a president, a paid secretary, and a fixed office. Dr. F. W. Pavy, F.R.S., the president of the National Committee for Great Britain and Ireland, was nominated president, and it was determined that the office of the paid secretary should be at The Hague. By these means it is hoped that there will be a continuity of policy in the affairs of the congress which has hitherto been impossible, because there has been no permanent board to which difficulties and questions of policy could be referred.

The work of the sections did not prove of much interest, although many members attended and the papers were exceptionally numerous. The subjects chosen for discussion, like appendicitis, malignant disease of the larynx, the tuberculin treatment of tuberculosis, and uterine myomata, did not lend themselves to the expression of very novel views, and if the speakers who took part in them were not very inspiring, they were not belligerent, and the congress was spared the painful scenes which have occasionally turned the arena into a veritable battlefield.

Puerperal infection was selected appropriately as a subject of discussion. It was a tardy tribute to the memory of Semmelweis, the pioneer of modern obstetric prophylaxis, who died broken-hearted in the town where he had spent the best years of his life in declaiming against the fearful mortality of childhood and showing some of the means by which it might be avoided. He remained a voice crying in the wilderness until the end, but the statue erected by international effort, and placed in the gardens of the Ergebet-teren, was visited by every member of the congress, and was duly decorated with tributes from every nation.

The general addresses were excellent, and drew very large audiences, who listened most attentively. Prof. Holländer showed by means of lantern-slides some of the diseases and mutilations depicted in the records of the Incas and Huacos. Dr. Bashford, director of the Imperial Cancer Research in London, explained by similar means the present state of the cancer question, whilst Prof. Loeb, of Berkeley, made a remarkable communication upon artificial parthenogenesis.

The net outcome of the congress was the hold which the doctrine of immunity has gained upon the whole of the scientific side of the medical profession. Evidence of its importance was forthcoming from every side. There was a general discussion upon the subject. Dr. Bashford laid much stress upon it in his general address, and it formed an important factor in the work done by Prof. Loeb. It is evident that a great future lies before those who are working at the subject. At the present time there is much confusion and overlapping, a jargon of confusing terms masks the principles, but it is clear that before long the whole theory will be simplified and a most important agent will be added to the practice of medicine.

THE INTERNATIONAL SEISMOLOGICAL ASSOCIATION.

THE third meeting of the permanent committee of the International Association of Seismology was held at Zermatt on Monday, August 30, and the three succeeding days. Out of twenty-two States which now belong to the association, seventeen were represented. In his presidential address, Prof. Schuster directed attention to the importance of determining the movement of the soil in a seismic disturbance, and laid stress on the conditions which seismographs must satisfy, in order that the components of the displacements should be capable of being deduced from the records obtained.

A number of committees, which had been appointed at the previous meeting, now presented their reports. Perhaps the most important of these referred to the microseismic oscillations, which have lately attracted attention in many places. Two kinds of oscillations are to be distinguished, one having a period varying between four and nine seconds, and the other a period of about half a minute. The short-period microseism is often observed simultaneously over large portions of the earth's surface; its most interesting feature, which was independently discovered by Prince Galitzin in Pulkowa, by Hecker in Potsdam, and by Omori in Japan, is that there is a direct relationship between the amplitude of the oscillation and the period, the larger amplitude corresponding to the longer period. Dr. Klotz, the representative of Canada, has also investigated the subject, and found that whenever a centre of low barometric pressure, after traversing the continent, reaches the ocean, these microseismic waves of short period appear. Though we cannot at present give a quite satisfactory explanation of these waves, Prof. Wiechert's suggestion that they are caused by the impact of ocean waves on land areas deserves further investigation. For this purpose the committee intends to set up, probably on the west coast of Ireland, an instrument capable of registering the number and height of the waves. The microseismic disturbances, which have a period of about half a minute, have been found to depend on the intensity of local winds. They seem due to a wave-motion set up on land in a similar manner to that in which waves are set going on the ocean.

Probably the most important communication made to the meeting was that in which Prince Galatzin showed that it is possible to determine the azimuth of the seat of an earthquake by combining the indications of two seismographs, set up so as to give displacements in two directions at right angles to each other. The coincidence of the azimuth determined in this way for a number of earthquakes with that known independently was quite remarkable, the difference in many cases being less than a degree. As the distance of the earthquake can be determined from the interval elapsing between the arrivals of the forerunners and surface waves, Prof. Galitzin's investigations show that it is possible to fix the locality of an earthquake by observations at one distant station only; but such a result could only have been achieved by means of a perfection of instrumental appliances consequent on a complete mastery of the problems involved. Mr. H. F. Reid, of Baltimore, unable, unfortunately, to be present himself, sent a communication, in which he summarised his experiences gained by a study of the San Francisco earthquake. After directing attention to various instrumental matters, notably the absence of damping in many of the American instruments, which rendered the investigation difficult, he suggests the theory of a slow secular displacement as a preliminary condition leading to a seismic catastrophe, and shows how, if this theory be true, a certain class of earthquakes might be predicted.

Prof. Omori communicated a report on the Messina earthquake, in addition to his report on microseismic waves.

Communications were also made, among others, by Prof. Palazzo, of Rome; M. Angot, of Paris; M. Rosenthal, of Tiflis; M. Choffat, of Lisbon; while Prof. Hecker, of Potsdam, gave an account of his more recent results of tidal displacements in the earth. The meeting concluded with a lecture by Prof. Heim, in which an historical summary of the subject was given from the geologist's point of view.

At previous meetings the desire had been expressed that a complete bibliography of the subject should be published annually; a committee was appointed which reported in favour of coming to an arrangement with the International Catalogue of the Royal Society, all papers on seismology in that catalogue to be joined together in one volume, instead of, or perhaps in addition to, their being classified, as at present, partly under geology, partly under physics, and partly under applied mathematics. There is good ground for believing that such an arrangement could be made, and the meeting adopted the committee's report.

A report on the arrangements for an annual catalogue of earthquakes was presented by Prof. Forel, of Morges. The method to be adopted in such a catalogue, in order to make it most generally useful, gave rise to a good deal of difference of opinion; but after discussion in committee a compromise between different views was effected. Prof. Forel having completed his tenure of office as vice-president, M. Hipites, of Bucarest, was elected to be his successor.

The Federal Council of the Swiss Republic had entrusted the arrangements for the meeting to the Schweizerische Naturforschende Gesellschaft, and, with the assistance of Mr. Seiler, the delegates and their families were cared for in a most excellent manner. At the conclusion of the meeting satisfaction was expressed both at the success of the scientific results, and at the hospitable reception accorded to the members present.

BRONZE-AGE INTERMENTS IN SWITZERLAND.

UNDER the title of "Le Cimetière du Boiron de Morges," M. F. A. Forel has issued a report on some remarkable prehistoric interments in Switzerland, and though it occasionally lacks the lucidity of arrangement and grace of style which characterise French work of this kind, it will still be found full of interest.

These interments are attributed to the Bronze age, or, as the author terms it, "le bel-âge du bronze des Palafitteurs." The graves are flat, without mounds or stone pedestals, the latter, he thinks, having been probably replaced by wooden posts which have now decayed. They lie in no definite order or in lines one behind another; nor is there any rule of orientation in the graves themselves. It is remarkable that earth burial and cremation are found side by side; in fact, the two methods of disposal of the dead seem to be contemporary, if the evidence of identity in the style of vases and bronzes deposited with the corpse be accepted as conclusive. It may be noted that M. Forel treats as cases of inhumation those in which the teeth are found intact; those of incineration when the roots of the teeth alone survive. There is nothing in the shape of a regular cist, only a slab laid in a horizontal position over the head and upper part of the body. The slab graves of this class contained funeral plates and dishes, or piles of urns and bowls, three or four in number, laid one above another. Only one tomb which held a cremated corpse contained a cinerary urn; in the others the bones lay in the mass of charcoal and other remains of the cremation. In such interments only a single corpse was discovered; hence it is supposed that the custom of sacrificing slaves or animals in the belief that their spirits would accompany the dead to the other world did not prevail. There are occasional remains of some kind of coffin; and in the cremation graves the jars probably contained offerings of food to the dead, meat in some cases forming part of such deposits. It is thus obvious that the people who used this cemetery believed in the survival of the spirit after death. M. Forel seems to imagine that this custom of providing food for the dead implies the existence of a sacerdotal class; but this is not confirmed by the analogy of the customs of modern savages, among whom the head of the household or some tribal elder performs the death rites.

The paper is accompanied by photographs of the graves and their contents, and is, on the whole, a useful contribution to our knowledge of the Bronze Age on the continent of Europe.

NOTES.

WE learn from the *Pioneer Mail* that the Government of India has issued a resolution concerning malaria in India. The Governor-General has had under consideration a proposal of the sanitary commissioner that a permanent organisation should be formed to inquire systematically into the problems connected with malaria. The number of deaths ascribed to fever throughout India approximates to four and a half millions, representing a mean death-rate of nearly twenty per thousand, and though this total is greatly in excess of the actual figure, owing to the practice of ascribing to "fever" deaths which are in reality due to other causes, yet it has been estimated that the actual death-rate from malarial fever is about five per thousand. The Governor-General has decided to convene a conference to examine the whole question, and to draw up a plan of campaign for the consideration of the Government of India and of the local governments. The conference will assemble at Simla on October 11, and it is expected that it will last about a week. The following is a rough outline of the subjects to be discussed:—(1) the distribution of malaria in India as a whole and in various provinces, with special reference to the sickness and mortality to which it gives rise; (2) the measures of prevention which have been adopted in the different provinces—drainage, mosquito destruction, the distribution of quinine—and the measure of success which has attended each; (3) the improvement of schemes of prevention, including the question of the most suitable form of quinine and the agency by which it can most effectively be distributed.

THE International Aëronautical Congress at Nancy opened on Saturday last, and will conclude to-day. The programme included papers on dirigible airships, on light motors for airships and aëroplanes, on the history of aëroplanes, on cartography, on photographic topography from balloons, on the properties and uses of hydrogen, and on the theory and practice of aërodynamics.

AT the Brescia aviation meeting a record in altitude flight was made on Monday last by M. Rougier, who ascended to a height of 198·50 metres (645 feet), as compared with the previous records made by Mr. Orville Wright in Berlin, 172 metres, and M. Latham at Rheims, 155 metres.

THE following is a list of the awards made in connection with the Brescia aviation meeting:—grand prize of Brescia (international) for a speed test over 50 kilometres: 1st, Mr. Curtiss, 2nd, Lieut. Calderara, 3rd, M. Rougier; Modigliani prize (international) for height: 1st, M. Rougier, 2nd, Mr. Curtiss; prize for carrying passenger (international): Lieut. Calderara; prize for starting in shortest time: 1st, Mr. Curtiss, 2nd, M. Leblanc; world's record for height: M. Rougier; Oldofredi prize (national) for 1 kilometre: Lieut. Calderara; prize given by the Corriere della Sera (national) for 20-kilometre flight: Lieut. Calderara; King's cup: Lieut. Calderara. The gold medal given by the King has been awarded to Buzio and Restilli, the engineers who constructed the Rebus engine of Lieut. Calderara's machine.

AVIATION meetings, according to the *Times*, are to take place at Johannisthal, Berlin, from September 26 to October 3, and at Issy-les-Moulineaux, near Paris, from October 30 to November 1.

ACCORDING to a New York correspondent of the *Times* great damage to property and some loss of life has been caused in the neighbourhood of the Mexican Gulf by a hurricane. On September 21 the waters of the Gulf and of the Mississippi were reported to be still rising, and trains were water-bound in many places.

THE thirteenth annual fungus foray of the British Mycological Society will be held at Baslow, Derbyshire, from Monday next until the following Saturday. In the evening of Wednesday the president of the society—Prof. M. C. Potter—will deliver an address on bacteria in their relation to plant pathology, and on Thursday Prof. R. H. Biffen will read a paper on the Laboulbeniaceæ, and Mr. A. D. Cotton will present some notes on new or critical British Clavariæ.

THE Allahabad *Pioneer Mail* announces that an agricultural association is in course of formation in Poona which has as its object the development of agriculture in the Deccan. The programme of work laid down by the promoters is a large one. It embraces an annual show in one of the Deccan districts, the publication of up-to-date agricultural information, chiefly, if not entirely, in the vernacular, the encouragement of better cattle breeding, the pressing of the importance of agricultural education, especially in the vernacular schools, and many other departments.

IN connection with the Hudson-Fulton celebration (September 25 to October 9), a list has been issued by the committee of the celebration commission of the museums, institutions, and societies which have prepared free exhibitions relating to Henry Hudson, Robert Fulton, and the history of steam navigation; paintings, objects of art, archæological specimens, and other things relating to the three centuries of New York's history; the discovery of the Hudson River and the introduction of steam navigation; plants, fish, and animals indigenous to the Hudson River valley.

AN expedition, consisting of members of the Utah Archæological Society, is reported to have made important discoveries along the Colorado River, in northern Arizona and southern Utah. The most important is a natural bridge, which spans 274 feet and is more than 300 feet high. On the top of it several fossils of remarkable size were found embedded.

ACCORDING to *Science*, the palæontological expedition of the University of Chicago to the Permian of northern Texas has returned from a successful trip. Numerous skulls and skeletons of small reptiles and amphibians were secured, giving to the University of Chicago, with its previous collections from that formation, an excellent representation of Permian vertebrates.

MR. HENRY ADAMS has been elected president of the Association of Engineers-in-Charge, in succession to Mr. James Swinburne, F.R.S.

LIEUT. SHACKLETON has been invited to deliver a lecture on October 9 before the Danish Royal Geographical Society.

DR. E. A. WILSON, who served under Captain R. F. Scott in that explorer's former Antarctic expedition, has accepted the post of medical officer for the projected expedition of Captain Scott to the South Pole.

QUESTIONED as to the truth or otherwise of the statement that he was to lead an expedition to the Antarctic regions, Commander Peary has replied:—"My work in the field of either the Arctic or the Antarctic is at an end, although my services will always be available if desired in promoting organisation or other work in those regions."

THE death of Mr. Bryan Cookson has robbed astronomy of one who, during but a short life, had already achieved much, and who gave promise of still further advancing our knowledge of that science. Mr. Bryan Cookson was a son of the late Mr. N. C. Cookson, of Wylam-on-Tyne. He was educated at Harrow, and at Magdalen College, Oxford. After some time spent in travelling he took up his residence at Cambridge, where he designed a new form of floating photographic zenith-telescope for the purpose of making original investigations on change of latitude and the constant of aberration. Later he worked for two years at Cape Town under Sir David Gill, His Majesty's astronomer at the Royal Observatory, Cape of Good Hope, and some of his results were published in a paper on the determination of the mass of Jupiter and the elements of the orbits of the satellites of that planet. On his return to Cambridge he erected his zenith-telescope, with which he continued his observations, many of which still await publication. About a year ago Mr. Cookson was appointed assistant at the Cambridge Observatory. He was a man of the highest character and of singular charm of manner, and his death, at the comparatively early age of thirty-six, is keenly felt amongst a large circle of acquaintances.

THE death is announced of Mr. T. Currie Gregory, a civil and mining engineer who was concerned in the building of the Great Western Railway of Canada, now merged in the Grand Trunk line.

THE death is announced, at the age of seventy-four, of Mr. Peter Barr, well known as a horticulturist, to whom in 1897 the Victoria medal of honour was awarded by the Royal Horticultural Society.

AN exceptionally cool September is being experienced this year, and the entire absence of really warm days is very unusual. At Greenwich during the first twenty-two days of the month the thermometer has only once exceeded 70°, the absolutely highest reading being 71°. The mean of all the maximum day temperatures is 64°, which is 5° below the average, and the mean of the minimum night temperatures is 48°, which is 2° below the average, the mean result for the first three weeks being 3.5° below the average. During the corresponding period last year there were six days with the shade temperature above 70° at Greenwich, and in 1907 there were nine such warm days, whilst in 1906 there were as many as eleven days with the thermometer above 70°, and on each of the first three days the shade temperature exceeded 90°. The rainfall for September is so far generally somewhat below the average, and the duration of bright sunshine is about normal. During the greater part of the period the United Kingdom has been under the influence of a region of high barometer readings, and this has warded off very greatly the inroad of cyclonic disturbances from the Atlantic.

WE have received from the editor (Dr. Ziegeler, Spandau Jagowstrasse 4) a copy of the *Wochenschrift für Aquarien- und Terrarien-kunde*, containing several articles of interest. The chief of these refers to the successful importation into Germany from Mexico of that rare Cyprinodont fish Xiphophorus, so called on account of the pointed process borne on the caudal fin of the male. A good description is given of the habits and appearance of both sexes. Notes on the common viper, on the reproduction of the frogs and toads of Germany, and sketches of fishing and of hunting make up an attractive number. In a covering letter the editor points out that his *Wochenschrift* is international in scope, and he invites those who are interested in the cult of the aquarium to assist him in realising this object by contributing to its pages. The subject is not merely one for amateur fanciers, but is capable of forwarding research in genetics.

THE second number of vol. ii. of "Memoirs of the Indian Museum" is devoted to the first portion of an account of the Indian Cirripedia Pedunculata, by Dr. N. Annandale, the stalked barnacles of the family Lepadidæ, in its modern restricted sense, forming the subject of this section. The collection of Indian cirripedes of this group in Calcutta is unusually rich both in the matter of species and individuals, and since it has been supplemented by specimens from various European museums Dr. Annandale has had before him a wealth of material which ought to render his monograph well-nigh complete. In the author's opinion, the primitive cirripede was provided with a large number of calcareous plates or valves, and from this ancestral type evolution has taken place along several lines, both as regards the structure of the internal parts and the various appendages, and as regards the valves. In each division occur partially parasitic types in which the valves have undergone more or less complete degeneration.

To the September number of the *Popular Science Monthly* Dr. H. S. Colton contributes a specially interesting article on Peale's Philadelphia Museum. Charles Willson Peale, who was born in 1741, was at first a portrait-painter, but about the year 1785 set about the formation of a natural-history museum, which was, indeed, opened in Philadelphia, with the addition of grounds where a certain number of live animals were kept. In the exhibition-cases Peale attempted, with the aid of artistically painted backgrounds, to show his zoological specimens amid their natural surroundings, a practice which, after long disuse, has of late years come into favour in museums on both sides of the Atlantic. Peale's greatest achievement was the recovery and reconstruction of the first skeleton—or rather two skeletons—of the American mastodon. In the spring of 1801 Peale was informed that the bones of a mastodon had been discovered in a marl-pit near Newburg, in New York State, and he proceeded to the spot and purchased from the owner for 300 dollars the bones already disinterred, and the right to drain and excavate the morass for the purpose of endeavouring to recover the remainder of the skeleton. With the aid of pumps and other machinery lent by Government, the recovery of the missing bones was successfully carried out, and the skeleton, lacking the lower jaw and part of the crown of the skull, was eventually mounted, with additions in wood of the missing parts, from a second skeleton obtained in the neighbourhood and likewise mounted. These skeletons are noticed by Cuvier in his memoir on the great mastodon. At the sale of the Peale Museum in 1850 the second skeleton was probably bought by P. T. Barnum, and, if so, may have been burnt in the destruction of his museum by fire in 1851. The first skeleton, after having been taken by Peale and his brother to London in 1803, where it was exhibited before the Royal Society, eventually found a home in the American Museum of Natural History at New York, where it is known, from having been in the museum of the latter city, as the Baltimore mastodon.

IN the *Journal of Morphology* for July (vol. xx., No. 2) Mr. O. P. Dellinger makes an interesting contribution to the discussion on the physical structure of protoplasm. There is still, in spite of the elaborate researches of Bütschli and others, much difference of opinion on this question. The present author makes the cilium the starting point of his investigations, and brings forward evidence to show that all contractile protoplasm has a fibrillar structure. He demonstrates, in an apparently satisfactory manner, that the cilia of Stylonychia are composed of spirally coiled fibrils, and that the flagella of Euglena, Chilomonas, and Spirillum consist each of four spiral filaments, which will account for the complexity of their movements. He finds that by using those methods and reagents by which cilia are best preserved it is possible to demonstrate the existence of a finely meshed reticulum in Amœba, and maintains that such a reticulum of contractile fibres would explain all the facts of amœboid movement. Osmic acid appears to be the most satisfactory reagent for fixing the contractile structures investigated.

AN investigation of the epiphytic mycorrhiza that invests the roots of *Monotropa Hypopitys* forms the subject of a paper contributed by Dr. J. Peklo to the *Bulletin International*, Prague (1908). He points out that there is a marked difference between the amount of mycorrhiza investing Monotropa roots in clay or humic soils, and that specimens in clay soils may be entirely free from the fungal covering. As is generally known, the fungus penetrates only into the epidermal cells, and for this reason is termed epiphytic. The plant secretes tannin products in these cells, which serve, in the author's opinion, to prevent the fungus from penetrating further within the root.

THE first of an announced series of pamphlets providing information on special Indian timbers deals with the timber yielded by *Diospyros Kurzii*, and known as Andaman marble or zebra wood. As the name implies, the wood is streaked in bands ranging from black to a brownish or pinkish grey, and it has been described as one of the handsomest timbers in the world. The pamphlet, compiled by Mr. R. S. Troup and published by the Government of India as Forest Pamphlet No. 7, supplies details regarding the qualities, available size, and amount of timber; it also contains an actual specimen of the wood.

ARISING out of an inquiry addressed to the director of Kew Gardens, Dr. O. Stapf supplies in the *Kew Bulletin* (No. 7) an article on the identification and properties of the wood known as "lignum nephriticum," which was regarded some three centuries ago as a valuable remedy for disorders of the bladder and kidneys; it was also known that an infusion of the wood was fluorescent. This property, together with a reference to the Mexican vernacular name "coatl," provided the clue to its identification as the product of the leguminous tree *Eysenhardtia amorphoides*. A chemical examination to ascertain the principles which give the wood its physical and possible therapeutical qualities is postponed until more material is available. Another determination by the same authority refers to the fodder grass which is making a reputation in Australia and Natal as *Phalaris commutata*, but which should be known as *Phalaris bulbosa*.

WE have received a copy of "The Problem of Practical Eugenics," a lecture delivered by Prof. Karl Pearson at the Galton Laboratory for National Eugenics. Prof. Pearson directs attention to the falling birth-rate, particularly in a manufacturing city like Bradford, and the conclusion is arrived at that this is due mainly to factory legislation, which has destroyed the economic value of the child. A Bradford doctor assured him that in the days before the Factory Acts more care was taken of the children on this account. Prof. Pearson says "the mistake of most legislation is that it is carried by appeal to the sentiment and feelings of relatively small classes—the cultured and highly sensitive upper and middle classes. The biological and economic bases of life are disregarded, and the result is only manifest twenty or thirty years later. The whole trend of legislation and social action has been to disregard parentage and to emphasise environment." Various suggestions are offered to remedy this effect while still maintaining factory legislation. The lecture is one which should be carefully studied by the educated public and our legislators who have the well-being of the race at heart.

AN important report, by Prof. W. J. Simpson, on the general state of sanitation and of public health in the West African colonies, has been issued by the Colonial Office. Prof. Simpson was sent to the Gold Coast with special reference to an outbreak of plague which occurred in Accra and the surrounding district in January, 1908. The outbreak lasted for six months; there were 344 cases with 300 deaths. Preventive inoculation was resorted to with conspicuous success, and was performed on 35,000 persons without a single accident or ill-effect. The general insanitary conditions existing in the colony are described by Prof. Simpson as being fraught with danger to the community. No real, effectual, and steady campaign against malarial fever in West Africa has yet been begun. There are no mosquito brigades maintained throughout the year, and it is no one's special duty to look after and to be responsible for the public health. No real progress is possible except by the formation of an organised health department completely distinct from the existing medical service of the colonies, and charged with the duty of advising the Government concerning improvements, and of seeing that they are effectively carried out. Owing to the absence of such a department towns are suffered to grow up from villages without any forethought, the result being often an insanitary condition that nothing but costly demolition will remedy. The report sketches an outline of the organisation and composition of the proposed sanitary service, and discusses its relations with the existing West African medical staff and with the Government.

THE Bulletin of the Sleeping Sickness Bureau (No. 9) contains *résumés* of a number of papers on trypanosomes and sleeping sickness. Dr. Moffat reports on a sleeping-sickness-like disease in Bechuanaland. He concludes that the disease closely resembles sleeping sickness, but if it is this disease it is probably imported, and not indigenous.

THE craniometrical evidence from India, which is at present scanty and in various respects unsatisfactory, has been usefully supplemented by the publication of the measurements of a series of skulls deposited in the Indian Museum, Calcutta, which have been carried out by Mr. B. A. Gupte under the supervision of Dr. Annandale. The collection contains 614 specimens, but many are broken and others do not indicate the caste or tribe of the subjects. Besides this, practically all come from the lowest strata of the population, from jails and hospitals, the more respectable members of the community being invariably cremated. The record is also vitiated by the impossibility of segregating the skulls of emigrants from other parts of India who happened to die in eastern India. These records, therefore, afford no safe basis for generalisation, but they may be useful to supplement measurements of the living subject, which are necessarily less trustworthy than those of skulls, because it is easier to arrange the position of the latter, and because the soft tissues of the head and face exhibit much individual variation and capacity for contraction and expansion. Mr. Gupte has good reason for appealing to persons throughout India who are in a position to collect skulls, the *provenance* and records of which can be accurately determined, to supplement the present collection, which is of little value for the classification of the multitudinous races and castes to be found within the Indian Empire.

THE first annual report (1908) of the Liverpool Committee for Excavation and Research in Wales and the Marches, which has its headquarters in the Liverpool University Institute of Archæology, and is closely associated there with the School of Celtic Studies, contains valuable preliminary surface surveys and detailed reports of tentative excavations at the Roman camps of Chester and Caerleon. The discovery of a Palæolithic implement at the former site is of special interest. A list of the relative number of coins found at Caerleon indicates an occupation of the camp in, or soon after, the principate of Vespasian. Mr. Evelyn-White adduces literary evidence pointing to occupation under Claudius. Two excellent plans of the camp have, apparently, a true north bearing, though the fact is not stated, for the orientation indicated is about 51° N.W.-S.E., which on paper is near enough to the theoretical azimuth for the district of sunrise at the winter solstice. In the preliminary surveys of cromlechs there is not a single reference to their orientation, and the subject has yet to be formally recognised by a committee which, as the list shows, represents all the archæological societies of Wales and the Marches.

DR. GEORG VON SMOLENSKI, of Cracow, contributes to *Petermann's Mitteilungen* (v., p. 101) an interesting study of the causes of the asymmetrical form of the north-and-south river valleys in Galicia, which are characteristically steeper on the eastern side than on the western. A careful examination of the different theories which have been proposed from time to time leads Dr. von Smolenski to conclude that no single hypothesis can account for all the observed facts, and he divides the valleys into two groups, those in which the asymmetrical form is being developed and extended at the present time, and those in which it remains as the result of a former condition no longer in existence. In the first group the asymmetry is due to the normal action of "Hilber's law," the base-level of each tributary of the master stream (the Dniester) being lower than that of the tributary next it to the westward. The second group is found to be due to the action of wind, and must have been formed at a time when the prevailing winds of the region were east and north-east. It appears independently that the formation did actually take place in late Pleistocene times.

The report of the Meteorological Committee for the year ended March 31 presents several points of especial interest. The various publications containing statistical results have been grouped together under the title "British Meteorological Year-book"; it appears strictly up to date, which will be a great advantage with regard to the supply of information to inquirers, the number of whom have much increased in recent years. Several publications on interesting subjects are in course of preparation. The 7h. a.m. international service of telegraphic weather reports, which was brought into operation on July 1, 1908, has been found to work satisfactorily, and since the commencement of the present year the reports by radio-telegraphy hitherto received from H.M. ships have been supplemented by wireless telegrams from Atlantic liners. The observations and accuracy of transmission have been satisfactory, but only a small number of the messages were received in time for current use, and much remains to be done before they can be utilised in a day map of the ocean. The weather forecasts issued in the morning newspapers and those issued during the harvest season (June–September) have been very successful, the percentage of accuracy (complete and partial) amounting to 92 and 96 respectively. The committee contemplates making some important modifications in the practice of the office as regards marine observations. Instead of devoting attention almost exclusively to the compilation of average results, it is proposed to compare the current with the mean values. Monthly outline charts in suitable form, with the mean values of various elements, are being prepared as the ground-work for plotting the observations recorded on voyages. By this means it is hoped eventually to trace the meteorological relationships of changes in different parts of the world.

The *Physikalische Zeitschrift* for September 1 contains a long illustrated article by Dr. Max Iklé on old and new little-known auxiliary apparatus for use in physical and chemical laboratories. The pieces of apparatus mentioned are taken from the catalogues of nineteen German firms of instrument makers, and are well worthy of the attention of instrument makers in general. Of special interest are the funnel holder of bent wire, the small instrument stand of adjustable height, the metal lens holder of the Schuster and Lees type, the Bunsen burner with the gas inlet at the side so as not to be stopped up by fused salts falling down the tube, the "emaille" insulated connecting wire for electrical work, and, finally, the list of monographs dealing with cements for physical and chemical work.

The well-known paradox of twisting a strip of paper and joining its ends in such a way as to form a surface with only one face and only one edge gives rise to the cubic surface known as Möbius's surface. This is, in fact, a surface generated by a straight line which revolves about a point in its plane through an angle of 180°, while the plane revolves about a straight line in itself through 360°. A discussion of the properties of this surface, by Prof. C. E. Cullis, forms one of the papers in the first number of the new Bulletin of the Calcutta Mathematical Society.

The Calcutta Mathematical Society has commenced the issue of a Bulletin which promises to be an important addition to our mathematical periodicals. In addition to original papers it contains a "summary of principal mathematical journals," with abstracts of many papers; a section headed "Societies and Academies," with full list of titles of papers read; "Reviews"; "Notes and News"; a bibliography of "New Publications," together with proceedings of the society itself, and lists of members and of books in the society's library. While the new bulletin thus assumes the cosmopolitan character of its American contemporary, several of the features which characterise it are distinctly new. The journal should fill a want which is felt no less by English than by Indian mathematicians. We had almost forgotten to mention another commendable feature—there are no "problems and solutions."

A paper on the liquefaction of clay by alkalis and the use of fluid clay casting in the ceramic industry, by Dr. E. Weber, which formed the subject of an interesting demonstration at the International Congress of Applied Chemistry, appears in full in German and in English in the eighth volume of the Transactions of the English Ceramic Society, before which society the paper had previously been read. The author shows that by the addition of a suitable quantity of alkali a stiff clay, containing not more than a normal quantity (15 to 20 per cent.) of water, can be made quite fluid; on pouring into plaster moulds the water and alkali are drawn out, and the clay quickly sets. The addition of the alkali does not affect the properties of the finished material, provided that it is only used in moderation, and the use of plaster moulds tends still further to neutralise its effects. In addition to the saving of labour-charges, it is claimed for the casting process that, by completely disintegrating the clay, it gives a very dense and uniform product free from all defects, and that when porous materials are admixed with the clay these become thoroughly impregnated, giving an absolutely dense, homogeneous, and strong mass. The method is in use on a considerable scale for the manufacture of glass furnaces, muffles for zinc distillation, gas retorts, and sanitary goods, as well as smaller articles. The same volume contains a description of a new casting machine, by J. G. Roberts, which is claimed to work with less manual labour than those previously in use, and to have an output of forty-five dozen articles per hour. The society is to be congratulated on the initiation of a series of abstracts from pottery journals, of which a first instalment, covering forty pages, and dealing with twenty journals, is now published.

The Parseval airship has recently passed the stipulated tests, and has been accepted by the Prussian War Office. The conditions laid down were capability of remaining at a height of about 5000 feet for more than ten hours, of landing at any specified place, and, in addition, capability of being quickly taken to pieces, transported by rail or by two-horse vehicles, fixed up, filled again, and started from any place. At the trials the airship actually kept afloat for $11\frac{1}{2}$ hours. We learn from a description in *Engineering* for September 10 that the ship has a cigar-shaped body about 190 feet long, and has a maximum diameter of about 31 feet. The balloon is charged with hydrogen, and has sufficient rigidity imparted to it by a slight excess of gas pressure—0·8 inch of water. To produce and maintain this gas pressure two *ballonets* or air-sacks have been provided within the balloon; these are charged with compressed air at a pressure of about $1\frac{1}{4}$ inch of water, and this supply is controlled by means of a system of valves. The motor develops from 100 horse-power to 120 horse-power, and the petrol tank contains nearly 100 gallons.

FEW present-day engineers are aware that Watt produced a steam tilt hammer some years before Nasmyth designed the type of hammer that bears his name. The works at Soho held at one time a great reputation for coppersmith work, and this class of work was done with a Watt tilt hammer, which continued to be in use until quite recently. A photograph of the hammer, together with many others showing machines used by Boulton and Watt, appears in an article in the *Engineer* for September 10. In examining the illustration of one of the Soho boring machines, we are reminded of Watt's early troubles in boring his cylinders—on one occasion we find him rejoicing over a finished cylinder which was nowhere more than ⅜-inch from true circularity. We agree with our contemporary that it is greatly to be deplored that the history of machine tools has not been preserved. The ingenuity which has produced the development of machine tools has contributed in no small degree to the rise and progress of mechanical engineering.

A CONSIDERABLE extension of our knowledge of the electrical strength of air has been made by Mr. E. A. Watson, of the University of Liverpool, who has measured the potential difference necessary to cause a spark to pass between two small metal spheres at various distances apart in air at pressures between one and fifteen atmospheres. His paper, and the discussion which arose on it, will be found in the August number of the Journal of the Institution of Electrical Engineers. From it we gather that air compressed to fifteen atmospheres will stand an electrical stress of 40,000 volts per millimetre, and it is to be hoped that this fact will soon find its application in apparatus in which high insulation is required.

Erratum.—In NATURE of September 16, p. 339, second column, line twenty-two from bottom, the word satisfactory should be unsatisfactory. The sentence should read:—"With a sextant and artificial horizon, a low altitude, such as 10° or 11° or below, is very unsatisfactory."

OUR ASTRONOMICAL COLUMN.

HALLEY'S COMET.—From a Central News telegram published in Monday's *Daily Telegraph*, we learn that Prof. Burnham has obtained two photographs of Halley's comet, with instruments at Yerkes Observatory.

OBSERVATIONS OF PERRINE'S COMET, 1909*b*.—A further observation of Perrine's comet, made by Dr. Max Wolf on September 5, is recorded in No. 4355 of the *Astronomische Nachrichten* (p. 179, September 12). With the reflector, and a power of 140, the comet appeared as a round, nebulous mass, of about 10′ diameter, increasing in intensity towards the centre. The brightness of the whole comet is about equal to the fourteenth magnitude, while the nucleus is about equal to a star of that magnitude.

Dr. Ebell gives an ephemeris for this comet in the same journal showing that it should become about 1·5 magnitudes brighter than it is at present by October 17. The observation of September 5 shows that this ephemeris then required corrections of −1m. 39s. and −23′.

OBSERVATIONS OF MARS.—In No. 4354 of the *Astronomische Nachrichten* (p. 159) M. Jonckheere gives a drawing illustrating his observation of August 11–12. The peculiar interest of the observation was the aspect of the Novissima Thyle, which, although still covered with ice, was detached from the polar cap. This feature of the Martian landscape appeared oval, with its broad extremity in long. 330° and its narrow end in long. 310°, its apparent length being 1·42″.

Measures of the polar cap show that its apparent diameter decreased from 4·33″ on July 16 to 3·00″ on August 21.

Further changes are recorded by M. Jarry Desloges in No. 4355 of the same journal. Observations made with a 37-cm. refractor on the Revard plateau on September 3 showed that the white polar spot was divided completely by a crevasse and a greyish region in long. 80°. The region of the Lacus Solis and d'Auroræ Sinus, so pale during the previous rotations, showed considerable changes, the details now appearing very different in form, colouring, and position to what they did in 1907. Juventæ Fons is dark and easily visible, and the canal Coprates appears to have changed its position since 1907. Nectar is dark and broad, and Araxes is double and very complicated in its structure. Lacus Phœnicis is blackish and is doubled, the southern portion being the smaller. Lacus Tithonius has very indefinite edges, and two dark spots are seen within its area. The Solis Lacus presents a number of detailed features, and is much elongated in the direction east-west. A number of canals, single and double, were observed, and all the regions observed presented such a complicated structure that it was found impossible to make complete drawings.

WATER VAPOUR IN THE MARTIAN ATMOSPHERE.—According to a despatch published in the *Times* of September 17, spectrograms of Mars and the moon, secured by a party of Lick observers on the summit of Mount Whitney, indicate that there is no appreciable quantity of water vapour in the Martian atmosphere. Prof. Campbell suggests that the positive results obtained by Prof. Lowell and other observers may be attributable to water vapour in the earth's atmosphere, but further details should be awaited ere the recent negative results are accepted as final. The photographs are stated to have been taken when Mars and the moon were at the same altitude, and under similar conditions of the earth's atmosphere, yet the vapour bands in the Martian are no stronger than in the lunar spectra; hence it follows that, at the time the spectra were obtained, the quantity of water vapour on Mars was apparently no greater than that on the moon.

THE MAXIMUM OF MIRA IN OCTOBER, 1908.—Dr. Nijland's observations of the magnitude of Mira, made at the Utrecht Observatory during the period July, 1908, to February, 1909, showed that the maximum (mag. = 3·5) occurred on October 6, 1908 (J.D. 2418221), five days before the time given by Guthnick's ephemeris (*Astronomische Nachrichten*, No. 4355, p. 165).

THE SPECTROHELIOGRAPH OF THE CATANIA OBSERVATORY.—In an extract from vol. xvii. of the *Rendiconti della R. Accademia dei Lincei*, Prof. Riccò describes the spectroheliograph now in use at the Catania Observatory, the first to be erected in Italy.

The instrument is made to attach to a telescope, and may be used with a prismatic, or a grating, dispersion. The regulation of the transit of the primary slit across the solar image is effected by a clepsydra containing water with 20 per cent. of glycerine added. The diameter of the solar image operated upon is 52 mm., but the primary slit is but 37 mm. long, therefore the whole disc takes two exposures. Some of the results obtained at Catania, in 1908, are reproduced with the paper, which is also printed in No. 8, vol. xxxviii., of the *Memorie della Società degli Spettroscopisti Italiani*.

Hα IMAGES ON SPECTROHELIOGRAMS.—In concluding a letter to the *Observatory*, M. Deslandres states that, on spectroheliograms taken in Hα light at Meudon, he has, this year, noted numerous instances where the spectroregister of velocities has revealed some very large radial displacements, similar to those observed by Young in 1872 and Hale in 1892. These were thought to be exceptional phenomena, but Mr. Buss, who calls them "horns," claims that he has seen them with relative frequency. The Meudon observations now confirm Mr. Buss's ocular observations.

DOUBLE-STAR MEASURES.—In Nos. 4353–4 of the *Astronomische Nachrichten*, Prof. Burnham continues the record of the observations of double stars made since the publication of his General Catalogue. The majority of measures refer to doubles otherwise neglected, and comparatively few of the Σ or $O\Sigma$ are considered to require present attention. About 150 systems are included in the list of measures now published.

COPENHAGEN CONGRESS ON THE TESTING OF MATERIALS OF CONSTRUCTION.

THE fifth Congress of the International Association for the testing of engineering materials met at Copenhagen on September 7–11. The attendance at this congress was very much larger than that at the previous meeting, which took place at Brussels three years ago. There was a particularly marked increase in the British representation, which had risen from about fifteen at Brussels to more than forty at Copenhagen. Among the British representatives were Mr. G. C. Lloyd, British member of council of the International Association, Mr. J. E. Stead, F.R.S., and Messrs. B. Blount, F. W. Harbord, L. Robertson, E. O. Sachs, F. Tomlinson, W. Rosenhain, and A. G. Roberts. Among the Continental members, Profs. Martens and Heyn (Berlin), H. Le Chatelier and L. Guillet (Paris), Messrs. Webster, Moldenke, Hatt, and Windsor-Richards (U.S.A.), were some of the best known. The membership of the congress thus very fully represented both engineering science and practice.

The formal opening of the congress took place in the presence of the King of Denmark in the large hall of the University of Copenhagen. The opening ceremony was performed in a few graceful words by the Crown Prince of Denmark. In his presidential address the president, Mr. Foss, explained the general aims of the association, and pointed out the fact that the present year was the twenty-fifth anniversary of the first inception of the association. He referred specially to the increased interest displayed in the present congress by British engineers, and said he hoped that this might lead to the establishment of a better mutual understanding between the Continental and the English-speaking engineers. An address by Mr. P. Larsen on the development of the Danish cement industry completed the proceedings, which were, however, considerably enlivened by the spirited rendering of a typically Scandinavian cantata by a choir of students.

The actual business of the congress, which occupied the mornings of September 8, 9, and 10, was divided into three sections, the meetings of which took place simultaneously in various rooms set apart for the purpose in the splendid Town Hall of Copenhagen, where every possible provision for the comfort and convenience of members had been thoughtfully made. Section A, being devoted to subjects connected with metals, was the largest as regards attendance, although Section B, devoted to cement and reinforced concrete, also attracted many members and much attention. Section C, devoted to miscellaneous materials, proved less important.

The papers and reports submitted to the three sections occupy the closely printed pages of several voluminous pamphlets, and these, as well as the discussions upon them, can only be indicated here in the briefest outline.

Section A devoted its first sitting to the subject of metallography, an official report of the progress of that science being presented by Prof. Heyn, of Berlin. The extent of this report, in which a considerable number of British papers are referred to in abstract, is striking evidence of the great strides which this new science has made—the period covered by this report marking an epoch through the loss of Dr. Sorby, the actual founder of the science. Although the report of Prof. Heyn referred to a large number of papers, some of considerable importance which have appeared in England and America were, no doubt inadvertently, omitted; in the discussion, therefore, it was suggested by Dr. Rosenhain that it would be desirable in the preparation of future progress reports of this kind to obtain the collaboration of competent members from each country with the view of compiling a complete triennial bibliography. Out of the subject-matter of this report a discussion arose as to the nature of the constituents of steel, in which Benedicks, Le Chatelier, and Heyn took part. A further and very satisfactory outcome of this discussion, followed by a private conference of some of the delegates, was the formulation of a set of international definitions referring to the nomenclature of the constituents of iron and steel; this set of definitions was placed before the congress under the unanimous recommendation of Messrs. Le Chatelier, Guillet, and Charpy (France), Heyn (Germany), Benedicks (Sweden), and Stead and Rosenhain (England). The new term "meteral," suggested by Howe and Sauveur (U.S.A.), was accepted with the significance in the case of the constituent of a metal which attaches to the term "mineral" in the case of the constituents of a rock, complexes of two or more meterals to be known as "aggregates"; these terms having the great advantage of being of international applicability, and also fairly obvious in meaning, have met with general approval. The terms "martensite," "osmondite," "austenite," and "pearlite," as well as the already universal terms "ferrite" and "cementite," have received clear definitions; thus the new term "osmondite" is to denote that constituent which is present in partly hardened or tempered steels which no longer consist of either austenite or martensite, but contain an intermediate constituent which arises in the passage of martensite into pearlite; this constituent, which some authors have hitherto called "troostite," is now to be known as "osmondite," and it is hoped that the full definition adopted by the congress will free the term "osmondite" from the haze of controversy which has hitherto obscured the term "troostite." The two terms "troostite" and "sorbite" have been left entirely out of these international definitions in the hope that their use will either be entirely dropped or, at all events, accompanied in each case by a special definition.

The adoption of these definitions constitutes one of the few quite definite results attained by the congress; in most other matters the discussions either produced no definite conclusion or the questions under consideration were referred to international committees to be subsequently appointed by the council. Thus the question of slag-enclosures in steel, raised by a paper by Rosenhain, led to a discussion in which the general trend of opinion was strongly in the direction of attaching greater importance to these enclosures than has hitherto been done. Guillet proposed that in order to keep this matter before the congress a committee be appointed to consider the subject and to carry out investigations as to the nature of these slag-enclosures and their effect on the mechanical properties of steel, and this proposal was adopted.

The questions of hardness tests on the one hand and of impact tests on the other each occupied almost an entire day's session of Section A. In regard to hardness tests, the Brinell ball test found many ardent supporters, but, on the other hand, Dr. Ludwik, of Vienna, presented a paper emphasising the advantages of cone-indentation tests, and a cone-hardness testing machine of Swedish manufacture was shown which appeared to be a serious rival to the Brinell machine of Martens-Heyn, which is regarded as the standard machine in Germany. The British delegates directed attention to the "hardness" testing machines in which the rebound of a hardened falling weight is observed, as these appeared to be unknown on the Continent.

The importance of impact tests was recognised by all who took part in the lengthy discussion on this subject, but the importance of standardising what was still a purely empirical test was also insisted upon. After some opposition from the German section, the congress finally adopted a set of standard test-bars for notched bar single-blow impact tests, but although the Charpy impact tester appears to be widely recognised as a satisfactory machine, it was decided not to adopt definitely any one apparatus.

Perhaps the most difficult question with which the congress had to deal was that of the standardisation of specifications as between different countries; the acceptance of an international specification by the congress being a matter which would seriously affect the industrial interests of the countries concerned, much difficulty and some little friction inevitably arose. It was quite evident from the outset that the final adoption of any universal specification was not yet possible at the present congress, and in nearly every case the questions of unified specifications were referred back to their respective committees. Perhaps the largest amount of progress was reported by M. Guillet as chairman of the committee on specifications for copper; at a meeting of this committee, which took place just before the congress at Copenhagen, the members present were able to agree on most points of an international specification. Unfortunately, the attendance at this meeting was not very large, but it is hoped that when the conclusions arrived at by this committee are circulated to all the members a universal agreement as to a specification very much on the lines of the British standard specification will be reached. In regard to iron and steel, the difficulties are much greater, but it is hoped that a nearer approach to agreement may be reached in time for the next congress; meanwhile, the only definite result in this direction is a carefully worded resolution indicating that the congress recommends the sale of pig-iron on a basis of chemical analysis alone, the old method of grading by fracture being discarded as too indefinite.

In Section B the papers dealing with reinforced concrete were first discussed, but the discussion was of a very general nature, the desire being widely expressed that methods of testing and experimenting should first of all be systematised and standardised. One of the subjects which received most attention was that of the action of sea-water on cement, the report by Poulsen describing the elaborate series of tests carried out on various points of the coast of Scandinavia from Esbjerg, in the south-west, to Vardö, at the extreme north of Norway, being very favourably received. Ultimately the section passed a resolution, combining one proposed by Mr. Sachs and another proposed by a French representative, setting up a committee to bring the whole question up to date for the next congress by preparing a summary of the papers already before the association, and also to carry out further experiments with specially prepared cements exposed to sea-water to test the influence of various percentages of sulphates.

In connection with cement-testing there was a good deal of heated discussion, principally as to the definition of a "standard sand," while Mr. Blount and his committee had to contend with some strong opposition in carrying their proposals in regard to volume-constancy tests.

A general business meeting of the congress took place on the concluding day (Saturday, September 11). After the formal business had been disposed of, Mr. J. E. Stead, F.R.S., was asked to deliver his lecture on the practical application of the microscopic examination of metals at the present time. So little time remained, however, that Mr. Stead could only give a very brief summary of his subject-matter, the lantern-slides being, however, shown in the afternoon by special request. While the report of Heyn on the progress of metallography had summarised the work of laboratories and investigators, Mr. Stead dealt with the use of the microscope in works practice, and was able to give an account of the manner in which microscopic methods were employed by a large number of firms both in England and in America. Examples of successful application of microscopic methods in the case of cast-iron, steel, copper, brass, and many other metals were given, the names of the firms in question being stated, including all those best known in their respective industries. The use of the microscope in the investigation of failures and breakages was finally described.

In addition to the actual business of the congress, the programme arranged by the reception committee included a large number of interesting visits and excursions; these included the new railway repair workshops, the works of Messrs. Burmeister and Wain, where shipbuilding is carried on, the Royal Danish Porcelain Works, and a number of municipal institutions, such as the electric power station, the refuse destructor, &c., as well as the newly organised State testing laboratories, the great breweries of Carlsberg and the fine museums endowed from their profits. The evenings of the congress week were occupied by a series of brilliant functions, including a reception by the Danish Society of Engineers, another by the Municipality of Copenhagen, a special performance at the Royal Opera House, and, finally, excursions to Sgodsborg and to Elsinore on the Oresund; the former, carried out by means of a steamer, which first took the party around the harbour of Copenhagen, was especially enjoyable, and it was followed by an informal dinner of huge dimensions (more than 900 sat down) at the beautifully situated Sgodsborg Hotel. Our Danish hosts were most warmly hospitable, and everything was done to make the impressions of Copenhagen as pleasant as possible—even the weather was favourable, so that the 500 visiting engineers saw Copenhagen at its very best. Although it may perhaps be said that no very striking decisions have been reached at this congress, it has undoubtedly served a very valuable purpose in bringing together a large number of scientific and technical workers who had hitherto known one another by correspondence only. Linguistic difficulties were, of course, of frequent occurrence, but willing interpreters were generally at hand; the discussions of the congress were, as a rule, translated into the three official languages—a difficult task, in which one or two of the British delegates displayed considerable activity. In fact, it was a widely expressed feeling—not a little gratifying to the British representatives—that at this congress there was much evidence of the fact that a great revival in matters of applied science had taken place in England since the last meeting of the congress. It is to be hoped that when the congress meets next—in America in 1912—still further evidence of this revival will make itself felt. Adequate British representation at these congresses is of great importance, not only in securing the due consideration of British interests, but also in securing due respect for British achievements and British capacity—respect which will help to promote the cause of universal peace.

GERMAN BOTANICAL CONGRESS.

A FEW years ago the three German societies specially interested in one or other branch of botany agreed to meet in the same district and at the same time each year, and the arrangement has proved so advantageous that it has become permanent. This year the societies met at Geisenheim, on the Rhine, in the Rheingau. The Botanical Institute at Geisenheim, where the meetings were held, is liberally supported by the Prussian Government, and in most respects seems ideal. Both staff and students are well housed on the spacious premises, and the courses are arranged to suit many different types of students. Owing, however, to the continuity of courses throughout the year, there is no regular vacation for the staff, the members of which must in time, one would think, lose somewhat in vigour and freshness of teaching. The institute exists for the promotion of the interests, scientific and practical, of the vineyard, and its wine, and of the fruit and vegetable industries.

There are separate buildings for chemistry, plant physiology, pathology, and fermentation, each fully equipped and under its own chief. The connection between science and practice is very intimate, and research is encouraged. From the fermentation station pure yeast cultures are sent all over the world. The whole institute is under the able administration of Prof. Wortmann, to whom the success of this year's meeting is largely due.

Naturally, several papers on the vine and on wine, too specialised for general notice, were contributed by experts. Attention was directed to the fungus *Rhacodium cellare*, which lives on cork, and causes the deterioration of wine in store. Sound sterilised corks, replaced unconditionally each year, are a necessary precaution against the damage wrought by this trouble.

Much of the time of the economic botanists was occupied by papers on the potato and its diseases. Particular attention was directed to the disease called "leaf-roll," not to be confused with "leaf-curl." Alarmist reports of the extent of the disease and of the injury it was inflicting appeared in the German Press last year. Though these reports have been shown to be exaggerated, the disease is clearly doing much harm. It is, as the writer noticed, widely spread in many parts of Ireland, but not yet recorded for Great Britain, or for France (judging from a conversation recently with M. Maublanc at the Pathological Institute in Paris). There are several features of striking interest in connection with leaf-roll. It is generally recognisable by the more or less dwarfed, stunted haulms, and the inrolled, often more or less coloured, leaflets. In leaf-curl the surface of the leaflets is crumpled. In the first year of attack the tubers may appear sound and of normal weight. The disease is, however, in them, as shown by the next year's diminished, diseased crop. Appel's view, that Fusarium is generally present in the vessels of the stem, is not supported by others. One hypothesis is that the disease is due to degeneration of the particular variety attacked, another that manure and soil may have a disturbing influence on the metabolism and ferments of the plant. No one has yet succeeded in infecting healthy stock with leaf-roll. It is readily transmitted by tubers, and, Count Arnim thinks, possibly by seeds also. In spite of all the attention devoted to the investigation of this disease, its cause is still a mystery, and until this is solved it is impossible to suggest general preventive measures. On no account should the tubers from a leaf-roll plant be used as seed.

During the meeting Wittmack summarised his views on the tuber-bearing species of Solanum. He holds that all European potatoes come from one true species, *Solanum tuberosum*, that *S. Maglia* is also a true, closely allied species, and that both differ from *S. Commersonii*. He praised highly the drawings, made for Sutton and Sons, of the Solanums by Worthington Smith. Wittmack was sent by the German Government to inspect the plots of *S. Commersonii violet*, believed by Labergerie and Heckel to be a valuable disease-resisting variety, and, they think, derived from *S. Commersonii* by mutation. It appears, however, to be identical with Paulsen's Blue Giant, a variety of *S. tuberosum*, and, like all other varieties, liable to leaf-blight and other potato diseases.

Lindner directed attention to the difficulties of identification of fermentation organisms. He proposed the creation in Berlin of a central station where photomicrographs of such organisms from all parts of the world could be stored, named when necessary, and registered for consultation. He illustrated his views by three volumes of such photographs, and in the course of the meeting used them to name a soil organism exhibited by H. Fischer. Hosseus described the rice industry in Siam, and urged the claims of rice on the Germans as a cheap and nutritious food. Ewert described the over-wintering of the conidia of Fusicladium, the cause of apple and of pear spot. The systematists devoted one day to the reading of papers by Drude, Gilg, Diels, Ross, &c. Schwendener was elected honorary president of the Deutsche Botanische Gesellschaft, before which, at a morning sitting, two important papers were read, one by Senn on the movements of chromatophores, including a beautiful illustration of diatom cell-division, and another by Kniep on assimilation activity under different rays of light.

A special feature of this year's meeting, which ought not to go unrecorded, was the testing in different localities of the wine of the district. On the last day at Geisenheim the three bodies sat in common for three hours to test no fewer than thirty-five different kinds of wine, provided by the Rheingau Wine Society.

Some forty members subsequently spent several days in botanical excursions in the valleys of the Nahe and Mosel. At Bertrich fine specimens of *Buxus sempervirens* and *Acer monspessulanum* were to be seen growing in plenty on the rocky slopes. On the shores of the crater-lake (Pulvermaar) at Gillenfeld, *Pilularia globulifera* formed a regular sward.

It was agreed to meet next year at Münster in time to allow members to attend the International Botanical Congress, and also the Seed-testing Conference at Brussels at Whitsuntide. T. J.

THE BRITISH ASSOCIATION AT WINNIPEG

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS (ABRIDGED) BY PROF. JOHN L. MYRES, M.A., F.S.A., PRESIDENT OF THE SECTION.

The Influence of Anthropology on the Course of Political Science.

ANTHROPOLOGY is the Science of Man. Its full task is nothing less than this, to observe and record, to classify and interpret, all the activities of all the varieties of this species of living being. In the general scheme of knowledge, therefore, anthropology holds a double place, according to our own point of view. From one standpoint it falls into the position of a department of zoology, or geography; of zoology, since man, considered as a natural species, forms only one small part of the animal population of this planet; of geography, because his reason, considered simply as one of the forces which change the face of nature, has, as we shall see directly, a range which is almost world-wide. From another point of view anthropology itself, in the strictest sense of the word, is seen to embrace and include whole sciences such as psychology, sociology, and the rational study of art and literature; since each of these vast departments of knowledge is concerned solely with a single group of the manifold activities of man. In practice, however, a pardonable pride, no less than the weighty fact that man, alone among the animals, truly possesses reason, has kept the study of man a little aloof from the rest of zoology. Dogmatic scruples have intervened to prevent man from ever ranking merely as one of the "forces of nature," and have set a hard problem of delimitation between historians and geographers. And the pardonable modesty of a very young science—for modern anthropology is barely as old as chemistry—has restrained it from insisting on encyclopædic claims in face of reverend institutions like the sciences of the mind, of statecraft, and of taste.

Yet when I say that anthropology is a young science I mean no more than this, that in the unfolding of that full bloom of rational culture, which sprang from the seeds of the Renaissance, and of which we are the heirs and trustees, anthropology found its place in the sunlight later than most; and almost alone among the sciences can reckon any of its founders among the living. This was of course partly an accident of birth and circumstance; for in the House of Wisdom there are many mansions; a Virchow, a Bastian, or a Tylor might easily have strayed through the gate of knowledge into other fields of work, just as Locke and Montesquieu only narrowly missed the trail into anthropology.

But this late adolescence was also mainly the result of causes which we can now see clearly. Man is, most nearly of all living species, the "ubiquitous animal." Anthropology, like meteorology, and like geography itself, gathers its data from all longitudes, and almost all latitudes, on this earth. It was necessary therefore that the study of man should lag behind the rest of the sciences, so long as any large masses of mankind remained withdrawn from its view; and we have only to remember that Australia and Africa were not even crossed at all—much less explored—by white men, until within living memory, to realise what this limitation means. In addition to this, modern Western civilisation, when it did at last come into contact with aboriginal peoples in new continents, too often came, like the religion which it professed, bringing "not peace but a sword." The customs and institutions of alien people have been viewed too often, even by reasonable and good men, simply as "ye beastlie devices of ye heathen," and the pioneers of our culture, perversely mindful only of the narrower creed, that "he that is not with us is against us," have set out to civilise savages by wrecking the civilisation which they had.

Before an audience of anthropologists, I need not labour the point that it is precisely these two causes, ignorance of many remoter peoples, and reckless destruction or disfigurement of some that are near at hand, which are still the two great obstacles to the progress of our science. But it is no use crying over spilt milk, and I turn rather to the positive and cheering thought that the progress of anthropology has been rapid and sure, in close proportion to the spread of European intercourse with the natives of distant lands, and that its further advance is essentially linked with similar enterprises.

Anthropology and Politics in Ancient Greece.

Philosophy, as we all know, begins in wonder; it is the surest way to jostle people out of an intellectual groove into new lines of thought, if they can be confronted personally and directly with some object of that numerous class which seems uncouth only because it is unfamiliar. The sudden expansion of the geographical horizon of the early Greeks, in the seventh and sixth centuries B.C., brought these earliest and keenest of anthropologists face to face with peoples who lived for example in a rainless country, or in trees, or who ate monkeys, or grandfathers, or called themselves by their mothers' names, or did other disconcerting things; and this set them thinking, and comparing, and collecting more and more data, from trader and traveller, for an answer to perennial problems, alike of their anthropology and of ours. Can climate alter character or change physique, and if so, how? Does the mode of life or the diet of a people affect that people's real self, or its value for us? Is the father, as the Greeks believed, or the mother who bore them, the natural owner and guardian of children? Is the Heracles whom they worship in Thasos the same god as he whose temple is in Tyre? Because the Colchians wear linen, and practise circumcision, are they to be regarded as colonists of the Egyptians? or can similar customs spring up independently on the Nile and on the Phasis? Here, in fact, are all the great problems of modern anthropology, flung out for good and all, as soon as ever human reflective reason found itself face to face with the facts of other human societies, even within so limited a region as the old Mediterranean world.

And I would have you note that these old Greek problems, like all the supreme problems of science old and new, were not theoretical problems merely. Each of them stood in direct relation to life. To take only cases such as I quoted just now from the Father of History—is there, for example, among all the various regions and aspects of the world, any real earthly paradise, any delectable country, where without let or hindrance the good man may lead the good life? Is there an ideal diet, an ideal social structure, or in general, an ideal way of life for men; or are all the good things of this world wholly relative to the persons, the places, and the seasons where they occur? I do not mean that the ancient Greeks ever found out any of these things, for all their searching; or even that all ancient seekers after marvels and travellers' tales were engaged consciously in anthropological research at all. I mean only this: that the experiences, and the problems, and the practical *end* of it all, were as certainly present to the minds of men like Herodotus and Hippocrates, as they have been in all great scientific work that the world had seen.

In the same way it has for some while been clear to me that neither Plato nor Aristotle, the great outstanding figures of fourth-century Greece, was constructing theories of human nature entirely in the air. Their conceptions both of the ideal state of society, and of the elements which were fundamental and essential in actual societies as they knew them, were determined to a very large extent by their observation of real men in Sparta, Persia, or Scythia. But it is also clear that much that had been familiar to the historians of the fifth century, and particularly to Herodotus, had fallen out of vogue with the philosophers of the fourth. Systematic clearness had been attained only by the sacrifice of historic accuracy. Thucydides, in fact, standing right in the parting of the ways between history and rhetoric, might fairly have extended his warnings to a dissociation of history from political philosophy, which was just as imminent.

Anthropology and the Renaissance.

At the Revival of Learning it was the same as in the great days of Greece. New vistas of the world were being opened up by the voyagers; new types of men, of modes of life, of societies and states, were discovered and described; new comparisons were forced upon men by new knowledge crowding thick into their minds; and new questions, which were nevertheless old as the hills, made eddies and rapids in the swift current of thought, and cried out for an answer. Take the central political problems, for example: What constitutes the right to govern, and what is the origin of law? In mediæval Europe this was simple enough. The duke, or the king, or the bishop governed by authority of the emperor, or the pope; and pope and emperor ruled (like Edward VII.) "by the Grace of God." Yet here, in Guinea, in Monomotapa, in Cathay, and in Peru, were great absolute monarchies which knew nothing of the pope or the emperor, and were mighty hazy about God. Yet their subjects obeyed them, and gave good reasons for their obedience, and chiefest of their reasons (as in all times and places) was this: "We should be much worse off if we didn't."

Unsocial Man and the Pre-Social State.

It would take me very far afield if I were to try to show how this universal answer came to change its ground from politics to anthropology, so that to the question—how men knew that they would be much worse off if they didn't—the answer came, that "once upon a time they *had been* much worse off, *because* they didn't." For my present purpose it is enough to note that, in all ages, philosophers who set out to define the *nature* of the State, have become involved in speculations about its *origin*; that historians in their researches into its origin have been forced into conclusions as to its nature; and that in both cases every belief about the Nature of the State has been found to involve a belief about a State of Nature; an answer of some kind, that is, to the question whether man was originally and naturally a social animal, or whether at some early period of his history he became social and domestic. In the latter event, how was domestication effected, and what sort of thing was undomesticated man? In the ancient world, after long controversy, Aristotle's definition of man as the "social animal" had carried the day, and ruled that question out of court. But at the Revival of Learning, the unnatural behaviour of certain actual societies towards their individual members had revived irresistibly the whole question whether society was part of the natural order at all, and not a "device of the heathen," a mistake or a *pis aller*; and whether, if society was not thus "natural," men would not really be better off if they returned to their natural, pre-social, *unsocial* state, and began again at the beginning, to work out their own salvation. This belief in a pre-social state played a large part in the political philosophy of the seventeenth and eighteenth centuries; and conversely it was the very fact that the pre-social state as a philosophical conception fell out of vogue at the beginning of the nineteenth, which has distinguished modern political philosophy so markedly from its predecessors.

The Patriarchal Theory.

All theories of a Social Contract as the starting-point of human societies presupposed that mankind had actually passed through a Pre-Social State; and the proof which had been offered of this supposition, though partly theoretical and *a priori*, had partly also been inductive and based on experience. Further, the experience of "primitive Man" which was actually open to the philosophers of the seventeenth and early eighteenth centuries had been, in fact, such as to force the conclusion not merely that a Pre-Social State had once existed, but that some barbarous peoples had not yet emerged from it. It was a sad error of observation, as we now know, which led to that conclusion; but given the travellers' tales, in the form in which we can read them in the "Cosmographies" and "Voyages" of the time, I do not see how that conclusion could have been avoided without culpable neglect of such evidence as there was. If blame is to be assigned in this phase of inquiry at all, it is to be assigned to the travellers and traders, for making such poor use of their eyes and ears. All, however, that I am concerned to establish at present is this, that one of the most important and far-reaching speculations of modern political philosophy, the speculation as to a Pre-Social Condition of Mankind, and a Social Contract which ended it and brought in Society and the State, arose directly and inevitably from the new information as to what primitive man *was* and *did*, when he was studied in the seventeenth century at Tombutum, or Saldanha Bay, or the "backwoods of America," or the "bank of the Orinoco river."

But the Social Contract Theory has long since passed out of vogue. Its political consequences are with us to-day, like the political consequences of the belief in the Divine Right of Kings; but the theories themselves are dead, and likely to remain so. Plato and Aristotle, with their belief in Man as a Naturally Social Animal, have come by their own again, for most of us, if not for all; and the search for an ideal State, which shall realise and fulfil Man's social instincts, is again in full cry.

What part, if any, has the direct study of barbarous people played at this fresh turn of the wheel? Let us look once again at the state of geographical knowledge, and more particularly, as before, at the regions in which by transitory chance of circumstances, there was most to be learned at the moment. First, the British occupation of India was the occasion, on the one hand, of the discovery of Sanskrit, the creation of this science of comparative philology, and the demonstration of a new link of cultural affinity over the whole realm of Aryan speech. The same political event led no less directly to the discovery of the patriarchal structure of Hindoo society, and so through the comparative study of Indian, Roman, and ancient Celtic and Teutonic law to an inductive verification of Aristotle's doctrine of the "naturalness" of patriarchal society. This doctrine dominated political science for nearly fifty years. "The effect of the evidence derived from comparative jurisprudence," Sir Henry Maine could write in 1861,[1] "is to establish that view of the primæval conditions of the human race which is known as the Patriarchal Theory. There is no doubt, of course, that this theory was originally based on the Scriptural theory of the Hebrew patriarchs in Lower Asia. . . . It is to be noted, however, that the legal evidence comes nearly exclusively from the institutions of societies belonging to the Indo-European stock, the Romans, Hindoos, and Sclavonians supplying the greater part of it; and indeed the difficulty, at the present stage of the inquiry, is to know where to stop: to say of what races of men it is *not* allowable to lay down that the society in which they are united was originally organised on the patriarchal model." And he refers explicitly to the former controversy between Filmer and Locke, to point out how the tables had now been turned upon the latter.

Thus in the half-century which intervenes between Herder and Maine, the political philosophy of Europe seemed to have turned almost wholly from exploration to introspection; from the Pacific to early Rome and the German forests; and from the study of survivals in the modern practice of savages, to that of primæval custom betrayed by the speech and customs of the civilised world. It was Aristotle over again, with his appeal to custom, ancestral belief, and canonical literature, following hard upon the heels of the visionary revolutionary Plato. Maine's own words, indeed, about Rousseau[2] would be applicable almost without change to the course of Greek thought in the fourth century B.C. "We have never seen in our own generation," he says, "indeed the world has not seen more than once or twice in all the course of history, a literature which has exercised such prodigious influence over the minds of men, over every cast and shade of intellect, as that which emanated from Rousseau between 1749 and 1762. It was the first attempt to re-erect the edifice of human belief after the purely iconoclastic efforts commenced by Bayle, and in part by our own Locke, and consummated by Voltaire; and besides the superiority which every constructive effort will always enjoy over one that is merely destructive, it possessed the immense advantage of appearing amid an all but universal scepticism as to the soundness of all foregone knowledge in matters speculative. . . . The great difference between the views is that one bitterly and broadly condemns the present for its unlikeness to the ideal past, while the other, assuming the present to be as necessary as the past, does not affect to disregard or censure it."

I have devoted some space to these first steps of Linguistic Palæontology and Comparative Jurisprudence because the method of inquiry which they announced promised at first sight to make good a very serious defect in the instruments of anthropological research. Human history, outside of Europe and of one or two great oriental States like China, hardly went back beyond living memory; even Mexico had no chronicles beyond the first few hundred years, and the records of old-world States like China, which at first sight offered something, turned out on examination to have least to give. They had lived long, it is true, but their lives had been "childlike and bland," devoid of change, and almost empty of experience. Consequently there was no proof that the "wild men" of the world's margins and byways were really primitive at all. The Churches held them children of wrath, degenerate offspring of Cain; the learned fell back upon pre-Adamite fictions, to palliate, rather than to explain their invincible ignorance of Europe and its ways.

[1] Maine, "Ancient Law," pp. 122-3.

[2] *Ibid.*, pp. 86-9.

Here, however, in the new light thrown by the history of speech, there seemed to be a prospect of deep insight into the history of human societies. Disillusionment came in due course, when doctors disagreed; but illusion need never have taken the form it did, had either the philologists or the philosophers realised that all the really valuable work was being done within the limits of a single highly special group of tongues; that the very circumstance that this group of tongues had spread so widely, pointed to some strong impulse driving the men who spoke them into far-reaching migrations; that one of the few points upon which linguistic palæontologists were really unanimous was that both the Indo-European and the Semitic peoples, in their primitive condition, were purely pastoral; and that this pastoral habit was itself an almost coercive cause for their uniformly patriarchal organisation. The last point, however, belongs so completely to another phase of our story that it is almost an anachronism to introduce it here. It serves however to indicate, once again, if that be necessary, how completely the philosopher, and even the man of science, is at the mercy of events in the ordering of his search after knowledge. It is, indeed, almost true to say that if the primitive Aryan had not had the good fortune not merely to live on a grass-land, but also to find domesticable quadrupeds there, there could no more have been a science of comparative philology in modern Europe than there could be among the natives of your own Great Plains or of the Pacific Coast: for in no other event would there have been any such "family of languages" to compare.

In the absence of warning thoughts like these, however, the comparative philology and the comparative law of the patriarchal peoples of the North-West Quadrant and of India went gaily on. What Maine had done for India, Maine himself, with Solm and von Maurer, in Germany; Le Play, de Laveleye, and d'Arbois de Joubainville in France; W. F. Skene in far-off Scotland; Whitley Stokes and others in Ireland; Rhys in Wales; and Mackenzie Wallace and Kovalevsky in Russia, had done for the early institutions of their respective countries: all emphasising alike the wide prevalence of the same common type of social structure, based upon the same central institution, the Patriarchal Family, with the *Patria Potestas* of its eldest male member as its overpowering bond of union: and Maine's own words do not the least exaggerate the beliefs and expectations which were evoked by this new aspect of the Study of Man.

The Matriarchate in Southern India, Africa, and North America.

The Patriarchal Theory lasted barely fifty years. It had owed its revival, as we have seen, to two fresh branches of research, comparative jurisprudence and comparative philology, both stimulated directly by the results of European administration in Northern India. It owed its decline to the results of similar inquiries in other parts of the world, stimulated no less directly by other phases of the great colonising movement, which marks, above all other things, the century from 1760 to 1860. Here again a small number of examples stand out as the crucial instances. British administration in India had, of course, been extended over the non-Aryan south, as well as over the north; and in Travancore, and other parts of the Madras Presidency, British commissioners found themselves confronted with types of society which showed the profoundest disregard of the Patriarchal Theory. Like the Lycians of Herodotus, these perverse people "called themselves after their mothers' names": they honoured their mother and neglected their father, in society, and government, as well as in their homes; their administration, their law, and their whole mode of life rested on the assumption that it was the women, not the men, in whom reposed the continuity of the family and the authority to govern the State. Here was a *parecbasis*, a "perverted type" of society, worthy of Aristotle himself. It is a type which, as a matter of fact, is widely distributed in Southern and South-eastern Asia, and had been repeatedly described by travellers from the days of Tavernier (in Borneo) and Laval (in the Maldive Islands), if not earlier still. It existed also in the New World, and Lafitau had already compared the Iroquois with the ancient Lycians. But it was Buchanan's account of the Nairs of the Malabar

Coast, published in 1807, which came at the "psychological moment," and first attracted serious attention. At the other extremity of India, also, analogous customs were being recorded, about the same time, by Samuel Turner in Tibet, which might have given pause at the outset to the speculators who hoped to base general conclusions on anything so special and peculiar as the customs of Aryan India.

Similar evidence came pouring in during the generation which followed; partly, it is true, as the result of systematic search among older travellers, but mainly through the intense exploitation of large parts of the world by European traders and colonists. Conspicuous instances are the Negro societies of Western and Equatorial Africa, first popularised by the re-publication of William Bosman's "Guinea" (1700), in Pinkerton's "General Collection of Voyages and Travels" (London, 1808, &c.), and by Proyart's "Histoire de Loango" (1776), which also reached the English public in the same invaluable collection. But it was from the south that the new African material came most copiously, in proportion as the activity of explorers, missionaries, and colonists was greater. Thunberg's account of the Bechuanas[1] takes the lead here; but for English thought the principal authorities are, of course, John Mackenzie[2] and David Livingstone.[3]

It was not to be expected that America, which had made such remarkable contributions to the study of Man in the seventeenth and eighteenth centuries, should fall behind in the nineteenth, when its vast resources of mankind, as of Nature's gifts, were being realised at last. From Hunter,[4] Gallatin,[5] and Schoolcraft,[6] in the 'twenties, to Lewis Morgan[7] in 1865, there was hardly a traveller "out West" who did not bring back some fresh example of society destructive of the Patriarchal Theory.

As often happens in such cases, more than one survey of the evidence was in progress simultaneously. Bachofen was the first to publish,[8] and it is curious that his great book on "Mother-right" appeared in the very same year as Maine's "Ancient Law." Lubbock's "Prehistoric Times," in the next year, represents the same movement of thought in England in a popular shape, but almost independently. In America, Lewis Morgan, whom I have noted already as an able interpreter of Iroquois custom, followed up his detailed studies of Redskin law by a Smithsonian monograph in 1871 on "Systems of Consanguinity and Affinity of the Human Family," and, in 1877, by his book on "Ancient Society." Meanwhile Post had published his great work on the "Evolution of Marriage"[9] in 1875, and J. F. McLennan his first "Studies in Ancient History" in 1876. It was the generation of Darwin and of the great philologists, as we have seen, and "survivals" were in the air: Dargan[10] pointed out traces of the Matriarchate in the law and custom of Germany, and Wilken[11] in those of early Arabia. The period of exploration, if I may so term it, closed on this aspect of the subject with Westermarck's "History of Human Marriage," which was published in London in 1891.

Australian Evidence: Totemism and Classificatory Kinship.

I have now mentioned India, South Africa, and North America, three principal fields of English-speaking enterprise during the nineteenth century, and have indicated the contribution of each to modern anthropology in its bearing on political science. Only Australia remains; and, though Australia's task has been shared more particularly with North America, I shall be doing no injustice to Lewis Morgan or to McLennan if I couple with their names those of Fison and Howitt,[1] as the discoverers of classical instances of societies which observe neither paternal nor maternal obligations of kinship as we understand them, but have adopted those purely artificial systems of relationships which in moments of elation we explain as "Totemic," or, in despair, describe as "classificatory."

Hermann Post: Comparative Jurisprudence.

Our retrospect, therefore, of the last fifty years shows clearly once again how intimately European colonisation and anthropological discoveries have gone hand in hand: first to establish a "Matriarchal Theory" of society as a rival of the Patriarchal; and then to confront both views alike with the practices and with the theories of "Totemism."

From the point of view of political science, all this mass of inquiries finds applications already in more departments than one; though it is probably still too early to appraise its influence adequately. The new Montesquieu has not yet arisen to interpret to us the "Spirit of the Laws." Most directly, perhaps, we can trace such influence in the "Comparative Jurisprudence" of Hermann Post, whose first work on the "Evolution of Marriage" appeared, as we have seen, in 1875. Post's general attitude is best seen in his "Introduction to the Study of Ethnological Jurisprudence," which was published in 1886, and in his "African Jurisprudence" of 1887.[2] As the result of a survey of social organisations, considered as machinery in motion, Post points out very justly that it is useless to attempt to explain social phenomena on the basis of the psychological activities of individuals, as is too commonly assumed, because all individuals whose conduct we can possibly observe have themselves been educated in some society or other, and presume in all their social acts the assumptions on which that society itself proceeds. "I take the legal customs of all peoples of the earth," so he wrote in 1884,[3] "the residual outcome of the living legal consciousness of humanity, for the starting-point of my inquiry into the science of law; and then, on this basis, I propound the question, What is law? If by this road I arrive eventually at an abstract conception of law, or at an idea of law, then the whole fabric so created consists, from base to summit, of flesh and blood." It is the same method, of course, which had already yielded such remarkable results to Montesquieu, and even to Locke. The point of view is no longer that of a Maine or a McLennan, students of patriarchal or of matriarchal institutions by themselves. It is that of a spectator of human society as a whole; and such a point of view only became possible at all when it was already certain that no great section of humanity remained altogether unexplored, however fragmentary our knowledge might still be, of much that we ought to have recorded. And its immediate outcome has been to throw into the strongest possible relief the dependence of the form and still more of the actual content of all human societies on something which is not in the human mind at all, but is the infinite variety of that external Nature which Society exists to fend off from Man, and also to let Man dominate if he can.

This was, of course, already the standpoint of Comte, with his emphasis on the *monde ambiant*. But Comte, the citizen of a State which except in Canada had failed to colonise, and therefore had little direct contact with non-European types of society, confined himself far too exclusively to European data. His strength is precisely where the science of France was so magnificently strong in his day, in the domain of pure physics; it is his analogies between politics and physics which are so illuminating in his work, as in that of his English compeer, Herbert Spencer;[4] and it is the weakness of both in the direction

[1] Pinkerton, vol. xvi.

[2] John Mackenzie, "Ten Years North of the Orange River" (1859-69). Edinburgh, 1871.

[3] David Livingstone, "Narrative of an Expedition to the Zambesi and its Tributaries (1858-64)." London, 1865.

[4] Hunter, "Manners and Customs of several Indian Tribes located West of the Mississippi." Philadelphia, 1823.

[5] Gallatin, "Archæologia Americana." Philadelphia (from 1820 onwards).

[6] Schoolcraft. "Travels in the Central Portions of the Mississippi Valley" (New York, 1825); "Notes on the Iroquois" (1846).

[7] Lewis H. Morgan, Proc. Am. Acad. Arts and Sciences, vii., 1865-8.

[8] Bachofen, "Das Mutter-recht." Stuttgart, 1861.

[9] Hermann Post, "Die Geschlechtsgenossenschaft der Urzeit und die Entstehung der Ehe." Oldenburg, 1875

[10] Dargan, "Mutter-recht und Raub-ehe und ihre Reste im Germanischen Recht und Leben." Breslau, 1883.

[11] Wilken, "Das Matriarchat bei den alten Arabern." Leipzig, 1884.

[1] Fison and Howitt, "Kamilaroi and Kurnai." Melbourne and Sydney, 1880.

[2] Hermann Post, "Einleitung in das Studium der ethnologischen Jurisprudenz" (Oldenburg, 1886); "Afrikanische Jurisprudenz" (1887). His position is, however, already clear in his first synthetic work, "Dr. Ursprung des Rechts," 1876, as well as in his earlier book on Marriage For a good summary of Post's views see Th. Achelis, "Die Entwickelung der modernen Ethnologie" (Berlin, 1889), pp. 113-28, and the same writer s "Moderne Ethnologie" (1896).

[3] Post, "Die Grundlagen des Rechts" (188

[4] Compare Quetelet's "Essai de Physique sociale' (1841), as a symptom of the trend of French thought at this stage.

of anthropology which mainly accounts for the shortness of their respective vogues.

Friedrich Ratzel: Anthropo-geography.

At the point which we have now reached in this rapid survey of our science, it was obviously to Geography—the systematic study of those external forces of Nature as an ordered whole—that Anthropology stretched out its hands; and it did not ask in vain. But while English geography had remained exploratory, descriptive, and (like English geology) *historical* in its outlook, the new German science of *Erdkunde*—"earth-knowledge" in the widest sense of the word—had already come into being on the basis of the labours of Ritter and the two Humboldts, and under the guidance of such men as Wagner, Richthofen, and Bastian; the last named also an anthropologist of the first rank. It was, thus, to a distinguished pupil of Wagner, Friedrich Ratzel, that anthropology owed, more than to any other man, the next forward step on these lines. In Ratzel's mind, History and Geography went hand in hand as the precursors of a scientific Anthropology.[1] History to define *when*, and in what order, Man makes his conquests over Nature; Geography to show *where*, and within what limits, Nature presents a conquerable field for Man. Much of this, of course, was already implicit in the teaching of Adolf Bastian, whose monumental volumes on "Man in History" had appeared at Leipzig as early as 1860; his "Contributions to Comparative Psychology" in 1868; and his "Legal Relations among the Different Peoples of the Earth" in 1872[2]—three years before Post's first essay. But Bastian, inaccessible for years together in Tibet or Polynesia, was rather an inspiration to a few intimate colleagues than a great propagandist; and besides, it was not until the appearance of his "Doctrine of the Geographical Provinces" in 1886[3] that he touched on this precise ground, and by that time Ratzel's "History of Man" had already been out for a year.[4]

Epilogue.

These examples, I think, are sufficient to show how intimately the growth of political philosophy has interlocked at every stage with that of anthropological science. Each fresh start on the never-ending quest of *Man as he ought to be* has been the response of theory to fresh facts about *Man as he is*. And, meanwhile, the dreams and speculations of one thinker after another—even dreams and speculations which have moved nations and precipitated revolutions—have ceased to command men's reason when they ceased to accord with their knowledge.

And we have seen more than this. We have seen the very questions which philosophers have asked, the very questions which perplexed them, no less than the solutions which they proposed, melt away and vanish, *as problems*, when the perspective of anthropology shifted and the standpoint of observation advanced. This is no new experience; nor is it peculiar either to anthropology among the natural sciences, or to political science among the aspects of the Study of Man. It is the common law of the mind's growth, which all science manifests, and all philosophy.

And now I would make one more attempt to put on parallel lines the course of political thinking. It is not so very long ago that a great British administrator, returning from one of the gravest trials of statesmanship which our generation has seen, to meet old colleagues and classmates at a college festival, gave it to us as the need he had most felt, in the pauses of his administration, that there did not exist at present any adequate formulation of the great outstanding features of our knowledge (as distinct from our creeds) about human societies and their mode of growth, and he commended it to the new generation of scholarship, as its highest and most necessary task, to face once more the question: What are the forces, so far as we can know them now, which, as Aristotle would have put it, "maintain or destroy States"?

But if a young student of political science were to set himself to this life work, where could he turn for his facts? What proportion of the knowable things about the human societies with which travellers' tales and the atlases acquaint him could he possibly bring into his survey, without a lifetime of personal research in every quarter of our planet?

I have in mind one such student setting out this coming session to investigate, on the lines of modern anthropology, the nature of *Authority* and the circumstances of its rise among primitive men; and the difficulty at the outset is precisely as I have described. In the case of the "black fellows" of Australia such a student depends upon the works of some four or five men, representing (at a favourable estimate) one-twentieth even of the known tribes of the accessible parts of that continent. For British South Africa he would be hardly better served; for British North America, outside the ground covered in British Columbia by Boas and Hill-Tout, he would have almost the field to himself; and the prospect would seem to him the drearier and the more hopeless when he compared it with things on the other side of the forty-ninth parallel.

Now, our neighbours south of that line have the reputation of being practical men; in other departments of knowledge they are believed to know well "what pays." And I am forced to believe that it is because they know that it *pays*, to know all that can still be known about the forms of human society which are protected and supervised from Washington, that they have gone so far as they have towards rescuing that knowledge from extinction while still there is time. The Bureau of Ethnology of the United States of America is the most systematic, the most copious, and, I think, taking it all in all, the most scientific of the public agencies for the study of any group of men, *as men*. The only other which can be compared with it is the ethnographical section of the last census of India, and that was an effort to meet, against time, an emergency long predicted, but only suddenly foreseen by the men who were responsible for giving the order. Thus, humanly speaking, it is now not improbable that in one great newly settled area of the world every tribe of natives, which now continues to inhabit it, may at least be explored, and in some cases really surveyed, before it has time to disappear. But observe, this only applies to the tribes which now continue to exist; and what a miserable fraction they are of what has already perished irrevocably! It is no use crying over spilt milk, as I said to begin with; the only sane course is to be doubly careful of whatever remains in the jug.

An Ethnological Survey for Canada.

And now I conclude with a piece of recent history, which will point its own moral. When the British Association met first outside the British Isles, it celebrated its meeting at Montreal by instituting, for the first time, a section for Anthropology; and it placed in the chair of that section one of the principal founders of modern scientific anthropology, Dr. Edward Burnett Tylor, then recently installed at Oxford, and still the revered Professor of our science there. Through his influence mainly, but with the active goodwill of the leading names in other sciences in Canada, a research committee was formed to investigate the north-west tribes of the Dominion; and for eleven consecutive years expeditions wholly or partly maintained by this Association were sent to several districts of British Columbia. These expeditions cost the Association about 1200*l*. in all. I am glad to think that the chief representative of this Committee's work, Dr. Franz Boas, has long since realised, in his great contributions to knowledge, the high hopes which his early reports inspired.

When the Association met the second time on Canadian soil, at Toronto, the occasion seemed opportune for a fresh step. Dr. Boas had already undertaken work on a larger scale and under other auspices. But it was thought likely that if a fresh Committee of the Association were appointed, with wider terms of reference and further grants, it would be possible to select and to train a small staff of Canadian observers, and by their means to produce such a series of preliminary reports on typical problems of Canadian anthropology as would satisfy the Dominion Government that the need for a thorough systematic survey was a real one, and that such a survey would be practicable with the means and the men which

[1] Ratzel, "Anthropo-geographie" Leipzig, vol. i., 1882; ii., 1891.
[2] Bastian, "Der Mensch in der Geschichte" (Leipzig, 1860); "Beiträge zur vergleichenden Psychologie" (Berlin, 1868); "Rechtsverhältnisse bei verschiedenen Völkern der Erde" (Berlin, 1872).
[3] Bastian, "Zur Lehre von den geographischen Provinzen." Berlin, 1886.
[4] Ratzel, "Völkerkunde" (Leipzig, 1885). His *method* is best studied in the first volume of his "Anthropo geographie" (Leipzig, 1882).

Canada itself could supply. Among the leading members of this Ethnographic Survey Committee I need only mention three—the late Dr. George Dawson, Mr. David Boyle, and Mr. Benjamin Sulte, each eminent already in his own line of study, and all convinced of the great scientific value of what was proposed. The first year's enterprise opened well: workers were found in several districts of Canada; the Association sent out scientific instruments, and formed in London a strong consultative committee to keep the Canadian field-workers in touch with European students of the subject. But the premature death of George Dawson in 1901 broke the mainspring of the machine; the field-workers fell out of touch with one another and with the subject; the instruments were scattered, and in 1904 the Ethnographic Survey Committee was not recommended for renewal.

I need not say how great a disappointment this failure has been to those of us who believe that in this department of knowledge Canada has great contributions to make, and who know—as this meeting too knows perfectly well—that if this contribution to knowledge is not made within the next ten years, it can never be made at all. I am not speaking merely of the urgency of exact study of the Indian peoples. This indeed is obvious and urgent enough; and the magnificent results of organised effort in the United States are there to show how much you too can still rescue, if you will. But at the moment I appeal rather for the systematic study of your own European immigrants, that stream of almost all known varieties of white men with which you are drenching yearly fresh regions of the earth's surface, which if they have had experience of human settlements at all, have known man only as a predatory migratory animal, more restless than the bison, more feckless and destructive than the wolf. Of your immigrants' dealings with wild nature, you are indeed keeping rough undesigned record in the documents of your Land Surveys, and in the statistics of the spread of agriculture over what once was forest or prairie; and in time to come, *something*—though not, I fear, much—will exist to show what good (and as likely as not, also, what irremediable harm) this age of colonisation has done to the region as a whole. But what you do not keep record of is Nature's dealings with your immigrants; you do not *know*—and so long as you omit to *observe*, you are condemned not to know—the answer to the simple all-important question, *What kinds of men do best in Canada? What kind of men is Canada making out of the raw material which Europe is feeding into God's Mills on this side?*

Over in England, we are only too well aware how poor a lead we have given you. We, too, for a century now, have been feeding into other great winnowing chambers the raw crop of our villagers. We have created (to change the metaphor), in our vast towns, great vats of fermenting humanity, under conditions of life which at the best are unprecedented, and at their worst almost unimaginable. That is *our* great experiment in modern English anthropology—*What happens to Englishmen in City slums?* and we shall hear, before this meeting ends, something of the methods by which we are attempting now to watch and record the outcome of that experiment in the making of the English of to-morrow. We are beginning to know, in the first place, what types of human animal can tolerate and survive the stern conditions of modern urban life. We are learning, still more slowly, what modes of life, what modified structure of the family, of the daily round, of society at large, can offer the adjustment to new needs of life, which human nature demands under this new, almost unbearable strain. We are seeing, more clear in the mass, even if hopelessly involved in detail, the same process of selection going on in the mental furniture of the individuals themselves; new views of life, new beliefs, new motives and modes of action; new, if only in the sense that they presuppose the destruction of the old.

That is our problem in human society at home. And yours, though it has a brighter side, is in its essentials the same. Geographers can tell you something already of the physical "control" which is the setting to all possible societies on Canadian soil. Scientific study of the vanishing remnants of the Redskin tribes may show you a little of the effects of this control, long continued, upon nations whom old Heylin held to be "doubtless the offspring of the Tartars." Sympathetic observation and friendly intercourse may still fill some blanks in our knowledge of their social state; how hunting or fishing—or, in rare cases, agriculture—forms and reforms men's manners and their institutions when it is the dominant interest in their lives. But what climate and economic habit have done in the past with the Redskins, the same climate and other economic habits are as surely doing with ourselves. In the struggle with Nature, as in the struggle with other men, it is the weakest who go to the wall; it is the fittest who survive. And it is our business to *know*, and to record for those who come after us, what manner of men we were when we came; whence we were drawn, and how we are distributed in this new land. An Imperial Bureau of Ethnology, which shall take for its study all citizens of our State, as such, is a dream which has filled great minds in the past and may some day find realisation. A Canadian Bureau is at the same time a nearer object, and a scheme of more practicable size. In the course of this meeting, information and proposals for such a Bureau of Ethnology are to be laid before this section by more competent authorities than I. My task has only been to show, in a preliminary way, what our science has done in the past, to stimulate political philosophy, and to determine its course and the order of its discoveries.

"Some men are borne," said Edward Grimstone just three centuries ago, "so farre in love with themselves, as they esteeme nothing else, and think that whatsoever fortune hath set without the compasse of their power and government should also be banished from their knowledge. Some others, a little more carefull; who finding themselves engaged by their birth, or abroad, to some one place, strive to understand how matters pass there, and remaine so tied to the consideration of their owne Commonweale, as they affect nothing else, carrying themselves as parties of that imperfect bodie, whereas in their curiositie they should behave themselves as members of this world." It is as "members of this world," I hope, that we meet together to-day.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY PROF. E. H. STARLING, M.D., F.R.S., PRESIDENT OF THE SECTION.

The Physiological Basis of Success.

DURING past years it has been customary for the Presidents of Sections in their addresses either to give a summary of recent investigations, in order to show the position and outlook of the branch of science appertaining to the Section, or to utilise the opportunity for a connected account of researches in which they themselves have been engaged, and can therefore speak with the authority of personal experience as well as with that imparted by the presidential Chair. The growing wealth of publications with the special function of giving summaries and surveys of the different branches of science, drawn up by men ranking as authorities in the subject of which they treat, renders such an interpretation of the presidential duties increasingly unnecessary, and the various journals which are open to every investigator make it difficult for me to give in an address anything which has not already seen the light in other forms. The Association itself, however, has undergone a corresponding modification. Founded as a medium of communication between workers in different parts of the country, it has gradually acquired the not less important significance of a tribunal from which men of science, leaving for a time their laboratories, can speak to an audience of intelligent laymen, including under this term all those who are engaged in the work of the world other than the advancement of science. These men would fain know the lessons that science has to teach in the living of the common life. By standing for a moment on the little pinnacle erected by the physicist, the chemist or the botanist, they can, or should be able to, gain new hints as to the conduct of the affairs of themselves, their town or their State. The enormous advance in the comfort and prosperity of our race during the last century has been due to the application of science, and this meeting of the Association may be regarded as an annual mission in which an attempt is made to bring the latest results of scientific investigation into the daily routine of the life of the community.

We physiologists, as men who are laying the foundation on which medical knowledge must be built, have as our special preoccupation the study of man. Although every animal, and indeed every plant, comes within the sphere of our investigations, our main object is to obtain from such comparative study facts and principles which will enable us to elucidate the mechanism of man. In this task we view man, not as the psychologist or the historian does, by projecting into our object of study our own feelings and emotions, but by regarding him as a machine played upon by environmental events and reacting thereto in a way determined by its chemical and physical structure.

Can we not learn something of value in our common life by adopting this objective point of view and regarding man as the latest result of a continuous process of evolution which, begun in far-off ages, has formed, proved and rejected myriads of types before man himself appeared on the surface of the globe?

Adaptation.

In his study of living beings, the physiologist has one guiding principle which plays but little part in the sciences of the chemist and physicist, namely, the principle of adaptation. Adaptation or purposiveness is the leading characteristic of every one of the functions to which we devote in our text-books the chapters dealing with assimilation, respiration, movement, growth, reproduction, and even death itself. Spencer has defined life as "the continuous adjustment of internal relations to external relations." Every phase of activity in a living being is a sequence of some antecedent change in its environment, and is so adapted to this change as to tend to its neutralisation and so to the survival of the organism. This is what is meant by adaptation. It will be seen that not only does it involve the teleological conception that every normal activity must be for the good of the organism, but also that it must apply to *all* the relations of living beings. It must therefore be the guiding principle, not only in physiology, with its special preoccupation with the internal relations of the *parts* of the organism, but also in the other branches of biology, which treat of the relations of the living animal to its environment and of the factors which determine its survival in the struggle for existence. Adaptation therefore must be the deciding factor in the origin of species and in the succession of the different forms of life upon this earth.

Origin of Life.

A living organism may be regarded as a highly unstable chemical system which tends to increase itself continuously under the average conditions to which it is subject, but undergoes disintegration as a result of any variation from this average. The essential condition for the survival of the organism is that any such disintegration shall result in so modifying the relation of the system to the environment that it is once more restored to the average in which assimilation can be resumed.

We may imagine that the first step in the evolution of life was taken when, during the chaotic chemical interchanges which accompanied the cooling down of the molten surface of the earth, some compound was formed, probably with absorption of heat, endowed with the property of polymerisation and of growth at the expense of surrounding material. Such a substance could continue to grow only at the expense of energy derived from the surrounding medium, and would undergo destruction with any stormy change in its environment. Out of the many such compounds which might have come into being, only such would survive in which the process of exothermic disintegration tended towards a condition of greater stability, so that the process might come to an end spontaneously and the organism or compound be enabled to await the more favourable conditions necessary for the continuance of its growth. With the continued cooling of the earth, the new production of endothermic compounds would probably become rarer and rarer. The beginning of life, as we know it, was possibly the formation of some complex, analogous to the present chlorophyll corpuscles, with the power of absorbing the newly penetrating sun's rays and of utilising these rays for the endothermic formation of further unstable compounds. Once given an unstable system such as we have imagined, with two phases, viz. (1) a condition of assimilation or growth by the endothermic formation of new material; (2) a condition of "exhaustion," in which the exothermic destructive changes excited by unfavourable external conditions came to an end spontaneously—the great principle of natural selection or survival of the fittest would suffice to account for the evolution of the ever-increasing complexity of living beings which has occurred in the later history of this globe. The adaptations, *i.e.* the reactions of the primitive organism to changes in its environment, must become continually more complex, for only by means of increasing variety of reaction can the stability of the system be secured within greater and greater range of external conditions. The difference between higher and lower forms is therefore merely one of complexity of reaction.

The naked protoplasm of the plasmodium of Myxomycetes, if placed upon a piece of wet blotting-paper, will crawl towards an infusion of dead leaves, or away from a solution of quinine. It is the same process of adaptation, the deciding factor in the struggle for existence, which impels the greatest thinkers of our times to spend long years of toil in the invention of the means for the offence and defence of their community or for the protection of mankind against disease and death. The same law which determines the downward growth of the root in plants is responsible for the existence to-day of all the sciences of which mankind is proud.

The difference between higher and lower forms is thus not so much qualitative as quantitative. In every case, whatever part of the living world we take as an example, we find the same apparent perfection of adaptation. Whereas, however, in the lower forms the adaptation is within strictly defined limits, with rise in type the range of adaptation steadily increases. Especially is this marked if we take those groups which stand, so to speak, at the head of their class. It is therefore important to try and find out by a study of various forms the physiological mechanism or mechanisms which determine the increased range of adaptation. By thus studying the physiological factors, which may have made for success in the struggle for dominance among the various representatives of the living world, we may obtain an insight into the factors which will make for success in the further evolution that our race is destined to undergo.

It is possible that, even at this time, objections may be raised to the application to man of conclusions derived from a study of animals lower in the scale. It has indeed been urged, on various grounds, that man is to be regarded as exempt from the natural laws which apply to all other living beings. When we inquire into the grounds for assuming this anomic, this outlawed condition of man, we generally meet with the argument that man creates his own environment and cannot therefore be considered to be in any way a product of it. This modification or creation of environment is, however, but one of the means of adaptation employed by man in common with the whole living kingdom. From the first appearance of life on the globe we find that one of the methods adopted by organisms for their self-preservation is the production of some artificial surroundings which protect them from the buffeting of environmental change. What is the mucilaginous envelope produced by micro-organisms in presence of an irritant, or the cuticle or shell secreted by the outermost cells of an animal, but the creation of such an environment? All unicellular organisms, as well as the units composing the lowest metazoa, are exposed to and have to resist every change in concentration and composition of the surrounding water. When, however, a body cavity or *coelom*, filled probably at first with sea-water, made its appearance, all the inner cells of the organism were withdrawn from the distributing influence of variations in the surrounding medium. The cœlomic fluid is renewed and maintained uniform in composition by the action of the organism itself, so that we may speak of it as an environment created by the organism. The formation of a body cavity filled with salt solution at once increased the range of adaptation of the animals endowed therewith. Thus it enabled them to leave the sea, because they carried with them the watery environment which was essential for the normal activity of their constituent cell units. The assumption of a terrestrial existence on most parts of the earth's surface involved, however, the exposure to greater ranges of temperature than was the case in the sea, and indicated the necessity for still further increase in the range of adaptation. Every vital process has its optimum temperature at which it is carried out rapidly and effectively. At or a little above freezing point the chemical processes concerned in life are suspended, so that over a wide range of the animal kingdom there must be an almost complete suspension of vital processes during the winter months, and at all times of the year a great dependence of the activity of these processes on the surrounding temperature. It is evident that a great advantage in the struggle for existence was gained by the first animals which succeeded in securing thermal as well as chemical constancy of environment for their cells, thus rendering them independent of changes in the external medium. It is interesting to note that the maintenance of the temperature of warm-blooded animals at a constant height is a function of the higher parts of the central nervous system. An animal with spinal cord alone reacts to changes of external temperature exactly like a cold-blooded animal, the activity of its chemical changes rising and falling with the temperature. In the intact mammal, by accurately balancing heat loss from the surface against heat production in the muscles, the central nervous system ensures that the body fluid which is supplied to all the active cells has a temperature which is independent of that of the surrounding medium. These are fundamental examples of adaptation effected by creation of an environment peculiar to the animal. Numberless others could be cited which differ only in degree from the activity of man himself. In some parts of this country, for instance, the activity of the beaver in creating an artificial environment has until lately been more marked than that of man himself. We are not justified, then, in regarding mankind as immune to the operation of natural forces which have determined the sequence of life on the surface of the globe. The same laws which have determined his evolution and his present position as the dominant type on the earth's surface will determine also his future destiny.

We are not, however, dealing with or interested in simple survival. Lower forms of life are probably as abundant on the surface of the globe as they were at any time in its history. Survival, as Darwin pointed out, is a question of differentiation. When in savage warfare a whole tribe is taken captive by the victorious enemy, the leaders and fighting men will be destroyed, while the slaves will continue to exist as the property of the victors. Survival, then, may be determined either by rise or by degradation of type. Success involves the idea of dominance, which can be secured only by that type which is the better endowed with the mechanisms of adaptation required in the struggle against other organisms.

Among the many forms of living matter which may have come into being in the earlier stages of the history of the earth, one form apparently became predominant and must be regarded as the ancestor of all forms of life, whether animal or vegetable, viz., the nucleated cell. The almost complete identity of the phenomena involved in cell division throughout the living kingdom indicates that all unicellular organisms and all organisms composed of cells have descended from a common ancestor, and that the mode of its reproduction has been impressed upon all its descendants throughout the millions of years which have elapsed since the type was first evolved. The universal distribution of living cells renders it practically impossible for us to test the possibility of a spontaneous abiogenesis or new formation of living from non-living matter at the present time. We cannot imagine that all the various phenomena which we associate with life were attributes of the primitive life stuff. Even if we had such stuff at our disposal, it would be difficult to decide whether we should ascribe the possession of life to it, and there is no doubt that any such half-way material would, directly it was formed, be utilised as pabulum by the higher types of organism already abounding on the surface of the globe.

Integration and Differentiation.

An important step in the evolution of higher forms was taken when, by the aggregation of unicellular organisms, the lowest metazoon was formed. In its most primitive forms the metazoon consists simply of a cell colony, but one in which all individuals are not of equal significance. Those to the outer side of the mass, being exposed to different environmental advantages from those within, must even during the lifetime of the individual have acquired different characteristics. Moreover, the sole aim of such aggregation being to admit of cooperation by differentiation of function between the various cell units, the latter become modified according to their position, some cells becoming chiefly alimentary, others motor, and others reproductive. Cooperation and differentiation are, however, of no use without coordination. Each part of the organism must be in a position to be affected by changes going on in distant parts, otherwise cooperation could not be effected. This cooperation in the lowest metazoon seems to be carried out by utilisation of the sensibility to chemical stimuli already possessed by the unicellular organism. We have thus coordination by means of chemical substances ("hormones") produced in certain cells and carried thence by the tissue fluids to other cells of the body, a mechanism of communication which we find even in the highest animals, including man himself. To such chemical stimuli we may probably ascribe the accumulation of wandering mesoderm cells—*i.e.* phagocytes—in an organism such as a sponge, around a seat of injury or any foreign substance that has been introduced. By this mechanism it is possible for distant parts of the body to react to stimulation of any one part of the surface. Communication by this means is, however, slow, and may be compared to the state of affairs in civilised countries before the invention of the telegraph, when messengers had to ride to different parts of the kingdom in order to arouse the whole nation for defence or attack.

Foresight and Control.

Increased speed of reaction and therefore increased powers in the struggle for existence were obtained when a nervous system was formed, by a modification of the cells forming the outer surface of the organism. By the growth of long processes from these cells a conducting network was provided, running through all parts of the body and affording a channel for the rapid propagation of excitation from the surface to the deeper parts, as well as from one part of the surface to another. From this same layer were produced the cells which, as muscle fibres, would act as the motive mechanism of the organism. Thus, from the beginning, the chief means of attack or escape were laid down in close connection with the surface from which the stimuli were received. A further step in the evolution of the nervous system consisted in the withdrawal of certain of the sensory or receptor cells from the surface, so that a specially irritable organ, the central nervous system, was evolved, which could serve as a distributing centre for the messages or calls to action initiated by changes occurring at the surface of the body. At its first appearance this central nervous system would hardly deserve the epithet of "central," since it formed a layer lying some distance below the surface, and extending over a considerable area; though we find that very soon there is an aggregation of the special cells to form ganglia, each of which might be regarded as presiding over the reactions of that part of the animal in which it is situated. Thus in the segmental worm-like animals a pair of ganglia is present in each body segment, and the chain of ganglia are united by longitudinal strands of nerve fibres to form the ganglionated cord, or central nervous system.

Such a diffused nervous system, in which all ganglia were of equal value, could, however, only act for the common weal of the whole body when a reaction initiated by stimulation at one part was not counteracted by an opposing reaction excited from another part of the surface. For survival it is necessary that in the presence of danger, *i.e.* an environment threatening the life of the individual or race, the whole activities of the organism should be concentrated on the one common purpose, whether of escape or defence. This could be effected only by making one part of the central nervous system predominant over all other parts, and the part which was chosen for this predominance was the part situated in the neighbourhood of the mouth. This, in animals which move about, is the part which always precedes the rest of the body, and therefore the part which first experiences the sense impressions, favourable or dangerous, arising from the environment. It is this end that has to appreciate the presence or approach of food material, as well as the nature of the medium into which the animal is being driven by the movements of its body. Thus a predominance of the front end of the nervous system was determined by the special development at this end of those sense organs or sensory cells which are *projicient*—*i.e.* are stimulated by changes in the environment proceeding from disturbances at a distance from the animal. The sensory organs of vision and the organs which correspond to our olfactory sense organs and are aroused by minute changes in chemical composition of the surrounding medium, are always found especially at the front or mouth end of the organism. The chances of an animal in the struggle for existence are determined by the degree to which the responses of the animal to the *immediate* environment are held in check in consequence of stimuli arising from *approaching* events. The animal, without power to see or smell or hear its enemy, will receive no impulse to fly until it is already within its enemy's jaws. It must therefore be an advantage to any animal that the whole of its nervous system should be subservient to those ganglia or central collections of nerve cells which are in direct connection with the projicient sense organs in the head. This subservience is secured by endowing the head centre with a power, firstly, of controlling and abolishing the activities (*i.e.* all those aroused by external stimuli) of all other parts of the central nervous system, and, secondly, of arousing these parts to a reaction immediately determined by the impression received from the projicient sense organs of the head and originated by some change in the surroundings of the animal which has not yet affected the actual surface of its body.

Education by Experience.

The factors which so far determine success in the struggle for predominance are, in the first place, foresight and power to react to coming events, and, in the second place, control of the whole activities of the organism by that part of the central nervous system which presides over the reaction. The animal therefore profits most which can subordinate the impulses of the present to the exigencies of the future.

An organism thus endowed is still, however, in the range of its reactions, a long way behind the type which has attained dominance to-day. The machinery we have described, when present in its simplest form, suffices for the carrying out of reactions or adaptations which are determined immediately by sense impressions, advantage being given to those reactions which are initiated by afferent stimuli affecting the projicient sense organs at the head end of the animal. With the formation of the vertebrate type, and probably even before, a new faculty makes its appearance. Up to this point the reactions of an animal have been what is termed "fatal," not in the sense of bringing death to the animal, but as inexorably fixed by the structure of the nervous system inherited by the animal from its precursors. Thus it is of advantage to a moth that it should be attracted by, and fly towards light objects—*e.g.* white flowers—and such a reactivity is a function of the structure of its nervous system. When the light object happens to be a candle flame the same response takes place. The first time that the moth flies into and through the candle flame, it may only be scorched. It does not, however, learn wisdom, but the reaction is repeated so long as the moth can receive the light stimuli, so that the response, which in the average of cases is for the good of the race, destroys the individual under an environment which is different from that under which it was evolved. There is in this case no possibility of educating the individual. The race has to be educated to new conditions by the ruthless destruction of millions of individuals, until only those survive and impress their stamp on future generations whose machinery, by the accumulation and selection of minute variations, has undergone sufficient modification to determine their automatic and "fatal" avoidance of the harmful stimulus.

The next great step in the evolution of our race was the modification of the nervous system which should render possible the education of the individual. The mechanism for this educatability was supplied by the addition, to the controlling sensory ganglia of the head, of a mass of nervous matter which could act, so to speak, as an accessory circuit to the various reflex paths already existing in the original collection of nerve ganglia. This accessory circuit, or upper brain, comes to act as an organ of memory. Without it a child might, like the moth, be attracted by a candle flame and approach it with its hand. The injury ensuing on contact with the flame would inhibit the first movement and cause a drawing back of the hand. In the simple reflex mechanism there is no reason why the same series of events should not be repeated indefinitely, as in the case of the moth. The central nervous system, however, is so constituted that every passage of an impulse along any given channel makes it easier for subsequent impulses to follow the same path. In the new nerve centre, which presents a derived circuit for all impulses traversing the lower centres, the response to the attractive impulse of the flame is succeeded immediately by the strong inhibitory impulses set up by the pain of the burn. Painful impressions are always predominant. Since they are harmful, the continued existence of the animal depends on the reaction caused by such impressions taking the precedence of and inhibiting all others. The effect therefore of such a painful experience on the new upper brain must far outweigh that of the previous impulse of attraction. The next time that a similar attractive impression is experienced the derived impulse traversing the upper brain arouses, not the previous primary reaction, but the secondary one, viz. that determined by the painful impressions attending contact with the flame. As a result, the whole of the lower tracts, along which the primary reaction would have travelled, are blocked, and the reaction—now an educated one—consists in withdrawal from or avoidance of the formerly attractive object. The burnt child has learnt to dread the fire.

The upper brain represents a nerve mechanism without distinct paths, or rather with numberless paths presenting at first equal resistance in the various directions. As a result of experience, definite tracts are laid down in this system, so that the individual has the advantage not only of his lower reflex machinery for reaction, but also of a machinery which with advance in life is adapted more and more to the environment in which he happens to be. This educable part of the nervous system—*i.e.* the one in which the direction of impulses depends on past experience and on habit—is represented in vertebrates by the cerebral hemispheres. From their first appearance they increase steadily in size as we ascend the animal scale, until in man they exceed by many times in bulk the whole of the rest of the nervous system.

We have thus, laid down automatically, increased power of foresight, founded on the Law of Uniformity. The candle flame injures the skin once when the finger is brought in contact with it. We assume that the same result will follow each time that this operation is repeated. This uniformity is also assumed in the growth of the central nervous system and furnishes the basis on which the nerve paths in the brain are laid down. The one act of injury which has followed the first trial of contact suffices in most cases to inhibit and to prevent any subsequent repetition of the act.

The Faculty of Speech.

If we consider for a moment the vastness and complexity of the stream of impressions which must be constantly pouring into the central nervous system from all the sense organs of the body, and the fact that, at any rate in the growing animal, every one of these impulses is, so to speak, stored in the upper brain, and affects the whole future behaviour of the animal, even the millions of nerve cells and fibres which are to be found in the human nervous system would seem to be insufficient to carry out the task thrown upon them. Further development of the adaptive powers of the animal would probably have been rendered impossible by the very exigencies of space and nutrition, had it not been for the development of the power of speech. A word is a fairly simple motor act and produces a correspondingly simple sensory impression. Every word, however, is a shorthand expression of a vast sum of experience, and by using words as counters it becomes possible to increase enormously the power of the nervous system to deal with its own experience. Education now involves the learning of these counters and of their significance in sense experience; and the reactions of the highest animal, man, are for the most part carried out in response to words and are governed by past education of the experience-content involved in each word.

The power of speech was probably developed in the first place as a means of communication among primitive man living in groups or societies; as a means, that is to say, of procuring cooperation of different individuals in a task in which the survival of the whole race was involved. But it has attained still further significance. Without speech the individual can profit by his own experience and to a certain limited extent by the control exercised by the older and more experienced members of his tribe. As soon as experience can be symbolised in words, it can be dissociated from the individual and becomes a part of the common heritage of the race, so that the whole past experience of the race can be utilised in the education—*i.e.* the laying down of nerve tracts—in the individual himself. On the other hand, the community receives the advantage of the foresight possessed by any individual who happens to be endowed with a central nervous system which transcends that of his fellows in its powers of dealing with sense impressions or other symbols. The foresight thus acquired by the whole community must be of advantage to it and serve for its preservation. It is therefore natural that in the processes of development and division of labour, which occur among the members of a community just as among the cell units composing an animal, a class of individuals should have been developed, who are separated from the ordinary avocations, and are, or should be, maintained by the community, in order that they may apply their whole energies to the study of sequences of sense impressions. These are set into words which, as summary statements of sequence, are known to us as the Laws of Nature. These natural laws become the property of the whole community, become embodied by education into the nervous system of its individuals, and serve therefore as the experience which will determine the future behaviour of its constituent units. This study of the sequence of phenomena is the office of Science. Through Science the whole race thus becomes endowed with a foresight which may extend far beyond contemporary events and may include in its horizon not only the individual life, but that of the race itself as of races to come.

Social Conduct.

I have spoken as if every act of the animal were determined by the complex interaction of nervous processes the paths of which through the higher parts of the brain had been laid down by previous experience, whether of phenomena or of words as symbolical of phenomena. The average conduct, however, of the individual, determined at first in this way, became by repetition automatic—*i.e.* the nerve paths are so facilitated by frequent use that a given impulse can take only the direction which is set by custom. The general adoption of the same line of conduct by all the individuals of a community in face of a given condition of the environment gave in most cases an advantage to those individuals who were endowed with a nervous system of such a character that the path could be laid down quickly and with very little repetition. Thus we get a tendency, partly by selection, largely by education, to the establishment of reactions which, like the instincts of animals, are almost automatic in character. As MacDougall has pointed out, the representations in consciousness of automatic tendencies are the emotions. Moral conduct, being that behaviour which is adapted to the individual's position in his community, is largely determined by these paths of automatic action, and the moral individual is he whose automatic actions and consequent emotions are most in accord with the welfare of his community, or at any rate with what has been accepted as the rule of conduct for the community.

Rise in Type dependent on Brain.

Thus, in the evolution of the higher from the lower type, the physiological mechanisms, which have proved the decisive factors, can be summed up under the headings of integration, foresight and control. In the process of integration we have not only a combination of units previously discrete, but also differentiation of structure and function among the units. They have lost, to a large extent, their previous independence of action and, indeed, power of independent action, the whole of their energies being now applied to fulfilling their part in the common work of the organism. At first bound together by but slight ties and capable in many cases of separating to form new cell colonies, they have finally arrived at a condition in which each one is absolutely dependent for its existence on its connection with the rest of the organism and is also essential to the well-being of every other part of the organism.

This solidarity, this subjection of all selfish activity to a common end, namely, preservation of the organism, could only be effected by a gradual increase in the control of all parts by one master tissue of the body, the actions of which were determined by impulses arriving from sense organs which themselves were set into activity by coming events. We thus have with the rise in type a gradually rising scale in powers of foresight, in control by the central nervous system, and in the solidarity of the units of which the organism is composed.

In the struggle for existence the rise in type has depended therefore on the central nervous system and its servants. Rise in type implies increased range of adaptation, and we have seen that this increased range, from the very beginning of a nervous system, was bound up with the powers of this system. Whatever opinion we may finally arrive at with regard to the types of animals which we may claim as our ancestors on the line of descent, there can be no doubt that Gaskell is right in the fundamental idea which has guided his investigations into the origin of vertebrates. As he says, "the law for the whole animal kingdom is the same as for the individual. Success in this world depends upon brains." The work by this observer which has lately appeared sets forth in greater detail than I have been able to give you to-day the grounds on which this assertion is based, and furnishes one of the most noteworthy contributions to the principles of evolution which have been published during recent years.

We must not, however, give too restrictive or common a meaning to the expression "brains" used by Gaskell in the dictum quoted above. By this word we imply the whole reactive system of the animal. In the case of man, as of some other animals, his behaviour depends not merely on his intellectual qualities or powers, to which the term "brain" is often in popular language confined, but on his position as a member of a group or society. His automatic activities in response to his ordinary environment, all those social acts which we ascribe in ourselves to our emotions or conscience, are determined by the existence of tracts in the higher parts of his brain, access to which has been opened by the ruthless method of natural selection and which have been deepened and broadened under the influence of the pleasurable and painful impressions which are included in the process of educatinn. All the higher development of man is bound up with his existence as a member of a community, and in trying to find out the factors which will determine the survival of any type of man, we must give our attention, not to the man, but to the tribe or community of which he is a member, and must try to find out what kind of behaviour of the tribe will lead to its predominance in the struggle for existence.

Political Evolution.

The comparison of the body politic with the human body is as old as political economy itself, and there is indeed no reason for assuming that the principles which determine the success of the animals formed by the aggregation of unicellular organisms should not apply to the greater aggregations or communities of the multicellular organisms themselves. It must be remembered, however, that the principles to which I have directed your attention are not those that determine survival, but those which determine rise of type, what I have called success. Evolution may be regressive as well as progressive. Degeneration, as Lankester has shown, may play as great a part as evolution of higher forms in determining survival. The world still contains myriads of unicellular organisms as well as animals and plants of all degrees and complexity and of rank in the scale of life. All these forms are subordinate to man, and when in contact with him are made to serve his purposes. In the same way all mankind will not rise in type. Many races will die out, especially those who just fall short of the highest type, while others by degradation or differentiation may continue to exist as parasites or servants of the higher type.

Mere association into a community is not sufficient to ensure success; there must also be differentiation of function among the parts, and an entire subordination of the activity of each part to the welfare of the whole. It is this lesson which we English-speaking races have at the present time most need to learn. In the behaviour of man almost every act is represented in consciousness as some emotion, experience or desire. The state of subordination of the activities of all units to the common weal of the community has its counterpart in consciousness as the "spirit of service." The enormous value of such a condition of solidarity among the individuals constituting a nation, inspired, as we should say, by this spirit of service, has been shown to us lately by Japan. In our own case the subordination of individual to State interests, such as is necessary for the aggregation of smaller primitive into larger and more complex communities, has always presented considerable difficulty and been accomplished only after severe struggle. Thus the work begun by Alexander Hamilton and Washington, the creation of the United States, is still, even after the unifying process of a civil war, incomplete and marred by contending State and individual interests. The same sort of difficulties are being experienced in the integration of the units, nominally under British control, into one great nation, in which all parts shall work for the good of the whole and for mutual protection in the struggle for survival.

The Lesson of Evolution.

Just as pain is the great educator of the individual and is responsible for the laying down of the nervous paths, which will determine his whole future conduct and the control of his lower by his higher centres, so hardship has acted as the integrator of nations. It is possible that some such factor with its attendant risks of extermination may still be necessary before we attain the unification of the British Empire, which would seem to be a necessary condition for its future success. But if only our countrymen can read the lesson of evolution and are endowed with sufficient foresight, there is no reason why they should not, by associating themselves into a great community, avoid the lesson of the rod. Such a community, if imbued by a spirit of service and guided by exact knowledge, might be successful above all others. In this community not only must there be subordination of individual to communal interests, but the behaviour of the community as a whole must be determined by anticipation of events—*i.e.* by the systematised knowledge which we call Science. The universities of a nation must be like the eyes of an animal, and the messages that these universities have to deliver must serve for the guidance and direction of the whole community.

This does not imply that the scientific men, who compose the universities and are the sense organs of the community, should be also the rulers. The reactions of a man or of a higher mammal are not determined immediately by impulses coming from his eyes or ears, but are guided by these in association with, and after they have been weighed against, a rich web of past experience, the organ of which is the higher brain. It is this organ which, as the statesman of the cell community, exercises absolute control. And it is well that those who predicate an absolute equality or identity among all the units of a community should remember that, although all parts of the body are active and have their part to play in the common work, there is a hierarchy in the tissues—different grades in their value and in their conditions. Thus every nutritional mechanism of the body is subordinate to the needs of the guiding cells of the brain. If an animal be starved, its tissues waste: first its fat goes, then its muscles, then its skeletal structures, finally even the heart. The brain is supplied with oxygen and nourishment up to the last. When this, too, fails, the animal dies. The leading cells have first call on the resources of the body. Their needs, however, are soon satisfied, and the actual amount of food or oxygen used by them is insignificant as compared with the greedy demands of a working muscle or gland cell. In like manner every community, if it is to succeed, must be governed, and all its resources controlled by men with foreseeing power and rich experience—*i.e.* with the wisdom that will enable them to profit by the teachings of science, so that every part of the organism may be put into such a condition as to do its optimum of work for the community as a whole.

At the present time it seems to me that, although it is the fashion to acquiesce in evolution because it is accepted by biologists, we do not sufficiently realise the importance of this principle in our daily life, or its value as a guide to conduct and policy. It is probable that this doctrine had more influence on the behaviour of thinking men in the period of storm and controversy which followed its promulgation fifty years ago, than it has at the present day of lukewarm emotions and second-hand opinions. Yet, according to their agreement with biological laws, the political theories of to-day must stand or fall. It is true that in most of them the doctrine of evolution is invoked as supporting one or other of their chief tenets. The socialist has grasped the all-importance of the spirit of service, of the subordination of the individual to the community. The aristocrat, in theory at any rate, would emphasise the necessity of placing the ruling power in the hands of the individuals most highly endowed with intelligence and with experience in the affairs of nations. He also appreciates the necessity of complete control of all parts by the central government, though in many cases the sense organs which he uses for guidance are the traditions of past experience rather than the science of to-day. The liberal or individualist asserts the necessity of giving to each individual equal opportunities, so that there may be a free fight between all individuals in which only the most highly gifted will survive. It might be possible for another Darwin to give us a politic which would combine what is true in each of these rival theories, and would be in strict accord with our knowledge of the history of the race and of mankind. As a matter of fact the affairs of our States are not determined according to any of these theories, but by politicians, whose measures for the conduct of the community depend in the last resort on the suffrages of their electors—*i.e.* on the favour of the people as a whole. It has been rightly said that every nation has the government which it deserves. Hence it is all-important that the people themselves should realise the meaning of the message which Darwin delivered fifty years ago. On the choice of the people, not of its politicians, on its power to foresee and to realise the laws which determine success in the struggle for existence, depends the future of our race. It is the people that must elect men as rulers in virtue of their wisdom rather than of their promises. It is the people that must insist on the provision of the organs of foresight, the workshops of exact knowledge. It is the individual who must be prepared to give up his own freedom and ease for the welfare of the community.

Whether our type is the one that will give birth to the super-man it is impossible to foresee. There are, however, two alternatives before us. As incoherent units we may acquiesce in an existence subordinate to or parasitic on any type which may happen to achieve success, or as members of a great organised community we may make a bid for determining the future of the world and for securing the dominance of our race, our thoughts and ideals.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ST. ANDREWS.—At a meeting of the University Court held on Saturday last, Dr. Arnold Hartley Gibson, senior demonstrator and assistant lecturer in engineering and lecturer on hydraulics at Manchester University, was appointed to the chair of engineering at University College, Dundee, in the room of Prof. Fidler, resigned.

Mrs. Edwin Neave was appointed lady warden of University Hall, St. Andrews, in the room of Miss Melville, who was recently appointed to Queen Margaret's College, Glasgow.

Mr. F. M. Milne was appointed lecturer in clinical pathology, and Mr. Charles Kerr clinical medical tutor.

The eighty-seventh session of Birkbeck College will be begun on Monday next, when an address will be delivered by Principal H. A. Miers, F.R.S.

Harvard University has received the sum of 3000*l.* from Mrs. J. A. Rumrill in memory of her late husband. It will be used to establish three scholarships.

Mr. T. Mather, F.R.S., has been appointed professor of electrical engineering at the City and Guilds Central Technical College in succession to the late Prof. Ayrton, F.R.S.

The new buildings of the Nicol Russell Engineering School and the Fisher Library (in connection with the University of Sydney, New South Wales) were opened by Lord Chelmsford on September 20.

The inaugural address of the session 1909–10 of the University of Bristol will be delivered on Thursday evening, September 30, by the Vice-Chancellor of the University, Sir Isambard Owen, who will take as his subject "The Significance of a University."

The Tulane University of Louisiana has during the past year come into possession of the following amounts:—400,160*l.* from the Newcomb estate, which sum will go to the Newcomb College—the women's department of the University—founded by Mrs. J. L. Newcomb as a memorial to her daughter; 10,000*l.* from Mrs. I. A. Richardson towards the establishment of a chair of botany; and 1000*l.* from the late Miss L. Miles for the purchase of books for the library.

The Home Secretary has signified to the council of the Royal College of Surgeons his decision to approve the by-laws regarding the admission of women to the examinations for the diplomas of the college. He has further expressed his willingness to sign the formal document which is to be submitted after the next meeting of the council of the college on October 14. It is understood, however, that meanwhile it will be possible to complete the necessary formalities in time for women to enter for the examinations of the Royal College to be held in January next.

Mr. W. Buchanan has been appointed lecturer on electrotechnics and the design of electrical machinery to Faraday House, London. Mr. Buchanan had a distinguished college career, first at the Royal College of Science, London, and subsequently at Glasgow University, where he was "Thomson experimental scholar" in Lord Kelvin's laboratory. He has been for fifteen years with the Electric Construction Company, Wolverhampton, first as designer of alternating current machines and subsequently as chief engineer.

The calendar of the Merchant Venturers' Technical College, Bristol, is now available. It will be remembered that in connection with the inauguration of the University of Bristol it was arranged that this college should provide the faculty of engineering in the University. A preliminary prospectus has been issued of the lectures and courses of practical work in the laboratories and workshops, designed, amongst other things, to prepare students for the various degrees in engineering to be conferred by the University. In addition to this university work the college is to continue to provide the continuous and complete preparation for an industrial career which it has hitherto done. Day and evening classes in a great variety of technological subjects have been arranged for the coming winter. It is satisfactory to find from the calendar that earnest efforts are being made by the governors and principal of the college to secure the active cooperation of enployers in their endeavours to provide suitable technical education for the men and women engaged in the industries of Bristol and neighbourhood.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 13.—M. Bouchard in the chair.—H. Deslandres communicated a telegram from P. **Lowell**, stating that the presence of free oxygen has been proved in the atmosphere of Mars. The oxygen band B is clearly stronger in the Mars spectrum than in that of the moon.—The movements of the upper solar atmosphere above and round the faculæ. The cellular vortices of the sun: H. **Deslandres.** Details of the work done with the new spectrograph at the Observatory of Meudon. A diagram is given showing the radial movements of the upper K_3 layer of the solar atmosphere above and round a facula.—The study of sea temperatures: A. Bouquet **de la Grye.** A knowledge of the temperatures of the sea over a wide area is an important factor in weather forecasts.—The trypanolytic power of the blood of some cold-blooded vertebrates with respect to *Trypanosoma evansi*: A. **Laveran** and A. **Pettit.** The blood of some of the cold-blooded vertebrates contains active trypanolytic substances, and there seems to be a relation between the presence of these substances and the toxicity of the serum. Closely related vertebrates showed differences in the trypanolytic power, the case of *Rana esculenta* and *R. temporaria* being especially remarkable in this respect.—The problem of Sophus Lie: N. **Saltykow.**—Practical formulæ for the calculation of aërial helices: M. **Drzewiecki.**—The magnetic *rôle* of oxygen in organic compounds: P. **Pascal.** The constants given in this paper enable the value for the magnetic susceptibility of an organic compound containing oxygen to be used as a guide to its structure.—The estimation of phosphorus in combustible substances by the calorimetric bomb: P. **Lemoult.** If certain precautions are taken, details of which are given, the determination of phosphorus in organic compounds by combustion in the calorimetric bomb possesses advantages over the methods in general use both in rapidity and accuracy.—The law of the fading of mnemonic traces as a function of the time in *Limnaea stagnalis*: Henri **Piéron.**—The natural means of defence of certain cold-blooded vertebrates against the trypanosome of surra, *Trypanosoma evansi*: A. **Massaglia.** Phagocytosis appears to play no part in the destruction of the trypanosomes.

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THURSDAY, SEPTEMBER 30, 1909.

APPRECIATIONS OF CARL VON LINNÉ.

Carl von Linné's Bedeutung als Naturforscher und Arzt. Schilderungen herausgegeben von der Königl. Schwedischen Akademie der Wissenschaften anlässlich der 200-jährigen Wiederkehr des Geburtstages Linné's. Pp. iv+168; 48; 43; 188; 86, 2 pl.; 42. (Jena: G. Fischer, 1909.) Price 20 marks.

THIS volume is a German version of that issued in May, 1907, by the Royal Swedish Academy of Science, and consists of six appreciations of the great Swedish naturalist.

The first of these, by Emeritus Prof. Otto E. A. Hjelt, was written at the request of the Academy, and is a revised edition of a former work prepared for the celebration of the quatercentenary of Upsala University in 1877, embodying various improvements through recent investigation into Linnean matters, due to the devotion of the late Dr. E. Ährling and Prof. T. M. Fries. In common with the other essays, this is separately paged, and may be procured apart from its accompanying discourses.

Linné's remarkable services to botany and zoology have thrown somewhat into the shade his acquirements as a practising physician and professor of medicine. This essay will do much to draw attention to this side of Linné's activities. It must not be forgotten that he was rescued from a suggested apprenticeship to a tailor or shoemaker, by the sagacity of his early teacher, Rothman, who assured Nils Linnæus that his son showed great aptitude for medicine. It was for this that Linné entered the University of Lund, and afterwards migrated to Upsala for further improvement; he took his degree of M.D., to earn a livelihood, and he practised in Stockholm after his return to Sweden. His first chair at Upsala was of medicine, and though soon afterwards he exchanged it for that of botany, he continued to keep in touch with it during his career, and left manuscripts showing his unabated interest, in spite of his exertions in other directions. A list of his medical writings at the end of this essay contains eighty-six titles.

This is followed by "Carl von Linné und die Lehre von der Wirbelthieren," of Prof. Einar Lönnberg, in which a *résumé* is given of Linné's predecessors in zoology, from Conrad Gesner, Rondelet, Aldrovandi, and others, to Ray and Willoughby, and contrasting the order brought in by methodical arrangement under Classes, Orders, and Genera.

The third essay, "Carl von Linné als Entomolog," is by Dr. Chr. Aurivillius, and is here separately given; in the original Swedish edition, Linné was considered as a zoologist, in a joint memoir with the previous author, but in this issue the part of each writer is set out separately. Following the same line of thought as in the foregoing essay, Dr. Aurivillius points out that the collections formerly belonging to Queen Lovisa Ulrika at Drottinngholm and of King Adolf Fredrik at Ulriksdal, which had been arranged and catalogued by Linné, have been in the keeping of the University of Upsala since 1803.

Dr. C. A. M. Lindman is responsible for the next memoir, "C. v. L. als botanischer Forscher und Schriftsteller," and is the longest of the series. Beginning with Linné's early training and first catalogues of local plants, it deals with that wonderful series of books which were printed in Amsterdam, the "Systema Naturæ," "Genera plantarum," "Flora lapponica," "Hortus Cliffortianus," &c., especially drawing attention to such parts of Linné's botanical teaching which are apt to be overlooked, such as his attempts at a natural system, and observations in morphology and physiology of plants; of these, many are to be found in his dissertations and travels, rarely looked at now. Indeed, Linné's books are chiefly referred to at the present day from the systematic point of view. The fact that his busy mind had occupied itself on problems which even now are unsolved is lost sight of, because his observations must be sought for in their original Latin or Swedish dress. The latter portion especially of Dr. Lindman's work should be carefully read, and will heighten our wonder at the enormous amount of work accomplished by the occupant of the Chair of Botany at Upsala.

Linné regarded as a geologist forms the next part of this volume, and is due to Prof. Nathorst; it is illustrated with two plates, and ten figures in the text. Both as petrologist and palæontologist the merits of Linné are set out, and his keen insight into geological causes are dwelt upon. Linné had but little opportunity as a field geologist; his travels were practically bounded by his official journeys to Gotland, Westgotland, and Skåne, and yet his observations merit careful reading in the light of modern science.

A similar appreciation is given by Prof. Sjögren in the last section, "Carl von Linné als Mineralog." The Linnean collection of minerals was sold by Dr. J. E. Smith in 1796, when about to remove from Chelsea to Norwich, and its present condition and place are unknown. But it is enough to gather from the various statements in the writings of Linné to put before us the views of the great naturalist in honour of whom these essays were composed.

The chief difference noticed between the original and the present edition is the omission of the reprint of Linné's "Clavis medicinæ," which formed an appendix of ninety pages to Prof. Hjelt's memoir.

B. D. J.

INDIA-RUBBER MANUFACTURE.

The Manufacture of Rubber Goods. A Practical Handbook for the Use of Manufacturers, Chemists, and Others. By Adolf Heil and Dr. W. Esch. English Edition by E. W. Lewis. Pp. viii+236. (London: C. Griffin and Co., Ltd., 1909.) Price 10*s*. 6*d*. net.

IT is now several years since the late Dr. Weber's treatise upon "The Chemistry of India Rubber" was published. The book was reviewed in these columns at the time, and has become a standard work upon the scientific principles involved in the production of rubber. A companion volume upon the practical manufacture of rubber articles was con-

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templated by the author, but his decease prevented its production; and the present work is to be regarded as a substitute. It is a translation of Heil and Esch's "Handbuch der Gummiwarenfabrikation," adapted for English usage in respect of the machinery generally employed in this country.

Non-technical readers may be reminded that crude rubber as imported contains a number of impurities—water, woody tissue, sand, and other mineral matter. Moreover, it is unvulcanised, and to fit it for diverse uses various "filling" substances must be incorporated with it. The process of manufacture consists, therefore, in the purification of the raw material; the mixing of this with ingredients which will impart the required colour, durability, or other special property to the article; the fashioning of this plastic mixture into tyre, tube, or whatever finished article is desired; and lastly, the vulcanisation of the object with sulphur, or chloride of sulphur, whereby the rubber becomes non-adhesive, harder, and more durable.

The authors give the plan and arrangement of a factory for the carrying out of these operations in what they consider to be the most advantageous manner. They direct special attention to the necessity for excluding dust in the making-up of rubber goods, since leaky seams are liable to develop in goods if particles of dust are allowed to settle on the edges of the article during the joining process. Another point to which they direct attention is the necessity, after the rubber has been washed free from admixed impurities, of drying it in a rational way. Far too little regard is had to this important detail. The large surface-area exposed favours atmospheric oxidation of the moist, warm rubber, and the time of exposure should therefore be as short as practicable. On the other hand, if the material is imperfectly dried, goods made from it are liable to rapid deterioration. To dry it thoroughly, quickly, and safely is the desideratum; and the authors describe modern drying-rooms and centrifugal plant adapted to this purpose. While not recommending any one method as the best in all circumstances, they discuss the general principles involved, and plead for an intelligent application of them.

The necessity for avoiding undue "working" or kneading of the dried rubber is also insisted upon. Not only does it increase the expense, but the quality suffers deterioration thereby. True, "rubber substance" is regarded as a mixture of polymerised hydrocarbons, and too much kneading results in a presumed depolymerisation of a portion of the material, with consequent injury to the texture.

A number of examples are given illustrating the composition of "mixings" for making different kinds of rubber articles; and the machinery for working and calendering the mixtures is described at some length.

As regards vulcanisation, it is a remarkable fact that the processes still used are carried out essentially in the same way as when first introduced, some seventy years ago, by Goodyear, Hancock, and Parkes. The details, of course, differ with the different factories; and the empirical methods evolved are guarded as trade secrets. In fact, so perfectly has long experience developed the rule-of-thumb indications that the authors think scientific investigation can hardly result in any noteworthy revolution in the methods of manufacture. It may be so; but this is not quite the spirit in which progress is made. A few years ago indigo-planters would have said much the same thing.

Many illustrations accompany the text, which is generally lucid, though occasionally with a leaning to Teutonic stolidity. Except in this respect, the translator has eliminated any lingual indication of the origin of the book, which can be recommended as a very practical and useful work. C. S.

VECTOR ANALYSIS.

Vector Analysis: an Introduction to Vector-methods and their Various Applications to Physics and Mathematics. By Dr. J. G. Coffin. Pp. xix+248. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 10*s*. 6*d*. net.

THIS "Introduction to Vector-methods and their Various Applications to Physics and Mathematics" is an exposition of the late Willard Gibbs' vector analysis. The author in his preface warns us that "no attempt at mathematical rigor is made"—which perhaps explains the opening sentence of chapter i.: "A vector is any quantity having direction as well as magnitude." What of finite rotations? Are they not to be considered quantities having direction and magnitude? In an appendix the author compares notations, not always quite accurately. He believes Willard Gibbs' notation to be the simplest and most symmetrical of any of the existing kinds. Burali-Forti and Marcolongo, who believe they have devised the perfect notation, object to Willard Gibbs's "dot" in the scalar product, using a "cross" instead. As regards the question of symmetry, the truth is that the vector product is not symmetrical, for in Gibbs's notation $\mathbf{a}\times\mathbf{b}=-\mathbf{b}\times\mathbf{a}$. As a matter of fact each vector analyst can always find sufficiently self-pleasing arguments in favour of his pet notation.

Notation apart, the book is well put together, and lays stress on many important applications in dynamics, elasticity, hydrodynamics, electricity, and magnetism. The differential operator ∇, in its Gibbsian phase, is developed in considerable detail. But will non-Hamiltonian vector analysts never realise how much they lose by working with what is not, after all, the real Hamiltonian operator? By discarding the associative law in vector products they lose the flexibility of the real ∇. Pages of definitions would be saved by a simple return to Hamilton and Tait; and not only so, but the mind of the student would be freed from the task of committing to memory the laws of the equivalent operators as used by Gibbs, Heaviside, Gans, Jahnke, Bücherer, Föppl, Burali-Forti and Marcolongo, &c. In the exercises at the end of chapter v. we notice two mistakes. In exercise (4) we are told that $\nabla.(\mathrm{a}\times\mathrm{r})=2a$, where a is the length of the vector $\mathbf{a}$. In quaternions this is $S\nabla Va\rho$. But $\nabla Va\rho=2a$, a *vector*, which can have no scalar part. Again, in Exercise (13) we have by definition

$$\epsilon^{\mathbf{a}} = 1 + \mathbf{a} + \frac{\mathbf{a}^2}{1.2} + \frac{\mathbf{a}^3}{1.2.3} + \ldots,$$

where

$$\mathbf{a}^2 = \mathbf{a}.\mathbf{a},\ \mathbf{a}^3 = \mathbf{aa}.\mathbf{a},\ \mathbf{a}^4 = \mathbf{a}.\mathbf{aa}\ \mathbf{a},$$

and we are to prove that

$$\epsilon^{\mathbf{a}} = \cos a + \mathbf{a}_1 \sin a,$$

where a is the length of $\mathbf{a}$, and $\mathbf{a}_1$ is the unit vector along $\mathbf{a}$. Now according to Gibbs $\mathbf{a}.\mathbf{a} = +a^2$, so that all the terms of the assumed expansion must be positive. How then can they give the *sine* and *cosine*? The statements are true *only* if we use the Hamiltonian vector whose square is *minus* the square of its length. The linear vector function is introduced for the discussion of the kinetics of a rigid body. This is purely Hamiltonian, and is very good so far as it goes. The investigation, however, seems to lack here and there the strength and spontaneity of Tait's classical discussion.

RETAINING WALLS AND ROAD BRIDGES.

(1) *Graphical Determination of Earth Slopes, Retaining Walls, and Dams.* By Prof. C. Prelini. Pp. ix+129. (London: A. Constable and Co., Ltd., 1908.) Price 8s. net.

(2) *The Design of Highway Bridges, and the Calculation of Stresses in Bridge Trusses.* By Prof. M. S. Ketchum. Pp. xxi+544. (New York: The Engineering News Publishing Co.; London: A. Constable and Co., Ltd., 1908.) Price 16s. net.

(1) THIS book brings together for the use of the engineering student in a handy form for reference the various graphical methods due to Culmann, Rebhann, and others, for solving problems connected with earth pressures.

The first chapter treats of the stability of earth slopes; the cohesive force in a bank of earth is determined by graphical methods, and hence is deduced the most probable plane of sliding; by means of the parabola of cohesion the various slopes of equilibrium for various heights of bank are determined, and its application to practice is then discussed; the considerable economy in excavating deep trenches with slopes correctly designed is proved by worked out examples.

In the second chapter the design of retaining walls is taken up; the author points out that all the various theories which have been employed can be divided into two groups, (*a*) those depending on the theory of the sliding prism, (*b*) those depending on analytical theory. A graphical solution, due to Rebhann, of the sliding prism type is then given; this method is then applied to a series of practical cases, both for retaining walls when surcharged, and when free of surcharge. The variation of pressure with height of wall, and position of the centre of pressure are dealt with, and also the effect of cohesion on the pressure against retaining walls, and the pressure of passive resistance of the earth in the case of abutments which are pushed outwards by arches.

In the next chapter there is an analytical demonstration of Rebhann's theory, and brief statements of the formulæ of Rankine and Weyrauch. In a series of three tables the author gives the values of the earth pressure against walls of different heights as deduced by these three formulæ, and the results agree so well that it is evident that any one of the three methods is equally trustworthy from the practical point of view.

The results obtained in the preceding chapters are applied in chapter iv. to the design of various types of retaining walls; and the important problem of the determination of the necessary thickness at the base of a retaining wall in order that it may be stable under earth pressure is fully discussed for each type of wall.

The last chapter of the book is devoted to masonry dams, which, as the author points out, are simply a particular case of retaining wall, with the material sustained practically frictionless; it is shown that the most economical profile, theoretically, is a triangular one, but in practice this is an impossible section. The modification needed in order that the dam may have a certain thickness at the top is then discussed, and the pentagonal profile deduced. It is shown that this theoretical profile is the basal form of all modern high dams. The book should prove especially useful to civil engineering students during their final college year.

(2) While many text-books have been devoted to the design of railway bridges, but little attention has been hitherto given to the equally important question of the design of road bridges, and, although the work of calculating the stresses in the different members is the same for both types, there are, owing to the very different requirements to be met, radical differences in the design of the two classes of bridge. This book, therefore, meets a distinct want, and it will be especially useful to the young designer, in view of the fact that the author has given special attention to the problem of the design of the substructure, which is usually quite neglected in books on bridge design. An entire chapter has been devoted to the design of floor beams, floors, shoes, and pedestals, and other similar details, and it is in regard to such matters that the young engineer most commonly finds the need of help and guidance.

The ninth chapter will prove of considerable use, not only to the student, but also to the teacher; as the author points out, in order to obtain a thorough knowledge of the calculation of stresses in bridge trusses, it is essential that the student should work through numerous problems—altogether twenty-four problems are worked out in detail in this section of the book, and a second similar one has been added to each of the twenty-four problems as a further exercise for the student to solve with the help afforded by the worked-out example; some of the solutions are obtained graphically, others by algebraic methods. Another valuable section is that devoted to influence diagrams, or influence lines, which are required in studying the variation of the effect of a moving load or system of loads, on a truss.

Special attention has been given to the design of high truss steel bridges, and to plate girder bridges, and this section of the book is well illustrated with reproductions of working drawings, which, in spite of the necessary small scale, are perfectly clear and distinct in all the essential details. The stresses in, and the design of, solid masonry arches and culverts form the subject of two chapters, and, though there is nothing specially novel in the treatment adopted, these sections of the book will be welcome to the draughtsman who is engaged in this branch of bridge design, especially as the author has given some useful notes on the theory of reinforced concrete.

In part iii. of the book there is a full critical investigation of an existing structure—the weights, costs, and efficiencies of the members of a Pratt highway bridge of 160 feet span are fully worked out, and the errors in design pointed out, and the modifications which would improve the design are suggested. There is no doubt that such an investigation is bound to make students familiar with bridge details, and we would commend this method to the notice of engineering teachers.

T. H. B.

OUR BOOK SHELF.

Die Strahlen der positiven Elektrizität. By Prof. E. Gehrcke. Pp. xi+124. (Leipzig: S. Hirzel, 1909.) Price 4.50 marks.

At a moment when scientific thought is being concentrated on the consideration of the nature of positive electricity, we can only welcome the appearance of a book which aims at bringing together, in the short compass of a hundred pages, all the principal facts bearing on the subject. This Prof. Gehrcke has done, and he has done it well, for, with the exception of a few slight omissions, he has put before his reader all that is essential with regard to positive rays. But we could wish that more than this had been done, for it is a little disappointing to find the results of experiments given, often with little, if anything, to indicate the theoretical deductions which can be drawn from them. Indeed, not infrequently the opinions of different investigators as to the interpretation of the results of experiments are recorded without any comment as to the relative merits of rival theories. No doubt it was the intention of the author to keep the work within definite limits, but it seems that much has been sacrificed merely for the sake of brevity. In no part of the book is this more apparent than in the portion devoted to radio-activity and the nature of the α rays. Here descriptions are often so short that it is questionable whether anyone not already fully acquainted with the subject will be able to follow the reasoning.

In the part dealing with radio-activity there are a few inaccuracies which call for comment. On p. 90 the author states that it is usually supposed that one α particle is given off from each atom during any radio-active process involving the emission of such particles. In view of the work of Bronson, who showed, for example, that an atom of thorium emanation, in breaking up, gives off four times as many α particles as an atom of thorium B or C, this is clearly not the case. Again, the table on p. 89 contains some mistakes. The volatilisation point of radium A, given as 1000° C., is too high, and that of radium C, as 1100° C., is too low. The volatilisation point of radium B is given as 20° C., instead of 600° C. That radium B can escape, at ordinary temperatures, from a surface coated with active deposit is correct, but the phenomenon is not due to any true volatility of the substance at ordinary temperatures, and has been explained on quite different lines.

Das Seelenleben der Tiere. By Dr. P. Ohm. Pp. 117. (Stuttgart: Neue Weltanschauung, 1909.)

This little book is the fourth of a series called "Weltanschauungs-Fragen," and apparently intended to include contributions to the monistic philosophy of Haeckel. Consequently, Dr. Ohm brings forward the two principal theories of animal intelligence—one that it is totally different in kind from human, and the other that it is the product of evolution, and differs only in degree, but is essentially of the same nature. After a brief historical introduction to the subject, and noticing the opinions held by various authors from Plato to Wasmann, Darwin, and Harold Höfding, Dr. Ohm speaks of the dawning intelligence indicated in Protista, sponges, Medusæ, Hydra, molluscs, &c., and then inserts a chapter on instinct to controvert the view advocated by Wasmann that it is a perfect and divine inspiration, quite different from reason. Here he deals especially with the manifestations and imperfections of the intelligence of insects, especially ants and bees.

Another chapter is devoted to the "Seelenleben" ("soul-life," or, more correctly, intelligence) of insects and spiders, with special reference to their eyes, antennæ, sense of direction, &c., and a figure is given of the Indian tree-ant (*Œcophylla smaragdina*) using one of its own larvæ to spin threads. An illustration is also given of the large garden diadem spider and its web. Another chapter follows, on the senses, habits, and intelligence of vertebrate animals, and the book concludes with a comparison between human and animal intelligence; and the author regards the faculty of speech as the essential difference between them. A short bibliography is appended.

Dr. Ohm has written a thoughtful little book, and has dealt with a difficult subject fairly and moderately. His work will be read with interest by students interested in the important questions with which it deals; but everyone is so much influenced by preconceived ideas, on one side or another, that it is almost impossible to form an unbiassed opinion about them.

W. F. K.

Comment Former un Esprit. By Dr. Toulouse. Deuxième Édition. Pp. x+260. (Paris: Librairie Hachette et Cie., 1908.)

This book is the reply to a request for ten lessons to professional teachers and parents which should embody what Dr. Toulouse's experience as a psychologist and a medical man has taught him to think essential to "the cultivation of an intelligence." He starts from a position with which critics of educational institutions on this side of the Channel have made us familiar; "we teach everything in school to-day except how to think and how to act." His remedy is also familiar—education should aim at teaching us not so much to know as how to apply knowledge to the regulation of the important affairs of life. To achieve this end it must train us, in accordance with sound principles of "method" (in the Cartesian sense), to observe, to judge, to feel, to act. The author's discussion of these methodical principles is broad-minded and suggestive, but it is too brief and schematic to be of much direct service to the teacher in the class-room or the parent in the home. His recommendations have much more value when they either express the practical wisdom of a man who has managed his life successfully or deal with specific topics on which his experience as a medical psychologist gives him authority. Under the latter heading attention may be directed to a vigorous argument for the frank instruction of boys and girls in "the phenomena of life."

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.]*

Visibility of Halley's Comet.

THE discovery of Halley's comet at a time so far preceding the date of perihelion passage adds another proof of the great capacity of the photographic method. The interesting point to many observers is as to when the comet will become visible to them as a telescopic object. This must, of course, depend in a large measure upon the diameter of their glasses and on their powers of vision. After the present moon has left the sky, say during the second week in October, the comet ought to have increased in light sufficiently for it to be observed in a 12-inch telescope. The calculated magnitude of the comet will be $14\frac{1}{2}$ on October 15, and its distance from the earth about 230 millions of miles. Its apparent position will then be five degrees west of γ Geminorum, and near 72 Orionis. On October 16 the comet will be just two degrees south of 71 Orionis (mag. 5·5), and ought to be visible as a very faint nebulosity, especially if the night is good. The transparency of the air has an important influence on the perception and aspect of faint comets and nebulæ, for a really suitable sky will enable objects to be glimpsed which are utterly invisible on bad nights when there is diffused light, thin cloud, mist, or fog prevalent. The comet will be visible in an excellent position nearly all night during most of the winter, but will continue small and faint until it blazes out next April. W. F. DENNING.

The Presence of Hæmoglobin in Invertebrate Blood.

MAY I make use of your columns to correct a statement in my article on Crustacea in vol. iv. of the "Cambridge Natural History," which I am afraid may seriously mislead the reader? Referring to the alleged presence of hæmoglobin in the blood of Branchipus and Daphnia, I have stated in a footnote on p. 30 that the fact that the red blood of Lernanthropus has been proved not to contain hæmoglobin throws doubt on the reality of its presence in the other two animals. At the time of writing I was not aware that the authority on which the presence of hæmoglobin in Branchipus and Daphnia rested, and I was inclined to impugn, was Sir Ray Lankester, who, in the late 'sixties and early 'seventies, published a series of researches which laid the foundation of a comparative knowledge of the distribution of hæmoglobin and similar respiratory pigments in the animal kingdom (see especially Proc. Roy. Soc., vol. xxi., December, 1872, p. 70). After reading these articles it is clear to me that Sir Ray Lankester's statement as to the presence of hæmoglobin in the blood of Branchipus and Daphnia, resting as it does on careful microspectroscopic examination, is quite unaffected by what may or may not be the case in Lernanthropus, so that I can only withdraw my footnote with many apologies to him and to readers of the "Cambridge Natural History." With regard to Lernanthropus and its allies, small crustacea parasitic on fish and mussels, which possess a closed vascular system containing a red fluid, there is still some doubt. Van Beneden, who discovered Lernanthropus in 1880, states (*Zoologischer Anzeiger*, Bd. iii., p. 35) that he examined the blood spectroscopically, and found the oxyhæmoglobin lines.

More recently Dr. Steuer (*Arbeiten Zool. Inst. Wien*, vol. xv., p. 14, 1903) sent numerous specimens of an allied form, Mytilicola, to Prof. R. von Zeynek in Vienna, who came to the conclusion that the blood did not contain hæmoglobin, since (1) with glacial acetic acid and sodium chloride no hæmin crystals were obtained; (2) after reduction with potassium cyanide and ammonium sulphide, the characteristic reduced hæmoglobin lines were not formed; (3) there was no hæmochromogen reaction.

Curiously enough, we are not told whether the simple examination of the blood gives the oxyhæmoglobin lines, as Van Beneden stated, or not, so that we are left in doubt whether Van Beneden was altogether in error or the red substance in the blood of Lernanthropus possesses one of the properties of hæmoglobin but not the others. The matter being in this unsatisfactory state, it is very desirable that someone, to whom the opportunity is offered, should re-investigate the blood of Lernanthropus.

New College, Oxford. GEOFFREY SMITH.

MAGNETIC STORM OF SEPTEMBER 25.

DR. CHREE, F.R.S., has sent us the following communication on the above:—

The magnetic storm of September 25 exhibited the rapid oscillatory movements that are usually associated with the appearance of aurora. As recorded at Kew, the storm commenced suddenly at about 11.43 a.m. During the next nine hours there was an almost uninterrupted succession of large oscillatory movements in the magnetic curves, especially those of declination and horizontal force. The storm was of comparatively short duration, no movements of any great size being recorded after 8.30 p.m. on September 25, and by 1 a.m. on September 26 little trace of disturbance was left. When the storm was at its height the oscillatory movements were so rapid that the record left on the photographic paper was frequently too faint to show minute details, and the limits of registration were at times exceeded.

At the commencement there would appear to have been an exceedingly rapid oscillatory movement of the declination needle, after which the needle moved to the east continuously for about 15 minutes. After the first 12 minutes, during which a movement of 72′ was recorded, the trace got off the sheet, so that the full extent of the easterly drift is not shown. After a few minutes' absence the trace reappeared, but, after some oscillatory movements of the needle, the trace got off the sheet again on the same side as before at about 12.12 p.m., and remained off on this occasion for nearly 40 minutes. During the whole of this time the needle pointed at least 70′—at times, probably, a good deal more—to the east of its normal position. After coming on the sheet about 12.52, the trace exhibited some minor oscillations superposed on a rapid drift across the sheet. The entire width, representing 2° 7′, was crossed in less than half an hour, and the trace at about 1.20 p.m. got off the sheet on the opposite side. The needle then pointed about 1° to the west of its normal position. Between 1.20 p.m. and 8.30 p.m. there were a number of large oscillations, movements of 40′, 60′, or more, now east, now west, taking place in the course of a few minutes. The largest of the rapid oscillations clearly shown took place between about 8.7 and 8.22 p.m., a westerly movement of 98′ being followed by an easterly movement of 84′. The disturbance shown by the horizontal-force curve was no less remarkable. The commencing movement at 11.43 a.m. went beyond the lower limit of registration, a fall of 430 γ taking place in about 10 minutes. At this time the trace was off the sheet for only about 5 minutes. After reappearing it showed large oscillations. By 12.53 p.m. it had crossed the sheet to the other side, the change of force during one period of 13 minutes being no less than 625 γ. The trace was off the sheet continuously from 3.55 to 5.10 p.m., the horizontal force during the whole of this time exceeding its normal value by more than 300 γ. Except when off the sheet, the trace showed continuous large oscillatory movements during the whole afternoon. The largest clearly shown was partly synchronous with the large declination oscillation near 8 p.m. already described; it consisted of a rise of 520 γ and fall of 710 γ, all in the course of 17 minutes.

The declination range, 2° 7′, and the horizontal-force range, 740 γ, actually recorded, represent merely the full width of the photographic paper. How much these ranges were exceeded it is impossible to say, but, judging by the look of the curves, the excess was probably considerable. The vertical-force trace got off the sheet only on one side, and this element would appear to have been less disturbed than the other two. Still, as the trace was off the sheet continuously for nearly an hour after 3.35 p.m., the chances are that the true range exceeded somewhat largely the range 530 γ actually recorded. The duration of the storm was comparatively short, but whilst it lasted it exhibited an energy which has been very seldom rivalled at Kew. The oscillatory movements were quite as rapid as those of October 31, 1903, and the range of the elements has probably not been exceeded during the last twenty years, not even during the great storm of February 13, 1892.

Magnetic storms such as the present inevitably create an interest in the explanations that have been advanced to account for the phenomenon. The theories of Arrhenius and of Nordmann, the theories and researches of Birkeland, and the deductions made by Maunder from the Greenwich disturbances all point to the sun as the ultimate source, and to some form of discharge—ions, electrons, or such like carriers of electricity—as the immediate vehicle. The electrical nature of aurora is difficult to dispute, and the fact that storms like the present appear to be invariably associated with aurora visible far outside the polar regions unquestionably supports in some ways theories such as those of Birkeland or Arrhenius.

When we come, however, to details, difficulties present themselves. If magnetic storms are directly due to the electrical currents which render the upper atmosphere luminous, how comes it to pass that the visual phenomena of aurora are so constantly changing, whilst even in the most conspicuously variable of magnetic storms the larger movements of the magnets take usually 5, 10, or 20 minutes to accomplish, the force appearing to alter at a nearly uniform rate for minutes on end? The relatively gradual nature of the magnetic change is a true phenomenon—as clearly indicated by the short-period magnets of the Eschenhagen pattern, as in the larger Kew magnets with periods of 10 seconds or more. There is, again, the very remarkable fact that when we go to high latitudes, where aurora and magnetic disturbance are both almost daily occurrences, the association of the two phenomena becomes much more difficult, if not impossible, to recognise. The absence of visible aurora during active magnetic disturbances may be reasonably accounted for during the Arctic summer, when the sun is above the horizon, but it is a different matter when we find the magnets rather quieter than usual during the occurrence of a bright aurora. Unless we are to assume a fundamental difference of type between auroras presenting the same spectroscopic lines, or a variety of sources for different magnetic storms, there is a difficulty which is not easily surmounted. The only explanation that has occurred to me is the possibility that the visual phenomena may represent merely intense local concentration of electrical current, and that the main portion of the discharge frequently makes no appeal to the eye, and is of a much more steady and persistent character. Another difficulty in regarding the phenomena of magnetic storms as entirely and directly due to the action of electrical currents associated with aurora is that it is a frequent occurrence—as on the present occasion—for the horizontal force to be considerably depressed below the normal value when the storm has apparently ceased and for some considerable time thereafter. It is possible, of course, that the external currents have partly demagnetised the earth, or at least modified its distribution of magnetism, and that there are recuperative tendencies tending to cause reversion to what is for the time being a more stable distribution; but if this be the true explanation, the demagnetising action and the recuperative tendencies are presumably in action during the course of the storm, and profoundly modify the magnetic phenomena. To many minds subscription to some theory may be a necessity for intellectual comfort, but in the case of magnetic storms reservation of judgment appears at present the more scientific attitude.

In addition to the foregoing we have received the following communication from Prof. A. Fowler, of the Imperial College of Science and Technology, South Kensington:—The possible occurrence of a magnetic storm and auroral display on September 24 or 25 was suggested by observations of the large spot which was then on the sun's disc. On September 24 the spot was a little west of the central meridian—which appears to be the most favourable position in relation to magnetic disturbances—and spectroscopic observations showed that it was of the same disturbed type as the spot associated with the great magnetic storm of October 31, 1903 (NATURE, vol. lxix., p. 6).

On Friday evening (September 24) the sky was overcast, and it did not then occur to me to test the possible presence of aurora by the spectroscope. On Saturday evening, however, although the sky was at first completely clouded over, the spectroscope gave unmistakable evidence that an auroral display was in progress. From 6.40 to about 7.30 (the sun set at 5.52), the whole sky was filled with a feeble light, with brighter patches here and there, and the characteristic green line of the auroral spectrum was seen in every direction. The greatest intensity was at first near the zenith, but the line was easily visible over the entire sky, and was even seen in the light reflected by a pocket handkerchief. This condition continued with diminished brightness until near 8 p.m. Between 8 and 9 o'clock the display was very feeble, but shortly after 9 the auroral line was again fairly distinct in a faintly luminous belt about 10° above the northern horizon. After 9.30 no evidence of aurora was obtained, although the sky was then partially clear.

The general distribution of the green line over the heavens in clearer skies has been occasionally noted by Ångström and others, but I have not yet found any previous record of such a wide diffusion of the auroral light when the sky was completely clouded. If wholly above the clouds, the aurora must have been of extraordinary brightness in order to produce this effect.

Besides the green line, there were three fainter nebulous lines or bands in the green and blue, which have been frequently mentioned by previous observers. A careful search was made for the red line which appears in "crimson" auroræ, but its presence was not even suspected.

As to the sun-spot, there was a brilliant reversal of the C line of hydrogen over one of the umbræ when I observed it at 12.20 p.m. on September 24, and on opening the slit it was clear that this appearance was produced by a very bright overlying prominence. Reversals of the chromospheric lines b_3 and 1474 K were also suspected, but the observations were stopped by clouds. According to Tacchini and Lockyer, it is the prominence, rather than the spot, which should be considered as related to the magnetic disturbance.

AVIATION.

THE successful aviation week recently concluded at Rheims should do much to popularise aviation, if that subject is not sufficiently popular already. The large number of newspapers and periodicals devoted to aërial navigation is, however, sufficient evidence of the amount of public interest which centres round the new form of locomotion. At a railway bookstall at Tarbes, in the Pyrenees, a few weeks back, the present writer saw no fewer than five different papers devoted to flying machines. Possibly the number of such journals is equal to, even greater than, or at any rate comparable with, the number of successful flights that have been performed; it certainly appears as if the frequency with which a new journal comes out is not small in proportion to the frequency of aëronautical successes. Indeed, at the present rate, the assigning of new titles to these journals will soon take the form of a problem in permutations and combinations.

When it is attempted to draw scientific conclusions from these successful flights there is not, after all, so very much to be said. The difference between a machine that will fly one mile and a machine that will fly a hundred miles is mainly that the latter must be able to carry a heavier load in the form of petrol or other fuel than the former. In the case of high flights the same remarks apply, though the construction of a machine which is capable of ascending or safely descending at a considerable angle to the horizon presents many points of scientific interest which, no doubt, will receive the attention they deserve sooner or later, unbeknown to the average newspaper reader. In saying that when aviation takes the form of record-breaking it ceases to be a science and becomes a sport, we are, of course, not taking into account all the work of an experimental character in the construction and perfection of motors, propellers, and aëroplanes which has to be gone through behind the scenes before the sport can be indulged in. We have, however, failed to find that any very definite and striking new result has been proved by the recent triumphs.

It would seem, in fact, as if writers on the subject were directing their attention to the early history of aërial navigation to make up for the fact that there is very little to write about in a mere statement of records. Under the title of *Ila*, a weekly journal is appearing in connection with the International Aëronautical Exhibition at Frankfurt, of which the historical section is an important feature. It is interesting to revive acquaintance with the early, and in many cases fantastic, devices of Barthélemy Lourenço de Gusman, Besnier, Jacob Degen, Blanchard, the *Minerva* of Robertson, with its suspended ship and cabins, and an old cartoon of an omnibus and horses hanging from a balloon. As for Lourenço, a special number (Illustrierte Aëronautische Mitteilungen xiii, 17, *Ila* iii.) contains references to his exploits in view of August 8 of this year being the 200th anniversary of his supposed flight. The article by Mr. B. Wilhelm is prefaced by a short editorial note by Capt. H. W. L. Moedebeck, and seems to support the view that Lourenço actually went so far as to make a small model of a fire-balloon rise in the air in presence of the King of Portugal. Of pictures of Lourenço's grotesque and fantastic design we have two in the number in question, but in No. 10 of *Ila* it is pointed out that if Gusman really did fly, his ship must certainly have looked quite different.

Another article dealing with the general history of aërial navigation, both past and present, forms the subject of a special number of *La Nature*, issued on August 21 in connection with the Rheims meeting of the following week. A useful feature is the series of illustrations, each showing in one figure a collection of the principal types of airships and aëroplanes, in much the same way that the early history of the subject is summarised in the interesting old "Tableau d'Aviation" of fame. Of these we reproduce the two illustrations of the most recent aëroplanes. The article concludes with a calendar of "the great dates of aviation," which is here given, with addition of the Rheims records:—

Date	Aeronaut	Place	Distance and Duration
Oct 14, 1897	Ader	Satory ...	Flight of 300 metres.
Sept. & Oct. 1905	Wright Bros.	Kitty Hawk	Flights of 17 to 38 km.
Nov. 12, 1906	Santos Dumont ...	Bagatelle ...	220 m. in a straight line.
Jan. 13, 1908	H. Farman	Issy	Kilometre in closed circuit.
July 6, 1908	H. Farman	Issy	Prize for ¼ hour.
Sept. 9, 1908	O Wright...	Fort Meyer.	63·975 km. in 1h. 3m. 15s.
Oct. 10, 1908	W. Wright	Mans	1h. 9m. 45s., two persons.
Oct. 30, 1908	H. Farman	Bouy to Rheims ...	First actual journey, 27 km.
Oct. 31, 1908	Blériot ...	Toury to Artenay & back ...	First circular trip.
Dec. 31, 1908	W. Wright	Pau	123 km. in 2h. 18m. 33·6s.
June 5, 1909	Latham ...	Camp de Châlons ...	1h. 7m. 35s. on monoplane.
July 18, 1909	Paulhan ...	Douai... ...	150 metres altitude on biplane.
July 25, 1909	Blériot ...	Sangatte to Dover ...	Channel flight, 37 m.
Aug. 4, 1909	R. Sommer	C. de Châlons	2h. 10m. on biplane.
Aug. 7, 1909	R. Sommer	,, ,,	2h. 27m., time record
Aug. 23, 1909	Curtiss ...	,, ,,	10 km. in 8m. 37·6s. (speed).
Aug. 24, 1909	Blériot ...	,, ,,	10 km. in 8m. 4·4s. ,,
Aug. 25, 1909	Paulhan ...	,, ,,	131 km. in 2h. 43m. 24·8s.
Aug. 26, 1909	Latham ...	,, ,,	154·5 km. in 2h. 13m. 9·6s.
Aug. 27, 1909	Farman ...	,, ,,	180 km. in 3h. 4m. 56·4s.
Aug. 28, 1909	Latham and Farman	,, ,,	Altitude 120–130 m.

When the newspapers state that one portion of the course has come to be called "the valley of death," from the numerous wrecks that every day strew its fields, and when we refer to the accidents to Paulhan, Fournier, Blériot, and still later to the death of Lefèbvre and the accidents to Lieut. Calderara, to Bossi, and to Le Blanc, it will be seen that aëroplane triumphs are being bought at the expense of many thousands of pounds spent in rebuilding completely smashed-up machines, not to mention the risk to life and limb.

Of course, a considerable proportion of these accidents are undoubtedly accidents in the true sense of the word, but when we read, as we have done over and over again, that machines have suddenly stopped dead from no explicable cause, and then suddenly plunged to the ground, the idea of longitudinal instability at once suggests itself, and the obvious remedy is that aviators should wait until this subject has at least been thrashed out mathematically, or should devote a fraction of the sum they spend on repairs of broken parts to furnishing the assistance which would enable the theoretical investigations to be pushed forward without delay instead of being hung up for months at a time owing to pressure of other work.

Such a course would have been by far the shortest, cheapest, and best way of disposing of one of the important difficulties connected with aviation. But what chance of success would a mathematician have if he made an appeal of this kind? The world is full of people who have made, or imagine they have made, epoch-making discoveries, and who only require funds for their development. Their effusions find their way into every journal that does not adopt the most strict censorship over the scientific value of its contributions. The time has passed when any value can be attached to projects for aërial navigation which are not supported by either theory or experiment, yet such projects still succeed in appearing in print, and naturally ninety-nine people out of every hundred mistake the chaff for the grain. In the Journal of the Franklin Institute for July, for instance, Mr. Russell Thayer propounds the idea that all you have to do is to attach a gyroscope to a dirigible balloon and provide it with a sail in order to make it abandon its path of least resistance, drifting with the wind, and plough through the air in a different direction. Even the heading of the paper contains the sentence "The lever in space without a fulcrum on the earth!"

We leave readers of NATURE to form their own opinions of this recent contribution to a journal professing to be "devoted to science and the mechanic arts." But if Mr. Russell Thayer will turn to *Ila*, No. 10, p. 174, he will see that his idea of an airship supported by balloons and driven by sails was anticipated in the year 1670 by the Jesuit priest Francesco Lana, of Brescia, whose design possesses the additional merit of dispensing with the gyroscope!

Returning to the serious side of the problem, it suggested of enabling an aviator to observe the resistance, and consequently to ascertain the relative velocity of his machine. Captain Renard concludes his "conferences" on aviation in the *Bulletin de la Société d'Encouragement* for June. From Mr. Octave Chanute we have received by a recent mail papers on "The Evolution of the Two-surface Machine," and "Soaring Flight" (American *Aëronautics*, September and October, 1908, April, 1909), which remind us of the useful pioneer work in which Mr. Chanute was engaged, particularly before the Wright brothers took the subject so much in hand. In the *Revue scientifique* for August 14, Capt. Paul Renard writes on "The Antoinette Aëroplane and High Flights." Prof. Houssay, as a zoologist, writes, in the *Revue générale des Sciences*, xx., 14, on the stabilisation of fishes by fins and other appendages, and points out a certain analogy with the stabilisation of dirigibles. Photography by carrier pigeons is discussed in *Ila* for July 10, which also contains illustrations, which should interest philatelists, of letters sent by balloon post during the siege of Paris in 1870, and now exhibited at Frankfurt.

In view of the immense amount of popular enthusiasm aroused by aëroplanes, long before they have reached the stage at which they are likely to be used as a common means of transport, it is somewhat interesting to think that an invention has appeared almost unnoticed which is accessible to everyone, and is capable of affording quite as much genuine enjoyment to those who use it as the aëroplane, at a fraction of the cost. The piano-player was heralded by no flourish of trumpets, it received no attention in the Press, save in the makers' advertisements, and there is no journal devoted to its interests. Yet from a scientific point of view it possesses many remarkable—almost marvellous—properties, which afford abundant material for research. But if such researches were undertaken, no one would publish or read them. All the fashion is for aëroplanes.

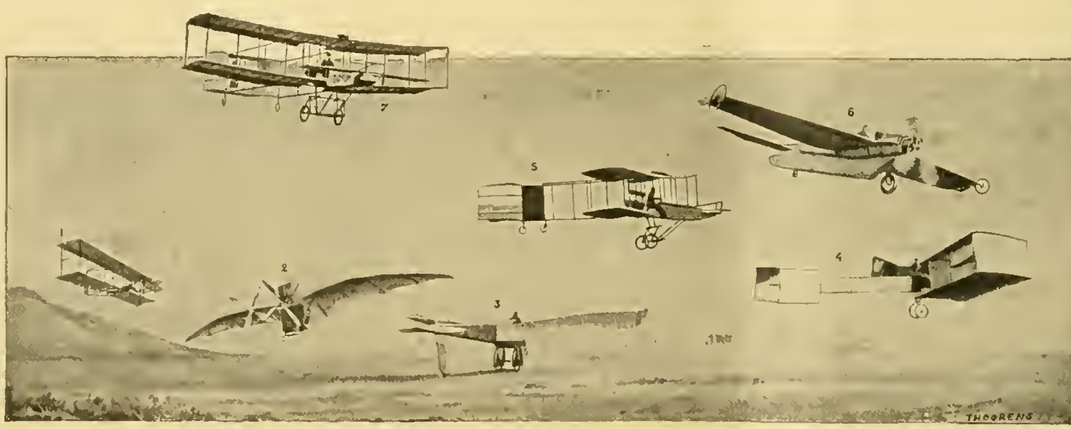


FIG. 1.—1. Wright glider (1900–3). 2. Ader (1890–7). 3. First Blériot monoplane (1906). 4. Santos Dumont's machine which made the first officially recorded flight (1906). 5. Farman's biplane which made the first circuit of a kilometre (January 13, 1908). 6. Robert Esnault Pelterie monoplane (1907–8). 7. Delagrange biplane (1908).

is impossible to glance at the two illustrations accompanying this article without forming the general impression that in many of the types figured the longitudinal stability is defective and the lateral stability *nil*, or worse than *nil*. It is merely the danger of making statements which are unsupported by the most circumstantial evidence that prevents us from expressing a very strong and emphatic view regarding pretty well every machine in the collection. The one fact which appears definitely established is that aëroplanes which are unstable, both longitudinally and laterally, can perform flights of indefinite length in the hands of skilled aviators, and this result will receive its full and proper explanation in the prospective mathematical theory. Indeed, for those who can appreciate them, mathematical researches on stability are much more fascinating than flights on aëroplanes.

A few further papers are deserving of mention. In the number of *La Nature* referred to, an apparatus called "wrightmeter" is suggested, invented by M. Dalloz for the stated purpose of determining the coefficient of resistance of air. As this resistance is measured on a *sphere*, this does not go very far in determining the resistances commonly occurring in aërodynamics, the more useful application being that

G. H. BRYAN.

Since the above article was in proof, the science of aviation has sustained a sad loss by the death of Captain Ferber. Although Captain Ferber's name has not come prominently before the public as a record-breaker, this perhaps is in some measure due to the scientific spirit in which he studied aviation. Captain Ferber commanded the Alpine Battery at Nice from 1900 to 1904, and during that time became interested in aviation. His first models, like the old-fashioned quadrilateral boy's kite, had aëroplanes of considerable longitudinal dimensions, but on becoming acquainted with the gliding experiments of Chanute, Herring, and the Wright Brothers, he was not long in adopting the two-surfaced rectangular type. Captain Ferber materially developed our theories of longitudinal stability, and he also gave a mathematical investigation, probably the first, of lateral stability. In view of the last statement, and the fact that Ferber's machines were furnished with special triangular sails in order to render them laterally stable, it seems somewhat rash to suggest that his fatal accident was due to the precautions being inadequate; yet it is just possible we may find that such was the case; if so, it is remarkable that Ferber should fail when others who have taken less adequate precautions have succeeded. Before his death Captain Ferber attributed the accident to flying too low, so that the machine struck the ground when it heeled over. Captain Ferber was the author of a number of papers and articles dealing with aviation, and also a keen balloonist.

G. H. B.

THE ROYAL OBSERVATORY AND ELECTRIC TRAMWAYS.

FROM statements recently appearing in the public Press, many people have been led to regard the Astronomer Royal as an uncompromising opponent of tramway electrification; but as it is perfectly well known that Greenwich is very well supplied with electric trams, it must be quite evident that this impression cannot be correct.

It is specifically alleged that:—

(1) The extension of the overhead trolley system from the Arsenal gates to the Woolwich Free Ferry is blocked by the refusal of official sanction.

(2) The same official sanction is withheld from all schemes for the authorised electric tramway from Woolwich to Eltham.

The facts we have been able to ascertain are as follows, premising that the Admiralty, and not the Astronomer Royal, is officially responsible for safeguarding the efficiency of the observatory records, and that the Board of Trade has to provide for adequate protection of the observatory for the magnetic portion of the work.

FIG. 2.—8. Blériot monoplane after accident. 9. Luyties American helicopter. 10. Bonnet Labranche biplane. 11. Vuia helicopter. 12. Goupy triplane. 13. Curtiss's American biplane. 14. Zeus aëroplane. 15. Ferber biplane. 16. Santos Dumont's Demoiselle. 17. Gastambide Mangin biplane. 18. Farman's biplane which travelled from Bouy to Rheims (October 30, 1908). 19. Wright's machine which made the record flight with two passengers (1h. 9m. 45s.). 20. The Antoinette V., which made the record for monoplanes (1h. 7m. 35s.) and attempted to cross the Channel. 21. The Blériot XI., which crossed the Channel on July 25, 1909.

(1) The proposal appears to have been brought up suddenly, without previous warning, towards the latter part of August, at a time when, as is well known, many Government officials are expected to be away on leave, and, consequently, delay is almost certain. It appears also that as soon as the question was gone into by those concerned, it was decided to consent to the proposal on the strict understanding that any further step in the conversion of the existing horse-tramway between East Greenwich and Woolwich should be by extension of the conduit system eastwards, and not of the trolley system westwards. It is, of course, impossible to say how long it will be before this decision can have any practical effect, but it is certain that no further delay can be attributed to the observatory.

(2) As regards the authorised tramway from Woolwich to Eltham, we find that many Eltham residents are strongly opposed to the overhead system, while the official position is not one of hostility to the overhead system *per se*, but of insisting on insulated returns, any system which ensures this for the protection of Greenwich magnetic records being free from this official objection. As a case in point, the G.B. surface-contact system was proposed by the County Council several years ago and sanctioned officially, but was then dropped after some inconclusive experiments. Recently a new surface-contact system, the S.P. system, was made the subject of an article in *Engineering*, May 28, and claims to avoid the risk of danger alleged against the G.B. system. It has been tried and favourably reported on, but has not apparently been suggested for the Woolwich and Eltham tramway.

The official attitude thus seems perfectly consistent and reasonable, and not unsympathetic. The suggestion of overhead wires without insulated returns within a radius of three miles from the observatory ought once for all to be dropped. If the County Council objects to the expense of the conduit system and to the inconvenience of equipping the overhead system with insulated returns, it is for them to find a satisfactory alternative. Unless the protective clauses insisted on by the Government are to become a dead letter, it is futile to try to blame the observatory for delay or obstruction, and it is in the last degree unlikely that the Admiralty will be persuaded to stultify its own action and contention by allowing these clauses to be overridden.

PETER BARR.

THE name of this eminent horticulturist, whose death we announced last week, will ever be associated with the development of narcissi. Born in 1826, in the former village of Govan, which has long since been absorbed in the city of Glasgow, he was the son of a mill-owner who found recreation from weaving in the cultivation of tulips and other florists' flowers. The son appears to have inherited a strong love for floriculture, for he soon tired of the looms, and obtained employment in various seed businesses, until in 1861 he commenced business, with a partner, on the site of the present premises of Messrs. Barr and Sons, King Street, Covent Garden, under the title of Barr and Sugden. Barr then directed his attention to practical floriculture, experimenting with hellebores (Christmas roses), tulips, lilies, and pæonies. For these purposes he found it necessary to take up a piece of ground at Tooting, where he conducted trials which interested the leading florists of the day. He next scoured the country over for narcissi, meeting with considerable success in his quest. Two amateurs had already formed wonderful collections of these flowers which, unknown to the general public, they had cultivated for nearly a quarter of a century. These were Mr. W. Backhouse, of Darlington, and Mr. Edward Leeds, of Manchester. Barr made up his mind that if he could only obtain possession of these collections he would have all the best of existing daffodils in his own possession. By dint of perseverance and enterprise he succeeded in this, and the collections were removed to Tooting, where for years afterwards new seedling varieties flowered every year. Every variety worth cultivating was named and its name registered, for he recognised that no commercial success would follow unless the public could be assured that every plant catalogued was accurately and intelligently named. But the varieties continued to multiply so greatly that he found it necessary to elaborate a classification, grouping the sorts into sections according to the length of the trumpet or perianth tube and other characteristics. Mainly owing to Barr's representations, the Royal Horticultural Society promoted a Daffodil Conference in 1884, and his system of classification was then, in the main, adopted. Not long after this the attention of market growers was directed to these bulbs, and in the Scilly Isles, in Cornwall, in Lincolnshire, and other places acres of land were planted for the purpose of supplying the markets with cut blooms, with the result we see to-day in the millions of flowers that are offered everywhere for sale.

Peter Barr retired from business in 1896, after botanising in various places in Europe for the purpose of collecting rare daffodils in their native habitats. In 1808 he began a tour round the world, which lasted seven years. He visited America, Canada, Japan, China, Australia, New Zealand, and, on his way home, spent twenty-one months in South Africa. During this world tour he lectured on daffodils, and was interviewed and acclaimed almost everywhere as the "Daffodil King," a title which had been given him in this country by his fellow-floriculturists.

One of the finest white trumpet daffodils ever raised was distributed a few years ago by his firm, and it was named after Peter Barr.

NOTES.

WE learn from the *Times*, with deep regret, of the death, on Sunday last, of Prof. Anton Dohrn, the founder and director of the Zoological Station at Naples.

SIR THOMAS ELLIOTT, Secretary to the Board of Agriculture and Fisheries, has been nominated by the French Government to be a Companion of the Order "du Mérite Agricole."

IN view of the retirement, to which reference has been made in these columns already, of Prof. J. Cleland, F.R.S., from the chair of anatomy, and of Prof. Jack from the chair of mathematics, at the end of the present month, there has been set on foot, on the initiative of the business committee of the general council of the University of Glasgow, a movement for making appropriate recognition of their long and distinguished services. Circulars have been issued to the whole body of university graduates and to members of other learned bodies with which Profs. Cleland and Jack have been connected. In the circulars it is stated that the form of recognition will, to a large extent, depend on the amounts subscribed, but it is thought that it might fitly include the provision of some fund for the advancement of anatomical and anthropological science in the case of Prof. Cleland, and of mathematical science in the case of Prof. Jack, and the presentation to the University of portraits or busts by an eminent artist. Representative committees have been formed to administer each fund, and the preliminary lists of subscriptions show that the movement has already met with a hearty response. Men of science and others desiring to take part in the recognition and to contribute to either fund are invited to communicate with the honorary secretary and treasurer, Mr. Archibald Craig, clerk of the University general council, 149 West George Street, Glasgow.

The Antarctic vessel *Nimrod*, now moored in the Thames off the Temple Pier, was opened yesterday for the inspection of the public by the Lord Mayor of London.

Shocks of earthquake on the morning of September 22 are reported from the Bouches-du-Rhône, Rognes, Reggio di Calabria, Messina, and Athens, but in no case does much damage appear to have been done.

It is stated by the British Antarctic Expedition, 1910, that arrangements have been made for the purchase of the *Terra Nova* for the projected expedition of next year. The vessel, which is a whaler, was built in 1884. In 1903 she was purchased by the Admiralty as relief ship for the *Discovery* expedition. The year 1905 saw her in the service of the North Polar expedition, on a visit to Franz Josef Land. The size and strength of the ship make her a fitting receptacle for the extensive equipment which it is necessary she should carry for the full success of the plans of the expedition. After being duly inspected on behalf of the expedition in Newfoundland she will sail for England and, it is hoped, reach the Thames about the end of October or early in November. The officers and crew for the expedition have now been selected.

The presidential address of Mr. W. Noble Twelvetrees will be delivered to the Civil and Mechanical Engineers' Society at Caxton Hall, Westminster, on Thursday, October 7.

According to a *Times* correspondent a group of French, German, and Belgian patrons of aviation are offering a prize of 10,000*l.* to be awarded to the aviator who rises, with a fixed point as centre, to a height of 250 metres, flies a thousand metres from this altitude in a horizontal direction, and finally, returning, soars for a quarter of an hour at a height of 20 metres over the point of departure. An alternative feat is to make a flight from Brussels to Paris or from Brussels to Cologne, without a stop, at a speed of 60 kilometres an hour.

It is stated in *Tropical Life* that an International Cotton and Fibre Exhibition will be held in London in 1912, and that in conjunction with it there will be an important conference for the purpose of considering the cotton and fibre questions in their various aspects. A section of the exhibition will be devoted to other fibres, animal, vegetable, and mineral.

According to a Reuter message from Rome, the Juba, in Benadir, has formed a new mouth. Some months ago a violent typhoon broke through the spit of land separating the sea from that part of the river which runs parallel with the coast, and the action of the sea and the current combined have since made a new mouth 450 yards in breadth and formed a long lagoon which, with little expense, can be converted into a serviceable harbour. The same message states that the Italian Resident, Captain Ferrari, has found that the Webbi Shebeli does not, as was supposed, lose itself in marshes in the Ballis country, but is an affluent of the Juba, into which it runs some 120 miles from the latter's mouths.

The *Electrician* states that a gift has been made to the American Institute of Electrical Engineers by the Western Electric Company of a valuable collection of patent specifications. The specifications range from May 30, 1871, to December, 1908, and number approximately 100,000.

Among the popular lectures shortly to be delivered at the Royal Victoria Hall, Waterloo Bridge Road, are the following:—on October 5, "Marconi's Transatlantic Wireless Telegraphy," by Prof. W. Lynd; on October 19, "The Great Earthquake in Jamaica," by Dr. Vaughan Cornish; on October 26, "New Guinea," by Mr. J. E. Liddiard.

The annual exhibition of the Royal Photographic Society, at the New Gallery, Regent Street, will remain open until the end of October. It is divided into four principal sections—pictorial, scientific and technical, professional work, and trade exhibits of apparatus and materials. The scientific student will find matters of interest in every section, including even the pictorial, for, as the society has reverted to its old custom of stating the method of production, the pictorial photographs may be looked upon, if so desired, as specimens of the various processes. The section specially devoted to scientific and technical subjects is this year of a wider interest than usual. The greater number of exhibits represent the character and habits of various living creatures, from the largest to the smallest, and in this department is included special collections of work by the Zoological Photographic Club and by a number of German naturalists, the latter having been collected by R. Voightländer, of Leipzig. The astronomical photographs include recent plates from Greenwich, Stonyhurst College, and the Heidelberg Observatory. Among those who show spectrum photographs we notice the names of Prof. Zeeman, Prof. H. Kayser, A. Fowler, and C. H. Fabry and H. Buisson. Dr. C. L. Leonard contributes Röntgen-ray photographs that show peristaltic waves in the stomach and intestines. Experiments on the resolving power and other properties of photographic plates are shown by C. E. K. Mees and E. K. Hunter. Photomicrography, telephotography, and balloon photography are well represented, and there are a few interesting exhibits that refer to the methods of process work. Of colour photography, although there are many specimens, the only progress indicated is in the direction of the perfecting of the newer plates, more particularly the Thames plate. The regular disposition of the three colours in this plate renders it specially adaptable to reproduction by different methods. We would point out that many photographs of great interest are mounted as lantern-slides, and that these are shown on a stand by themselves, away from the general collection of scientific and technical exhibits.

Rainy, cool, and unsettled weather has prevailed throughout September, and although the rainfall in the aggregate has not generally been excessive, there have been few days without rain, except during the third week of the month. The total measurement of rain is in excess of the average in London by about 0·3 inch, and rain fell on nineteen days. The day temperatures have continued remarkably low for the time of year, and at the London reporting station of the Meteorological Office, in St. James's Park, the sheltered thermometer has not once touched 70°. At Greenwich there was only one day with 70° or above, the highest reading being 71°, on September 6. There has not been so cold a September since 1897, and as recently as 1907 there were fifteen days during the month with a temperature of 70° or above. Our weather over the British Islands has been chiefly under the influence of cyclonic disturbances, which have arrived with considerable frequency from off the Atlantic.

In the September number of the *American Naturalist* Dr. R. F. Scharff reviews the evidence in favour of an early Tertiary land-connection between North and South America. He believes in the existence during early Tertiary times of a strip of land connecting western North America with Chile, when Central America and northern South America were submerged. Such a connection, it is urged, is supported by many lines of evidence, and would serve to explain the occurrence of Eocene armadillos in North America and the affinity between the Canadian porcupine (Erethizon) and the Santa Crucian Stiromys.

In addition to their great abundance, the star-fishes of Alaska and British Columbia are remarkable, according to a paper by Prof. A. E. Verrill in the September issue of the *American Naturalist*, for the redundancy in the number of their rays, this being specially noticeable in the family Asteriidæ, the members of which, despite many exceptions, are generally five-rayed in other parts of the world. "Besides the species that normally have an increased number of rays, or vary indefinitely, there are others which have, more or less rarely, a smaller or larger number as monstrosities. . . . Various other monstrous variations occur somewhat frequently, such as forked rays, supernumerary rays arising from the dorsal surface, &c."

The second part of the first volume of the Records of the Canterbury Museum (New Zealand) contains an account of the scientific results of a trawling expedition undertaken by the New Zealand Government in 1907. The expedition seems to have been organised entirely from the commercial point of view, and the facilities afforded for scientific investigation were by no means so great as they might have been. It is therefore not surprising that the scientific results are somewhat meagre. This is the more unfortunate, as we still know comparatively little about the marine biology of the waters around the New Zealand coast. The investigations, chiefly of local naturalists, have made us very fully acquainted with the terrestrial fauna of the Dominion, and much has been done in the way of shore-collecting; but systematic marine biological research is, as a rule, beyond the reach of private individuals, and it is here that an enlightened Government might be fairly expected to take an opportunity for encouraging the advancement of science.

Protozoology is very much in evidence in vol. liii., part iv., of the *Quarterly Journal of Microscopical Science*, which contains no fewer than five papers on this subject. Miss Muriel Robertson describes the life-cycle of a new trypanosome from Ceylon, of which the principal host is the soft tortoise, *Emyda vittata*, and the intermediate host a leech of the genus Glossiphonia. Mr. C. Clifford Dobell describes the processes of physiological degeneration and death in *Entamoeba ranarum*. Dr. McCarrison places on record his observations on the Amœba in the intestines of persons suffering from goitre in Gilgit; Dr. Row describes the development of the parasite of oriental sore in cultures; and Prof. Minchin discusses the structure of *Trypanosoma lewisi* in relation to microscopical technique. Several of these papers are remarkable for the beauty of the coloured plates which accompany them, and the same is true of a short paper by Messrs. Muir and Kershaw describing, under the name *Peripatus ceramensis*, a new species of Peripatus from Ceram, the first to be recorded from the Moluccas. In the same number Mr. Joseph Mangan describes the entry of zooxanthellæ into the ovum of Millepora, and gives some particulars concerning the medusæ.

The report on forest administration in Southern Nigeria for 1907 contains an account of a tour through the west provinces, described by Mr. H. N. Thompson, the conservator of forests. Two fine forest tracts were explored at Ijaye and Ilesha, both of which are situated in the dry-zone vegetation. The first-named is called after an ancient town which was destroyed about sixty years ago, and since that time part of the forest has grown up. Here there were found to be mahogany trees with a girth measurement exceeding 10 feet, which implies a much more rapid rate of growth than is betokened by ring counts. The same conclusion is derived from the dimensions of trees planted in the botanical gardens, wherefore Mr. Thompson advances the opinion that probably the mahogany trees show three or four well-marked zones of growth each year, corresponding to the four definite seasons.

The reasons for deterioration that follow upon self-fertilisation or inbreeding of the maize plant have been investigated by Dr. G. H. Shull, who puts forward in the publication of the American Breeders' Association (vols. iv. and v.) certain conclusions based on the results of experimental cultivation. Plants selected according to the number of rows of grain in the ear were allowed to self-fertilise, when two strains became evident. For reasons which are given, it is considered that the individuals in a maize field are generally very complex hybrids, and that these strains are elementary species or biotypes, so that, according to the author's premises, self-fertilisation tends to isolate elementary forms, producing a homozygous condition, *i.e.* pure forms. Crosses between the two strains led to a distinct increase in the yield, whence the following method of propagation is suggested. Pure races of maize are to be obtained by self-fertilisation, and the crosses made between these pure races provide seed corn for the field crop.

Botanical teachers making use of lantern-slides may be glad to know of a new series of slides produced by Messrs. F. E. Becker and Co., Hatton Wall, London, from original photomicrographic negatives prepared by Mr. C. W. Greaves. A first series of fifty slides is announced, of which several relate to sections of anomalous dicotyledonous stems, others to the anatomy of stem, leaf, and root of angiosperms and the pine; a few represent cryptogamic and fossil sections. The phanerogamic specimens examined are clear and well defined, being taken from good microscopic sections, and the section of a Fucus conceptacle is excellent in general contour and detail.

An abstract of the report of the director of the Bombay Bacteriological Laboratory for 1908 appears in the *British Medical Journal*, from which we learn that the issue of anti-plague vaccine was little short of that of the preceding year, when the disease was severely and widely prevalent, the number of doses dispatched being 533,315 against 620,923. Experiments were carried out regarding the efficiency of rat and rat-flea destroyers, but they were not satisfactory or conclusive. The general bacteriological work was of a varied description. Special inquiry was made regarding an outbreak of malaria in the fort and dock area of Bombay; the investigation is still in progress. An outbreak of relapsing fever in the Kolaka district was also made the subject of special study. The laboratory rendered assistance and advice regarding questions relating to plague and other infective diseases, and courses of instruction were arranged for hospital assistants and others with reference to plague inoculation and bacteriological work.

Mr. C. Carus-Wilson has printed a paper, read by him before the Geological Society of London, on the pitting of flint surfaces. He directs attention to the frequently polygonal and rudely hexagonal character of the outer ends of the pits found on flints in a certain stage of decomposition, and to the considerable amount of water that may be absorbed by the external layers of such flints. But he shows much uncertainty of view as to the mode of origin of the pits; the suggestion made in the text that their polygonal outlines are connected with the crystalline form of the absorbed water as it froze seems, to say the least, fantastic. In a footnote, however, the author compares these outlines with the shrinkage-cracks of such rocks as basalt, and regards the ice merely as the agent that split off the lost portions of the flint. Would it not be simpler to regard the rudely polygonal outlines as resulting from the intersection of successively formed and adjacent cup-like surfaces of fracture?

We have received the report of the chief inspector of mines in Mysore for the year 1907–8, which opens with the statement that there was a large diminution in the number of applications for mining licenses as compared with the previous year; the statistics of licenses granted show, on the other hand, an increase from 101 in 1906 to 242 in 1907. The gold production showed a decrease of 5·84 per cent. as against a decrease of 8·67 per cent. in 1906, the comparison in each case being with the previous year; it amounted to a value of 2,041,129*l*. in 1907, and the total value of bullion produced from the commencement of mining operations in 1882 to the end of June, 1908, was 28,598,155*l*. Air blasts seem still to be frequent, but there was a decrease in the number of accidents. Statistics are given of the production of manganese and chrome, 82,835 tons and 11,197 tons respectively, but as regards other minerals it is reported that the statistics have been handed over to the curator of the Geological Museum for report as to whether it is possible to extract any useful information from them.

The Proceedings of the Royal Society of Edinburgh (vol. xxix., p. 602) contains a paper, by Mr. E. M. Wedderburn, on the deep-water oscillations recently described by Prof. Pettersson (Nature, August 12, p. 197). Working on a suggestion made by Sir John Murray, Mr. Wedderburn adduces evidence to show that the oscillations observed in the Skagerak are analogous to those which have been observed by the Scottish Lake Survey, and that they really show the presence, not of a long-period tide, but of a temperature seiche, having its node at the mouth of the Skagerak and its loop at the point of observation.

A preliminary summary report on coast changes in east Yorkshire, by Mr. T. Sheppard, of The Museum, Hull, forms a contribution to the investigation of the larger question of changes on the east-coast region of England during the historical period, undertaken by the research department of the Royal Geographical Society. Mr. Sheppard, after pointing out that the coast line between Bridlington and Spurn Point is of special interest because, while on the one hand enormous tracts of land have disappeared within historic times, on the other large areas have been formed, embanked, and cultivated, divides his district into five sections, the Holderness coast from Bridlington to Kilnsea, Spurn Point, the North Humber shore, the South Humber shore, and the Humber itself. Each district is treated from the point of view of geological evidence, historical evidence, and actual measurement. The general results indicate a wastage of the thirty miles of cliff between Bridlington and Spurn at a rate of about 7 feet per annum, and a growth on the Spurn during recent years of 17 feet per annum southward, with a net increase of 9 feet per annum in the width of the point. To the west of the Humber are large areas of land, now partly cultivated and productive, which were formerly watery wastes.

An important paper on evaporation in Egypt and the Sudan, by Mr. B. F. E. Keeling, is published by the Survey Department of Egypt. The author first deals with the results of comparisons of various types of evaporimeters used in Egypt at different times. Those now in use are mostly of the Piche and Wild patterns, exposed in double-louvred screens; their readings are apparently comparable in different climates, if similarly exposed, where the mean wind velocities are not widely different. A table is given showing the mean daily evaporation at stations in the Nile Valley; in Egypt and the North Sudan it is greater in the summer, while in the rainy areas it is at a maximum in the dry winter season, as is to be expected. One section of the report deals with the evaporation from open expanses of water. In the neighbourhood of Cairo the mean amount was 4·2 mm. per day (winter 3 mm., summer 5·3 mm.); on Lake Victoria it is estimated at 3 mm. per day. In the last section some remarks are made on the relation of evaporation to other meteorological factors; the mean daily curve of evaporation at Helwan closely follows the curve of saturation deficit.

In the September issue of *Man* Prof. Flinders Petrie describes a find of string nets of the seventeenth Egyptian dynasty which are practically unique. They were found associated with an untouched burial near Thebes. This is, perhaps, the most varied and rich collection of funeral remains which has ever been brought from Egypt. It will be preserved as an entire group in the Royal Scottish Museum, Edinburgh. The corpse was enclosed in a single coffin painted with wings in blue and gold. On the neck was a splendid golden collar; on each arm a gold armlet; round the waist an electrum girdle, copied from a Nubian pattern, made of seeds and leather. The whole collection of jewellery weighs half a pound avoirdupois—the largest group of gold-work which has ever left Egypt. The string nets associated with these remains, of which Prof. Petrie gives photographs, illustrate the remarkable skill in string-working attained by the Egyptians of that era. He also announces the discovery, at Memphis, of the great palace of King Apries (about 580 B.C.). Scale armour, bronzes, a remarkable silver plaque with a gold figure of Hathor, and a great carved portal, now in ruins, are part of the discoveries at this site.

In the September issue of *Man* Dr. C. G. Seligmann describes what is known as the Bandar cult among the Kandyan Sinhalese. It is a form of ancestor worship, Bandar being the title applied to the canonised spirits of eminent persons to whom, soon after their death, offerings are presented in order to induce them to protect the worshipper from evil and to grant him good fortune. One of the most important of these spirits is Kosgama Bandar, who takes his name from the village in which he lived in the eighteenth century or earlier. He seems to have rebelled against the King of Kandy, by whom he was captured and executed. He and similar spirits exercise authority under the control of Skanda, one of the four guardian deities of Ceylon. Dr. Seligmann prints, with a translation, a curious invocation addressed to this spirit.

FASCICULES 1 and 2 of the *Bulletin des Séances de la Société français de Physique* for 1909 contain thirteen memoirs, several of which have already been noticed in these columns. Amongst those not previously dealt with may be mentioned that by M. G. Delvalez, on the Hall effect in liquids. According to the electronic theory of conduction of electricity, this effect should be extremely small, while experiment appeared to show that it was a million times greater than the theoretical value. M. Delvalez has succeeded in showing that these observed effects were due to the convection currents in the liquid, set up because it is a mobile conductor carrying current through a magnetic field. The motion generates an electromotive force, which has been measured as the Hall effect. By using an alternating electromotive force to produce his main current, and arranging to balance the Hall electromotive force against the fall of potential down an induction free resistance traversed by the main current, he has shown that the effect is very small, certainly less than one three-thousandth of the value previously observed.

THE use of platinum felt, as suggested by Monroe in 1888, in place of asbestos as a filtering medium is recommended by Mr. W. O. Snelling in a paper in the Journal of the American Chemical Society (vol. xxxi., pp. 456–461). In addition to its insolubility in almost all the ordinary chemical agents, it has the advantage of extraordinary porosity, combined with the power of retaining completely and easily such finely divided precipitates as barium sulphate and calcium oxalate; a series of tests showed that the filtration was six times more rapid than with an asbestos filter containing one-third the quantity of asbestos. The precipitate can be dissolved off, and the felt used again and again; moreover, a damaged filter can readily be patched by the adding of chloroplatinic acid and igniting. The use of the "Monroe crucible" for atomic-weight determinations is especially advocated. Another issue of the same journal contains a paper by Mr. J. T. Stoddard on rapid electro-analysis with stationary electrodes (*ibid.*, pp. 385–390), in which it is claimed that by using a kathode of gauze or of mercury, a stationary anode, and a heavy current, complete decomposition of the metal can be effected as rapidly as with a rotating electrode; under these conditions the liberation of gas, and the convection currents consequent on the heating of the liquid, appear to provide sufficiently for the agitation of the fluid without recourse to mechanical methods.

THE *Philippine Journal of Science* for March contains a third paper by Raymond F. Bacon on the Philippine terpenes and essential oils, and a paper by Mr. H. D. Gibbs on the oxidation of phenol. The latter author has taken advantage of the tropical sunshine to study the red coloration which is developed by phenol when exposed to air and light, and has carried out the investigation with remarkable care and thoroughness. He shows that the phenol becomes coloured in presence of oxygen, but not of hydrogen, nitrogen, and carbon dioxide. The action is caused by oxidation, quinol, quinone, catechol, and carbon dioxide being produced; the principal coloured compounds are probably quinone condensation products, the red colour being attributed to phenoquinone. The oxidation is not appreciable in the dark at room-temperatures, but becomes measurable at 100°, and fairly rapid at the boiling point of phenol. In sunlight the rate of coloration is rapid, and increases with the temperature; it is affected by the ultraviolet absorption of the glass, by atmospheric conditions, and by the altitude of the sun. Ozone is very reactive; it gives the same products as oxygen, and in addition glyoxylic acid has been detected. Anisol, the methyl ether of phenol, gives no coloration either by the action of ozone or of oxygen and sunlight.

MESSRS. E. B. ATKINSON AND CO., of Hull, forward us an improved pattern of Soxhlet's apparatus for the extraction of oils and fats. The new form is fitted with a glass stop-cock on the syphon tube. By regulating the overflow, the thimble can be kept full of the solvent during the extraction, instead of being alternately filled and emptied. Also, by closing the stop-cock at the end of an operation, the solvent can be retained in the upper part of the apparatus; this allows the flask containing the extracted fat to be almost freed from the solvent, so that it can be placed straightway in the drying-oven. A bulb on the upper part of the side-tube facilitates the passage of the vaporised solvent if liquid should collect there. The new pattern thus appears to have distinct advantages over the older form.

THE use of the Walschaerts valve gear on American locomotives has been greatly extended since its introduction into the States a few years ago. The advantages of this gear render it very suitable for the large engines employed in America, and its success has led to experiments with others of a similar type. Several railways are now trying the Pilliod motion, a gear made by the Pilliod Company of Chicago, and described in the *Engineer* for September 3. In this gear, as in the Walschaerts, the motion is derived partly from a return crank on the main crank-pin and partly from the crosshead. The moving parts are the same for any class of engine, and weigh about 1000 lb. There is no load on the reversing lever, which can be unlatched and moved in any condition with the regulator either open or closed. The motion is expected to effect a considerable saving in fuel and in maintenance and repairs. The release is late; thus with cut-off at 25 per cent. the release is at 85 per cent.; the Walschaerts gear, with a similar cut-off, releases at about 65 per cent. of the stroke. Special adaptability for high speeds is claimed.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN OCTOBER:—

Oct. 6. 11h. 59m. to 12h. 34m. Moon occults κ Geminorum (mag. 3·7).
8. 10h. 37m. Minimum of Algol (β Persei).
11. 7h. 26m. ,, ,,
12. 23h. Venus in conjunction with δ Scorpii (star 0° 7′ S.).
13. 6h. Saturn in opposition to the Sun.
17. 17h. Venus in conjunction with the Moon (Venus 2° 17′ S.).
18–24. Epoch of October meteoric shower (Orionids, Radiant 92° + 15°).
20. Saturn. Major axis of outer ring = 46″·15, Minor axis = 9″·21.
27. 8h. Saturn in conjunction with the Moon (Saturn 1° 17′ N.).
,, 19h. Mercury at greatest elongation west.
31. 9h. 8m. Minimum of Algol (β Persei).

OBSERVATIONS OF HALLEY'S COMET, 1909*c*.—Photographs showing Halley's comet were obtained at the Greenwich Observatory, with the 30-inch reflector, on September 9, two days before it was discovered by Prof. Wolf. Owing to the proximity of the moon the two exposures were limited to thirty minutes and twenty-five minutes respectively, and the very faint cometary images were not identified until after the receipt of the telegram announcing the discovery at Heidelberg. The positions determined gave corrections of +24s. and −4′ to the ephemeris published in No. 4330 of the *Astronomische Nachrichten*.

In a supplement to No. 4356 of the *Astronomische Nachrichten*, where the above observations are recorded, Prof. Wolf states that the comet is already a fairly bright object, of about the sixteenth magnitude, appearing as a nebulous mass of 8″–10″ diameter having a central condensation.

Photographs were also secured by Mr. Knox Shaw at the Helwan Observatory on September 13 and 15, and by Dr. H. D. Curtis, with the Crossley reflector at the Lick Observatory, on September 12, 13, and 14.

ANOTHER LARGE SUN-SPOT.—During last week another large sun-spot was to be seen on the solar disc. It was first observed, at South Kensington, on September 18 near to the limb and a few degrees south of the sun's equator. Developments took place until on Saturday last, when just past the central meridian, it consisted of one large nucleus and several smaller ones, and was visible to the naked eye. It is perhaps worthy of note that a magnetic storm, of sufficient magnitude to interfere seriously with the transmission of telegrams, took place on Saturday.

OBSERVATIONS OF MARS.—In a telegram to the Kiel Centralstelle (Circular No. 112), Prof. Lowell announces that the Martian antarctic canals are disappearing, and that the general pallor of the various features continues. He also states that the Solis Lacus is double.

Regarding the naked-eye appearance of the planet, Mr. J. H. Elgie recently directed attention to the apparent nearness of Mars as compared with the neighbouring stars of Pegasus. He suggests that this sense of nearness might be due to the propinquity of a wooded ridge over which the planet was rising, the Pegasus stars being well above the ridge, and therefore beyond this influence. At the same time, the brilliant irradiation of the planet seems quite sufficient to account for a phenomenon which must appeal to anyone seeing the planet on a clear evening.

OBSERVATIONS OF SATURN.—A telegram from Prof. Lowell to the Kiel Centralstelle, published in Circular No. 113, announces that a dark medial streak has been observed on Saturn's equator, and that there is an appearance of lacings similar to those seen on Jupiter. Further, an intense white spot, in saturnian latitude 50° S., was detected by Mr. Slipher and transitted at 14h. 5m. (Washington time) on September 23.

THE FUTURE OF ASTRONOMY.—In an address delivered at the Case School of Applied Science, Cleveland (U.S.A.), in May, Prof. E. C. Pickering took as his subject the future development of astronomy, paying special attention to the methods whereby the limited financial resources and *personnel* may be used with the greatest advantage to the science. After a review of the several past epochs of astronomy, and some rather amusing remarks as to how monetary gifts are made and used at present, he outlined the general scheme, to which he has previously referred on various occasions, and the principle of which underlies the splendid organisation of resources built up at the Harvard College Observatory. The central feature of the scheme is one large, and perforce international, observatory employing, say, 200 or 300 assistants, and maintaining three stations. Of the latter, one would be in latitude about 30° N., and another the same distance south; western America is suggested as a suitable *locale* for the former, South Africa for the latter, and each would be selected wholly for its climatic conditions, which premises fairly great altitudes and desert regions. Each observing station would have instruments of the largest size, such as the 7-foot reflector previously suggested for South Africa, and would do practically no reductions or measuring. These would be carried out at the third station, situated where living and labour are cheap, where the photographs, &c., would be stored. Such an organisation would exist for the benefit of all serious astronomers; anyone wishing to engage on any piece of work would simply requisition the raw material, *e.g.* sets of special photographs, from the central bureau. If not in stock, the required photographs would be secured at the earliest convenient opportunity. By thus centralising and organising astronomical resources, Prof. Pickering claims that the science would benefit immensely, because the waste at present resulting from overlapping, or from being forced to use inadequate raw material, would thereby be eliminated (*Popular Science Monthly*, vol. lxxv., No. 2).

THE INSTITUTE OF METALS.

THE publication of the first volume of the Journal of the Institute of Metals marks the completion of a full year's work. The institute has been formed to advance and disseminate knowledge in connection with the manufacture and properties of the non-ferrous metals and alloys. The members are fortunate in having for first president Sir Wm. White, who delivered an excellent address, in the course of which he dealt in a very able manner as well with the delicate subject of "trade secrets" as with the important one of the relationships between manufacturers and users of metals, although his oft-reiterated special pleading for the National Physical Laboratory during the meetings must have been rather wearying to the other important workers represented.

The paper by Mr. J. T. Milton, chief engineer of Lloyd's, on some points of interest concerning copper and copper alloys, is mainly about troubles experienced by users, and is valuable for members of all types; but the statement on p. 68 that the temperature of pouring the white metal into bearings is left to the ordinary workman is not the case in at least one of the great Sheffield-Clyde firms, as for many years this has been done with the aid of a suitable pyrometer, and probably is so still. The paper drew a very long and good discussion, in which Prof. Gowland's remarks that ancient bronzes were very impure, so that their hardness could not be due to exceptional purity, and that by careful hammering modern bronzes can be made as hard as ancient, were of interest to those who are often being met by the statement that the method of hardening bronze tools is a lost art.

The mechanism of annealing in the case of certain copper alloys, by Messrs. G. D. Bengough and O. F. Hudson, is of a very theoretical nature as a whole, but gives several practical hints on the treatment of brass. Mr. J. T. W. Echevarri's paper, on aluminium and some of its uses, is most interesting, although his reasons for its efficacy in preventing blow-holes in steel (p. 130)—that it combines with the gases and produces an innocuous slag—would hardly be accepted. In the discussion the president remarked that not only had aluminium proved unsatisfactory for shipbuilding because of serious corrosion (p. 156), but that, though suitable aluminium alloys might yet be obtained, they had to be discovered. Notes on phosphor-bronze, by Mr. A. Philip, is thoroughly practical, and contains several tables of tests with corresponding analyses, with a full discussion as to the most suitable compositions and tests for different purposes.

In metallographic investigations of alloys Mr. W. Rosenhain gives a good critical summary of methods, but, unfortunately, attempts to bolster up the discredited differential method of taking cooling curves. On p. 213 he recommends that "the slowest possible rate of cooling should be adopted in cooling-curve experiments"; but long experience teaches that the rate of cooling must be chosen according to the nature of the alloy and the objects of the investigation. In Dr. Desch's paper, on inter-metallic compounds, surely the complicated "broken solidus curve MBNPQRESTUG" for an institute of metals might have been better chosen from a real example than an imaginary one, so that such members as waded through it all would have a reward of facts as well as principles. Dr. Shepherd in the discussion endeavoured to explain to the members what the present writer has tried to impress on several investigators, namely, that though a pyrometer be capable of great accuracy, it does not follow that the phenomena are observed to the same degree of accuracy, and also that though the phase rule is a guide, it must be remembered that it was deduced for ideal conditions, and takes no account of the time factor or of the rate of diffusion or viscosity. Dr. Shepherd favours the use of heating curves, but his remark that "in the case of transformations in the solid phase he had found no satisfactory results with cooling curves" must sound strange to investigators on steel—the pioneers in this type of work—the well-known Ar_1, Ar_2, Ar_3 being all points on cooling curves. For demonstration purposes cooling curves are generally taken because more convenient, but for a complete investigation both heating and cooling curves must be studied. Had this not been done, the important effect on suitable hardening temperatures for steel of the difference between Ar1 and Ac1 would still be left not fully explained. The remarkable irreversibility in certain nickel-iron alloys of the A2 point, the only one reversible in ordinary mild steel, demands the consideration of both curves.

Mr. W. H. A. Robertson's paper, on plant used in the manufacture of tubes, is of a practical and descriptive nature.

The last paper of all, the relation between science and practice and its bearing on the utility of the Institute of Metals, by Sir Gerard A. Muntz, Bart., treats of a subject probably the most important of the series for a first volume. It is a short paper written by invitation of the president, but it gives formal expression to a general feeling, much in evidence in personal conversation with all grades of workers connected with the metal trades, that information is needed in a form not too academic, expressed in language that the intelligent who are not mere theoretical specialists can understand. When the practical man, who must produce results, compares the air of omniscience assumed by some purely theoretical metallurgists with the smallness of the help they seem able to give him in his work, he is apt to be discouraged and to have thoughts about metallurgical science that he ought not to be led to think. The science underlying metallurgy is not yet sufficiently understood to do entirely without the extremely useful empirical conclusions of intelligent practical men, and hence elaborate generalisations, often on inadequate bases (the "raw science" of Mr. Rosenhain), can generally only be suggestive of methods of attack on matters of difficulty in works, and one must take all available help from practice to command success. Long personal experience in connection with delightful and somewhat successful investigations of this nature, made in conjunction with those actually engaged in works, serves only continually to strengthen this view. The Institute of Metals, to be worthy of its name, must welcome any paper on purely scientific original work connected with non-ferrous metals if convinced that the results are trustworthy, however remote their practical utility may seem; but it must also consider the immediate needs of the great majority of its members by encouraging papers of a practical scientific nature, expressed in language that may be understood by the most intelligent members who are actually engaged in works practice.

A. McWILLIAM.

THE BRITISH ASSOCIATION AT WINNIPEG.

SECTION K.

BOTANY.

OPENING ADDRESS BY LIEUT.-COLONEL DAVID PRAIN, C.I.E., LL.D., F.R.S., PRESIDENT OF THE SECTION.

Sutor ne supra crepidam judicaret, probably an old saying when Pliny wrote, is still a safe guide. The limitations of life and of knowledge are different, and human effort is thereby so conditioned that progress depends on specialisation in study. Specialisation lessens the temptation to forget this caution; but the force of the proverb is not weakened. It also conveys a behest, and compliance with this behest helps to counteract the narrowed outlook which specialisation sometimes encourages.

Those whose studies are confined to some limited field often welcome a sketch of the aims and methods of work with which they are not familiar. Such a sketch may be held to have served its purpose if the subject discussed, and its relationship to cognate studies, be rendered intelligible.

No apology, therefore, is made for the subject now taken up, even if it be sometimes hinted that this subject —Systematic Botany—is inimical to originality, the antithesis of scientific, and outside the limits of botany proper. These views depend on half-truths and arbitrary connotations. They do not affect the fact that the primary purpose of systematic study is to advance natural knowledge. The systematic worker, in furthering this object, does not halt to consider whether his work be applied rather than original, technical rather than scientific.

As a matter of history, the scope of systematic study practically coincides with what botany once implied; as a matter of fact, it corresponds to what zoology implies now. The accident that man, on his physical side, is like the beasts that perish has led to the recognition of animal physiology and anatomy as independent sciences. Owing to the absence of any such fortuitous circumstance vegetable anatomy and physiology remain under the ancestral roof. These off-shoots of botany are as vigorous as their zoological counterparts. They may be entitled to think that systematic methods are old-fashioned, and it may be desirable that they should set up separate establishments or form alliances with the corresponding off-shoots of zoology. But nothing in all this justifies the eviction of systematic botany from the family home.

The statement that systematic methods are old-fashioned may be accepted without conceding that these methods are out of date. Systematic work, while sharing in the general advance in knowledge, has been able, amid far-reaching changes, to maintain continuity of method in the pursuit of its double purpose. This has been a benefit to botany as a whole when crucial discoveries or illuminating theories have, in other fields, led to a re-orientation of view requiring the use of fresh tablets for the record of new results.

Disintegration and re-adjustment due to altered outlook are familiar processes. Histology, parting company with organography to serve physiology, is now an independent study, one of the branches of which occasionally declines to accept any doctrine unconfirmed by cytological methods. The study of problems relating to nutrition and reproduction has been considered the especial task of physiology. Now, the chemist at times claims the problems of nutrition as part of his field, and we look for advances in our knowledge of reproductive problems to the cytologist and the student of genetics. These instances are adduced from without because relative exemption from distintegration is a distinctive feature of systematic study. The two-sided task of the systematist is to provide a census of the known forms of plant life and to explain the relationships of these forms to each other. The work on one side is mainly descriptive, on the other mainly taxonomic, but the two are so interdependent, and their operations so intimately blended, that it is difficult to treat them apart. Re-orientation in botanical study has led to seismic disturbances in the taxonomic field, but the materials supplied by descriptive work have remained unaffected, and therefore have been ready for use in the repair or reconstruction of shattered "systems."

The exemption from radical change in method, which marks systematic work, is due to those characteristics that expose it to the charges of discouraging originality and of calling only for technical skill. It also largely explains why systematic study, especially on the descriptive side, is not attractive to minds disposed towards experimental inquiry. The labour involved is as exacting, accurate record and balanced judgment are as necessary, in descriptive as in experimental research. "A skill that is not to be acquired by random study at spare moments" is as essential in descriptive as in other work, while the relief that variation in method affords is precluded. Increased experience, here as elsewhere, leads to more satisfactory results, but without, in this case, mitigating the toil of securing them. The testing of theories, often an inspiring task in experimental research, in the descriptive field retards progress. But if in descriptive work imagination and the spirit of adventure are undesirable, these qualities are not inhibited by systematic study as a whole. Imagination is legitimate and useful in the taxonomic field, and in another line of activity—the acquisition of the material on which descriptive work is based—the spirit of adventure is essential to success.

The untravelled descriptive worker is not without consolations. His work is as necessary to botany as that of the cartographer to geography, or the grammarian to literature. His results are means to the ends that others have in view. If these results often appeal to coming rather than to contemporary workers, the descriptive writer is at least largely spared the doubtful benefit of immediate appreciation. He can pursue his studies unaffected by any considerations save those of adding to the sum of human knowledge and of bringing a necessary task appreciably nearer completion. In descriptive study it is the work rather than the personality of the worker that tells. Yet the work is not without human interest, because systematic writings rarely fail to reflect the character of the writers. The intimate knowledge of descriptive treatises, which floristic or monographic study entails, usually leads to mental estimates of the actual authors. The evidence on which these estimates depend is unwittingly given and unconsciously appreciated. But its value is not thereby diminished, and estimates so formed may prove useful checks on contemporary judgments.

The descriptive worker as a rule makes his work "the primary business of his life, which he studies and practises as if nothing else in the world mattered." But he does not hold aloof from those engaged in other lines of botanical activity. His evidence is mainly obtained from organography and organogeny; but, just because his results are for the use of others, the descriptive botanist has to keep abreast of all that is done in every branch of his science. New weapons are constantly being forged, and not in morphological workshops only; with these and their uses the descriptive worker must be familiar, for the need to employ them may arise at any moment. If he does not always abandon old friends for new, this is not because the systematist is unaware of their existence, or unprepared to apply new methods. The descriptive worker employs his tools as a craftsman; like other craftsmen, he finds that tools do not always fulfil the hopes of their designers. In descriptive work, too, as elsewhere, a steam hammer is not required to break every nut; the staff and sling may be arms as effective as those of the hoplite. There are occasions when the descriptive writer does appear to hold aloof by declining to accept proffered evidence. But his motive is not arrogant; it is only altruistic. If he is to avoid the risk of causing those who depend on his results to reason in a circle, the descriptive writer must obtain these results, if not without extraneous aid, at least without help from those for whose immediate use they are provided.

Taxonomic study is pursued in an environment which differs from that surrounding descriptive work. The descriptive student can hardly see the wood for its trees. The taxonomic student works in more open country, and can look on the wood as a whole. He has, too, the benefit of companionship. The palæobotanist meets him, with all the lore of mine and quarry, as one ready to exchange counsel; other workers attend to give or gather information.

The community of interest which unites the systematic worker, chiefly concerned with existing plant-types, and the palæobotanist, primarily interested in types now extinct, is strengthened by the bond which identity of purpose supplies. But the two are differently circumstanced; the systematic worker is ordinarily better acquainted with the characters than with the relationships of his types; the palæobotanist usually knows more of the relationships of his types than he does, or ever may do, of their characters. The material of the palæobotanist rarely lets him rely on ordinary descriptive methods in defining his plants; he has to depend largely on anatomical evidence, which supplements and confirms, but hardly replaces, the data of organography. On the taxonomic side the palæobotanist is restricted to phylogenetic methods; here again he is handicapped, though less than on the descriptive side, by the fragmentary character of his specimens. The palæobotanist hardly does more than the phylogenist, hardly as much as the anatomist, towards advancing the object all have in common.

The same community of interest unites in their labours the organographic systematist and the morphologist whose interests are phylogenetic. Here, however, though the task of the two be complementary, the mode of attack is so different as almost to mask their identity of purpose. The comparative morphologist studies the planes of cleavage indicated by salient differences in structure and development. The system he evolves is composed of the entities, sometimes more or less subjective, that combinations of characters suggest. The method in intention, and largely in effect, passes from the general to the more particular, though the process is tempered by the fact that the characters used are derived from such types as exhibit them. The organographic systematist, after summing up the characters which mark individual types, aggregates these according to their kinds. Having estimated the features that characterise individual kinds, he aggregates these according to their families. Families are thereafter aggregated in higher groups, and these groups are subjected to further aggregation. The system thus evolved is composed of those entities, always in theory objective, that successive aggregations indicate, and the process is one of constantly widening generalisation.

The comparative morphologist, though glad when his results can be practically applied, follows truth for its own sake. His work is thus on a higher plane than that of the organographic systematist, whose aggregations are primarily utilitarian. But the work of the latter is not less valuable because its scientific character is incidental. Were our knowledge of plant-types exhaustive, a generally accepted artificial arrangement of these would be as useful to the applied botanist as a professedly natural one. But our knowledge is incomplete, and the accession and intercalation of new types renders any artificial, and most attempts at a natural, system sooner or later unworkable. The more closely an arrangement approximates to the natural system, the less can the intercalation of new forms affect its stability. The more stable a system is, the more easily will its details be remembered and the more useful will it prove in practical reference work. Here, therefore, for once, self-interest and love of truth go hand in hand.

Since the organographic systematist learns their characters from his groups, while the comparative morphologist defines groups by the characters he selects, their results, were knowledge complete, should be identical, and this identity should prove their accuracy. But knowledge is finite, and these results are not always uniform. The want of uniformity is, however, often exaggerated because the reasons are not always appreciated.

One cause is the difference in personal equation, which affects alike the worker who deals with things and him who considers attributes. It would be contrary to expectation were every phylogenist to assign the same value to each character, or every systematist to apply the same limitation to each type or group of types. The divergence of view on the part of two observers may show a small initial angle; it may nevertheless lead them to positions far apart. But while divergence of view is the most obvious explanation of the want of uniformity apparent in systematic results, it is the least effective cause. This inherent tendency to differ manifests itself in contrary directions; in the long run individual variations are apt to cancel each other.

The nature of the work counts for more than the predisposition of the worker. The aggregations on organographic lines, which were the main guides to the composition of the higher groups until phylogenetic study was seriously undertaken, do not assist the comparative morphologist. The characters on which phylogenetic conclusions may be based increase in value in proportion to the width of their incidence, so that the greater their value for phylogenetic purposes the less do they aid the descriptive worker in discriminating between one plant-type and another. Often they are characters which for practical reasons the descriptive worker must avoid. Organography, then, may not give evidence as to characters whereof cognisance cannot be taken, while for another reason the comparative morphologist may not use characters derived from descriptive sources. The object of the phylogenist is to take his share in advancing our knowledge of taxonomy; to seek from the systematist the evidence on which his results are based would be to vitiate the reasoning of both. All that the phylogenist can ask the descriptive worker to do is to supply the units that require classification.

The comparative morphologist, relying mainly on anatomical and embryological evidence, at first had a hope that his method of study might enable him to supply his own units and thereby render further taxonomic work based on organography unnecessary. This hope remains unfulfilled, and the phylogenist, as a rule, limits his efforts to a narrower field. The organographic systematist realises that in the present state of our knowledge the study of the incidence of selected characters gives more satisfactory results as regards the composition of the higher phyla than repeated aggregation can attain, while the comparative morphologist recognises that, as matters stand, the approximations of organography in respect of types and kinds are more satisfactory than any he can yet offer. Since, however, the progress in one case is outwards, in the other the reverse, a zone of contact is inevitable. This zone, in which the influence of both methods of study is felt, is occupied by those groups immediately higher in value than the natural families of plants, and it is here that discrepancies in the results attained chiefly manifest themselves. These discrepancies take the form of unavoidable differences of opinion as regards the composition of collections of natural families. If a family A possesses ten characters of ordinal import, whereof it shares eight with a family B and only two with a family C, while the characters combined in A are, as regards B and C, mutually exclusive, the organographic systematist is ordinarily induced to group A and B together and to exclude C from that particular aggregation of families. If, on the other hand, the phylogenist finds that the two characters common to the families A and C are met with in other families, D, E, F, he will ordinarily be led to place A, C, D, E, F in the same higher group from which the family B, notwithstanding its greater general agreement with A than any of the others, must be excluded. This source of discrepancy is, however, less potent than might be expected. When the evidence advanced by either is very strong, the other worker readily accepts it; in doubtful cases mutual accommodation takes place, the one worker limiting his groups, the other applying his criteria with less rigidity.

The healthy disregard for formal consistency which admits of adjustments to further practical ends does not, however, alter the fact that a system thus attained can only approximate to the natural arrangement at which both workers aim. Gaps in knowledge may be bridged with histological or teratological aid, or safely crossed with the help of some sudden intuition or happy speculation. But the existence of anomalous types and groups serves as a reminder that much has yet to be learned with regard to living types, while the widest gap in our knowledge of these is a fissure as compared with the chasms that confront the palaeontologist. In this the taxonomist of either type finds the incentive to further effort.

The automatic adjustment of differences due to idiosyncrasy, and the mutual accommodation of those arising from method of work, still leave considerable want of harmony in taxonomic results to be accounted for. What appear to be rival systems of classification compete for recognition. As each such system professes to be the nearest attainable approximation to the natural arrangement, the evidence of a state of dissension and confusion in the taxonomic field appears to those unfamiliar with systematic work to be incontrovertible. Dissension may be admitted; confusion there is none. Pictures of the same subject by different artists may be very unlike, yet equally true; what appear to be rival systems are only manifestations of one.

It is not difficult to form a conception of this system; it is less easy to share the conception with others. Let us imagine a closed space approximately spherical in shape, its surface studded with symbols that mark the relative positions of existing plant-types. Let us imagine the lines of descent of all these types to have been definitely traced and effectively mapped. We find, starting from near the centre of our sphere, a radiating system of lines; we find these lines to be subject to repeated dichotomy and embranchment which may take place at any point; we find the resultant lines departing from the original direction at any angle and in any plane; we find the *nodus* of any individual dichotomy or embranchment capable of serving as the focus of origin for a subsidiary system comparable in everything except age with the centre of our sphere, and conceivably exceeding in the multiplicity of its ramifications the primary system itself. Some only of our lines reach the symbols that stud our spherical surface, though every symbol is the terminal of some such line. Here a terminal is fairly isolated, and the line it limits goes far towards the centre with little or no dichotomy or embranchment. Elsewhere our terminals are closely set, the lines they limit running inwards in company until some proximate *nodus* is reached. Moreover, within our sphere, in the abrupt terminals of various lines we can dimly trace the vestiges of other spheres, not always concentric with our present sphere, once studded with symbols marking the existence of types now extinct. Imagine further the centre of our hypothetical space as not necessarily a primary centre, but merely the *nodus* of some dichotomy or embranchment in a system of which ours is but a residuary fragment.

As we are practically limited to superficial delineation, an intelligible picture of our system is more than the science of perspective and the art of chiaroscuro can be asked to provide. What is unattainable on the flat is still more impossible in sequence. Serial presentation involves a point of departure; convenience, predilection, hazard, may dictate what this shall be, and determine the sequence adopted. The result is not a variety of systems, but a series of variants of one system. Considering how complex the problem is, the number of variants is remarkably small. In any case the differences met with are inconsequent; they do not affect the facts, and the facts alone really count. The trained taxonomist knows that no serial disposition can indicate, even vaguely, the relative position and import of all these facts. Plane presentation, though more adequate than serial by a dimension, falls short of accuracy; the surface on which the bulk of the facts may be displayed can have no lateral boundary. Even if its presentation on a globe be attempted, the diagram must be incomplete; many of the points to be shown lie beneath the surface. Convention might overcome the difficulty involved in the indication of extinct types, but the diagram would still fail by a dimension to demonstrate the descent of the forms superficially represented.

Intercourse with the phylogenist, while directly influencing the relationship of the organographic systematist to taxonomy, has indirectly modified his attitude towards the diagnosis and limitation of plant-types. Taxonomic study based on evidence other than descriptive has stimulated histological research and fired the anatomist with an ambition to replace by his methods those of organography. It is certainly not for want of industry or care that the success of the phylogenist in the taxonomic field has not also attended the diagnostic work of the anatomist. This failure to replace organographic by anatomical methods is due to the fact that the qualities which make histological evidence useful in generalisation lessen its value in discrimination. That anatomical characters may be of great use even in diagnosis has been less fully appreciated than it might by those habituated to organographic methods. On the other hand, anatomists who have not benefited by an apprenticeship in descriptive study at times overlook the fact that the value of histological evidence in diagnostic work is indirect. Codification of the scattered results of systematic anatomy has now shown the descriptive worker how useful histological methods are when skilfully and properly used, and has at the same time made it apparent to the anatomist that, in respect of grades lower than ordinal, his methods are more fitted for proof than for demonstration. Their alliance is now cordial and complete.

While descriptive and anatomical study conjointly make for accurate discrimination, opinion and circumstance combine to prevent uniform delimitation of plant-forms or "species," and no conceivable compromise can overcome this difficulty. With the term "species" is bound up a double controversy—what idea the word conveys, and what entity the word connotes. Into the first we need not enter: we must assume that our ideas are sufficiently uniform to render the term intelligible. The second we cannot take up here; we must accept the position as we find it, and note, in a spirit of detachment, how in actual practice the systematic botanist does delimit his "species." In doing this we have to discriminate between the effect which observed facts produce on different minds, and that which different mental states produce on the records of facts. The results obtained may be essentially identical though arrived at in different ways; as, however, the results are not always uniform, the existence and effect of these two factors must be carefully noted.

It is rather unusual to find that workers whose powers of observation are equal take precisely the same view of every member of a group of nearly allied forms. One, from predisposition or accident, is influenced rather by the characters whereby the forms differ; another is more impressed by those wherein they agree. In monographic work especially the same worker may find himself alternately more alive to the affinities and more struck by the discrepancies among related forms. At one time he feels that his difficulties may be best solved by recognising all these forms as distinct, at another he inclines to the view that they may be but states of one protean species. Where the capacity for detecting differences is naturally strong, the disposition is towards segregation; where there is a keen eye for affinities, the reverse. The facts in both cases are the same; their influence on minds in which the faculty of observation, though equally developed, has a natural bias in a particular direction may thus be different.

This inherent variation in mental quality, of which the observer may personally be unaware, and over which he may have incomplete control, is not, however, so potent a factor as a difference in mental attitude, usually the result of training or tradition. The existence of two distinct attitudes on the part of authors towards their "species" is common knowledge. In the absence of more suitable terms we may speak of them as the "parental" and the "judicial." To the parental worker his species are children, whose appeals, even when *ad misericordiam*, are sympathetically received. To the judicial worker his species are claimants, whose pretentions must be dispassionately weighed. The former treats the recognition of a species as a privilege, the exercise of which reflects honour. The latter views this task as a duty, the performance of which involves responsibility. With amply characterised forms the mental attitude is inconsequent, but when critical forms are reviewed it is all-important. Here the benefit of a doubt is the practical basis of final decision. This benefit in the case of the parentally disposed worker may lead to the recognition of a slenderly endowed species; in the case of the judicially inclined, to the incorporation of an admittedly critical form in some already described species, the conception of which may thereby be unduly modified.

These attitudes do not in practice divide descriptive workers into two definite classes. Some writers display one attitude at one period, the other at another period of their career. Occasionally the two alternate more than once in a writer's history. Cases are known in which one attitude is consistently adopted towards species of one natural family, the other towards species of a different family.

When want of uniformity in delimitation is due to the varying effect of the same facts on different observers there is no room for either praise or blame. Capacity for appreciating affinities is complementary to that for discrimination. The fact that now one, now the other tendency is more highly developed makes for general progress. Workers in whom the two may be more evenly balanced can strike a mean between the discordant results of colleagues more highly endowed than they are in either direction. But those who possess a capacity for compromise do not mistake this for righteousness; they are apt to wish themselves more gifted with the opposing qualities of those whose work they assess.

When cases in which want of uniformity in delimitation due to difference in mental attitude on the part of independent workers are considered, we again find that praise and blame are inappropriate. If both attitudes have defects to be guarded against, both have merits that deserve cultivation. The defects are patent and rarely overlooked; the careful systematist, more critical of his results than anyone else can be, is alive to the risks which attend stereotyped treatment, and on his guard against the excesses to which this may lead. It is more often forgotten that both attitudes have their uses, and that each should be exhibited at appropriate times. Here, however, no middle way is possible; the mean between the two attitudes has the qualities of a base alloy. It is the attitude of indifference, fatal to scientific progress, and productive of results that are useless in technical research.

The ideal arrangement in monographic study is the collaboration of two workers, one highly endowed with the discriminating, the other with the aggregating faculty. But for the statement of their joint results both must adopt the judicial attitude. On the other hand, in floristic work, in isolated systematic contributions, and in all descriptive work undertaken on behalf of economic research, the better because the more useful results are supplied by workers in whom capacity and attitude combine to induce the recognition rather than the reduction of easily characterised forms.

In the present state of our knowledge uniformity in the delimitation of what are termed "species" is unattainable. We are in no danger of forgetting this fact; what we do sometimes overlook is that, circumstanced as we are, such uniformity is undesirable. The wish to be consistent is laudable; when it becomes a craving it blunts the sense of proportion and may lead to verbal agreement being mistaken for actual uniformity. The thoughtful systematist, when he considers this question without prepossession, finds that forms which in one collocation need only be accorded a subordinate position must, under other conditions, receive separate recognition.

The normal effect on specific limitation of the causes that militate against uniformity is easily understood, and the resulting discrepancies can be allowed for in statistical statements. There are, however, cases where the capacity for appreciating differential characters or points of agreement is so highly developed as to obscure or even inhibit the complementary capacity. The effects are then ultranormal; nicety of discrimination exceeds the "fine cutting" allowable in floristic work; aggregation exceeds the limits useful in monography. No common measure is applicable to the results, and the ordinary systematist, who has definite and practical objects in view, expresses his impatient disapproval in unmistakable terms. The work of those addicted to one habit he characterises as "hair-splitting"; that of those who adopt the other he speaks of as "lumping." The industry displayed in elaborating monographs which attribute a thousand species to genera wherein the normal systematist can hardly find a score must often be effort misplaced. The same remark applies to the excessive aggregation that substitutes for a series of quite intelligible forms an intricate hierarchy of subspecies, varieties, subvarieties, and races. Orgies of reduction are moreover open to an objection from which debauches of differentiation are free. Discrimination can only be effected as the result of study; the finer the discrimination, the closer this study must be. Reduction offers fatal facilities for slovenly work, over which it throws the cloak of an erudition that may be specious. When dealing with excessive differentiation the normal systematist is on solid ground; when following extreme reduction he may become entangled in a morass. Yet workers of both classes only exhibit the defects, for ordinary purposes, of striking merits, and there are occasions when the results that each obtains may be of value to science.

Its mnemonic quality renders taxonomic work practically useful. Its application in economic research does the same for specific determination. Economic workers are chiefly interested in useful or harmful species; to others they would be indifferent were these not liable to be mistaken for such as are of direct interest. The identification of economic species and their discrimination from neutral allies is not always simple, because species that are useful or noxious are often those least perfectly known. The qualities that render them important frequently first attract attention; these may be associated with particular organs or tissues, and samples of these parts alone may be available. Ordinarily, when material is incomplete, critical examination has to be postponed. In economic work, however, this may not be possible, and the systematist, just as in dealing with archæological or fossil remains, may here have to make the most of samples and fragments in lieu of specimens. Cultural help and anatomical evidence sometimes lead to approximate conclusions; often, however, as with neutral species, definite determination must await the communication by the field botanist of adequate material. Even then a difficulty, comparable with that frequently met with in archæological and palæobotanical study, may be encountered. As archæological or fossil material may, owing to the conditions to which it has been subjected, look unlike corresponding fresh material of the same or similar plants, so may trade samples, owing to special treatment, bear little outward resemblance to the same organs and tissues when fresh.

When material of economic plants is ample another difficulty may be encountered. Domesticated species often undergo perplexing variation. In studying this variation the systematist may have to seek linguistic and archæological help, and be led into ethnological and historical by-paths. In classifying the forms that such domesticated plants assume he gladly avails himself of aid from those whose capacity for detecting affinities is unusually developed. But even with extraneous assistance the systematist, in this field, sometimes fails to attain final results. He can, however, always pave the way for the student of genetics, whose work involves the study of the "species" as such. As regards forms of economic importance which neither organography nor anatomy can characterise, but which the chemist or biologist can discriminate, physiological methods are required to explain the genesis or elision of qualities evoked or expunged under particular conditions.

A highly developed capacity for aggregation, if properly controlled, is also useful in the study of plant distribution from a physiographical standpoint. The systematist shows his sympathy with phytogeographical needs in two very practical ways. He declines, out of consideration for the geographical botanist, to deal with inadequate material, and for the same reason he refuses, in monographic studies, to be influenced by geographical evidence. The monographer is conscious that if he pronounces two nearly related forms distinct, merely because they inhabit two different areas, he is digging a pit into which the phytogeographer may fall when the latter has to decide for or against a relationship between the floras of these two tracts. But the fact that, with existing knowledge, uniform delimitation of species is impossible, seriously weakens the value of normal systematic results for phytogeographical purposes. The units termed "species" that are most useful in floristic and economic study are often too finely cut to serve distributional ends. When all existing plant-types have been treated on monographic lines the results may with relative safety be used by the phytogeographer, since errors due to personal equation may be regarded as self-eliminating. As matters now stand, however, the geographical botanist obtains his evidence partly from monographs, partly from floras, and is apt to be misled. Yet even in floristic work the systematist sees that the "species" which it is his duty to recognise often arrange themselves in groups of nearly allied forms. These groups, which need not be entitled to sectional rank, while very variable as regards the number of species they contain, are more uniform than species in respect of their mutual relationships. They are therefore more useful than species as units for phytogeographical purposes. In defining these groups the faculty for aggregation is essential, and those in whom this faculty is highly developed may here be profitably employed, even when their discriminating powers show a certain amount of atrophy.

The cases, by no means rare, of workers who, with a comparatively poor eye for species, display great talent in their treatment of genera, afford indirect but striking proof that the faculty for aggregation may be more highly developed than its complement, and that the dominance of this faculty may ensure useful results. But the *a priori* expectation that in dealing with families this dominance should be still more valuable is not borne out by experience, for in this case it is recognised that aggregation has probably been pushed too far. This error has not been attributable to the faculty for aggregation so much as to the evidence at its disposal; the corrective has largely been supplied by the use of anatomical methods as supplementary to organographic data.

The physiologist in studying processes is not always obliged to take account of the identity of the plants which are their theatres of action. He has at hand many readily accessible and stereotyped subjects the identity of which is a matter of common knowledge, and as his experience increases he learns that he may sometimes neglect the identity even of these. If he asks the systematist to determine some type on which his attention is especially focussed, the physiologist only does this in order that he may be in a position to repeat all the conditions of an experiment required to verify or modify a conclusion. A passive attitude towards systematic study has thus been created in the mind of the physiologist; this passivity has been intensified by the fact that the direct help which the physiologist can render to systematic study is limited. Physiological criteria are indeed directly applied for diagnostic purposes in one narrow field, where organography and anatomy are synonymous and inadequate. But if it be true that the diagnostic characters on which the bacteriologist relies belong to some non-corpuscular concomitant of his organism, this attempt to apply physiological characters to systematic ends has failed. In many cases physiological characters do influence taxonomic study. Differences in the alternation of generations, specialised habits connected with nutrition, peculiarities as regards response to stimulation, variation in the matter of protective endowments, admit of application in systematic work, and are constantly so applied in the characterisation of every taxonomic grade. But the evidence as to these characters reaches the systematist through secondary channels, so that the help which physiology renders is indirect, and the passivity of the physiologist remains unaffected.

This passivity has at last been shaken by the development of the study of plant distribution from a physiological standpoint. The practical value of this study has been affected by the employment of a terminology needlessly cumbrous for a subject that lends itself readily to simple statement, and by the neglect to explain the status, or verify the identity, of the units included in its plant associations. A reaction against the use of cryptic terms has now set in, and the physiological passivity which has led workers in this field to ignore systematic canons when identifying the units discussed shows signs of disappearing. The œcologist, it is true, must classify his units in accordance with characters that differ essentially from those on which reliance can be placed by the systematist. But the characters made use of must be possessed by his units, and the œcologist now realises that, in effecting his purpose, he is as immediately dependent on descriptive results as the economic worker or the geographical botanist, and that, if his work is to endure, his determinations must be as precise as those of the monographer, his limitations as uniform as those of the phytogeographer. The needs of the œcologist are, however, peculiar, and his units must be standardised accordingly. Œcological units are not the groups of species, uniform as to relationship, which the geographical botanist requires; nor are they the pragmatical "species" of floristic and economic work. They are the states, now fewer, now more numerous, that these floristic "species" assume in response to various influences; and œcological associations can only be appreciated and explained when all such states have been accurately defined and uniformly delimited. In accomplishing this task the faculty for detecting differences is the first essential, and the physiologist has here provided a field of study wherein workers, whose tendency to nicety of discrimination unfits them for normal systematic study, may find ample scope for their peculiar talent, and accomplish work of real and lasting value.

We find, then, that the taxonomy of the wider and more general groups is now mainly based on phylogenetic study, and is largely scientific in character and application. The taxonomy of the narrower and more particular groups, based on organographic data supplemented by anatomical evidence, is often somewhat empirical in character, and is largely applied for technical purposes. Among the grades chiefly so applied, the "species" is a matter of convenience, variously limited in response to special requirements, while the "family" is a matter of judgment, crystallising slowly into definite form as evidence accumulates. But the "genus" is relatively stable, and, in consequence of its stability, has long been "a thing of dignity." The distinctive air thus imparted to botany is best appreciated when a zoological index is examined.

The use of scientific names, more precise than popular terms and more convenient than descriptive phrases, facilitates the work of reference in applied study. These names are accidents which do not affect the taxonomic status of the units to which they are applied, but do, however, reflect the want of uniformity in the limitation of these units. The non-systematist who has to apply systematic results appreciates that, as knowledge now stands, this is unavoidable, and makes allowance for the state of affairs. But applied workers complain that, in addition to this, descriptive writers show a tendency to care more for names than for the forms they connote, and wantonly alter the designations of familiar forms. The complaint is just, yet the action is not wanton. The tendency in its present form is of recent origin, and, paradoxical as the statement may seem, is the outcome of a wish for uniformity and stability in nomenclature. Of these two qualities the latter is of more importance in applied work, and therefore the more essential. Unfortunately the systematist has given a preponderating attention to the former, and, in his effort to attain a somewhat purposeless consistency, has allowed his science to wait upon the arts of bibliography. He has placed his neck under a galling and fantastic yoke, for nomenclature, though a good and faithful servant, is an exacting and singularly inept master.

To err is human, and the standard of diagnostic work, high as it is, falls short of the standard which the systematic worker desires to attain. It is this fact that explains the remarkable openness of mind, and the great readiness to accept correction, to which systematic study conduces. To this also is attributable the singular freedom of systematic research from the practice of making capital of the fancied shortcomings of fellow-workers. Exhibitions of this commercial spirit are not altogether unknown, and in one narrow field, where systematic results are practically applied, they are sufficiently common to appear characteristic. But they are contrary to the traditional spirit of systematic study, which is uncongenial to the arts of *réclame*.

The subject is by no means exhausted. Time, however, forbids more; but the purpose of this sketch will have been fulfilled if it has helped those whose work lies elsewhere to appreciate more clearly what systematic study tries to accomplish, and to realise the place it fills in the household of our common mistress, the *Scientia amabilis*.

SUB-SECTION OF K.

AGRICULTURE.

OPENING ADDRESS BY MAJOR P. G. CRAIGIE, C.B., F.S.S., CHAIRMAN OF THE SUB-SECTION.

THE occupant of this chair, in the great annual convention of the promoters and appliers of science, cannot fail at the outset of a new session to put on record his emphatic endorsement of the claim, so strongly and so reasonably pressed by his distinguished predecessor at Dublin, that distinctively agricultural problems, instead of being regarded as a subsidiary sub-section of any single division of the Association, should be accorded the full dignity and convenience of a "Section." Specialised research is today one of the governing features of scientific inquiry. It is but fitting, therefore, that those who are trying to equip the agriculturist with all the knowledge which recent speculation and experiment have to offer for the fuller and more economic development of the soil should at least be allotted equal space and sectional rank with the engineer, whose problems are discussed in Section G, or with the schoolmaster, whose educational methods are debated in Section L.

If there were any country in the world where an apology could legitimately be offered for relegating agricultural science to a secondary position, it is certainly not that in which we meet to-day. In this wide Dominion of Canada, in this progressive province of Manitoba, in this great city of Winnipeg, where the agricultural industry must dominate the interests of the people, hardly any subject in the whole range of study can claim a more paramount degree of attention than the utilisation of the land for the use of man.

This is by no means a matter which can be disposed of as an occasional side-issue in the deliberations of any single Section. If we agriculturists have been tardy in coming to be taught by the men of science, we are in earnest now in the application for instruction that we make. Neither is it to any one science we appeal. Even the stern mathematician or physicist of Section A can teach us something, arithmetical and meteorological, for the right conduct of our business and the wiser forecasting of our plans. The chemists of Section B have, in an infinite variety of tasks, to come to the aid of the farmer, and they have doubtless much to tell of the magic they can promise in the direction of fertilising methods. Section C must be raided for the experts who know the contents of the soil itself and its capacities. Section D may have much to pass on to us concerning the live stock and the insect enemies of our farms. Section E may enlighten us on the world-wide distribution of crops and the new regions awaiting the skill of the husbandman. To Section F we look for warnings as to the economic conditions and barriers which—as we are apt to forget—hedge round our industry, and for the statistics which must govern the varying direction which we give to our enterprise from time to time. The mechanical operations of our calling suggest to us the practical assistance which Section G can surely offer. Nor does even Section H lie wholly remote from the inquiries we may need to make as to the resources of the globe and the wants of diverse communities. The physiology of Section I opens regions of research quite germane to many of our daily studies. Under Section K, as an overlord, we rest to-day assured that if every botanist is not a farmer, every farmer must in a sense be a practical botanist, for ever face to face with the plant and its environment. Perhaps also, in common with all the rest of the world, we may have something to our advantage to hear from the pedagogues of Section L, who may advise our scientific counsellors as to the best form in which even the practical farmer may be taught.

Addressing ourselves, however, to the immediate task in the sub-section allotted to us, I suggest to you to-day that, having regard to the place where we meet, I may, as a proper prelude to your debates, invite you to consider, even if only in the broadest way, what are the leading factors that govern the fluctuations of this our industry of agriculture all the world over, and in new countries in particular. The first factor of all is undoubtedly population—its growth, its rapidly varying local distribution, and its changing and diversified needs. It is for man that crops are raised, whether these crops are to furnish food for direct consumption or for the sustenance of live stock, or whether they furnish us with our clothing, like the wool and the cotton of other lands, or with the materials for shelter, as the great timber crops which your vast forests here may bear. When we know what is the demand at any given place and time, we shall be prepared to give a more exact examination to the means of turning out the effective supply at the right moment and in the right place, be it of wheat, of meat, of fruit, of wool, of flax, of cotton, or of timber.

Sir Horace Plunkett told us last summer that he hoped to find in an Agricultural Section "some humanised supplement to the separated milk of statistics." Perhaps he unconsciously reflected in that remark the suspicion that in earlier days the agricultural debates, which, for want of a better place, took place in the Economics and Statistics Section, unduly paraded the bare figures of the position. But I myself confess that, however mortals may shrink from the rigid arbitrament of arithmetic, neither the teaching of the man of science nor the rhetorical advice of the philosopher will lead the agricultural student of the future, even if he have the luxury of a complete Section of his own, to any fertile result, unless he begins by a clear diagnosis of the facts as they stand, on the one hand as regards population, on the other as regards production. We shall by no means waste time if we try to investigate, with some approach to exactness, what are the areas still available for extended cultivation, and who and where are the consumers of our products, and what are their present and future demands.

Obviously, however, in the limits of an Address like this it is impracticable to make, in any detail, a world survey such as this implies, and it is only the most patent of the changes in the world's populations and their agricultural demands which I can put before you. There was a time when the human family lived in self-contained groups, extracting their requirements from the soil which lay around them. So lately as one hundred years ago there was very little of the international trade in food or other agricultural products such as is familiar to our practice to-day. The nations largely lived on their own territories, and the world has wide sections still where production is limited by local needs. But even a hundred years ago or more perpetual questions were emerging as to the time when men should have multiplied more rapidly than food. The transportation revolutions of the nineteenth century may be almost said to have laid that scare by their aid to the mobility alike of the world's populations and of the world's produce. For the migration of men from dense settlements to open lands on the one hand, and the transport of their produce to the cities of the old world on the other, have simplified, and may simplify still further, the solution. It is all a question of distribution.

If the world holds to-day just twice as many souls (as the best demographic authorities seem to assume) as it did only some two generations back, this growth has been by no means uniform, and the development is governed and provoked by the pressure of population on sustenance. Sometimes, I think, we are apt to forget what Prof. Marshall, of Cambridge, has so well laid down, that "man is the centre of the problem of production as well as that of consumption, and also of that further problem of the relation between the two which goes by the name of distribution and exchange." Vastly has the latter problem been simplified by the giant strides the second half of last century has seen in annulling distance and in facilitating transport, until all the world bids fair to become a single community. Whether the present distinguished British Ambassador to the United States was right in looking forward to the gradual unification of the type of the world's inhabitants by the diverse processes of ultimate extinction and absorption of inferior races, I think we will agree with him that the spread into new regions of conquering or colonising races has provoked desires for, and made practicable the supply of, far more varied wants than once were even contemplated, or could indeed have been made available, while the producing areas were sundered widely from the consuming centres.

The sixteen hundred million souls this earth of ours now carries are at present by no means evenly spread over its surface, and a population chart reveals the most extraordinary diversity in the density of the people on the soil. More than one-half are on the continent of Asia, and of these a large section are densely clustered in India, China, and Japan. In Europe, where the average density is double that of Asia, and approximately one-fourth of the world's inhabitants are gathered, many portions are nevertheless still far less thickly peopled than the Eastern States just named. Populations, over any considerable areas, exceeding 500 to the square mile, may be found on the world's map not only in parts of the United Kingdom, in Belgium, or in Saxony, but yet again on the Lower Ganges, on the Chinese coast, and even in portions of the narrow valley of the Nile. But the Indian or the Chinaman are not, broadly speaking, to be ranked among the communities of which we are thinking when we concentrate our attention on the increasing transport of breadstuffs or of meat from the New World to the Old, which has become the prominent feature of the agriculture of our own day, whatever attention may have to be given to the conditions of the Far East at some distant date.

The great movements of agricultural products which have signalised the last half-century are not for the most currents of food supply into Asia, or into Africa, or North America, despite certain limited exceptions which are just beginning to attract attention, as possibly hereafter significant in the case of imports of wheat into Japan or China, of Australian meat into Eastern Asia and South Africa. The Asiatic or the African agriculturist is for the most part content to find the primary necessities of life close at hand. It is mainly Europe, and indeed Western Europe, that calls to-day for the import of breadstuffs or meat or dairy produce. There the growing volume of sea-borne imports has not only materially influenced the agriculture of old settled countries, but at the same time has signalled to the European toiler that space and plenty awaits him oversea, and has stimulated the development of new spheres of cultivation at a rate which the relatively sparse population of the New World, unless largely recruited by immigration, could never accomplish.

I ventured some years ago, from the chair of the Royal Statistical Society, to review the recent changes we have seen in the structure of the world's populations, and urged the greater wisdom of bringing the men to the food rather than the food to the men. The centripetal force which was, in all parts of the earth and not in the oldest countries only, packing more and more together the human family in vast industrial centres, which drew the materials of their handicraft and the food for their maintenance from far distant lands, seemed to my judgment a much less healthy form of development than the older centrifugal impulse which led man to move himself to the newer regions, where the produce was nearer to the mouth of the consumer, and where he could fulfil the oldest obligation of the race to go forth and replenish the earth and subdue it. The vision that meets us here of ample land awaiting man, of possibilities of agricultural production which can only be realised by well-considered and augmented immigration, impresses the visitor from an old and overcrowded country. Before and above all speculations of what transport has done, and may yet do, to carry masses of agricultural produce across the ocean, I must claim, as the better prospect, a steady settlement of these wide acres by a population resting on the soil which this great Dominion offers, and drawing from it, by a more diversified and more general and more wholesome type of farming, a far better, and in the long run a more economic, return than the mere extraction of grain for export can ever promise.

Taking the thirteen States of Western and Central Europe as an example of what I mean, there were added there, in the last seventy years of the nineteenth century, on a comparatively limited surface, something like 100,000,000 new consumers to the 167,000,000 persons previously resident on the 1,700,000 square miles of territory occupied by this group of nations. These numbers, too, take no count of the emigration which has lightened the pressure on the soils of the home lands of Europe. Clearly the maintenance of nearly 70 per cent. more consumers must have meant either a vast development of local agricultural production or a vast demand upon the acreage of the new land of the West, or both. The defective nature of the early statistics obstructs the search one naturally makes into the extent on which these new populations on the old lands have been fed on larger local areas, or from larger yields on non-expansive areas. Adopting, therefore, a much shorter range of view, the lifetime of a single generation has given us 30 per cent. more consumers in Western and Central Europe than were there in 1870, the German element rising apparently by 50 per cent., the Scandinavian, Belgian, and Dutch group of small nationalities by 44 per cent., and the United Kingdom by 40 per cent. in this interval, while these developments were of course reduced in their effect on the total by the slower growth of the South-Western nations and the nearly stationary condition of France.

No larger areas, but rather smaller ones, of the chief food grains are apparent in Great Britain or Scandinavia or North-Western Europe. The German areas of wheat and rye show practically little change, and although, if the Hungarian areas are larger in the centre of Europe, the general movement is not upward in respect of food-producing area. Even in live stock the numbers scarcely keep pace with population, for although the herds and the swine of Western and Central Europe have risen by nearly a fourth in the one case and three-fifths in the other, the sheep, except in Great Britain, are much fewer now.

On the average of the first quinquennium of the present century the home production of wheat represented only about 20 per cent. of the consumption in the United Kingdom or in Holland, 23 per cent. (apparently) in Belgium, 64 per cent. in Germany, and perhaps 80 per cent. in Italy; and the imported grain to fill the deficits was considerably more than 400,000,000 bushels. Nearly half this came, of course, from Eastern Europe, and particularly Russia. Such a mass of produce would require 20,000,000 acres elsewhere, even if the exporters could raise it, as most have certainly *not* done, at twenty bushels per acre, and nearly double that area if the yield was only that of some of our largest exporters to-day.

The actual reductions of area in Western Europe are not in the aggregate extensive, although Belgium has seen her grain area shrink from 30 to 25 per cent. of her total surface, France from 28 to 25·5 per cent., and the United Kingdom from 12 to 10 per cent. The grain-growing capacity of European States varies greatly, and it would be interesting, were the data everywhere available, to see how far we have distinct evidence of an appreciable if not any great advance in the yields extracted from the non-expanding areas under the more recent conditions of scientific knowledge. Nowhere is so large a share of the total surface under grain as in Roumania, an Eastern European State and not inconsiderable wheat exporter, and there, at all events, the total grain acreage developed between 1886 and 1906 by nearly 25 per cent., and the surface under wheat by 72 per cent. The yield there, according to some official reports, was something over fifteen bushels per acre in the five years before 1890, and in those ending 1906 it was more than nineteen bushels—the latest year nearly touching twenty-three bushels; the barley yields of the same State rising from an average in the former quinquennium of thirteen bushels to more than nineteen bushels in the latter.

In Hungary, another European grain exporter, the wheat acreage has been materially developed, rising from more than 7,000,000 acres to 9,500,000 in twenty years to 1906, and but slightly receding since, while the yields are also materially greater.

France, with a drop in wheat acreage of 1,000,000 out of 17,000,000 acres, has between 1884 and 1908 raised the average of her production on a five years' mean from 17·8 bushels to 20·2 bushels, and thus turned out somewhat more produce from a lessened surface.

Germany, on a constant but much smaller wheat area of 4,700,000 acres, with a quinquennial average yield of 20·3 bushels, would seem to have raised this to 27·0 in 1899–1903, touching a still higher level in more recent seasons, when 30 bushels were apparently approached, although some changes in her statistical methods of inquiry may slightly reduce this comparison.

Some effort to feed new mouths from old acres has thus indeed been made. Nevertheless, without disregarding altogether the qualifications which a careful statistician would deem it his duty to admit, one may broadly say Western Europe looks mainly for the growing needs of her consumers to the still exporting States of Eastern Europe, to the New World regions of North and South America, and in a minor degree to Australasia.

Before we quit our session here in Winnipeg we may expect to learn something of scientific interest and of economic guidance respecting the response of Canada to the Old World's call. But it is not for grain alone that densely peopled countries turn to the new fields of the West. Probably the geographical conditions of our place of assembly this year will not lead us at all closely into discussion on the variations in the sources and fluctuations in the volume of the wool supply, or that of cotton, but the possible development of live stock on the territories of newly settled countries may be expected to come well within our purview, and afford us lessons in the development of the export trade in meat and dairy products, and the relation of the Canadian to the surplus of other States. The Royal Statistical Society of London had a paper this summer by an old colleague of mine, Mr. R. H. Hooker, which, although primarily devoted to the supply of Great Britain herself, and the price of meat in her markets, has a world-wide view of what is going on all around us in the conditions of production and of transport in a commodity as important to human life as wheat itself.

Fully a quarter of a century has gone by since, on a former visit to Canadian soil at Montreal in 1884, I raised a debate on this subject of the production and consumption of meat, and the various conditions of its transport. The twenty-five years that have passed since then have not rendered that particular topic a less important one for the consumers of old countries or the farmers of new, but ever-varying factors are presented by the opening of new territories to exploitation and the denser massing of accumulated populations with growing needs, and increasing preference for the most concentrated form of aliment. Among the most recent factors to be remembered as influencing one side of the meat-trade future are the admissions of qualified experts in the United States as to the degree in which the growth of population there was beginning to trench upon the meat surplus of that Republic. On the other hand, the producer will not fail to bear in mind the rapidly advancing importance of partially developed areas and the great advantage of the more economic forms of dead-meat transport now adopted in South America, and will weigh against these the degree in which the herds of the vast prairies of North-Western Canada may be further utilised when questions of handling economically the resultant meat supply may be effectively elaborated.

To-day, however, and here especially, one cannot but be reminded that in whatever direction we look for the aid of science to stimulate the development of Canadian resources, or to help the producers now in these provinces in measuring the probabilities that lie before them, or to summon eager emigrants to the land you have to offer them, there is an intense and ever-engrossing interest in the present and the future of wheat. Alike, therefore, to the statistician and economist on the one hand, and to the experimentalist and investigator on the other, we turn to ask what advice they can give to the farmer of a new country with an area so vast as the North-West of Canada presents, whether and how far and at what rate, with profit to himself and with benefit to the bread consumer across the ocean, he can push the extension of the well-nigh eight million acres of wheat land which the Dominion claims to show her visitors in 1909.

The problem, important as it is to this particular region where we are met, cannot, however, rightly be treated as a purely Canadian question. It is a problem of world-wide interest and of great magnitude and more complexity than has been sometimes recognised, for it is none other than the issue of the race between population and production so far as at least one primary essential of human diet—bread—is concerned.

Within a year of the last visit to this Dominion of the British Association the question was raised by no less an authority than the then President of that body at the Bristol meeting of 1898, whether the possible wheatfields of the globe possessed a potential capacity of expansion sufficient to meet the hypothetical needs of the bread-eaters of even one generation ahead; whether, in fact, a dearth of wheat supply was not already within sight, and by 1931 would be upon us. The suggestion that the wheat-producing soil of the world was already becoming unequal to the strain put upon it by the multiplication of men was not unnaturally met by a vigorous criticism. The mere suspicion that some day, however, there would not be land enough to go round, that famine could be averted only by the beneficial magic of the chemist, is too vital a possibility—even if some of us do not place the date so near or rely so fully on some of the computations made—not to command a very careful examination of the remedy propounded, the promise of the artificial production of nitrate in such a volume and at such a price as would raise the average of the world's production from 12·7 to 20, if not even to 30 bushels of wheat per acre.

The fixation of nitrogen, not as a dream but as a certainty, was, it will be remembered, claimed by Sir William Crookes as the condition on which the great Caucasian race was to retain its prominence in the world, and avoid being squeezed out of existence by races to whom wheaten bread is not the "staff of life."

Personally, I confess I am not so pessimistic as to the surface still available for wheat-growing even without this aid. If we grant that the so-called contributory areas, at a date two or three years before the close of last century, were just what was then stated, that the bread-eating population of that date was rightly guessed at 516,500,000—a much more difficult certainty to reach in the manner adopted by the American statistician whose figures were adopted—and that both the growth of population and of "unit consumption" would proceed exactly in the ratio suggested, it may legitimately be asked, does it nevertheless follow that no such increment of area can be looked for as would satisfy the larger mass of consumers calculated for as likely to be dependent upon wheat in 1911 or 1931 on the scale here laid down?

I should not, in any statistical investigation into these questions, be contented to assume the probability of the exact continuance of previous ratios in the rate of production, or that of individual consumption over such periods, and my experience of very big averages makes me shy of adopting a simple mean of such wide diversities as correctly representing the head-rate consumption of wheat. These are points which might be more fittingly debated elsewhere. I want to narrow the issue now to the actual and more recent course of the wheat-growing surface; for it seems to me that the lesson of such figures as we have in the past, and as those of Mr. Wood Davis's tables, is rather one of irregular than of arrested extension. The periodical opening up of new areas, very often in advance of consumptive requirements of the time, would seem almost invariably to be followed by a pause while prices recover from the over-supply, and that again by new developments and exploitation in new directions, or by better methods on the areas made tributary to the wants of the ever-increasing men.

We may admit that the course of the wheat acreage from 1870 to 1884 and thence onward to 1898 showed—first, a material advance outstripping that of population, then an admitted and serious check, with a subsequent advance, although one below that of the bread consumers of the world.

Let me ask, however, if a later view of the wheat area at the disposal of the world's consumers is not well qualified materially to diminish, if not to dissipate, the "cosmic scare" which, no doubt contrary to the real design of the distinguished chemist who followed Mr. Davis's estimates, was induced by the figures of 1898? My own comparisons of the later growth of acreage covers only the decade from 1897 to 1907, or as nearly to these years as figures permit, and in the form I originally designed it might bring into view something less than 230,000,000 acres as the world's present extent of wheat-field. But, to place matters on a more comparative level, I am willing to omit the large Indian totals and some few of the distant regions which, partly on account of the somewhat uncertain identity of the areas they include at different dates, and partly on account of their relatively small contribution to the bread of the Western world, do not find a place in the estimates with which I am now making a comparison. For the leading groups of other areas the figures stand in millions of acres to a single decimal:—

Groups	1897	1907	Increase in 10 years
Russian Empire	46·6	59·5	12·9
United States	39·5	45·2	5·7
Three chief European Wheat States	37·6	39·8	2·2
The Rest of Europe	20·8	21·4	0·6
Argentina and Uruguay	6·7	15·0	8·3
Canada	3·0	6·6	3·6
Australasia	5·0	6·0	1·0
Total	159·2	193·5	34·3

Now, whatever be the estimated increase in wheat-eating population between these two dates, it cannot in the aggregate be 21½ per cent., as is the growth of the wheat surface in these States. Nor would the result be materially affected if allowance were to be made for the three or four million acres represented by the exports of unnamed States in this table, or even by the inclusion of any minor units of wheat-growing, such as Portugal, or Greece, or Switzerland, for which Mr. Wood Davis estimated from sources not recognised in our official statistics, their totals being well under a single million acres, and the variation, if any, probably insignificant.

If, therefore, the growth of men outstripped the growth of wheat, as we have been warned was the case between 1884 and 1897, the growth of wheatfields has been well over the rate of population increase since that exceptional period, just as it was in the still earlier period between 1871 and 1884. Nor is the check to the rye acreage and its decline by 4 per cent., which seemed to have happened concurrently with the wheat check between 1884–97, continuing; for that, in the aggregate, seems to have returned to, though it has not perhaps much exceeded, the older level.

Comparisons at single terminal points have always a danger which may be avoided by examining more carefully the leading facts year by year. On the diagram which I introduce here I have tried, therefore, roughly to sketch the curves which indicate the growth of wheat acreage, both before and since 1898, in Russia, the United States, Argentina, Australia, and Canada, as typical of the exporting centres, while the acreage in France and Hungary has been added for comparison. The effect is, I think, to bring out the very much greater extension which has been going on during the last decade than could well have been looked for on the basis of the 1884–97 figures.

For the Russian Empire as a whole data are available only since 1895, but I have shown by a separate and steadily mounting line the wheat area of the fifty governments of European Russia, which are comparative for the entire period, and the latter are quite sufficient to establish my conclusion. There is, too, a suggestiveness about the course of prices (in shillings per quarter) in England, the chief recipient of wheat exports, which I have traced by a separate curve across this diagram. This may perhaps aid those who are disposed to make a closer study of the figures. That study may not improbably suggest that in the very latest year—for I have carried the diagram to 1908 where I can—we may be once again nearing another check, or temporary halt, in the course of wheat extension, such as that which puzzled inquirers more than ten years ago, but which proved only a pause in the task of finding all the bread the consumers wanted under the stimulus of better prices. The further leap of prices in 1909 to beyond the 40s. limit in England may effectively encourage extension.

Acreage of Wheat in Million Acres.

Year	Russian Empire	Of which in European Russia	United States	France	Hungary	Argentina	Australasia	Canada	Of which in N.-W.
1884	—	28·9	39·5	17·4	6·8	0·6	3·8	2·4	—
1885	—	—	34·2	17·2	6·8	—	—	—	—
1886	—	—	36·8	17·2	6·8	—	—	—	—
1887	—	—	37·6	17·2	7·3	—	—	—	—
1888	—	30·6	37·3	17·2	—	—	—	—	—
1889	—	—	38·1	17·4	—	—	3·8	—	—
1890	—	—	36·1	17·4	—	—	3·7	—	—
1891	—	—	39·9	14·2	7·9	—	3·4	2·7	—
1892	—	32·6	38·6	17·3	8·1	3·3	3·7	—	—
1893	—	32·4	34·4	17·5	8·6	—	4·0	—	—
1894	41·6	32·9	34·9	17·3	8·5	—	4·0	—	—
1895	42·2	31·9	34·0	17·3	8·3	5·1	3·6	—	—
1896	45·9	34·8	34·6	17·0	8·3	—	4·0	—	—
1897	46·7	35·6	38·5	16·3	7·4	—	4·5	—	—
1898	47·0	36·0	44·1	17·2	8·2	—	5·0	—	—
1899	49·7	38·0	44·6	17·1	8·4	—	5·9	—	—
1900	52·3	40·0	42·5	17·0	8·8	—	6·0	—	2·5
1901	54·3	41·9	49·9	16·8	8·9	8·3	5·6	4·2	—
1902	55·1	42·6	46·2	16·2	8·9	8·1	5·2	—	—
1903	57·2	43·8	49·5	16·0	9·2	9·1	5·5	—	—
1904	59·2	45·6	44·1	16·1	9·1	10·7	5·8	—	—
1905	62·2	48·1	47·9	16·1	9·2	12·1	6·5	—	3·9
1906	63·6	49·0	47·3	16·1	9·5	14·0	6·3	—	5·1
1907	60·0	45·5	45·2	16·3	8·6	14·1	6·1	6·1	—
1908	—	—	47·6	16·1	8·5	14·2	5·6	6·6	5·6

The exceptional arrest of wheat-growing in the United States between the years 1880–96, when—if we may accept the official statistics as actually representing fact—the rapid rise, which actually doubled the wheat acreage between 1870 to 1880, stopped altogether, was, I believe, the preponderating factor which suggested a general halt in wheat-growing. It should therefore be looked at more closely, and to get rid of the danger of attaching too much importance to the data of single years, the quinquennial average movement in the States over the whole of the last forty years may be summarised as under :—

Five-year Periods	Acreage in U.S.A.	Distinctive Wheat Acreage Levels
1868–72 ...	19,500,000	Extending rapidly up to 1880
1873–77 ...	25,500,000	
1878–82 ...	35,500,000	Nearly stationary from 1880 to 1896
1883–87 ...	37,000,000	
1888–92 ...	38,000,000	
1893–97 ...	35,500,000	Again extending to maxima reached in 1901 and 1903, with a later slight decline in the latest years
1898–1902 ...	45,500,000	
1903–1907 ...	46,800,000	

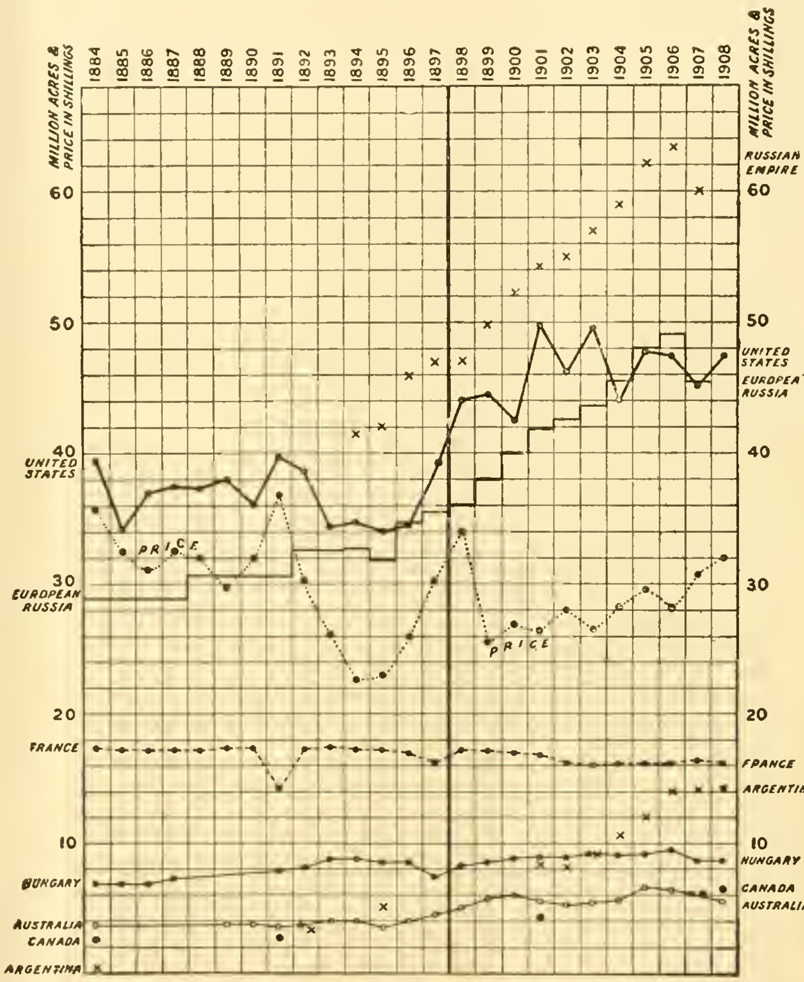
Population in the States has, of course, augmented steadily all over the forty years, from 37,000,000 to 86,000,000, yet all through the stationary years, as well as those of advancing acreage, exports of wheat and flour continued—as much as a third of the crop being shipped abroad in some years—and the transfer of the wheat lands north-westward in the States was doubtless the striking feature of the recovery. Rightly to understand the revolution in the wheat-growing of certain States of the Union would require a treatise for which time could not be given here.

Let me, however, recur again to the general position. In the table already given for the past decade the latest increase to be accounted for is 34,000,000 acres. I ask you to note that the Russian quota forms more than a third of the whole. Now it was Russia that was in a very special degree the subject of unfavourable remark in the wheat problem controversy of ten years ago. She was spoken of, I remember, as having reduced her consumption of bread by 14 per cent., and only by this means continuing her exports in defiance of her true needs, and contributing to the rest of the world therefore a merely provisional and precarious excess. I am not aware how the calculation here alluded to had been arrived at, nor have statisticians perhaps a very robust faith in the estimated numbers of the Russian population before the great census of 1897, but the subsequent history of her apparent wheat surplus is interesting.

The exports of wheat from Russia, which we were warned could not continue, and which had doubtless been unusually large between 1893 and 1898, shrank for three years after that date as if they would realise the prophecy which would relegate Russia from the ranks of exporters to the task of feeding her own population. But that mysterious empire has since then resumed her large supplies, and from 1902 to 1906 the exports ranged higher than before. Although forming only 24 per cent. of her estimated wheat crop, Russia's exports averaged 141,000,000 bushels over the first five years of this century, against 104,000,000 bushels over the whole preceding fifteen years. Quite lately we seem to see some restriction, but the history of the trade forbids a confident opinion that she has reached the end of her contributions to other lands.

So far as the areas under wheat are recorded, the Russian agriculturist keeps on extending his industry, and, low as the yields may frequently be, they are tending upward under, it may be presumed, some reform of the very primitive conditions of production. Within the fifty governments of European Russia alone, and omitting the Polish or Caucasian figures, which do not go so far back, the average area of 29,000,000 acres only in the 'eighties became 40,000,000 at the close of the century, rising to a maximum of 49,000,000 acres in 1906, a point from which a decline was shown in 1907 to 45,600,000 acres. This, however, even taking the latest and lower figure, is an advance of 10,000,000 acres in the last decade, or nearly 30 per cent.—surely considerably in advance of even the Russian growth of population, great as that is.

It has, I think, not been sufficiently realised that in the two decades stretching from 1887 to 1906, European Russia has added 1,000,000 acres of wheat per annum. This is not only a 70 per cent. advance in twenty years, but it is double the absolute area of 10,000,000 acres which the United States added in this interval. From



such official estimates as are furnished, the total produce of these fifty governments, where alone the figures are continuous, increased in a still higher ratio. The average production, which did not exceed 180,000,000 bushels in the five years before 1879, or 226,000,000 bushels in the quinquennium ending 1889, reached what appears to have been a maximum in 1904, and was averaged at 415,000,000 bushels for the whole five years' period then ending. If the later years are again at a lower level, they represent very nearly double the produce before 1879. The yield per acre, which stood below eight bushels to the acre between 1883 and 1892, averaged nine bushels over the next ten years, and has been 10·9, 10·4, and 11·4 bushels respectively in the three seasons ending 1904. In the south-western region, where the yield was just over eleven bushels in the decade ending 1892, it seems to have averaged fifteen in the ten years ending 1902, while more than eighteen and nineteen bushels were reported in 1903–4.

These figures omit the Polish, Caucasian, and Asiatic districts, for which a much smaller retrospect is possible. The acreage in Poland is small—little more than a million—and nearly constant in extent. But the wheat of Northern Caucasia, first accounted for in 1894, has risen from 5,600,000 acres to 8,300,000 in 1906, and the Siberian totals, after increasing, apparently but slightly, from 3,400,000 acres in 1895 to 4,800,000 acres at the close of the century, do not seem much to exceed 5,000,000 acres now. Russian wheat production does not therefore seem a wholly arrested process.

I own I was hardly prepared for this old nation's progress in wheat-growing, and I have no doubt that I shall be told that Russia has been exchanging one form of bread corn for another; in particular, that dependence on rye has decreased as production of wheat has grown. There is some truth undoubtedly in this, for the comparatively stationary character of the rye area indicates that the Russian people, increasing as they are and continuing still an export of rye to Germany and elsewhere, may themselves eat somewhat more wheat and rather less rye, and it is true also that a fluctuating record has attended the surface under the coarser and larger cereal crop. Its "low-water" point—61,900,000 acres—occurs in 1893, while its present figure is 66,000,000 acres. Relatively, therefore, while the rye shows no progress such as wheat, it cannot be said that the rye area has been utilised for the more valuable cereal, and the fact remains that there is more rye grown to-day, even in European Russia, than at any date since the last decade of last century began. Relatively to population, the available data show, the aggregate crops of wheat and rye together, in Russia as a whole, are materially greater than before.

Inquiry shows that the wheat extension in Russia has been made possible by an actual addition to the arable land, and not by deduction from other crops. A recent investigation quoted by a competent American authority informs us that some 23,000,000 acres of new arable land has been accounted for between 1881 and 1904, and, moreover, that a greater surface of this nominally arable area is now actually under cultivation than at the earlier date. These figures stand:—

Year	Total Arable Land acres	Under Crop acres	Wheat acres	Rye acres
1881	288,000,000	174,600,000	28,900,000	64,600,000
1904	310,700,000	205,900,000	45,600,000	65,600,000

It will be noted that this inquiry ends a year or two since, but had it been continued to 1906 the comparison would have been accentuated, and as it stands the additional area cropped in one way or another exceeds 31,000,000 acres.

In Mr. Wood Davis's later memorandum he combats the idea that the expected wheat crops from four relatively new areas of production—Siberia, Argentina, Australasia, and Canada—would meet the shortage he found threatened by his estimate. Not unnaturally he regarded an 8,100,000 addition of acres in these four regions in fifteen years as a very insufficient and unpromising quota to feed more than ten times that number of new bread-eaters on the globe between 1883–4 and 1898–9.

Assuming he rightly gave the increment of wheat between these dates as under, if I add to his table the latest data that I have, these new and gradually opening areas will show a rate of progress much greater in the nine succeeding years than before, even if there was no further increase in Siberia; for as to the areas to be included there I am certain. The figures I give in millions of acres:—

	1883–4	1898–9	Fifteen years increase	1907–8	Nine years increase
Siberia ...	2·0	3·3	1·3	3·3	—
Argentina	1·4	6·1	4·7	14·2	8·1
Australasia	3·2	4·5	1·3	5·6	1·1
Canada ...	2·4	3·2	0·8	6·6	3·4
Total ...	9·0	17·1	8·1	29·7	12·6

In the forecasts offered ten years ago Argentina as a wheat-grower was given a dozen years from 1898 to reach a possible acreage of 12,000,000 acres. She has reached that figure and passed it in less than a decade, and later current official estimates seem to concede to that region a close approximation to 15,000,000 acres to-day. As the actual pace here has bettered so considerably that prophesied, one may legitimately question the further limitations which allowed to Argentina no prospect of ever reaching a wheat area of 30,000,000 acres at any time. That these prophecies by no means coincide with later and probably quite similarly vague forecasts in the other direction goes without saying. In a recent official publication by the U.S.A. Government containing the report of an expert on the resources of Argentina and her farming methods, the competitive prospects of the great grain-exporting Republic of the South were scarcely so lightly treated. For my own part I rather agree with an officer of the Argentine Government there quoted (Señor Tidblom), who candidly admits that it was impossible with any accuracy to forecast the ultimate wheat area of Argentina, although I observe he adds that there were "more than 80,000,000 acres in the Republic that could be *immediately* devoted to successful wheat-farming if we had the farmers to do it." I have seen, though I could not accept, even more sanguine estimates in other quarters, which, with a yield of only ten bushels per acre, promised a crop of 1,238,000,000 bushels at some future date, and would involve an area of wheat land approaching 124,000,000 acres.

No one, I think, can note the strides which Argentina has taken in rapidly augmenting her wheat areas and exports, and that concurrently with the commanding place she is assuming as a meat rearer and exporter to the older peoples of Europe, without some recognition that a great future is possible. On the other hand, apart from climatic conditions, the future must be largely governed by the factor of population; and the nature of the Italian immigrants, their mode of culture, their non-intention in many instances to remain and own the land or identify themselves with the country—preferring to exploit one farm after another and reside on them until they make a small competence wherewith to return to Europe—are all reasons against the extremely favourable prospects which I have here adverted to.

Small relatively to the great extent of surface included in the Commonwealth of Australia is the proportion under wheat, but the Commonwealth is none the less as a rule an exporter. A little more than thirty years ago only about 1,400,000 acres were grown. This seems to have been a good deal more than doubled in the five years 1876–81, when a much smaller rate of increase followed for fifteen years—a check apparently reflecting the same tendency to arrest which we have seen so typically illustrated in the United States. Again, after 1896, just as in the great Western Republic, wheat-growing became again in favour, and the rapid spurt which followed brought the Commonwealth total to 5,700,000 acres as the century closed. Thereafter the rate of growth seemed checked anew, and after passing a maximum of just under 6,300,000 acres, it stands to-day under 6,000,000 acres. Twice during the last twenty years has Australia shown on balance a net importation of wheat, but from 1903 to 1907 the quantity exported has averaged 36,000,000 bushels, and it is not without interest to observe that the Australian exports of the present century have not all been consumed in Britain—South Africa, the western coasts of South America, and even some parts of India sharing in the surplus product of the Antipodean Continent.

The conditions and the future of Australian wheat have been quite recently dealt with in an interesting paper by Mr. A. E. Humphreys, read before the Society of Arts in London. It is here pointed out that the soils on which it is grown are rich in assimilable nitrogen, requiring little manurial expenditure in that direction, but poor in their percentage of phosphoric acid, while the climatic conditions as regards moisture have proved remarkably difficult. Efforts have been made, and apparently, if recent experiences be confirmed, with success, to breed new varieties of the wheat plant adapted to the peculiar climatic conditions of Australia and likely to increase the low average yields hitherto obtained. It is obvious that under Australian conditions the breeding of varieties of the wheat plant which will thrive on a low rainfall would make all the difference to Australia as a source of wheat exports. From 1902–7 the Australian average yield was only half that of Manitoba, or nine bushels per acre; but this included one year of disastrous drought (1902–3), wherein the Commonwealth average fell below 2½ bushels to the acre. In New South Wales and Victoria, wherein more than half the acreage lay, it was even below this according to the official figures. Such instances offer the strongest evidence that could be offered of the extreme variability of Australian conditions, and make one almost hesitate to quote Mr. Humphreys' own cheerful estimate that in the State of New South Wales alone, wherein nearly a third of the Australian acreage is found to-day, or 1,886,000 acres, there was a possible area of good wheat land of nearly ten times this, or 18,000,000 acres.

To the last I have left another sphere of wheat extension, and one that will be most of all familiar to my audience. Yet here again the forecast of the Canadian future made in 1898 was surely unduly pessimistic. The opinion then quoted by Sir William Crookes as that of trustworthy authorities assigned to the Dominion a bare total of 6,000,000 acres under wheat as all that could be expected to be reached within a dozen years. That period has not yet fully come, but I observe that by December 31, 1908, the official figures show an acreage as reached within the decade which exceeds by 10 per cent. the maximum allotted to 1910. If I were to add the figure now ascertained for the 1909 crop, a total of 7,750,000 acres is now reckoned upon, so that here again the forecast has been outstripped. The further proposal to estimate the maximum of the Canadian potential capacity for wheat production by 1923 at no more than 12,000,000 acres will therefore, I imagine, meet severe critics in Winnipeg to-day.

I greatly wish that our contribution to the knowledge of the economic future of Canadian development may be, as the result of discussions here, some approach to an agreement to avoid all exaggeration on the one hand or on the other in these forecasts of future wheat-growing in the North-West; but I am very conscious of the risk of all far-reaching prophecy in a problem where the more or less uncertain growth of the immigrant population plays as great a part as the soil or the climate.

Sir William Crookes, in endorsing the most modest estimates of the capacity of this region, mentions that he had before him calculations which, I think most of us will agree, were, to say the least, exaggerated in an opposite direction, attributing to Canada 500,000,000 acres of profitably utilisable wheat land. Against such inflated prophecies he argued that the whole area employed in both temperate zones of the world for growing all the staple food-crops was not more than 580,000,000 acres, and that in no country had more than 9 per cent. of the area been devoted to wheat culture. But error of estimate in one direction or another is quite inevitable when the available data on which to form a conclusion are so scanty. Replying later to journalistic criticism, Sir William, it must be remembered, acknowledged the undoubted fertility of portions of the North-West provinces; but, basing the conclusion on official meteorological statistics and on supplementary data supplied by Mr. Wood Davis as to the July and August temperatures of these regions, he suggested that "from one-half to one-third only" of Manitoba—the south-west portion already fully occupied—was adapted to wheat. It was doubtless in the light of these climatic records that he inclined to regard 200,000 square miles of the whole 300,000 square miles comprising Assiniboia, Alberta, and Saskatchewan, as these regions were then defined, as lying "outside the districts of profitable wheat-growing," while even of the remainder it was apparently suggested that it would take thirty years from 1898 to place as much as 18,000,000 acres *under all grain crops*. Can we here to-day, with another ten years' experience, reach a somewhat greater accuracy in this search into the possibilities before us?

As illustrating the remarkable discordance of view hitherto existing, it is well to have before us, as a starting point for debate, some specimens of later but still most widely varying estimates of the capabilities of this country. These I quote from the cautious report rendered by Prof. Mavor to the British Board of Trade in 1904, midway through the decade now closing. More or less speculative as it is fully acknowledged all estimates must be which purport to define the area "physically or economically susceptible of wheat production," that painstaking investigator set aside, as of little value, hypothetical curves setting forth the "northern limit of cereal production," trustworthy data for which "were not forthcoming, and if they were they would be constantly changing." After enumerating under fourteen different heads and sub-heads a formidable list of distinct but materially qualifying "conditions" or factors covering questions of soil, of temperature, and meteorology, of moisture, sunshine, and acclimatisation of the plant, Prof. Mavor suggests that, broadly speaking, the cleavage of the areas of different fertility runs obliquely from south-east to north-west through the great quadrilateral of the Canadian North-West. Alike in the north-eastern and in the south-western angle the conditions seemed to him more or less unfavourable. The south-eastern and north-western corners and the belt connecting them, however, presented relatively favourable conditions; an exception qualifying this subdivision was, however, suggested in the extreme north-west.

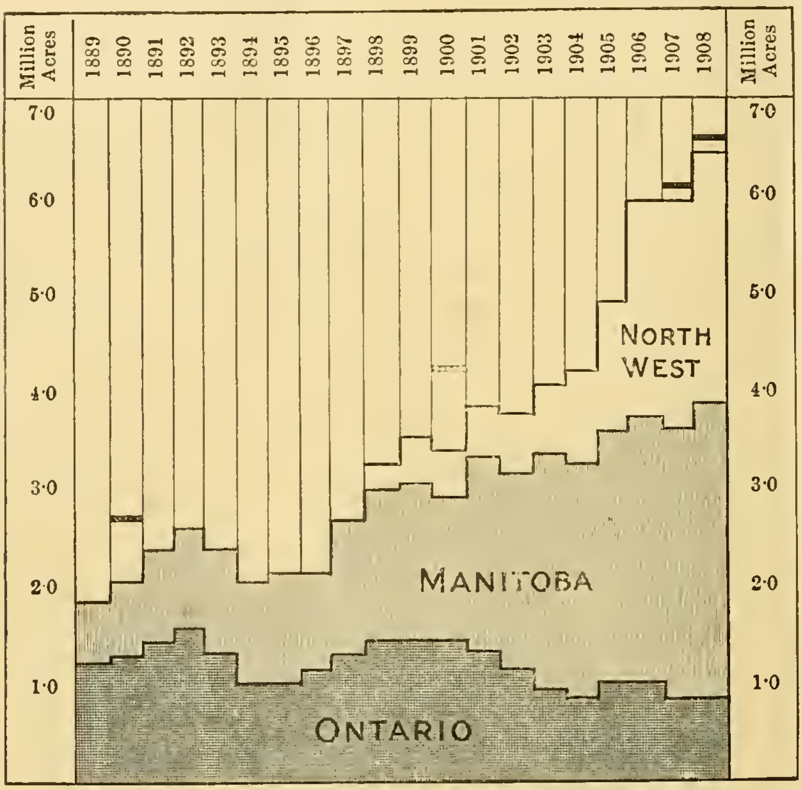
The vagueness of the statistical basis on which any numerical estimate of future wheat areas must rest cannot better be shown than by briefly referring to the results of five independent estimates which are quoted in this report. For the details of these estimates it is necessary to refer any student of the report to the analysis of each, differing as they do materially in their methods and in the classification of the areas comprised within the Manitoba, Assiniboia, Saskatchewan, and Alberta of that date. As regards the total area for settlement and for annual wheat-growing respectively, the first three of these estimates varied in placing the surface fit for settlement or susceptible of cultivation as low as 92,000,000 acres, and as high as 171,000,000, the annual surface available for wheat in these districts ranging from 13,750,000 acres to 42,750,000 acres, and the resultant possible produce from 254,000,000 bushels to 812,000,000 bushels.

It should be added, to make these figures clear, that all the estimators quoted assume as a condition precedent to their accomplishment such an influx of population and settlement of the country as would be adequate to secure the cultivation of the hypothetical cultivable area.

With Prof. Mavor, we may think that both the lower estimates are over-cautious and the third perhaps over-sanguine, while most properly he reminds us that beyond the physical capacity of any region, the question of economic advantage remains to be solved, under what may be conditions prevalent at a distant time, what effect a rise of price might have, and whether the farmers of the future would devote so much of their land as is here suggested, and so much of their working capital, to wheat alone. I ought to add that a fourth estimate referred to in the report takes the graphic form of a map, distinguishing the suggested area where the wheat crop is certain, where less certainty exists from the effect of summer frosts, and where, again, the crop is uncertain from insufficient moisture. Yet another estimate was quoted as made in 1892, but endorsed as not over-stating possibilities of the future in July, 1904, and this classified somewhat more than half the land of Manitoba as "land suitable for farming," or 23,000,000 acres, allotting to the rest of the North-West 52,000,000 acres more, or in all 75,000,000 acres. The same estimator, forecasting the results for 1912 (or three years from the present time), allotted to Manitoba a probable wheat production of 168,340,000 bushels, and to Alberta, Assiniboia, and Saskatchewan 181,600,000 bushels. This crop of 350,000,000 bushels of wheat was in addition to an estimate of a further 200,000,000 bushels of oats and 50,000,000 bushels of barley. I have little hesitation in concluding, with Prof. Mavor, that such widely divergent results, arrived at, as we are told, by competent estimators, illustrated the impossibility at the time of that report of setting out precise limits of cultivation in a region in which so much has yet to be done. To-day I would ask, Has the lapse of another quinquennium, full of interesting movements in both the population and the crops of the North-West, enabled us to reach any greater certainty? If so, the opportunity of this meeting affords an occasion to submit the conclusions, optimistic or pessimistic, practical or theoretical, economic or scientific, to the test of friendly and thorough discussion.

It is a relief to turn from the perplexing variety of these speculations as to the future to the relatively more solid ground afforded by the actual records of wheat extension here. If the progress of the past, and here once again more especially of the very latest decade, is to govern the prospect of the years to come, the wheat area of Canada must still possess a great expansive power.

There are defects of continuous statistics showing from year to year the total acreage of the Dominion, although the recent good work of the Census and Statistics Office promises that this will henceforth be remedied. But outside of the three great wheat-growing sections—Ontario, Manitoba, and the North-West—the surface under this cereal is not material. By the latest figures available the four Eastern Provinces do not now grow 170,000 acres collectively, while the small surface in British Columbia,



not appearing in the last general Bulletin, was only 15,000 acres at the last census. In the roughly sketched diagram I insert here, therefore, the course of wheat-growing on 97 per cent. of the 6,611,000 acres accounted for in 1908 may be conveniently, if only approximately, traced.

The decline in Ontario, where, as in other older settlements, wheat-growing shrinks as more diversified forms of agriculture evolve, is much more than compensated for when the acreage of Manitoba, and in later years the rest of the North-West, is superadded, as in the columns of this diagram, and the rapidity of the recent extension, which—had the 1909 figures reached my hands sooner would have carried the total area far beyond the seven million limit—testifies to the energy in the task of bread-raising which this hopeful section of the British Empire displays.[1]

[1] Were the preliminary estimates for 1909 taken into account, the total acreage would have been given as 7,750,000 acres—a rise of 1,139,000 acres in the latest twelve months. This is indeed the net result, for the West has added 1,402,000 acres—of which 1,289,000 were in Saskatchewan and 113,000 in Alberta—while there are declines in the East and in Ontario of an almost exact equivalent of the last-quoted figure, or 114,000 acres, and likewise a reduction of as much as 149,000 acres in Manitoba since 1908.

But whatever determinations we can reach on the hypothetical questions here propounded, whether we may regard the greater rate of wheat-field extension in the world at large, which has marked the last decade, as disposing of immediate alarm for the bread supply of the next generation, or whether we find in the recent whisper of augmenting prices corroboration of the gain of population on subsistence, it is clear that our statistical records require a further development and a much improved continuity, especially in the new regions of the wheat supply of the future. Nor yet, again, can we dispense with the urgent lesson that science has much to teach us in making more use than we do of the areas acknowledged to be under more or less rudimentary cultivation. If Sir William Crookes was right in adopting the American statistician's average of 12·7 bushels per acre as the mean of the recognisable wheat-fields of the world, the prospect of the extra seven bushels he sought as immediately desirable will make us eager to learn the very latest triumphs of the laboratory in winning for the soil a freer measure of the nitrogen of the air. Even here in Manitoba, where a much higher yield seems on the average to be maintained under existing conditions, and where the cultivators with their 18 bushels average start from a vastly higher level, the promise of such a scientific ally should gladden the heart of the hard-working pioneer.

One caution, however, I feel it my duty to give, as a practical rather than a scientific agriculturist. Whatever wonders are offered in the way of manurial adjuncts or mechanical contrivances, do not let our advisers overlook the paramount consideration of the cost which the newer systems may involve. For the extensive farming of a young country it is above all requisite to remember that expensive methods of cultivation are not as feasible as in the intensive husbandry of old settled regions. Hopefully as we may wait on the chemist's help, I confess that, for my own part, I incline still more confidently to the botanist, under whose ægis of protection agriculture has this year been placed by the decision of the authorities. The producer of new and prolific and yet disease-resisting and frost-defying breeds of wheat plants is to-day more than ever encouraged by what has been done in many lands of late in this direction, to suit the crop to its environment. Nothing could be a greater boon to the wheat farmers, handicapped by a short and irregular supply of summer warmth, and the occasional but often untimely invasion of the frost fiend, than the production of varieties of wheat at once prolific and early ripening, and suited to the relatively scanty moisture of semi-arid regions. What success Canadian investigators, with their renowned experimental system, have had in this direction we hope to hear at Winnipeg, while some of us who have listened to Prof. Biffen, of the Agricultural Department of Cambridge University, look for hopeful results from the application of Mendelian laws to the breeding of wheat.

In closing, let me add that though it is a quarter of a century since I last was here, the message I gave local agriculturists then is one I am tempted to repeat now. It is no use to treat the vast territories you have at your disposal as if they were a mere wheat mine to be exploited in all haste and without regard to its permanence and its future profitable development. It is unwise to proceed as if bread were the only item of food requiring attention at your hands, and to regard a spasmodic rush of grain for a limited number of years from a poorly tilled surface as the only way to profitable returns. The stale maxim of not carrying all your eggs in one basket has a very profound truth to rest upon. The farming of the future must ultimately be one of more careful tillage, more scientific rotations, and of consideration for the changes in the grouping of population and in the world-wide conditions of man and his varying wants. What is going on all over the world has to be learned and studied well, and wheat pioneers of the North-West must not forget the possibility of yet new competitors arising in the single task of wheat-growing, whether they are to be looked for in the still developing sections of the Russian Empire and the still open levels of Argentina, the little-known regions of Manchuria, the basin of the Tigris and Euphrates, the more completely irrigated plains of India, the tablelands of Central Africa, or perhaps under new conditions and a more developed control of the reserves of water supply on the southern shores of the Mediterranean or even in the long tilled valley of the Nile.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—According to the *British Medical Journal*, a movement is on foot for the establishment of university chairs at the Royal Infirmary for the teaching of (1) medicine and clinical medicine; (2) surgery and clinical surgery; (3) midwifery; and (4) pathology. It is proposed that these four professors should form the teaching staff so far as the Royal Infirmary is concerned. Under this arrangement, in place of a complete, there would be a partial medical school at the Royal Infirmary, so that university students, if they preferred, might take their final year at that institution instead of at the Western Infirmary and Gilmorehill. Towards the accomplishment of this object it is understood that the Muirhead trustees are willing to give two sums of 400*l*. a year each to found two of the chairs, that the funds of St. Mungo's College are to be concentrated on one chair, and that the Carnegie trustees are to supply the funds for the fourth chair. The scheme will require to be sanctioned by Parliament, and draft provisional orders for that purpose are being prepared. These will be submitted to the members of the University Court for their approval, probably at a meeting in October.

Dr. G. A. Gibson, professor of mathematics in the Glasgow and West of Scotland Technical College, has been appointed professor of mathematics in the University of Glasgow in succession to Prof. Jack. Prof. Gibson has published a number of original contributions of importance to mathematical science, and is the author of works on the calculus which are acknowledged to be among the best in the English language. His wide knowledge of the history and present state of mathematical science, unusual powers of logical and lucid exposition, and ability as a creative scholar, ensure enthusiasm for mathematical studies at the University and increased activity in scientific investigation.

LONDON.—University College:—The following public introductory lectures will be given as under:—Sir William Ramsay, K.C.B., F.R.S., on "Radium Emanation: one of the Argon Lines of Gases," on Monday (October 4); Prof. H. R. Kenwood, on "What Hygiene demands of School Teachers," on Wednesday (October 6); Prof. J. A. Fleming, F.R.S., on "Electrical Inventions and the Training of Electrical Engineers," on Wednesday (October 6); Prof. Garwood, "The Origin of Scenery" (October 7); Prof. Carveth Read, "The Psychology of Character" (October 7).

MANCHESTER.—The new chemical laboratories of the University will be opened on October 4, when it is expected that the Chancellor, Viscount Morley of Blackburn, will be present and confer honorary degrees on the American Ambassador; Sir Robert Stout, Chancellor of the University of New Zealand; Sir Alfred C. Lyall; and Prof. Otto Wallach, of the University of Göttingen.

MR. JOHN FISHER has been appointed lecturer in biology at the Agricultural College at Cedara, near Maritzburg.

THE prizes and diplomas awarded at the South-eastern Agricultural College will be distributed on October 9 by Principal H. A. Miers, F.R.S.

PROF. W. OSLER, F.R.S., will take as the subject of his address before the London School of Tropical Medicine on October 26 "The Nation and the Tropics."

DR. WALTER MURRAY, of the University of Dalhousie, Halifax, according to *Science*, has been elected president of the new University of Saskatchewan, situated at Saskatoon.

SIR T. CLIFFORD ALLBUTT, K.C.B., F.R.S., will distribute the prizes and deliver an address at the opening of the winter session of Charing Cross Hospital Medical College, instead of Lord Ridley, as was announced.

ACCORDING to a Reuter message, the Czech University of Prague has conferred the honorary degree of Doctor of Philosophy upon the following men of science:—Sir Archibald Geikie, K.C.B., P.R.S., Dr. J. E. Marr, F.R.S., Dr. Francis Darwin, F.R.S., and Prof. T. W. Richards, of Harvard University

MR. WILLIAM BROWN, lecturer in electrotechnology at the Royal College of Science, Dublin, has been appointed to the professorship of physics in the college in succession to Prof. W. F. Barrett, F.R.S., who is to retire on October 1 under the Treasury regulations as to age. Mr. Brown's successor is to be Mr. Felixe Whackett, one of the junior fellows of the Royal University of Ireland.

THE following courses of free Gresham lectures are announced for delivery at the City of London School:—geometry, by Mr. W. H. Wagstaff (beginning on October 5); physic, by Dr. Sandwith (beginning on October 26); astronomy, by Mr. S. A. Saunder (beginning on November 2). This is the first term these lectures will have been delivered other than at Gresham College.

IN connection with the Child Study Society there will be a reception by the president at 90 Buckingham Palace Road on October 7, when short addresses will be delivered by Miss A. Ravenhill, Dr. C. W. Kimmins, and Dr. G. E. Shuttleworth. Succeeding lectures will be by the Right Hon. Sir John Gorst, Dr. W. C. Sullivan, and Dr. A. R. Abelson on, respectively, "The Care of Children under the Poor Law," "The Child Criminal," and "Mental Fatigue."

TWO more calendars of London colleges have reached us, those of the East London College and Birkbeck College. The East London College is a school of the University of London in the faculties of arts, science, and engineering, and a rapid development in its work took place during last session. To the equipment of the school of engineering—civil, mechanical, and electrical—valuable additions have been made, while the botanical department has been reorganised. A considerable sum of money was placed at the disposal of the college committee for these purposes by the Drapers' Company, who specially ear-marked a portion of their benefaction for the improvement of the college library, which is now well housed and possesses a good collection of works dealing with the subjects in the college curriculum. We learn from its calendar that the pressing need of Birkbeck College is for increased space; the usefulness of the college is curtailed by its limited accommodation. New and more spacious college buildings, with more class-rooms and larger laboratories better adapted to modern requirements, would give a great impetus to the work of the college, and it may be hoped, in view of the marked success of the work accomplished in the past, that it will prove possible to secure the money necessary for reorganisation.

AT the meeting of the Chicago section of the American Mathematical Society on January 2 of this year, a committee was appointed for the purpose of investigating the possibility of improving the character of mathematical appointments in colleges and universities. In the July Bulletin Prof. E. J. Wilczynski publishes the proposals submitted by him to the committee. He suggested (1) that vacancies should be announced in the Bulletin in a special column devoted to the purpose; (2) that in the case of major positions, i.e. posts of 400*l.* a year upwards, if a university should desire expert assistance in filling a post, the council should elect a nominating committee for the purpose, the names of the members being published in the Bulletin; (3) in the case of minor positions, Prof. Wilczynski does not consider that much could be done owing to the frequency of vacancies, but, at the same time, an annual standing committee might be appointed. While these suggestions only apply to America, and the report of the committee, which is on somewhat different lines, is to be published elsewhere, the idea suggests itself that reform is none the less needed in Great Britain, and that not for mathematical appointments alone. The present system of sending in printed testimonials is not only a heavy expense to the younger candidates, who can ill afford the money, but in the case of older candidates it involves a serious loss of time that would otherwise be available for research, and debars many from offering themselves for appointments.

Much interesting information as to the provision made for instruction in science and technology in the great provincial centres of population can be gleaned from the calendars and prospectuses issued at this time of the year by the colleges and institutes which have grown up since the Technical Instruction Acts came into force. Among such year-books received we notice those of Armstrong College, Newcastle-upon-Tyne, the Belfast Municipal Technical Institute, and the Bradford Technical College. While at each of these well-equipped institutions the claims of pure science as the foundation of all successful industrial practice are duly recognised, each rightly makes a special effort to suit its classes in technology to the particular manufacturing needs of the area in which it is situated. It is possible only to give a few instances. At Armstrong College there are special courses for miners, and prominence is given to naval architecture. In connection with the latter work it is noteworthy that the B.Sc. degree of the University of Durham, of which this is a constituent college, is awarded in naval architecture. In the Belfast institute day courses have been established to provide a sound training in mechanical and electrical engineering, in the science and technology of the textile industries, and in applied chemistry. Similarly in Bradford, the department of textile industries deals with every aspect of the industry, and diplomas, we observe, are awarded in preparing, combing, and spinning, in weaving and designing, and in chemistry and dyeing.

SOME months ago a committee was formed, with Dr. E. Berl, of Zürich, as secretary, which decided to present to Prof. Georg Lunge, in celebration of his seventieth birthday and the jubilee of his doctorate, a gold medal bearing his portrait, and to collect and hand over to him a sum of money—40,000 francs have already been collected—to be disposed of at his discretion. The formal presentation was made by Prof. Bosshard in the chief chemical lecture theatre of the Zürich Polytechnic on Sunday, September 19, the theatre being crowded with chemists from almost every European country. Following this ceremony congratulatory letters and addresses were delivered by the delegates, Dr. Landolt, speaking for the Swiss Society of Chemical Industry, leading the way. He was followed by Dr. R. Schmidt, director of the famous Elberfeld works, who represented the Verein deutscher Chemiker, and by Geheimrat Bunte, who brought an address from the Karlsruhe Technical College. Dr. Lepetit brought an address from the Società chimica Italiana, and Dr. F. C. Garrett spoke for the Newcastle section of the Society of Chemical Industry, the present-day representative of the Newcastle Chemical Society, of which Dr. Lunge was one of the founders. Chemists who have studied at Zürich are naturally among Prof. Lunge's most devoted admirers, and on behalf of those resident in Great Britain Dr. Richard Seligman presented an address signed by many of Lunge's old students and English friends. Dr. R. Nötzli brought congratulations from Austria, and Herr Bell spoke on behalf of those who still have the good fortune to be working at Zürich. In addition, there were numerous presentations from the various learned societies of Switzerland and Germany, whilst several hundred congratulatory telegrams, including one from the Society of Chemical Industry, were received. In an admirable speech Prof. Lunge thanked the many speakers and the societies they represented, and announced his intention of handing over the money which had been collected to the polytechnic, the interest to be used at the discretion of the professors of chemistry for the assistance of young chemists who would otherwise have difficulty in continuing their studies or investigations for a sufficiently long period.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 20.—M. Bouchard in the chair.—Multiple monochromatic images of the sun given by the large lines of the spectrum: H. **Deslandres** and L. **d'Azambuja**. A historical account of the study of the different layers of the solar atmosphere by means of monochromatic images of the dark lines. In the present paper an account is given of new work, in which the successive layers of iron, calcium, and hydrogen have been distinguished. The upper layers, the most interesting but the most difficult to isolate, have been specially studied, the large spectroheliograph with three slits, built in 1907, having been of great service in this connection.—The earthquake of June 11, 1909: Alfred **Angot**. A map is given of the district affected, showing the zones of equal disturbance.—The action of mineral waters on the striation and form of the valves of diatoms: A. **Lauby**.—The washing of cider apples with an oxidising calcium salt, leading to a pure fermentation: Henri **Alliot** and Gilbert **Gimel**. It has been shown that washing the apples with a weak solution of calcium hypochlorite is very advantageous. The preventive action of normal serum from the sheep on *Trypanosoma duttoni*: A. **Thiroux**.—Calculation of the depth of seismic hypocentres: Comas **Solá**.

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THURSDAY, OCTOBER 7, 1909.

TWO BIRD BOOKS.

(1) *Birds of the World: a Popular Account.* By Dr. Frank H. Knowlton. With a chapter on the Anatomy of Birds, by Frederic A. Lucas; The whole edited by Robert Ridgway. Pp. xiii+873. (New York: Henry Holt and Company; London: Constable and Co., Ltd., 1909.) Price 30s. net.

(2) *Birds Useful and Birds Harmful.* By Otto Herman and J. A. Owen. Pp. viii+387. (Manchester: The University Press, 1909.) Price 6s. net.

(1) IT would seem that there is no satisfying the demand for books on birds. Every year places before, not the scientific ornithologist only, but the general reader, in this country, scores of volumes on this group of animals, which must indicate a ready sale for them. The taste for natural-history works has unquestionably been growing in England at a rapid rate during the last decade among all classes of the community, instigated and encouraged largely by the non-technical manner in which so many treatises of the highest scientific authority are being published for the general reader, the majority of them lavishly illustrated, as well as by the issue of so many local faunas, which give an impulse to the study of the species to be found in their own neighbourhood by those into whose hands the books fall.

Imitation is the sincerest flattery, we know. The "Birds of the World," the first of the two volumes on our list, is one of the American Nature series, projected by Holt and Company, of New York, to which the leading scientific men of America are to contribute. This volume, however, compares disadvantageously in one respect with those of the English Nature series, in handiness and comfort in reading or consulting. It is an octavo measuring $10\frac{1}{2}$ inches long by $7\frac{1}{2}$ inches wide, and nearly 3 inches thick. It contains 873 thick pages, and turns the balance at more than 4lb.; it might be termed a bi-manual, or perhaps more appropriately a table-edition. In respect to its contents, the book stands on a high pedestal of excellence.

The demand for books on birds seems to be developing in America as rapidly as it is doing in England, for the Nature series of the United States is due, as the preface assures us,

"to the great awakening of popular interest . . . in recent years in relation to our birds, an interest that has been fostered not only by the admirable work of the Audubon societies and the widespread nature teaching in the schools, but by the deeper, broader sentiment which is leading back to, and nearer to, nature. The increasing number of people yearly turning back to the country, either for recreation or permanent residence, has naturally stimulated a desire to know more intimately their surroundings—the trees, the flowers, the birds."

The three names which appear, as authors or editor, on the title-page are a sufficient guarantee that the desire of the migrant to the country to know more, not only about the birds of the United States, but of those of the globe generally, will be gratified amply, accurately, and in a manner likely to foster personal observation of those species within the reader's reach.

After an introductory chapter dealing with definitions, and such questions as pterylosis and feather structure, nests and eggs, we are presented with clearly, concisely written chapters on the anatomy of birds, their geographical distribution, migration and classification. The various subclasses and orders of birds are then dealt with in twenty-one further chapters. Dr. Knowlton recognises two subclasses—Archæornithes, with unique representation in the Archæopteryx, and Neornithes, containing all other birds, which he divides into twenty-one orders. Had space permitted, we should feel tempted to demur at the position assigned in the avian "tree" to the Hesperornithiformes and Ichthyornithiformes, and to the Palamedeæ and Opisthocomi. Taking the author's brigading as it stands, we find each of the orders discussed in a very interesting manner. The habits and life-history of all the more important species in each are described concisely, as space demanded much condensation; yet nothing essential or really important is omitted to enable the reader to obtain an excellent grasp of each group. The illustrations are very numerous, and, with a few exceptions, excellent. There are 233 black-and-white blocks, many of them full-page; of the latter, some of the best are reproductions of those beautiful life-like groups with scenic backgrounds which form one of the most attractive features of the American Museum in New York. The representation of the young hoatzins is specially instructive. Where the blocks, however, have been made from coloured plates in such works as Schlegel's "Diergaarden" or the Zoological Society of London's publications, the results have proved less satisfactory, inasmuch as the yellows and reds of the originals have come out too dark. The smaller text-figures also leave something to be desired, occasionally, in the clear definition of markings on the plumage. Of the sixteen full-page plates reproduced in the three-colour process, with which the volume is further embellished, specially noteworthy are those of the mandarin-duck, the racket-tailed kingfisher, and the lesser bird of paradise. The figure of the kiwi on p. 29 is taken, we presume, from a drawing of the type which was mounted for Lord Stanley's collection at Knowsley, before the correct attitude and habits of the apteryx were sufficiently known either to scientific men or to taxidermists. Buller's "Birds of New Zealand" would have supplied a better model.

The information contained in the "Birds of the World" is, as already remarked, nearly everywhere up to date, and very accurate; but the omission of any reference to the Phororachidæ is surprising. In regard to the moa, the bird is described as being absolutely wingless. Evidence, however, was obtained from a turbary deposit near Omaru proving that certainly one species of Dinornis possessed a humerus that functioned in its glenoid cavity on the scapulo-coracoid; and, if the writer be not mistaken, a small bone is in existence in New Zealand very similar in form to that described as belonging to the humerus of Œpyornis. The moa had probably, therefore, a diminutive wing like that of the kiwi. With regard to the question whether the Maoris ever saw the moa, it is stated on p. 81 that "it appears that the Maoris have only been in their present location for about ten generations, or some 250 or 300 years, and the moa could hardly have lived within that period, and it is held as probable that their extinction was several centuries earlier than this."

Definite evidence of the contemporaneity of the Maori and the moa was adduced some eighteen years ago, during the exploration of the Sumner Cave, near Christchurch. The mouth of this rock-shelter had been closed by a landslide before the arrival of the Europeans in the South Island, the result, probably, of an earthquake, while a meal was in progress. The occupants succeeded in escaping, but round the fireplace about which they had been sitting were found moa bones and portions of the eggs, with the shell-membrane intact, on which they had been feasting. On the floor near by lay a boat-bailer and other objects with the carving truly characteristic of the Maori upon them.

Of the three specimens of the now extinct *Dromaeus ater* discovered, and brought to Europe by the French expedition under Baudin, all have now been located, as stated in the work before us—two in Paris (a skeleton and mounted specimen), and one (a skeleton) in Florence. A fourth specimen, it might have been mentioned, is now in the Lord Derby Museum, Liverpool, and was exhibited at the International Ornithological Congress in London by the Hon. Walter Rothschild on behalf of the director of that institution. As to the black swan of Australia, it seems extremely probable that it was indigenous to New Zealand as well as to the island-continent. The bones of a species, described under the name of *Chenopis sumnerensis*, hardly differing from those of *Chenopis atrata*, were found among the débris of the disturbed meal referred to above in the Sumner Cave, as well as in an ancient kitchen-midden in the Chatham islands.

A very full index completes this very excellent, succinct, and trustworthy account of the "Birds of the World," and we hope it will, despite is bulkiness and weight, meet in the United States, and in England also, with the appreciation it fully deserves.

(2) The second volume in the list given above is of a very different character, and the reason for its publication in this country is not very apparent.

The book is a translation of portions of the valuable work prepared by the director of the Royal Hungarian Ornithological Bureau to enable landowners, farmers, fruit-growers, and gardeners in that country to discriminate their avian friends and foes, together with a somewhat well-worn account, padded with poetical quotations, by Mr. J. A. Owen, of a selection of our most common English birds, including always the statement whether the species is harmful or useful in England, which seems to be apparently the only excuse for Herr Herman's book (in part) appearing in an English garb. The English co-author believes that amongst the innumerable books on bird-life which have been published of late years "there has been a lack which this little volume may supply."

From a careful reading of the work we can really discover very little not to be found in nearly every book on British birds. It includes also a few species, common in Hungary, which rarely visit England, or are only winter visitors which can trouble the English agriculturist but little. It lacks, moreover, the details "arranged on a regular scientific basis" and "the investigations with regard to the food of birds carried on by a fully qualified entomologist" upon which Herr Herman has proved the various species of Hungary to be useful or harmful, and which would have impressed the corresponding classes of readers in England as those for whom the volume was prepared in Hungary. A more thorough work on the economic value of birds in the English language is to be found in the Bulletins of the U.S. Department of Agriculture, which contain the life-history and the detailed results of the examination of hundreds of individuals of each species, including nearly as many English ones as are given in the volume under review. "Birds Useful and Harmful" may, nevertheless, assist in spreading the knowledge of those birds, persistently persecuted, that deserve protection. F.

A GROUP OF "FLORAS."

(1) *A Tourist's Flora of the West of Ireland.* By R. L. Praeger. Pp. xii+243; with 5 coloured maps, 27 plates, and 17 figures. (Dublin: Hodges, Figgis and Co., Ltd., 1909.) Price 3*s.* 6*d.* net.

(2) *Illustrated Guide to the Trees and Flowers of England and Wales.* By H. G. Jameson. Pp. xi+136. (London: Simpkin, Marshall and Co., Ltd., 1909.) Price 2*s.* 6*d.* net.

(3) *Flora Koreana. Pars Prima.* By T. Makai. (Journal of the College of Science, Imperial University of Tokyo, Japan, vol. xxvi., article i., 1909.)

(4) *The Botany of Worcestershire. An Account of the Flowering Plants, Ferns, Mosses, Hepatics, Lichens, Fungi, and Fresh-water Algae, which grow or have grown spontaneously in the County of Worcester.* By J. Amphlett and Carleton Rea. Pp. xxxiii+654. (Birmingham: Cornish Bros., Ltd., 1909.) Price 25*s.* net.

(1) MR. R. L. PRAEGER'S book is a solid contribution to the subject of phytogeography, and is increased in value by the many beautiful, mostly full-page, photographs of striking species of plants, some of which appear for the first time, as here illustrated. Coloured and uncoloured maps of the districts described or of the distribution of species add to the usefulness of the book, which is well indexed and singularly free from typographical errors. The introduction contains a short account of the physical features of the west of Ireland, of its, mainly edaphic, plant formations, and of the more remarkable features of its flora. The topographical section which follows contains valuable information on the character of the flora of the numerous regions selected for description. This section will appeal to the touring botanist, more especially as the information given is not purely botanical. The author might have expanded this section, with advan-

tage to the inquiring tourist to whom the west is unknown.

The systematic section forms half the book, and follows mainly the classification and nomenclature of the London catalogue. *Pilularia globulifera* is wrongly placed in the Selaginellaceæ. The distribution of each species is recorded, and in many cases it is due to the work of the author that the distribution is now known to be so extensive. First records are duly credited to the discoverers, and many interesting observations are embodied in the text. The Saxifrages and the heaths, *e.g.*, are adequately treated. The book can be well recommended for the sake of its illustrations, and would be worth purchase if it had none. It does justice to the delightful botanical and other attractive features of the west, and is a credit to author and publisher.

(2) The avowed object of the writer of this book is to enable readers, knowing little of botany, by its use to give names to the plants they find, the name being, the writer insists, the first essential. This idea is not at all in keeping with recent views on nature-study. Still, every student of botany should learn to name a plant by the help of a "flora." Teachers know how students, even with the keys in our best floras, fail from time to time to name a plant. In the book under review all flowering plants are divided into ten sections. One section—flowers in heads or umbels—includes the Papilionaceæ. In another section—flower parts in threes or sixes—Rumex occurs between Triglochin and Luzula. The section devoted to aquatic plants will prove useful. Monocotyledons and Dicotyledons are not differentiated. Ruscus is said to have "phyllodes" as leaves. This is one of the few cases in which botanical terms are introduced.

The second part of the book is devoted to a selected number of natural orders, and more especially to the means of identification of the species of different genera, arranged alphabetically. This is the most useful part of the book. The illustrations, though small, are generally good. Misprints are few. There is, however, no index. The book is cheap, and will prove serviceable to the reader who already knows his natural orders fairly well.

(3) Mr. Makai's work is indicative of the line followed by Japan on the absorption of a new province into its empire. Korea was quite recently annexed, and so early as 1906 Makai began his study of its flora. The systematist of Japan is to-day doing as the British systematists did at the time England first acquired and explored her colonies.

This first part of the "Flora Koreana" deals with the Polypetalæ and certain Gamopetalæ, and is well illustrated by fifteen plates (one or two of which are rather crowded) of plants mostly new to science. Though printer's errors are numerous and generally indicated in a list of *errata*, the volume is produced in a form in keeping with the high standard of the other publications of the College of Science of Tokyo. The keys to the genera, and, under each genus, to its species, are useful. Under each species its bibliography, habitat, distribution, and Japanese name are given. New species and varieties are described in Latin, and usually illustrated. The index is inadequate. It is necessary to search the body of the work for the novelties, and there is no general index to the contents of the plates. It is impossible to discuss the contents of the volume in detail. One illustration must suffice for comparison with our flora. The beautiful genus Acer is represented by fifteen species or varieties. Trifolium by one species only.

(4) This work deals in a comprehensive manner with the flowering and flowerless plants of the county of Worcester. In an introduction of twenty pages justice is done to earlier publications, Lees and Mathews being specially noted. The authors follow the London Catalogue in the names of the species, adding useful synonyms. First records are duly credited, and valuable specific distinctions are occasionally added. Some of the notes, now and then amusing, are often loosely worded, and might sometimes have been omitted with advantage. The mosses and liverworts are listed by J. E. Bagnall, and the fungi by C. Rea, both authorities on their groups. It is a little disconcerting to find *Protonema muscicola*, Ag., recorded as a fresh-water alga (crowding about the bases of moss-stems)! Throughout the book derivatives of the Latin names are given. A map showing the botanical areas of the county is an excellent feature. The book is a distinct advance on previous publications on Worcestershire botany, and should stimulate interest in field botany in the county. The price is high for a county flora, but local patriotism will probably rise to the occasion. T. J.

GEOLOGY OF NEW YORK CITY.

Geology of the City of New York. By L. P. Gratacap. Pp. x+232; with 65 figures and 4 maps. Third edition, enlarged. (New York: Henry Holt and Co., 1909.)

THIS general treatise on the underlying structure of the city of New York and its immediate surroundings appears to be the amplification of a shorter work on the same subject, printed privately for the author. Its outlook is local, and, as the interpolated "Class Directions" indicate, it is intended primarily for use in the instruction of the inhabitants of the great city. It is compiled from various sources, which are duly acknowledged, and contains, besides, some original observations, but these are not sufficiently important or numerous to appeal to the wider circle of geologists who have no particular interest in the locality. In many passages it emphasises the transformation wrought by man on the original aspect of the country, in deference, no doubt, to the naïve astonishment with which the average town-dweller receives such information.

New York is one of the few great cities founded upon crystalline schists. Some of the problems of the schists and their entangled igneous intrusions are touched upon by the author, but his grasp is hardly adequate for their unravelling. As in almost every similar region, diverse views are held respecting the age of the different members of the schistose series.

They are supposed by the official geologists of the U.S. Survey and others to include large masses of altered Palæozoic sediments, while the author supports the alternative opinion that most of these rocks are Pre-Cambrian. The Triassic rocks of the western side of the Hudson River, with their intrusive diabase which forms the picturesque Palisades, and the sparingly exposed Cretaceous strata of Staten Island are the only other "solid" formations known in the neighbourhood of New York.

The drift deposits and their associated phenomena, everywhere conspicuous, afford the subject for the final chapter of the book, which the author presents in a strain calculated to impress the uninitiated.

The arrangement of the book is somewhat confusing to the outsider, being based on the municipal divisions of the city. The style of writing is often turgid, over-ornamented, and not particularly accurate. A region is described as of "pene-Saharal loneliness"; there have been "loculicidal slippings" in the gneiss (the botanical adjective looking quite aggressive here); the drifts "tell the singular story which the long, tireless and infinite retinue of glacialists has been engaged in translating these long years"; and so on. Misprints are numerous, even in the preface "carefully" appearing as "carfully"; the so-called "bibliographies" contain few proper references; and there is no index to the volume.

In some appended notes on the archæology of Manhattan Island, some relics of the British army engaged in the Revolution are mentioned; and, considering the recency of the period, it seems curious to read that "the habits and life of the soldiery have been traced by the remains of their food, utensils, pikes, cutlery."

G. W. L.

THE LAWS OF INHERITANCE.

Elemente der exakten Erblichkeitslehre. Deutsche wesentlich Erweiterte Ausgabe in Fünfundzwanzig Vorlesungen. By W. Johannsen. Pp. vi+516. (Jena: Gustav Fischer, 1909.) Price 9 marks.

WITHIN the last few years the output of exact experimental work upon phenomena of heredity has been very large, and the progress made, as compared with that of the previous forty years, has been astounding. In England it has chiefly been produced by investigators who have strictly segregated themselves either to the Mendelian or the biometrical schools, and who as a rule seem unable to realise the merits of the work of their rivals. One may pause in astonishment on reading, in a recent work issued by the head of the Mendelian school, that

"Of the so-called investigations of heredity pursued by extensions of Galton's non-analytical method and promoted by Prof. Pearson and the English biometrical school it is now scarcely necessary to speak. That such work may ultimately contribute to the development of statistical theory cannot be denied, but as applied to the problems of heredity the effort has resulted only in the concealment of that order which it was ostensibly undertaken to reveal. . . . With the discovery of segregation, it became obvious that methods dispensing with individual analysis of the material are useless."

Most biologists, with no axes to grind, are able to appreciate the importance of the work of both schools, though at present it is scarcely possible for them to judge whether the work of the one is destined to be of more permanent value than that of the other. The mutually destructive criticism of the two, though not without value in stimulating healthy competition, has the unfortunate result that the biologist who is wedded to neither school finds it difficult to lay his hands upon an adequate but impartial description of their methods and results. To such we can cordially recommend the work on inheritance, by Prof. Johannsen, now before us. The Danish edition of this book was published in 1905, but the present edition is double the size of the original, and is practically a new work. It consists of twenty-five lectures, in the first eight of which the facts of variation and its statistical study are discussed. The author then describes at some length his own very interesting experiments upon a "pure line" of self-fertilised beans (Phaseolus), which he bred for six generations. He found that selection within such a pure line did not lead to departure from the type, *i.e.* beans grown from a small bean were exactly the same size as those grown from a large bean of the same plant. He designates these non-heritable variations in size as "fluctuations." These results have coloured the author's outlook upon problems of segregation, mutation, and selection, and before accepting his interpretation the criticism of his experimental results by Prof. Pearson and the late Prof. Weldon should be studied ("Biometrika," ii., p. 499).

In subsequent lectures the author discusses discontinuous variation, correlation, regression, and the effects of conditions of life, and then passes on to describe Mendel's law and de Vries's theory of mutation. Darwin's principle of natural selection acting continuously upon small, indefinite variations finds but small favour in his eyes, and he attributes the origin of species to the appearance of mutations and the production of new races by crossing, the new characters being propagated unchanged in accordance with Mendel's law. Selection produces nothing, but extirpates unfavourable mutations, and so leaves room for new and favourable ones. However, the author makes no attempt to explain how mutations, in spite of their extreme rarity, have been able to effect so much. Hence, as is only to be expected, these views on heredity, though worthy of full consideration, must be studied in a critical spirit.

H. M. Vernon.

OUR BOOK SHELF.

A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet. By Col. S. G. Burrard, R.E., F.R.S., and H. H. Hayden. Part iv. The Geology of the Himalaya. (Calcutta: Government Printing Office, 1908.) Price 2 rupees.

The fourth part of the sketch of the geography and geology of the Himalayas is entirely the work of Mr. H. H. Hayden, and is devoted to a review of the present state of our knowledge of the Himalayas. This knowledge is fragmentary; of the Himalayas east of Sikkim only a few small patches, and these close to the southern margin, have been visited, then comes the independent State of Nepal, of which nothing at all is known, and it is only in the British territory and the native States under British control at the north-western extremity of the range that the geology is known, even approximately There is, consequently, a tendency to extend the knowledge of this region to the rest of the range, and to draw conclusions which are only doubtfully applicable.

This tendency has not altogether been avoided, and the lengthy discussion of the age of the unfossiliferous sedimentary rocks of the Simla region seems to give this subject an importance which it does not possess, especially as, in the end, it is left in a state of little less uncertainty than before. The only clue to the age of these rocks is the fact that they contain a series of beds, the Blaini, which is generally acknowledged to present unmistakable signs of glacial origin. At one time this series was regarded as of Permian age, but this explanation is rejected, and the Blaini series is correlated with the pre-Cambrian glaciation which has been studied and described in Africa, China, Australia, and, we may add, in Norway. Mr. Hayden argues with great plausibility that the complete absence of any trace of fossils in a great thickness of rocks, which might well be expected to contain them, and their abundance in the great series of deposits on the other side of the snowy range, is more reasonably explained by a difference in age than in conditions of deposition. This reasoning we may accept, and acknowledge that the Blaini tillites are more probably pre-Cambrian than Permian in age, but the possibility that the rocks of the Simla area are a flysch facies of the fossiliferous sediments of Spiti must be borne in mind, and, until less equivocal evidence is adduced, the problem must remain unsolved.

With this exception the work is a well-balanced summary of the geology of the Himalayas, useful to those who wish to have the leading facts put briefly and clearly, and also, by the copious references to original authorities, invaluable as a guide to more detailed study.

Elementary Physiology for Teachers and Others. By W. B. Drummond. Pp. viii+198; illustrated. (London: Edward Arnold, 1909.) Price 2*s.* 6*d.*

THIS is a useful little book of its kind, elementary, as its title implies, and correct in its details, an element so often lacking in similar works. Like other books of its class, it necessarily contains a good deal of what is anatomy rather than physiology, and it chiefly differs from its competitors in pointing out the applications of physiology in the health, well-being, and training of children. This is by no means an unimportant point, seeing that the work is written for school teachers.

W. D. H.

Evolution: A General Sketch from Nebula to Man. By Joseph McCabe. Pp. vii+128. (London: Milner and Company, Ltd., n.d.) Price 1*s.* net.

THE author of this little book defines his aim as being "chiefly to present a panoramic view of the development of the world—especially the world that lies close about us—by a conscientious use of the results of many sciences, and aided by a personal acquaintance during many years with both telescope and microscope." The style is interesting, and the slight sketch provided may send a few general readers to first-hand authorities for further information. The language is not always precise; for instance, we find "refractory liquid fire," "a lowering of climate," and so on; but on the whole the volume may serve a useful purpose by introducing non-scientific readers to some problems of inorganic and organic evolution.

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.*]

Magnetic Storms and Solar Eruptions.

REFERRING back to the *Electrician* of nine years ago (December 7, 1900), I find that, following up a suggestion of G. F. FitzGerald made in 1893, I promulgated a view of major magnetic storms which events have confirmed. See, for instance, Mr. Maunder's paper in Mon. Not. R.A.S. for 1904, vol. lxv., p. 33.

What I have to point out is that a stream or beam of electrons ejected from the sun and passing near or over the earth would cause magnetic perturbations of the kind required—positive as it approached, zero as it passed over, negative as it receded; with many minor disturbances superposed due to variations of density, as well as others due to the effect of particles caught by the atmosphere.

Such a beam or stream of electrified particles is essentially a magnetic cyclone, and the changes in magnetic force as it travels past any locality bear a fairly close analogy with the changes in wind-velocity during the passage of an atmospheric cyclone.

The relative speed of such a solar beam, as it overtakes the earth, follows from the sun's angular velocity, and is 210 miles a second.

Earth currents would, in the main, be induced as it approached and checked as it receded.

The rotation of the earth in the magnetic field of such a stream is too slow to be effective: though locally in the neighbourhood of six o'clock an intense ray of the main beam might generate east and west currents.

Now magnetic disturbances recorded during the recent storm, and quoted by Dr. Chree in the *Times* and elsewhere, indicate a declination deflection of $1\frac{1}{2}$ degrees, followed by a reversed deflection of the same amount—all within a quarter of an hour.

This means—on the above theory—that the main beam took this time to traverse the place, so that the breadth of the beam was comparable to twenty times the earth's diameter. No doubt it is diffused, at this distance from the sun, by internal repulsion of the particles.

The intensity of field which would give the above deflection is approximately one-fortieth of that of the earth's horizontal intensity, or, say, 0·004 C.G.S., as the order of magnitude.

Taking these data, together with the known charge and velocity of electrons in kathode rays—say $e=10^{-20}$ electromagnetic C.G.S. units, $u=10^9$ centimetres per second—let us reckon the closeness of the crowd of particles in the beam necessary to account for the observed force.

The magnetic intensity at any place, distant r from the axis of a linear stream of sectional radius a and current density γ, is given by the following expressions:—

$$H=\frac{2C}{r}$$

$$C=\pi a^2\gamma$$

$$\gamma=n_1eu,$$

where n_1 is the number of particles per cubic centimetre of the stream.

This gives

$$n_1=\frac{rH}{2\pi a^2eu},$$

so taking a place just grazed by the beam, so that $r=a=20\times 2/\pi\times 10^9$, and putting in the other data just cited, we get

$$n_1=\frac{0·004}{80\times 10^9\times 10^{-11}}$$

$$=0·005 \text{ per c.c.},$$

or, say, five electrons per litre, on the average, all through the beam. I regard this as a modest and not unlikely estimate of crowdedness. The amount of matter ejected from the sun in this beam is insignificant, being less than a couple of tons per week.

The total current equivalent of such a beam is six hundred thousand amperes—which again is rather surprisingly moderate, and leaves plenty of margin for under-estimate of disturbance and for local perturbations too great for the instruments.

I send this little calculation because some doubt has been expressed as to whether the magnetic effect of a solar stream would be adequate to explain observed facts. It appears to me in general outline to be ample, both in amount and kind.

OLIVER LODGE.

University of Birmingham, October 4.

The Magnetic Storm.

Some details of the magnetic variations during a period including the great magnetic storm of September 25 may be of interest to the readers of NATURE.

From the beginning of the month the magnets were comparatively quiet, disturbed from a state of calm only by small oscillations, increasing somewhat on September 7, 8, and 15 until September 21, when a greater disturbance was recorded between noon and midnight. This was followed by an approximate calm until 8.30 a.m. of September 25, when the coming storm was foreshadowed by a sudden small dip in the curves of the declination and horizontal-force magnets, and a slower fall of vertical-force curve, indicating an eastward movement in declination and a diminution of the two components of force. The preliminary oscillations thus started remained small, averaging about 10′ of arc on both the declination and horizontal-force curves until some time between 11.40 a.m. and noon, whilst the films were being changed. It is, therefore, not clear on which side of the film the spot of light was carried away by the first great deflection; but in declination it remained off the paper until 11.40 a.m., when it was found returning from the east, while the horizontal force had already recovered, and, together with the vertical force, was showing a rapidly increasing intensity.

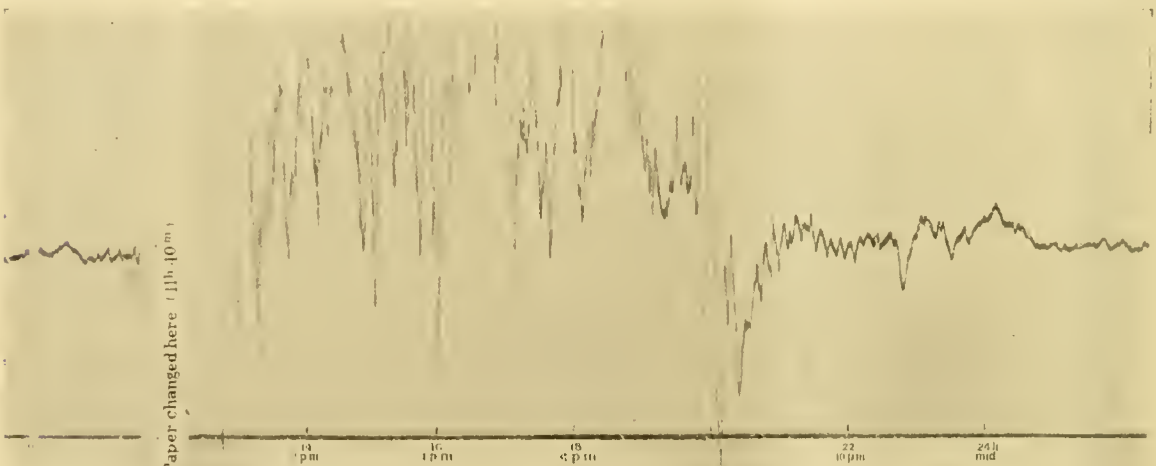
The general deflection in declination was westward throughout the storm, with many rapid moves off the film, and only two violent throws to the east, one at the commencement and the other at the end of the storm, the latter being a swing across the film from the extreme west edge over the east edge in less than two minutes of time, covering more than $2\frac{3}{4}$ degrees. An equally great and rapid movement on the horizontal-force curve took place at the same time near the close of the storm, with increase of the component force, and the vertical-force balance finally heeled over through loss of force.

The storm seems to have been at its height between 3.30 and 5.30 p.m., when the light spots of all three instruments were, for the most part, off the papers, and ended at 8.30 p.m. It was followed by smaller rapid oscillations of the declination and horizontal-force needles until midnight, when the small after-tremors commenced, and continued until about 6 p.m. of September 27.

The seismologist cannot fail to see in these three phases of oscillation an imitation of the pendular swings produced by a distant earthquake, and the preliminary movements are undoubtedly of the first interest to the student of terrestrial magnetism. The suggestion is very pointed that, whatever be the cause of the magnetic storm, it must be something arriving in our neighbourhood, whether directly from the sun or circulating round it, of which a part travels quicker and has less effect than the slower moving particles which produce the great oscillations; but we are in no position to meet the difficulties which beset any definite supposition as to the nature of these particles, and defend it against the apparent contradictions which assail it.

WALTER SIDGREAVES.

September 28.



Declination Magnetogram, Stonyhurst College Observatory, September 25, 1909.

THE MEETING OF THE INTERNATIONAL GEODETIC ASSOCIATION IN LONDON AND CAMBRIDGE.

THE meeting which began in London on Tuesday, September 21, and ended in Cambridge on September 30, has been notable in several respects. Great Britain joined the International Geodetic Association only twelve years ago. The triennial meeting has been held this year for the first time in England, and for the first time Greater Britain has been represented by special delegates from the Governments of India, Australia, and Canada; Chili has become a member of the association and sent a representative; and the Egyptian Government has been represented by one of the British officers of the Survey Department. The London meeting marks, then, a broadening of the interests of the association on the political and administrative side; on the scientific side it has been remarkable for the extremely interesting reports upon the special problems of the internal constitution of the earth and the lunar earth-tides.

About fifty delegates, from twenty nations, were appointed to represent their respective Governments, and came to the congress, which held its London meetings in the handsome apartments of the Institution of Civil Engineers, kindly placed at the disposal of the British representative. A large part of the business of the association consists in the reception and adoption of general reports of a highly condensed and technical character, impossible to summarise.

We believe that we shall do better to give an account of the principal discussions only, rather than to attempt to mention the name of every report and its author.

On Tuesday morning, September 21, the chair was taken by Mr. Haldane, Secretary of State for War, who warmly welcomed the association to England on behalf of the British Government. Sir George Darwin, vice-president, welcomed the delegates in the name of the Royal Society, in the absence of Sir Archibald Geikie, prevented by an accident from being present. General Bassot (president of the association) then took the chair and delivered his address; the permanent secretary (Prof. H. G. van de Sande Bakhuyzen) presented his report, and much business of a formal character was taken.

On the Wednesday morning the first business of importance was Prof. Hecker's account of his determination of the lunar earth-tides. Nearly thirty years ago Sir George Darwin and Mr. Horace Darwin tried to observe the lunar earth-tide in the Cavendish Laboratory at Cambridge, but the effect was masked by much larger deviations due to temperature. Prof. Hecker states that the effect of the solar heat was diminished 85 per cent. when his apparatus was transferred from the cellars of the Geodetic Institute to a chamber in a well shaft 25 metres below the surface. Here, in 1902 December, he installed his horizontal pendulums, and observed, with two small interruptions, until 1909 May. Analysis of the resulting curves shows an undoubted periodicity in half a lunar day, and a comparison of the observed with the easily calculated theoretical curve gives the following results:—The yielding is a little larger than would occur if the earth were a ball of steel, and about half the theoretical amount for a perfect fluid; there is little lag, so that the internal friction caused by deformation of the earth must be insignificant; the ratio between the major and minor axes of the elliptical curve does not agree with theory; this is probably not caused by local irregularity, but is, perhaps, due to the position of Potsdam near the western edge of the European-Asiatic continent; an investigation, whether the shape of the surface of the earth is changed by change of barometric pressure, gave inconclusive results. Prof. Hecker concluded that the outstanding questions could be settled only by observations at a number of stations, and he asked the association to stand godfather to these investigations.

In discussion, Sir George Darwin said that the association had in the past devoted much of its funds to the study of the variation of latitude; we may feel quite sure that Newcomb was right in regarding the prolongation of Euler's nutation period as due to the elastic yielding of the earth's mass; and he regarded Hecker's work, therefore, as a second chapter in the variation of latitude investigations. He accepted as worthy of consideration Prof. Hecker's explanation of the remarkable absence of symmetry in the path of the vertical, but suggested an alternative possibility. The curve was much compressed in the N.–S. direction, showing that the earth has much greater rigidity E.–W. than N.–S. It is possible to explain this to some extent by the earth's rotation. Lord Kelvin introduced the idea of gyroscopic rigidity, that is, of greater rigidity E.–W. due to rotation. Whether this is a sufficient explanation cannot be said, because no one has succeeded in solving completely the gravitational problem of a rotating elastic globe. Prof. Hecker's examination of the barometric effect had proved abortive; but he had been pleased to receive lately a letter from Mr. Napier Denison, of the Canadian Meteorological Service, who has succeeded in showing that on the Pacific coast, when the high-pressure system moves towards Alaska, the mean position of the vertical shifts in the same direction.

Dr. Backlund (Russia) suggested that in this matter the International Seismological Association might cooperate with the Geodetic Association in providing funds.

A commission to report on the subject was appointed as follows:—Dr. Backlund (Russia); Sir George Darwin (Great Britain); Baron Eötvös (Hungary); Profs. Haid, Hecker, and Helmert (Germany); M. Poincaré (France); and Prof. Weiss (Austria).

On the Thursday morning Sir David Gill presented his report on the progress of the great African arc of meridian. The British portion has been carried nearly to Tanganyika from the south, and a small section has just recently been measured on the Uganda-Congo frontier. The intervening section belongs to Germany. He understood that Prof. Helmert had already taken active steps to ask for money, and was sorry that for the moment the German Treasury had not responded with its usual alacrity. He could only hope that the little piece just completed to the north will act as a hook to which they will duly rise and be caught in the net of triangulation. We must now think of carrying the arc forward to Egypt, and from Egypt to join Struve's great arc which terminates on the Danube. Captain Lyons had travelled over most of the line in Africa, and Sir David Gill had his authority to say that the completion was only a question of money. There are no real geographical difficulties. Much has been made of the sudd, but this occupies only the valleys, and there are hills on each side. He believed, also, that it is possible to find, away from the river, a line more practicable and closer to the 30th meridian. To complete the whole from Uganda to the Danube would cost about 100,000*l.* He wished the association to adopt a resolution expressive of the importance of the work, and hoped that in time the Governments concerned, helped by private munificence, might be able to provide the money.

Colonel Close (General Staff) said that when it became necessary to send a party to survey the disputed territory on the Congo-Uganda boundary, the Colonial Survey Committee gladly took advantage of the occasion to measure a section of the arc of meridian. The British Government asked the Government of the Congo to approve and cooperate, and the latter appointed a commissioner, who observed all the latitudes. The Royal Society, the Royal Astronomical and Geographical Societies, and the British Association had contributed part of the funds. The whole was an admirable example of cooperation between governments and learned societies.

On the Saturday morning, Prof. Baron Eötvös presented a very encouraging report on the results of his three years' work with his torsion balance. In 1906 he had described the plan of this remarkable apparatus, which gives a rapid means of determining abnormalities in the direction and intensity of gravity. In response to a recommendation of the association, the Hungarian Government placed an annual sum of 60,000 crowns at the disposal of Baron Eötvös, who has been enabled thereby to make many improvements in his apparatus, and to complete a gravity survey over 400 square kilometres in the great plain of Hungary. Simultaneous observations with the torsion balance and with half-second pendulums of the standard Potsdam type, combined with determinations of the deviation of the vertical from astronomical and geodetic latitudes, resulted in a complete accordance, and established the accuracy as well as the extreme handiness of the torsion balance. Baron Eötvös' words give a graphic picture of the operations:—"M. Ch. Oltay followed the traces of the torsion balance and determined by means of his pendulums the differences in gravity between five stations. This voyage into the unknown, far from mountains and from all other irregularity in the distribution of [surface] masses, had a peculiar charm. As we marched over a quite uniform plain, our instruments continually revealed to us something that was hidden below, and we could always direct our steps so as to follow or to cross a series of masses, and in this fashion know them better and better." A bye-product of this work illustrates its remarkable delicacy. Newton had shown that the gravitational attraction upon units of mass of different substances is the same within one part in a thousand; Bessel reduced the limits of possible difference to one in sixty thousand. Baron Eötvös, with his torsion balance, has reduced them to one in a hundred million, and thus set at rest the disturbing doubt whether geodesists might not have to consider more than one geoid.

We have left little space for the other topics that came before the congress. Colonel Bourgeois' report on base measurements revealed a mistrust of invar wires which was not generally shared; the resulting discussion, however, revealed some difference of opinion as to the necessity of standardising these wires in the field, and as to the respective merits of wires and tapes; it was decided to publish an interim report on the subject as soon as possible. Mr. King, Dominion Astronomer, made the gratifying announcement that his Government had authorised the establishment of primary triangulation in Canada upon a strictly geodetic basis. Colonel Burrard, representing India, described the measures which had been taken to discover whether geologists are right in supposing that the Himalayas and Tibet are moving southward and crumpling up the Siwalik range from the alluvial plain. Mr. Keeling described the geodetic operations in Egypt, resumed two years ago by the Government of H.H. the Khedive, "after a regrettable interruption of twenty centuries." Dr. Backlund and Dr. Carlheim-Gyllensköld gave a further account of the geodetic operations in Spitsbergen. Colonel Bourgeois described the re-measurement by the French Academy of the historical "arc of Peru." Prof. Hecker reported on his determinations of gravity over the Black Sea, on a vessel put at his disposal by the Russian Government. There is a somewhat remarkable circumstance connected with these investigations. On his earlier voyages he omitted to take account of the alteration in gravity produced by the E.-W. motion of the ship. Baron Eötvös pointed out the omission, and Prof. Helmert showed from Hecker's observations that the correction appeared to make otherwise concordant observations discordant; hence, he said, the theory appears to be incomplete. Prof. Hecker finds, however, from his Black Sea observations that the correction in question is certainly required. It remains to be explained why the former observations were accordant without it. Prof. Helmert has undertaken that the whole shall be re-reduced.

The somewhat severe and technical labours of the congress were relieved by pleasant social functions, which were, however, kept strictly within bounds, and not allowed to become the burden which the festive side of a congress is too apt to be. On September 22, Sir George Darwin, representing the British Government, gave an official dinner to the principal delegates. On September 23, the president of the Royal Geographical Society took the whole party to Greenwich by water for a visit to the Royal Observatory and the Royal Naval College. On September 24, the Treasurer of the Royal Astronomical Society and Mrs. Hills were "At Home" at 32 Prince's Gardens. On September 25, the delegates and their ladies visited Windsor, on the gracious invitation of the King. On September 26 many of them visited the National Physical Laboratory.

On Monday, September 27, the congress moved to Cambridge, where those unaccompanied by ladies enjoyed the hospitality of Trinity, St. John's, and Caius Colleges, and many others received private hospitality. On September 28, Sir Robert and Lady Ball were "At Home" at the Observatory in the afternoon, and Sir George and Lady Darwin gave an evening party in St. John's College. The final meeting was held on Wednesday, September 29, and in the evening the visitors entertained their Cambridge hosts to dinner. Thus ended an exceedingly valuable, successful, and pleasant meeting.

THE ADMINISTRATION OF AGRICULTURAL EDUCATION.

A MEMORANDUM has just been issued setting out the arrangements which have been made between the Board of Agriculture and the Board of Education in regard to agricultural education. It has been known for some time that a certain amount of controversy existed between the two departments on account of the anomaly arising from the fact that the Board of Agriculture inspected and gave grants to the various agricultural colleges and other institutions for higher agricultural education, whereas agricultural instruction in secondary and primary schools, like all other forms of education, was controlled by the Board of Education. On the one hand it was felt that agricultural education could not thus be dissociated from the general system of the country; on the other hand, there was the danger that so special, and in many respects so weakly supported, a subject would never receive the attention it deserved without the fostering care of its own special department. The situation became more critical as it appeared that the Board of Agriculture, however anxious to retain its connection with the colleges, was unable to obtain the funds either to make adequate grants to existing institutions or to promote the creation of fresh colleges where they were needed. The two Boards appear now to have arrived at a compromise which still leaves the higher educational institutions under the charge of the Board of Agriculture, but also secures an interchange of views by the creation of an inter-departmental committee. The Board of Agriculture is to take charge of advanced schools of agriculture serving, as a rule, more than one local education authority's area, and taking students of an age of seventeen and upwards; under its charge also will be such special institutions as deal only with one branch of agricultural instruction, as dairying, forestry, &c. As before, the Board of Education will be in charge of the agricultural instruction that is provided by the county councils and other local educational authorities, but it is not clear by which board, or in what way, pressure can be brought to bear upon the backward counties that are now doing nothing for organised agricultural education. For example, the East Sussex County Council uses part of its "whisky money" to maintain an agricultural college, which is further assisted by grants from the Board of Agriculture; the West Sussex County Council next door puts the whisky money to the relief of rates, and does nothing for agricultural education. The defect in the Board of Agriculture's administration has been the fact that it has been powerless in such cases; it could neither compel nor bribe such counties to do their duty, and what the public interested in such matters is anxious to know is how the new arrangement will be worked to ensure a provision of higher agricultural education for farmers in all parts of the country, a national system that is not dependent on the caprice or the poverty of any county council.

The novel feature in the memorandum besides the Inter-Departmental Committee is a proposal to create a Rural Education Conference, consisting of representatives of the County Councils' Association, the Agricultural Education Association, and other agricultural organisations, with certain officers of the two Boards. Such a consultative committee seems to smack of the Board of Agriculture's favourite attitude of asking the farmers what it can do for them, but perhaps the influence of the Board of Education, which takes a less humble view of its own expert qualifications and powers to give a lead, will supply the stiffening and find a means of translating the suggestions of the conference into practice.

SCIENCE TEACHING IN GERMAN SCHOOLS.

THE habit of self-depreciation, or at any rate the latest manifestation of it, which is now so prominent a feature of our national life, can be traced to its beginning in a general dissatisfaction with our system of education. At a time when there was no misgiving as to the superiority of our navy, when our commercial supremacy was still unchallenged, and when no foreigner dared to be our rival in the world of sport, it was nevertheless felt that in the science of education we had much to learn from abroad. If our secondary schools, especially the great "public schools," were allowed to have been successful in the formation of character, yet the intellectual equipment of those who passed through them was, and still is, held by many to be miserably inadequate. Germany, on the other hand, is regarded as the land, *par excellence*, where not only the schoolmaster knows and does his business, but where a parental Government has elaborated an almost ideal system of mental training. It is interesting, therefore, to hear that in one important province of school work—the teaching of natural science—there is another side to the picture.

Dr. Erich Leick[1] finds it necessary to bring before the minds of the German public certain points that with us for some years have been received as axiomatic, and are no longer discussed. In England we believe and act on the doctrine that no scheme of education, even for the children of well-to-do classes, should omit all reference to the living world of nature. It is, moreover, generally agreed that courses of practical lessons where common objects are studied by each pupil form the best means whereby the power of observation, clearness of expression, and the inductive methods of science can best be acquired, let alone a general interest and love for living things. Yet in Germany up till now, so we learn from Dr. Leick, natural-history lessons, if given at all in the secondary schools, have been of the old didactic kind, in which the teacher lectures almost entirely for one, or at most two, school hours in the week, and practical work is conspicuous for its absence. This seems to hold good for other branches of science, especially in the classical gymnasia, where, as Dr. Hoppe[2] tells us, practical work in physics is not insisted on, and is done only by "Freiwillige." His pamphlet, in fact, is written to show that some boys will do laboratory work out of school if allowed, and he gives hints as to the best exercises for such volunteers.

[1] "Die biologischen Schülerübungen." By Erich Leick. (Leipzig: Quelle and Meyer, 1909.)

[2] "Freiwillige Schülerübungen in Physik in humanistischen Gymnasien." By Prof. Dr. Edmund Hoppe. (Leipzig: Quelle and Meyer, 1909.)

It need scarcely be said that thoughtful teachers in Germany are dissatisfied with this state of things, and it is gratifying to read in Dr. Leick's account that the example of England is gradually affecting German science teaching. In fact, anyone who has read Mr. O. H. Latter's article on the teaching of science in secondary schools, recently published as an educational pamphlet by the Board of Education (see NATURE, August 12, p. 192), may well rub his eyes with astonishment at the antiquated systems still prevailing in many of the German Gymnasien and Realgymnasien compared to those of our own schools. Is it too much to hope that our improved methods of teaching may bring forth fruit in the next generation, and do much to remove the reproach we are constantly hurling at ourselves that we are an unscientific nation?

The limits of this notice forbid a discussion of either of these interesting pamphlets. Suffice it to say that Dr. Leick, after a review of the gradual introduction of inductive methods into the study of natural science, describes the ups and downs that biological teaching has met with in Germany, and acknowledges the part played by the authorities of Hamburg and Bremen in insisting on natural history being taught in their schools. He shows clearly enough the kind of mental training that biology alone can give, although he is no revolutionary who would sweep away humane letters out of the field. Especially noteworthy is his tactful reference to the problem of sex, how it can best be dealt with by natural-history lessons in the hands of a sympathetic teacher. Doubtless the details of his scheme invite criticism, especially the use of the compound microscope by young pupils, but they offer food for thought to all who have to teach his subjects.

Dr. Hoppe's little work may be well offered to those classical masters in our public schools, if such there be, who still believe, like Darwin's headmaster, that natural science is a waste of time, and have forgotten in their zeal for grammar the true spirit of inquiry of the ancient Greeks. Teachers of practical physics may gain some useful hints from his list of exercises.

But, as has already been suggested, the chief interest to British teachers in these pamphlets lies in the fact that they give us glimpses of what we should not have suspected in so scientific a country as Germany. They confirm the present writer's impression after hearing a science lesson in a German Realschule, that the boys were standing aside and watching rather than taking off their coats and joining in the work themselves.

M. D. H

ANTON DOHRN.

THE whole biological world will feel a pang of grief at the news of the death of Anton Dohrn, the founder and director of the Zoological Station of Naples. It is true that he had accomplished the great work which he set himself forty years ago, and had seen the projects and dreams of his youth fully realised—and more than realised. I met Dohrn first in 1870 at Liverpool, when Huxley was president of the British Association, and in May and June of the next year went, after a winter spent in Leipzig, to join him at Jena, where he was a "privat-docent" in zoology. He was then thirty years of age, and had done some excellent embryological work on the Crustacea, in furtherance of which he had passed some months at Naples and Messina. His father, with whom I later spent some weeks at Naples, was a very remarkable man, one of the iron-willed, somewhat grim type of North Germans, a handsome old gentleman, known throughout Europe as a great collector of Coleoptera, a hobby which brought him into close personal friendship with similar enthusiasts in Italy, Spain, England, and France, whom he visited from time to time. He enjoyed an ample income from a sugar-refining business in Stettin, where he resided, and was anxious that Anton should accept the post of director of the Hamburg Zoological Garden, marry, and settle down there. But when I knew him at Jena, Anton had already made up his mind to do something really large and important for the progress of zoological science. Like others who had visited the Mediterranean in order to study its rich marine life, he had felt the difficulty of carrying on such work in lodgings, without apparatus, without library, and at the mercy of the fishermen whom it was necessary to employ and to conciliate. The French naturalist Coste had, when employed by the Government of the Second Empire to study economic questions connected with the national fisheries, established a laboratory, with aquaria, tanks, and fishing-boats, at Concarneau, on the Brittany coast. Henri de Lacaze-Duthiers had also arranged a permanent marine biological laboratory for himself and his pupils. The plan took shape in Anton Dohrn's mind of establishing a larger and more completely equipped laboratory than these on the Mediterranean coast, and, but for the war between France and Germany, he would probably have carried out his first intention and placed his laboratory on the coast near Marseilles. When I knew him he had already thought out the scheme which he realised, and had determined to try to secure a site at Naples in the Villa Reale, which stretches along the shore. He had succeeded with no little difficulty in securing a certain sum of money from his father—his heritage, in fact—and he intended deliberately to risk this in his enterprise. His plan was to secure the cooperation of all European universities in building and maintaining the Naples laboratory, or "station," as he proposed to call it. This meant, in all cases but that of England, the cooperation of the State Governments. But in order to obtain this support and cooperation he realised that it was necessary, at whatever effort and risk, to make a plunge—to start the "stazione," to erect a fine and imposing building, to demonstrate the convenience and excellence of its organisation, and thus to secure approval and unhesitating financial assistance. His plan was to sink his own fortune in that first step, and he did so. He obtained help from friends both at home and in this country as the building grew, and by tactful appeal and untiring effort—involving years of work given up to persuading statesmen, politicians, associations, professors, millionaires, and emperors of the value and importance of the great Naples "Stazione Zoologica"—he achieved for it a splendid and permanent position.

During the two months which I passed in 1871 at Jena, Dohrn, Kleinenberg, Abbé, and I used to dine in Dohrn's study, our meal being sent in from the Black Bear Hotel. We were usually joined by Willie Preyer, the professor of physiology, in our after-dinner walk in the "Paradise," which resembled Christ Church meadow on a smaller scale. I attended Gegenbaur's lectures, and was kindly given a place by Haeckel in his laboratory, where I was one day visited by the Grand Duke of Saxe-Weimar, who told me that he was a cousin of my Queen, and kissed Haeckel on both cheeks, much to my astonishment. I was working at the embryology of Mollusca, and especially at that of Pisidium, a minute bivalve, the haunt of which Kleinenberg showed to me. He himself was preparing his celebrated work on Hydra. Abbé was experimenting and applying mathematical knowledge in the optical workshop of Zeiss, which led later to the splendid result which all the world knows. Those delightful men, with the exception of the veteran Haeckel, are all dead now. Haeckel remains not only alive and active, but faithful to Jena. In those days Jena was a singularly beautiful place. The nearest railway station was at a distance of seven miles. It was a very small town. I had a room overlooking the "Prinzessen-garten," and was kept awake by the nightingales. Dohrn and I took long walks in the wooded hills of the Thuringer Wald, and I learnt and discussed fully with Dohrn his plans for the Naples "station." He adopted the name "station" because he hoped that, in the course of time, other thoroughly equipped marine zoological laboratories would be set up elsewhere on the same sort of international cooperative basis as that which he intended to adopt at Naples Port Jackson was one point which we selected for a future station, and some favoured spot on the Japanese coast another. Already, before we left Jena, and before he had opened any negotiations with the Neapolitan municipality, Dohrn had planned the series of monographs of the fauna and flora of the Gulf of Naples which has been so splendidly realised. Dohrn was a profound student of Goethe, and had a saying of the great teacher for every occasion. He was what appeared to me, with my English upbringing, singularly introspective, and he puzzled, even occasionally alarmed, me by his self-conscious and systematic cultivation of his will-power. I have no doubt that he was fully endowed with this power, as his remarkable accomplishment of what he set out to do proves, and I do not suppose his anxiety to keep it at a high pitch of activity was really of any effect in the end. When we were at Jena he did not smoke and drank very little. It was not, I think, until he was past forty that he took to tobacco. I left him at the end of June, 1871, promising to join him at Naples in October. He arranged to take an unfurnished flat in the Palazzo Torlonia, where we were to have ample space, and to take down with him plans for the projected laboratory, and an architect. Whilst he negotiated with the municipality and the Italian Government, I was to set up a temporary laboratory in our flat and pursue embryological work. This plan was carried out. Dohrn had succeeded in obtaining the definite and effective support of the new German Imperial Government, and his path with the Naples municipality was smoothed. But there was a good deal of haggling and putting forward of the palm of the hand (which Dohrn ignored) before the site to be occupied by the "Stazione" in the Villa Reale (or Nazionale, as it is now called) was made over, with many queer and strenuous conditions, to Dohrn, and so to the building contractor. When I left Naples in May, 1872, after an attack of typhoid fever, the walls of the laboratory were a couple of feet above ground. An example of the innumerable difficulties which Dohrn had to surmount is the challenge to a duel brought to him by the representative of the Neapolitan architect whom he had agreed (in order to conciliate the Neapolitans) to employ for the design of the elevation. This gentleman considered himself insulted because Dohrn refused to promise him a ten per cent. commission instead of the five per cent. which is usual in northern Europe. I had to act as Dohrn's second, and conferred with the Neapolitan architect's friend. On my insisting that Dohrn was a soldier of the German Emperor, and a very deadly man with the sabre—and determined not to yield to any nonsense—the challenge was withdrawn, and the insulted architect completed his task very satisfactorily. On another occasion, in my presence, Dohrn was deliberately threatened with assassination by a Neapolitan who could not get his own way. "You forget," the Neapolitan said, "that the night is dark and that for a few francs I can get a couple of men to deal with you." Another very awkward thing was that the young German architect who had come to Naples with Dohrn, and was living with us in the Palazzo Torlonia, suddenly went quite mad, and had to be sent home under escort. Happily he completely recovered. A great feature in our life at the Palazzo Torlonia was the occupation of one of the chief "flats" (ours was high up in a building against the Posilippo cliff) by the Baranowski family. Dohrn had made their friendship in Sicily a year before, and we spent nearly every evening with them. Baranowski had been governor of the Russian province of Orenburg, and was now employed by the Russian Government on important missions in China. His wife, a Polish lady, her sister, two daughters, and a son, took up their residence in the chief "suite" of our Palazzo, and in the late winter were joined by Baranowski himself, whose official business did not allow him to remain for long. All those dear friends of the Palazzo Torlonia are now dead and gone, with the exception of the elder of the two sisters, who three or four years later married Anton Dohrn, and is the mother of his four now grown-up sons: She nursed him in his last illness during the past six months at Munich. In 1874, when the Naples laboratory was built and its machinery at work, its rooms filled with professors and investigators from all parts of Europe, including the wonderfully gifted and beloved Frank Balfour and his friend Dew-Smith, I again spent three months at Naples. Dohrn was suffering from the labours he had gone through in securing the position of the laboratory, and also from the climate of Naples. He was engaged, but his marriage was delayed and his future wife's family were no longer at Naples. A very remarkable Englishman, Grant by name, who had been lecturer in English literature and a close friend of Dohrn's at Jena, was with him, and remained for some years in Naples. His delightful book, "Stories of Naples and the Camorra," is the memorial of the work Grant did there. He died some years ago. Later I made two short visits to Naples, and saw my friend with his family growing up around him. In the 'nineties he visited Oxford and received an honorary degree. For some years the University, following the example of Cambridge, had rented a table at the Naples station, and provided the travelling expenses of a graduate selected to pursue investigation there.

During the thirty-six years of its existence, the Naples station has increased vastly in size and the perfection of its organisation. Its biological library is one of the best in the world, its staff of servants, assistants, and skilled workers of all kinds unrivalled. Having secured capable assistants in all departments and the funds for carrying on the now large and celebrated institution, Dohrn was able to pursue some of the problems of vertebrate morphology which had occupied his mind already in Jena days. I think that the most important of the general ideas which he had arrived at in those early times was, first, that degeneration or simplification of organic structure is a result of evolution as well as increase of complexity, and that the relatively simple or less complicated members of a group are not necessarily more primitive or archaic than the more elaborately structured members. Also of great value was his determination to take a free and unprejudiced view as to the lines of the animal pedigree, and he particularly objected to being tied in any way to the conclusions of Haeckel on this subject. He successfully resisted the notion that either Amphioxus or the Ascidians represent in any definite or complete way the lower phases of vertebrate ancestry. He held that they were specialised, and, in the sense of being simplified, degenerate. He sought himself to connect the vertebrate stock with that of the chætopod worms, but though this hypothesis led him into many interesting discoveries of detail—which are published in a series of papers in the *Mittheilungen* of the Zoological Station of Naples—it cannot be said to have been placed on a secure footing, and we are still speculating, with very little assurance, as to the nature and structure of the pre-vertebrate ancestors of Vertebrata.

Dohrn was a great lover of classical music, like his father, and I think that music and philosophy were his chief relaxations from the severe labour of business correspondence and scientific discussion. He was very fortunate in having the opportunity, some fourteen years ago, of receiving the German Emperor at the Naples laboratory. He was able thoroughly to interest that able man in the work of the institution, who recognised that it was a real honour and glory to the German name, and accordingly gave to it his warm friendship and support. From that time forward large assistance has been given to the Naples laboratory from Berlin, and I believe that some definite responsibility in regard to the institution—involving possibly its ownership—now passes to certain authorities in Berlin.

It is a great and satisfactory thing which I have had to record here—the success of a noble effort. Dohrn's example in founding a "station" for marine zoology has been followed in a modest way elsewhere. The Marine Biological Laboratory at Plymouth, which I joined with others in founding some twenty-five years ago, was, confessedly, an attempt to provide on our English coast an institution similar to, if less spacious than, that established by Anton Dohrn at Naples. The Plymouth laboratory has done good service to science and to fishery interests, but London is not Berlin, nor are the ways of British departments of Government in regard to science in any way similar to those of the German Imperial Government. The former are ignorant, envious, and destructive; the latter are intelligent, friendly, and helpful.

E. RAY LANKESTER.

NOTES.

IN reply to a question asked in the House of Commons on Thursday last, the Postmaster-General stated that arrangements have been completed with the Marconi Company for the transfer to the Post Office of all their coast stations for communication with ships, including all plant, machinery, buildings, land, and leases, &c., and for the surrender of the rights which they enjoy under their agreement with the Post Office of August, 1904, for licences or facilities in respect of coast stations intended for such communication. In addition, the Post Office secures the right of using, free of royalty, the existing Marconi patents and any future patents or improvements, for a term of fourteen years, for the following purposes:—communication for all purposes between stations in the United Kingdom and ships, and between stations on the mainland of Great Britain and Ireland on the one hand and outlying islands on the other, or between any two outlying islands; and (except for the transmission of public telegrams) between any two stations on the mainland; and on board Post Office cable ships. All the stations will, under the International Radio-telegraphic Convention, be open for communication equally to all ships, whatever system of wireless telegraphy they may carry, and the Post Office will be free to use or to experiment with any system of wireless telegraphy at its discretion. All inland communication of messages by wireless telegraphy will be entirely under the control of the Post Office. Arrangements have also been made with Lloyd's for the transfer to the Post Office of their wireless stations for communication with ships, and for the surrender of all claims to licences for such communication.

AN Italian National League against malaria has recently been formed, and the first meeting is now taking place at Milan. The inaugural address is being delivered by Prof. Baccelli, and the following communications have been promised:—the present state of knowledge in regard to malaria, by Prof. Bordoni-Uffreduzzi; prophylaxis against malaria, by Prof. Castellino; the pathology of malaria, by Prof. Golgi; some questions relating to the pathology and treatment of malaria, by Prof. Grassi; little known abortive forms of malaria, by Prof. Queirolo.

THE programme of the second International Congress for the Repression of Adulteration in Food, Chemical Products, Drugs, Essential Oils, Aromatic Substances, Mineral Waters, &c. (to be held in Paris on October 17–24), has now been issued. The discussion of the various subjects will be classified in the following sections:—(1) wines, alcohols, syrups, liqueurs, beer, cider; (2) farinaceous foods, baking, pastries, meat and other pastes, spiced confectionery; (3) cocoa, chocolate, confectionery, honey, sugar, and sugar candy; (4) vinegar, mustard, pepper, spices, tea, coffee, chicory; (5) butter, milk, cheese, eggs; (6) lard and edible fats, margarine, provisions preserved in oil, bacon, sausages and pork products, salted provisions, and canned and bottled goods; (7) drugs, chemical products, essential oils, &c.; (8) mineral water (medicinal), aërated waters, ice.

IN opening the *Nimrod* Antarctic Expedition last week, the Lord Mayor of London stated that he intended to call a meeting at the Mansion House to initiate a fund towards the expenses of the forthcoming expedition under Captain Scott to the south polar regions.

IT is stated in the *Times* that a telegram has been received from Dr. T. G. Longstaff to the effect that he has arrived at Leh, in Ladak, after having connected the Tarim river with the Saichar glacier, making it about fifty miles long. This would appear to mean that the Tarim or Yarkand Darya river, which flows north from the Himalayas towards the Taklamakan desert, and had hitherto been supposed to rise near the Karakoram Pass, originates much further to the west in the Saichar glacier. On existing maps, what was supposed to be a branch of the river is shown to originate in the Saichar glacier, and it is that branch, apparently, which Dr. Longstaff makes out to be the main river.

THE Ottawa correspondent of the *Times* states that a telegram has been received by the Canadian Marine Department from Captain Bernier, of the Canadian Government steamer *Arctic*, which left Quebec fourteen months ago to cruise in the Arctic region, announcing his arrival at Point Amour, Labrador. Captain Bernier says that he has accomplished his mission, which was to report upon the ice conditions in Hudson's Straits in 1908 and then to proceed north and take possession of Banks Land and other Arctic lands for Canada; he also states that he discovered the record left at Winter Bay in 1819–20 by Lieut. (afterwards Sir E.) Parry.

PROF. J. v. HEPPERGER has been appointed director, and Dr. J. Palisa vice-director, of the Imperial University Observatory, Vienna.

MR. PHILLIP FOX, formerly of the Yerkes Observatory, has now assumed the directorship of the Dearborn Observatory, Evanston, Illinois, in succession to the late Prof. G. W. Hough.

WE learn with regret that M. J. A. Fraissinet, secretary of the Paris Observatory, died, in his sixty-third year, on August 29.

THE Denny gold medal has been awarded by the Institute of Marine Engineers to Mr. W. P. Durtnall, for his paper on the generation and electrical transmission of power for main marine propulsion and speed regulation, which was read at the Franco-British Exhibition in July, 1908.

As was announced in NATURE of July 15, a model engineering exhibition will be held at the Royal Horticultural Hall, Westminster, on October 15–23. We learn from the promoters that the exhibition will contain a number of exhibits of exceptional interest, *e.g.* model aëroplanes, working model steam and electric railways, electric clocks, light machine tools, model motor-boats, a model engineer's workshop in operation, and a working demonstration of wireless telegraphy by the latest Marconi apparatus.

SIR WILLIAM MACGREGOR, who is shortly to take up his duties as Governor of Queensland, was entertained at luncheon last week at Liverpool, and, speaking in reply to the toast of his health, said he had known the Liverpool School of Tropical Medicine from its inception. He had spent thirty-one years in the service of the country in the tropics, and he thought that few people had had a better opportunity than he had of seeing how much an institution of this kind was wanted in the world. Few men could better appreciate the amount of good it had been able to do. He had had the opportunity of renewing his studies at the school, and what he had been able to learn had been of considerable use to him and would be of great value to others. It was a great school, not on account of its size, but because it was the nucleus which was going to scatter broadcast tropical schools all over the Empire. The beginning of the Liverpool School of Tropical Medicine they owed from a scientific point of view to Major Ross, but to Sir Alfred Jones they were almost equally indebted. He looked upon the school as being the pioneer of all other schools of this kind that were to follow.

A COURSE of twelve free lectures under the Swiney trust will be begun in the lecture theatre of the Victoria and Albert Museum, South Kensington, on Saturday, November 6, by Dr. T. J. Jehu, who will take as his subject "The history of north-west Europe during Tertiary times."

THE new session of the Royal Geographical Society will open on November 8, when a paper entitled "Two Journeys in Bhutan" will be read by Mr. J. Claude White. The other papers expected to be delivered at meetings before Christmas are:—journey into northern Arabia, by Mr. Douglas Carruthers; explorations in the Hispar region, by Dr. Hunter Workman and Mrs. Bullock Workman; and a naturalist's travels on the Congo-Zambezi watershed, by Mr. S. A. Neave. The papers expected after Christmas are:—an expedition to the North Pole, by Commander Peary; explorations in and around Lake Chad, by Captain J. Tilho; explorations in Fernando Po and the Cameroons, by Lieut. Boyd Alexander; explorations in southern Nigeria, by Mr. P. A. Talbot; explorations in and around Magellan Straits, by Dr. K. Skottsberg; a journey from Uganda by Lake Rudolf to Abyssinia, by Captain C. H. Stigand; explorations in the Aldabras, by Mr. J. C. F. Fryer; climbing and exploring in Central Asia, by Dr. T. G. Longstaff; boundary-making and exploration in Bolivia and Brazil, by Major P. H. Fawcett; exploration in the Kasai region of the Congo, by Mr. E. Torday; a journey in South-west Africa, by Prof. Pearson; geographical conditions affecting the development of Australia, by Prof. J. W. Gregory, F.R.S.; and geographical conditions affecting the development of Canada, by Mr. W. L. Grant.

ARRANGEMENTS have been completed whereby a standard clock at the Hamburg Observatory, Bergedorf, is connected to the trunk telephone system. A sounder automatically emits a siren-like note from the fifty-fifth to the sixtieth second of each minute—mid-European time—and this goes automatically to all the receivers connected, at that time, with the special exchange number which has been allotted to the time signal. Thus Hamburg and neighbourhood and other towns of east Germany are supplied with a ready means of ascertaining the standard time.

THE past summer was characterised by cool and unsettled weather, and, with the exception of about a fortnight at the commencement of August, there was a peculiar absence of warm days. For the six months April to September the observations at Greenwich show that there were in all only fifty-three days with a temperature of 70° or above; of these, twenty occurred in August and eighteen in July, whilst there was only one instance in September. During the last quarter of a century the only years with as few warm days are 1888, 1894, and 1903. On the average of the last fifty years, there are seventy-four such warm days. There were nine days with a temperature of 80° or above, and in the last five years the number varies from two in 1907 to twenty in 1906. The absolutely highest temperature during the summer was 80°, on August 12 and 15. The aggregate rainfall at Greenwich for the six months is 14·04 inches, which is 1·75 inches more than the average summer fall of the last fifty years, the mean being 12·29 inches. With the exception of the summer of 1903, when the aggregate rainfall was 22·21 inches, there has been no summer as wet since 1888. There was an excess of rain in all the summer months except May and August, and the wettest month was June, with a total of 3·65 inches, which is 1·65 inches above the average. The early summer months were exceptionally bright, and a record duration of sunshine for any month was established in May, with 326 hours, but most of the subsequent months had a deficiency of bright sunshine.

SOME remarkable experiments on the reproductive apparatus of insects have recently been conducted by Prof. J. Meisenheimer, and are recorded by him in a treatise ("Experimentelle Studien zur Soma- und Geschlechts-Differenzierung") published by Fischer at Jena. The results of this investigation have been summarised by the author in the *Naturwissenschaftliche Wochenschrift* for August 29. The species selected for experiment was the well-known "gipsy moth," *Lymantria dispar*. The reproductive glands were removed from larvæ of both sexes, in some cases immediately after emergence from the egg. The difficulty of operating upon larvæ barely three millimetres long must have been great; it was, however, successfully overcome by aid of the galvanic cautery. In larvæ of a larger growth an actual transplantation was effected of testis into the female and ovary into the male. Details of much interest are given in the original paper; the main result is that, in strong contrast to the conditions obtaining in vertebrates, the removal of the primary sexual organs has no effect upon the development of the remainder of the sexual apparatus, or of the secondary sexual characters whether somatic or psychic. This takes its normal course even in the presence of a successfully transplanted primary organ of the opposite sex.

To the August number of the *National Geographic Magazine* Mr. H. M. Smith, U.S. Deputy Commissioner of Fisheries, communicates a very graphic and interesting account of the herring-fisheries of the world, in which stress is laid on the importance and value of this industry, which has determined the position of cities and influenced the destiny of nations. In America large numbers of the smaller-sized herrings are tinned and sold as sardines. In place of the methods adopted on this side of the Atlantic, weirs of stakes and brushwood play an important part in the American herring-fishery. As the average tidal rise and fall is 20 feet, and in spring nearly 30 feet, the weirs are necessarily large and strongly built structures. These weirs are fished at low water, when the fishermen enter in boats, set a seine and haul its ends together, and proceed to take out the fish in huge dip-nets. Sometimes, however, the herring are left high and dry by the falling tide, when they are collected by hand or with pitchforks.

IN No. 29 of the "North American Fauna," published by the Biological Division of the U.S. Department of Agriculture, Mr. E. W. Nelson gives an exhaustive account of the Leporidæ of North America, of which no fewer than ninety-seven species and races are recognised, against eighteen in 1887. Although in America all the members of the family are commonly termed rabbits, the author suggests that the name rabbit should be restricted to the so-called "cotton-tails," which produce blind and naked young in burrows or other concealed cavities, while the species related to the typical Lepus of the Old World should be designated hares. The fact that the cotton-tails resemble the European rabbit in the matter of habits and the condition of the young at birth goes far to justify their separation as Sylvilagus, although that term might perhaps be preferably employed in a subgeneric rather than in a generic sense. It is pointed out that both "jack-rabbits" and "cotton-tails" are serious pests to the agriculturist and horticulturist in the United States, although the former are considerably the worse of the two. On the other hand, these rodents form a valuable asset to the country as a source of food and of fur.

IN the annual report of the Natural History Section of the Indian Museum for 1908–9 the director states that the Museum Conference at Calcutta has done much to facilitate the interchange of opinions and specimens between the various museums of the country. At that conference it was agreed that the Calcutta establishment was to be the depository for all type-specimens, except such as, for climatic reasons, would be safer in London. Among recent additions attention is directed to a skeleton of the Mishmi takin (*Budorcas taxicolor*), which is alleged to be the only one in existence. If those of the living individuals of the species be excluded, this statement may be literally true, although it might have been added that the British Museum possesses skeletons of the Bhutan race (*B. t. whitei*) and of the Sze-chuen *B. tibetanus*.

IN the September number of the *Zoologist* Mr. G. B. Corbin states that the smooth snake (*Coluber laevis*, or *austriaca*) is still to be found in the New Forest and on the heath-lands on the opposite side of the Avon, where it was first recognised as a British species. Unfortunately, a portion of its habitat is slowly but steadily coming under the hand of the builder.

WE have received three parts (Nos. 1, 4, and 5) of a new Bulletin of Economic Biology, issued by the Department of Agriculture of the Federated Malay States, and published at Kuala Lumpur. No. 1, by Mr. H. C. Pratt, the Government entomologist, deals with termites found in rubber-plantations; No. 4, by the same author, is devoted to a zygænid moth (*Brachartona catoxantha*), the larva of which infests cocoanuts; while in No. 5 Mr. W. J. Gallagher discusses the best means of destroying the rats, which do serious damage to rice-fields.

MR. H. M. LEAKE has followed up his first paper on the experimental breeding of Indian cottons by a second, published in the Journal and Proceedings, Asiatic Society of Bengal (vol. v., No. 1). The author's object is to discover characters which behave as units under artificial crossing. In the present paper he records the constancy for Indian cotton plants of the position of the accessory bud on the main stem, *i.e.* certain plants regularly produce the accessory bud to the right, others to the left, of the main bud, but this character does not follow the Mendelian laws. Similarly, the main stem is always a monopodium, but the subsequent branching may be monopodial or sympodial; these are two distinct types, of which the sympodial is dominant. Further, it was observed that early flowering is a feature of the sympodial type, and herein lies the importance attached to a differentiation of Indian cottons according to their mode of branching.

THE thirty-fourth series of contributions to the flora of Africa, published under the direction of Dr. Engler, occupies the bulk of Engler's *Botanische Jahrbücher* (vol. xlii., parts i. and ii.). An important revision of African species of the genus Impatiens is supplied by Dr. E. Gilg, and Dr. Engler contributes descriptions of several new species, notably of the genus Mesembrianthemum. The classification of African species of the polymorphic genus Senecio is discussed by Dr. R. Muschler. Five subgenera, comprising about 500 African species, are demarcated. The subgenus Eusenecio is further divided into many sections, of which twenty are added by the author. The sections *crassuli* and *kleinioidei* are succulents, similar in this respect to the subgenus Kleinia; the section *tuberosi* is based on the production of large tubers; a large group is that of climbing plants, *scandentes*; other sections are the *pinifolii*, *rhizomatosi*, and *arborei*, the latter being represented by *Senecio Johnstonii*, a tree attaining a height of 45 feet.

A SECOND set of studies of tropical American ferns, by Mr. W. R. Maxon, is published in the Contributions from the United States National Herbarium (vol. xiii., part i.). The first paper deals with ferns collected in Guatemala by Baron von Türckheim, principally in the humid mountainous region of Alta Verapaz. The determinations include several new species, notably an interesting Campyloneuron and an epiphytic Lycopodium, also the species *Diplazium ternatum*, formerly recorded from Mexico. The author also supplies a revision of the West Indian species of Polystichum, with a key for determination. Diagnostic characters are sought in the presence or absence of a proliferous bud upon the rachis. Where present, it may arise immediately above the uppermost pinna, as in the species *heterolepis*, or on a whip-like prolongation, as in *P. decoratum*.

THE Cambridge Scientific Instrument Company, Ltd., has recently issued a new catalogue explanatory of its microtomes and accessory apparatus. The ingenious rocking microtome is, of course, universally known; the present-day instrument shows several improvements on the original pattern, notably in the fitting of the rocking arms. A second type of microtome, also a rocker, cuts flat sections, and is suitable for objects up to a diameter of 30 mm., while a larger microtome has been recently designed which will take objects up to 40 mm. diameter, and with which hard substances, such as bone or cartilage, can be manipulated.

THE Bulletin of the Johns Hopkins Hospital for August (xx., No. 221) is devoted to tuberculosis. The subjects dealt with are tuberculin treatment of dispensary patients, report of the work of the Phipps Dispensary for Tuberculosis, Marmorek's serum in the treatment of pulmonary tuberculosis, and the kind of employment suited to arrested cases of the disease. In the last it is concluded that farm-colonies are the best possible means for the after-care of consumptives.

THE July number of the *Journal of Comparative Neurology and Psychology* consists of a monograph, by Mr. M. E. Haggerty, on imitation in monkeys. To the lay mind there will appear no question as to the power of monkeys to learn by imitation. The experimental evidence, on the other hand, has not always been on the side of popular opinion. It is true that Hobhouse obtained experimental evidence of the imitation of human behaviour by monkeys, and that Kinnaman observed two cases in which one monkey, after watching another monkey that had learnt to get food by manipulating a mechanical device, itself repeated the performance; but Thorndike was unable to find any such imitation of one monkey by another, and in neither of the two monkeys studied by Watson was there evidence that the watching animal learnt to get its food by seeing how the other animal got it. Mr. Haggerty bases his observations on no fewer than eleven monkeys. Following previous workers, he places the animals "in the presence of simple mechanical devices, the manipulation of which opened doors, disclosed openings, or dropped food into the experiment cage." The important feature of his paper consists in the extraordinarily detailed record of the movements of the monkeys while under experimental conditions. The seven mechanical devices with which the monkeys were at various times confronted yielded sixteen cases of successful imitation (three of which were immediate), five cases of practically successful imitation, and five failures. Seven of the monkeys imitated in every form of test, two failed absolutely, while two succeeded in some tests but failed in others. The statistical results, however, are of less interest than the valuable description of the facts of behaviour, inasmuch as there is doubt as to what shall be allowed to count as imitation. In the present state of the subject it is observation that is needed, and this Mr. Haggerty's paper supplies in abundance.

THE June number of *Petermann's Mitteilungen* contains a short paper on the climate of Siam, by Dr. W. Gerbing, which deals specially with the observations made by Dr. Hosseus during journeys in 1904 and 1905. Little is known of the meteorology of the mountainous regions of the Laos States, where Dr. Hosseus spent most of his time, and the observations are therefore of considerable value. They consist chiefly of seven months' records kept at the mission station at Djeng Mai by Dr. Harris, and temperature observations made *en route* and during halts in climbing expeditions on the Dai Sutep.

THE Bulletin of the American Geographical Society (vol. xli., No. 8) contains an article on the Stonington Antarctic explorers, by Mr. E. S. Balch. The article is based on letters and papers belonging to Mrs. Richard Fanning Loper, of Stonington, Connecticut, who inherited them from her father, Captain Alexander Smith Palmer. These papers are few in number, as most of the Antarctic records of the Palmers were destroyed by fire in 1850, but they afford much valuable fresh information about four very fruitful exploring voyages, and throw many new side-lights on the formerly important sealing industry in the South Seas.

THE August and September numbers of the *Bollettino* of the Italian Geographical Society contain a report on the Messina earthquake of December 28, 1908, by Dr. Mario Baratta. The author gives the results of a full examination of the scene of the earthquake and a comparison of its effects with those of the earthquake of 1783. A number of illustrations and detailed maps accompany the report.

A SUPPOSED ancient canoe was recently discovered, embedded in sand below water (not in peat) near Lochmaben. It is formed of a single oaken trunk, and is about 13 feet long and 2 feet broad, with sides which can hardly have been 1 foot in height. The bottom is flat and smooth. On the inside there are two rows of neatly drilled holes, in which were wooden pegs. These holes are at intervals of 18, 21, 24, and 27 inches, and lie in shallow grooves close to the sides of the canoe. The bow has a distinct resemblance to that of a dug-out canoe, and it is of course possible that this may be an ancient boat with ribs to which rough planks were tied, but the evidence for this theory is hardly convincing. It differs greatly from the dug-out canoes found at Lochrutton and Friarscarse, which were probably used by the dwellers in the crannoges which existed in those lochs. We have to thank Mr. Thomas Henderson, of Lockerbie, for the measurements given above, which would seem to show that the people who made the holes used a foot rule divided into 12 inches. It is very likely, however, that a flat-bottomed boat of this kind might have been used in the loch at almost any period from 1200 A.D. to 1600 A.D.

ACCORDING to the *Jewish World*, the French expedition has made further notable discoveries at Susa, the Shushan of the Bible, the ancient Elamite capital. In the Acropolis the explorers found, superimposed one above the other, the remains of three cities dating back to B.C. 4000, and beneath these other settlements of the prehistoric period. The most important discoveries were three black stone pillars, on which was inscribed the law code of King Hammurabi of Babylon. The site appears to have been occupied by the Babylonians earlier than B.C. 2800. Subsequently the Elamites regained their independence, and retained possession of the city until B.C. 649, when it was sacked by Assurbanipal, King of Assyria.

PHYSICAL anthropologists in search of a new test of race to supplement that of the cephalic index, which no longer commands the authority once attributed to it, will welcome the essay, reprinted from the fourth volume of the *Philippine Journal of Science*, by Mr. R. B. Bean, entitled "Filipino Ears, a Classification of Ear Types." The author claims that he established for the first time a seriation of human ears, and that each ear type is associated with a physical variety of man. Most of the Filipino ears, except those of some long-term convicts, agree with the European type, and those varying from this standard are of an older morphological class. The Spanish population of Manila has ears closely agreeing with the European types among the Filipinos. In this, as in other characteristics, Chinese influence is apparent. He concludes that prehistoric Europeans have probably to some extent affected this ear type, and that Chinese ears are longer than those of Europeans, Filipinos, or Indians, because the Chinese population is composed more largely of the long-eared European types (northern, sub-northern, and Cro-Magnon). Ear type he believes to be to some extent independent of pigmentation, because the same type of ear is found in blonde and brunette Europeans, in dark- and light-skinned Filipinos, in dark-skinned Indians and light-skinned Chinese. It is improbable that his views of the permanence of ear type as a test of race will be accepted without criticism, but, at any rate, this monograph, with its large selection of photographs, raises a new and interesting problem.

AN interesting article on the climatic features of Wyoming and their relation to "dry-farming," by Mr. W. S. Palmer, section director, is published in the *U.S. Monthly Weather Review* of February last. From systematic data collected during the last seventeen years, it appears that the average annual rainfall of the State is 13·7 inches; in some parts the amounts vary from about 5 inches to 20 inches, and crops are now being successfully produced by the dry-farming method in semi-arid regions where a few years ago it was considered that the precipitation was not sufficient for the purpose. Prof. C. Abbe explains that the expression dry-farming may be considered as an abbreviation of dry-land-farming, and that the method consists in giving up the attempt to raise crops every year, and attempting instead so to conserve and utilise the moisture as to secure a crop every two or three years. Success depends essentially upon the annual quantity rather than upon the seasonal distribution of precipitation and evaporation.

IN the valuable meteorological charts of the Atlantic and Indian Oceans issued by the Meteorological Office for October, 1909, it is pointed out that the Southern Ocean has been remarkably free from icebergs and drift-ice throughout the first seven months of this year. Icebergs were frequently passed in 1908, and during the first five months of 1909 some were seen between latitude 52° and 59° S. and longitude 90° and 130° W., the loftiest being 300 feet high; but not a single berg has been sighted in the vicinity of Cape Horn. During the past quarter of a century many icebergs having an altitude of not less than 1000 feet have been met with in the Southern Ocean.

THE use of light filters in spectroscopic work whenever it is necessary to shut out all but a particular portion of the spectrum is so simple an expedient that we venture to direct attention to a list of Wratten light filters which has recently been issued. They consist of thin films of gelatin coloured with organic dyes, and the list gives the spectrum of the light transmitted in each case. One of the most useful for spectroscopic work appears to be the mercury green line filter, which is transparent for the mercury green line, but opaque for all the other mercury lines.

A DETAILED study of the lengths of the waves emitted by many of the ordinary forms of generators of short electric waves has been carried out by Messrs. H. W. Webb and L. E. Woodman at Columbia University, and the results are given in the August number of the *Physical Review*. The object of the authors was to establish such definite relations between the dimensions and electrical properties of the generators and receivers of the waves as to enable future workers to calculate the wave-length with certainty from the dimensions of the apparatus used. The method employed was Boltzmann's, the beam sent out by the generator being reflected at two mirrors, and the two half-beams brought together to produce interference. Rod, cylinder, Righi, and other generators were tested, and the wave-length measured in each case, a non-selective receiver being used. For apparatus of the same type, but of different size, the wave-length is proportional to the linear dimensions of the apparatus.

An interesting paper on sparks as indicators of the different kinds of steel was contributed by Mr. Max Bermann, Budapest, at the meetings of the International Association for Testing Materials, held in Copenhagen early in September. An abstract appears in *Engineering* for September 17, from which we learn that the author stated that the influence of the emery-wheel on the nature of the sparks was far outweighed by that of the quality of the steel. It seems from the author's experiments that the spark ray gives a precise indication of the quality of the metal, and may be so applied in practice. Pointed branching lines denote carbon steel (Siemens-Martin); leafy ends of the branching lines indicate Siemens-Martin steel containing a high percentage of carbon; spark pictures, with a blossom-branch-like appearance, are obtained from ordinary tool steel, and so forth. The author states that the spark test is so sensitive that it gives clear indication of a difference of 0·01 per cent. of carbon, and could be resorted to in the course of the Siemens-Martin process for testing the bath and also for the inspection of the finished material.

Among other interesting articles in the August number of *The Central*, the organ of the Old Students' Association of the Central Technical College, City and Guilds, is one on pipes for use underground, by Mr. H. A. Humphrey. In this article the writer emphasises the great value of a proper covering for steel pipes. Thin bituminous coatings, obtained by dipping in hot mixtures, is liable to be destroyed in places by the subsequent handling of the pipe. What is wanted is a coating which has elasticity and offers greater mechanical protection. The South Staffordshire Mond Gas Company followed the recommendation of the author for its mains, extending over an area of 120 square miles, a great portion of which lay in the "Black Country," thus rendering the mains liable to subsidences and to attacks from sulphur and acid compounds. The steel pipes were coated once with asphaltum, then wrapped round with Hessian or canvas, and afterwards again coated with asphaltum, the result giving a thick, tenacious coating of sufficient elasticity and strength. Five years' experience is now available, and has proved that even under the worst conditions such a coating, when properly applied, is an absolute preservative against corrosion.

OUR ASTRONOMICAL COLUMN.

Observations of Mars.—Further results of his observations of Mars are published by M. Jarry-Desloges in No. 4358 of the *Astronomische Nachrichten* (p. 224, September 24).

Changes are becoming more numerous, and the canals more visible. The observations made at the Massegros Observatory (Causse de Sauveterre) showed a new canal on Libya, but the Hellespontus was no longer visible. The Indus was seen to be intercepted at the estuary of the Oxus, and Syrtis Major and the Baie du Méridien were intersected. Since September 3, both at the Revard and the Massegros stations, a clear band traversing the Auroræ Sinus was recorded. The Revard plateau observing station is being dismantled before it becomes snowbound, and the instruments are to be remounted on the plains of the Beauce.

Having occasion to examine some of Prof. Lowell's 1907 photographs of Mars, M. Antoniadi was struck by the absence of the dark band which, according to visual observations, is circumjacent to the polar snows. Whilst recognising the possibility that this may be due to the photographic encroachment of the neighbouring bright area, M. Antoniadi does not think that this is the probable explanation; he would rather believe that in the visual observations the phenomenon is a subjective one, the appearance of a dark band being produced by contrast with the bright cap.

Some interesting letters, describing the observed phenomena, and drawings, communicated by MM. Jarry-Desloges and Antoniadi to Signor Schiaparelli, are published by the latter in No. 9, vol. iii., of the *Rivista di Astronomia* (Turin).

The Recent Magnetic Storm and Aurora.—From Mr. Basil T. Rowswell we have received an account of an auroral display observed by him, at St. Martin's, Guernsey, on the night of September 25, the date of the magnetic storm described in Nature for September 30 (p. 395). On going into the garden at 8 p.m. (G.M.T.) Mr. Rowswell was struck by the appearance of a rosy glow, at an altitude of about 60°, in the E.N.E. sky. This glow brightened and then faded away, or was obscured by misty clouds and, possibly, moonlight, until at 8.10 p.m. no trace of it was to be seen; nor could it be discerned at 9 p.m. when the sky was partially clear. That it was a true auroral display which he observed Mr. Rowswell has no doubt, and he suggests that, had the sky been clear, a good, if brief, display might have been seen at Guernsey.

Elements and Ephemeris for Halley's Comet (1909c).—A set of elements, computed by the Russian Astronomical Society, for Halley's comet is published in No. 4358 of the *Astronomische Nachrichten*. The perturbations for the period November 15·9, 1835, to December 13, 1909, were computed by the method of mechanical quadratures, and the time of perihelion passage is given as 1910 April 23. An ephemeris which accompanies the elements gives positions for every tenth day from September 4 to December 23, and agrees fairly well with the position determined, for September 11, from Prof. Wolf's photograph.

Double-star Observations.—In No. 4350 of the *Astronomische Nachrichten* Prof. Doberck compares the observations of a number of double stars, made by various observers, with the data deduced from the published orbits. For twenty-three objects he gives the places where the orbits were published, the years in which observations were made, and the differences, for each observer, in angle and distance. The names of the observers are given in abbreviated form in accordance with a comprehensive list published by Prof. Doberck in No. 4346 of the same journal.

A Newly discovered Nebula Cluster in Cetus.—In No. 4352 of the *Astronomische Nachrichten* Prof. Wolf announces the discovery of a small cluster of nebulæ in the constellation Cetus. The position of the cluster is $\alpha = 2h.\ 50m.$, $\delta = +5{\cdot}4°$ (1855·0), in a region which is generally very barren in these objects. The new object is very faint, with a central condensation, and has a filamentous appearance.

Observations of Variable Stars.—No. 4352 of the *Astronomische Nachrichten* is devoted to the discussion of twenty stars of which the variability is doubtful or small. The observations were made, photometrically, at Potsdam, by Herr W. Münch, during the period September, 1908, to March, 1909, and are discussed at some length.

Terrestrial Refraction in Egypt.—No. 33, vol. iii., of the *Cairo Scientific Journal* contains an interesting discussion of some observations of vertical refraction made by Mr. Xydis at Alexandria. The observer found a well-marked diurnal variation which, in November, 1908, gave for k, the coefficient of refraction, values ranging from 0·0497 (at 9h.) to 0·1186 (at 17h.); frequently the value, which is usually positive, was found to be negative. The observations are also discussed by Messrs. Craig and Keeling, the latter pointing out the difficulties inherent to observations of vertical refraction, especially when settings are made on a sea horizon. Observations made at Helwan Observatory in November, 1908, showed the refraction to vary between 0·781 and 0·101, and, when compared with others made in June, showed that k is much smaller in summer than in winter, the values ranging, in June, from 0·368 to 0·076. It also appears that the refraction in Egypt varies much more than in European countries.

THE IRON AND STEEL INSTITUTE.

THE autumn session of the Iron and Steel Institute commenced on Tuesday, September 28. Meetings for the reading and discussion of papers were held on Tuesday, Wednesday, and Thursday at the Institution of Civil Engineers, and were attended by a large number of members. In the absence of the president, the chair was taken by Lord Airedale, supported by the Duke of Devonshire, who presented the Carnegie gold medal to M. A. Portevin, in recognition of his researches on steel alloys.

A short paper on the production of iron and steel by the electric smelting process, by E. J. Ljungberg, gives information regarding some experiments made in Sweden at the works at Domnarfvet. The latest form of furnace employed resembles a common blast-furnace having three carbon electrodes fed by three-phase alternating current at about 40 volts, 60 cycles, and 9500 amperes. These electrodes take the place of tuyeres. The furnace has been running for 1903 hours, and has produced 280 tons of iron containing from 0·95 per cent. to 3·09 per cent. of carbon. In producing this quantity there was used 442 tons of ore, 24 tons of lime, 41 tons of coke, 58 tons of charcoal, 6·5 tons of electrodes, and 891,623 kilowatt-hours of current. No air whatever is used in the process. The manufacture of iron and steel direct from ore by electrical means is of importance in a country like Sweden, possessing practically no coal mines, but having numerous waterfalls available for the generation of electricity. A commercial start has been made by the installation of three large furnaces in Canada at Sault Ste. Marie.

The difficulties encountered in tests for determining the economy of steam engines used in driving reversing rolling-mill engines are explained in a paper by Mr. C. A. Ablett. Such tests are usually carried out by indicating the engine, and so estimating the steam consumption per indicated horse-power, or by measuring the feed water or coal consumption in cases where the boilers supplying the engine can be isolated. In the latter case the result can be expressed in pounds of steam or coal per ton rolled, provided a record is kept of the total weight of steel passed through the mill during the test. The author also describes how the power consumed in electrically driven mills may be obtained by means of an ordinary integrating wattmeter. The results of such tests are expressed easily in kilowatt-hours per ton. Five steelworks have decided to adopt electrical driving since the last autumn session of the institute, making more than twenty firms in all which have come to this decision. The author gives some results of electrically driven rolling mills, from which we quote the highest and the lowest. In rolling flange rails, 100 lb. per yard, from 2-ton ingots, output 30 tons per hour, 48·0 kilowatt-hours per ton were required. In producing 32-inch by 9-inch slabs from 6-ton ingots measuring 36 inches by 19½ inches, output 40 tons per hour, 4·3 kilowatt-hours were required.

An interesting paper on the growth of cast irons after repeated heatings was contributed by Profs. H. F. Rugan, of Louisiana, and H. C. H. Carpenter, of Victoria University, Manchester. The fact that certain types of cast iron grow after repeated heatings has long been familiar to engineers. Cast iron annealing ovens 8 feet in length, 3 feet in diameter, and 1½ inches in thickness, kept red hot for prolonged periods, sometimes grow to 9 feet in length in the course of use. The conditions under which the maximum growth occurs were first investigated, and, as a result, a period of four hours at 900° C. was chosen for the experiments. For growth to take place, repeated heating and cooling are required. In the tests, three commercial cast irons were examined, the test bars being heated in a cast-iron muffle protected by another muffle of fire-clay. The bars grew at different rates and to different extents, constant volume being reached after ninety-four heats. The growth in volume varied from 35·21 per cent. to 37·50 per cent. An increase in weight of from 7·82 per cent. to 8·60 per cent. was observed. The connection of growth and chemical composition was investigated on a series of iron-carbon alloys containing no graphite. An alloy was found the volume of which remains constant even after repeated heatings at about 900° C. This alloy is a white cast iron having about 3 per cent. of carbon and only small quantities of other constituents, of which silicon is the most important, and this should not exceed 0·2 per cent. to 0·3 per cent. The influence of silicon was examined in a series of iron-carbon-silicon alloys. The growth was found to be roughly proportional to the silicon present. In grey irons there are alloys the growth of which in air on heating is due entirely to oxidising gases penetrating their interior; in others, originally dissolved gases contribute to some extent to the growth.

Some experiments carried out at the Clarence Ironworks, Middlesbrough, are described in a paper by Mr. Greville Jones. These experiments had for their object the determination of whether the principal saving in fuel in blast-furnaces using dry air blast was due to the uniformity of the blast or to its dryness. Two furnaces were used, both of the same size and carrying the same load. For comparison, one of these was run with dry blast, and the other was supplied with blast in which the moisture was gradually increased up to 4 grains per cubic foot during the first of the four weeks over which the experiments extended. No appreciable difference was found in the working of the two furnaces.

Mr. R. S. Moore dealt with the fuel economy of dry blast in a subsequent paper. The author was associated with Mr. Jones in the tests at the Clarence Ironworks, and believes that the results of these tests point strongly to the fact that the great heat saving of the Gayley dry blast must be due to its dryness.

In another paper Mr. F. J. R. Carulla considers the development of the process of manufacturing artificial magnetic oxide of iron. Dr. William Gregory, of Edinburgh, first observed that when a solution of protosulphate of iron is divided into two equal parts, one of which is peroxidised, then mixed with the other, and precipitated by ammonia at a boiling heat, a black oxide is obtained which does not attract oxygen in drying, and is highly magnetic. Its composition must be $2FeO + Fe_2O_3$, as the two solutions contain equal quantities of iron, and Gregory suggests that it may occur native as a variety of magnetic iron ore. Dr. Wülffing first worked out its industrial manufacture from waste liquors. Notwithstanding difficulties, the product is difficult to spoil in the making, and the great protective value of the Gregory-Wülffing magnetic oxide of iron paint is acknowledged by all who have had any experience of it.

The serviceable life and cost of renewals of permanent way of British railways were dealt with in a paper by Mr. R. Price-Williams. The total annual cost of the maintenance and renewal of the permanent way and works now amounts to 15 per cent. of the entire working expenses, which for some years past have reached the high figure of 63 per cent. of the entire railway gross receipts. The wear and tear of permanent way during the last ten years amounts to 5039 miles of railway, which have become worn out and have been replaced in most, if not all, cases with stronger and better materials.

Dr. J. Newton Friend, in a paper on the corrosion of iron, points out that the ionisation of water, which forms the base of the electrolytic theory of corrosion, is purely an assumption of which we have no definite proof. Kohlrausch showed that water offers the greater resistance to the passage of an electric current the more carefully it is purified. Not a few chemists maintain that if absolutely pure water could be obtained it would be found to be incapable of conducting an electric current—in other words, that it would not be capable of ionisation. Leduc has directed attention to the extreme difficulty of removing every trace of dissolved gases from water by boiling. The author points out that the results obtained by Kohlrausch and Heydweiller may be simply a measure of the extent to which the dissolved gases remain in solution under the special conditions of the experiments. If such is really the case, the electrolytic theory of corrosion becomes a myth, whereas the acid theory is unaffected by it.

Dr. Friend read another paper on the action of air and steam on pure iron. His experiments show that pure iron combines with ordinary air and with air dried over phosphorus pentoxide with increasing readiness as the temperature rises. Below 150° C. the oxidation proceeds too slowly to be readily detected. Pure iron becomes tarnished when heated in pure steam at temperatures ranging from 350° C. upwards. The author concludes that the action of steam on iron takes place in two stages, first, the dissociation of the steam, second, the combination of the dissociated oxygen with the iron and the consequent liberation of free hydrogen gas. If this conclusion is correct, the dissociation pressure of the oxide of iron produced at 350° C. is of the order of $1 \cdot 02 \times 10^{-12}$ atmospheres.

A paper on tests of cast iron was read by Mr. E. Adamson. The general results were as follows. The best tensile and transverse tests are obtained from bars which have been machined. Transverse test bars cast on edge and tested with the "fin" in compression give the best results in testing. The transverse test is not so trustworthy or helpful as that of the moment of resistance. The use of high-grade ferro-silicon in the foundry is of no commercial value. Cast iron gives the best results when poured as hot as possible.

Mr. T. Swinden contributed a paper on the constitution of carbon-tungsten steels. This paper is a continuation of the author's earlier researches on the same subject. His hardness tests and exhaustive microscopic examination support in every respect the conclusions previously recorded upon the cooling-curve work, namely, that the "lowering temperature" marks a definite reaction in which the tungsten is involved, and that the rate of cooling from above the lowering temperature is without influence on the low point. It is suggested that the hypothesis of Edwards, that the lowering of the point is due to the formation of a carbide tungsten, is untenable. The theory of a double carbide formation is difficult to account for with the cooling curve and microscopic facts observed. A tentative hypothesis is given, wherein the lowering of the recalescence point is attributed to the solution of a tungsten compound, probably Fe_3W, at the lowering temperature. The tungsten is re-precipitated at the low point, and the Fe_3C immediately separates also.

THE OPENING OF THE LONDON MEDICAL SESSION.

ALTHOUGH under the present five-years' curriculum of medical study it is perhaps preferable for the student to commence his studies in the summer session, by a time-honoured ordinance the medical year in London always dates from October 1 or thereabouts, and is in many of the schools made the occasion for the distribution of prizes and the delivery of addresses of welcome and advice.

At University College Hospital Sir John Tweedy opened the session, and in his address dealt particularly with the importance of the experimental method in medicine. He pointed out that failure to appreciate the difference between the dissemination of knowledge and the advance of knowledge had given rise to much confusion of thought and not a little waste of endeavour. Perhaps the crudest manifestation of this confusion was the belief, real or feigned, by some persons that inquisitorial experiments are performed in hospitals on men, or on animals, or both. Less crude—nay, even creditable in a sense—was the notion that by establishing sanatoria or endowing special hospitals for the treatment of particular classes of general diseases it was possible to solve the problem of the nature and origin of these diseases and to hasten the discovery of the means of prevention and cure. He proceeded to give examples of the value of research in combating disease, instancing the discoveries relating to malaria, Malta and yellow fevers, and the arrest of hæmorrhage by the ligature of arteries, the last-named being the outcome of experiments on horses performed by Dr. J. F. D. Jones at the beginning of the last century.

At St. Mary's Hospital, the principal of the University of London, Dr. Miers, gave an address to the students on the importance of "theories." Dr. Miers said that for all people there was a certain period of life when they were ready and anxious to invent and to produce something original. It was in the period including the close of school life and the beginning of university life, or whatever came after school, that most people had been guilty of attempts to write poetry, or had endeavoured to construct a tale, or had believed themselves to be on the brink of a discovery or invention, or had taken up some new idea or theory of life which was for them, at least, a new thing of their own making and a piece of their own philosophy. It had been too much the fashion to decry youthful efforts, and to endeavour to persuade ourselves that knowledge and experience were required before anything good came out of a man unless he were a heaven-born genius.

After referring to the instances of Pasteur, Darwin, and other great workers in research, the lecturer went on to draw a distinction between the pleasure of merely acquiring knowledge or making observations, and that more intellectual pleasure of scientific discovery. He contended that after school days were over all the preparatory and educational work that they had to do should be taught and learnt in a new spirit, no longer as an exercise or a preparation, but as real active living research guided by the light of theory and inspired with the hope of discovery. He counselled medical students in all their work to adopt a theory and stick to it so long as they were able, and then, if necessary, to invent a new one, to work in the spirit of investigation in the light of their theories, and to regard all their work as belonging to medical science and illustrating the general principles of that science.

At the Middlesex Hospital, after Dr. Goodall, the sub-dean, had addressed the students on "walking the hospitals," in which he emphasised the importance of the ground-work of chemistry, biology, anatomy, and physiology for the intelligent study of clinical medicine, Lieut. Shackleton distributed the prizes and gave a sketch of some of his experiences in the Antarctic. The temperature of the explorers on the plateau went down to 94° F. or 93° F.—four or five degrees below normal—without ill effect. The members of the expedition did not suffer from colds, though on one occasion when a bale of clothing packed in England was opened they caught cold, but it disappeared when they went out, while those who remained in the hut still suffered.

"St. George's and the Progress of Physic" was the title of Dr. Rolleston's opening address at St. George's Hospital. The lecturer detailed many interesting facts in the lives of Matthew Baillie (physician to the hospital, 1787–1800), who did much for the study of anatomy; Thomas Young (physician, 1811–29), best known as the discoverer of the undulatory theory of light; John Hunter, the great anatomist and physiologist; Sir Benjamin Brodie, the well-known surgeon; and Edward Jenner, the discoverer of vaccination.

At the London School of Medicine for Women, Mrs. Garrett Anderson, M.D., in opening the proceedings, referred to the admission of Miss Woodward to the membership of the Royal College of Physicians.

Mrs. Henry Fawcett, LL.D., gave an address on "pioneering," in which she pointed out the courage and self-sacrifice displayed by the pioneer in every branch of human endeavour. The pioneers cleared away difficulties, made the road for those who followed safe and easy. If they really wished to recognise with gratitude the work which had been done for them by the great pioneers, she would wish nothing better for them than that they might be able to claim, even though they might not receive, the gratitude of those who followed after them in the noble profession to which they were devoting their lives.

FORTHCOMING BOOKS OF SCIENCE.

AGRICULTURE.

Constable and Co., Ltd.—Soils and Manures, J. A. Murray, illustrated.

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Wm. Blackwood and Sons.—The Life and Times of Akhnaton, Pharaoh of Egypt, A. E. P. Weigall, illustrated. *Constable and Co., Ltd.*—The Tomb of Queen Tiyi (Theodore M. Davis's Excavations), illustrated. *Macmillan and Co., Ltd.*—Totemism and Exogamy: a Treatise on Certain Ancient Forms of Superstition and Society, Dr. J. G. Frazer, 3 vols. *Swan Sonnenschein and Co., Ltd.*—Bushman Folk-lore, Miss L. C. Lloyd, edited by Dr. G. M. Theal, illustrated; History and Ethnography of South Africa, 1505–1795, 3 vols., Dr. G. M. Theal: vol. ii., Formation of the Cape Colony by the Dutch; vol. iii., Account of the Dutch, Portuguese, Hottentots and Bantu.

Biology.

F. Alcan (Paris).—La Critique du Darwinisme social, J. Novicow.—*John Bale, Sons and Danielsson, Ltd.*—Household Pests and Household Remedies, W. R. Boelter; Handbook of Animal Parasites of Men and of Animals, Drs. Braun and M. Luhe, translated; Biological Excursions: being an easily understood Introduction to Biology, Dr. C. Thesing, translated by W. R. Boelter, illustrated. *George Bell and Sons.*—A new edition of Hayward's Botanist's Pocket-book, containing, in a tabulated form, the chief characteristics of British plants, with the botanical names, soil, or situation, colour, growth, and time of flowering of every plant, arranged under its own order, with a copious index, G. C. Druce. *A. and C. Black.*—Egyptian Birds, C. Whymper, illustrated. *Blackie and Son, Ltd.*—Ancient Plants: a Simple Account of the Past Vegetation of the Earth and of Recent important Discoveries in that Realm of Nature-study, Dr. Marie C. Stopes, illustrated. *W. and R. 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Du Cane Godman, F.R.S., the fifth and concluding part, illustrated; The Adventures of Tommy, Sir Digby Pigott, C.B.; a nature-story book for boys and girls, describing further adventures of the hero of "The Changeling."

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Medical Science.

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THE BRITISH ASSOCIATION AT WINNIPEG.

SECTION L.

EDUCATIONAL SCIENCE.

Opening Address by the Rev. H. B. Gray, D.D., Warden of Bradfield College, Berkshire, President of the Section.

The Educational Factors of Imperialism.

Among all civilised races and in all epochs of the world's history there has existed an inveterate belief that the particular age in which men live is fundamentally distinct from those that have preceded it.

Even in the most stagnant periods the illusion has prevailed that *the present day* is a period of flux and movement more or less organic, and as such either to be welcomed or to be deplored.

Notoriously difficult, however, as it is to gauge the temper of an age while we live in its midst, yet the phenomena in England at the beginning of the twentieth century seem so unmistakably marked that even a superficial thinker can hardly fail to recognise the spheres in which the symptoms of change and unrest are clearly operating. They are surely in these two—the sphere of education and the sphere of Imperial sentiment.

It may not appear inapposite, therefore, if, meeting as we do in this city of phenomenal growth and infinite enterprise, our thoughts were to be directed in my inaugural address on the science of education towards discovering what may be either called the Imperial factors in education, or conversely, and perhaps more properly, the educational factors in Imperialism.

It may be perhaps safely said in this great Dominion what might possibly be disputed in the academic groves of our ancient English universities, that there was no width of educational outlook within our own little island until the last thirty years of the nineteenth century.

The only strongholds of learning which presumed to give the lead to English secondary education were to be found on the banks of the Isis and the Cam. In these antique, I hesitate to say antiquated, fastnesses, the "grand old fortifying classical curriculum" was, until lately, regarded as the main, if not the only, highroad to educational salvation. They preserved, indeed they preserve to this day, almost the same entrance bars against admission to their thresholds as existed in pre-Reformation days. And, conformably with the pursuit of these ideal studies, the vast mass of their emoluments were, and still are, appropriated to the pursuit of the ancient models of education.

The result of this monopoly on the lower rungs of the educational ladder has been obvious, and, to a scientific thinker, lamentable. The curricula of the public secondary schools have been narrowed, or rather have never been widened coincidently with the development of new spheres of knowledge and enterprise. The students in those institutions have been dominated from above, for just as "where the carcase is, there will the eagles be gathered together," so where the emoluments have been, thither do the cleverest students concentrate their intellectual forces.

The ambition of the ablest boys has been inevitably and exclusively concentrated on a single line of study, and (as often happens in the minds of the young) other no less humane but entirely unendowed departments of human knowledge have been laughed down and despised. Opprobrious epithets, even, have been bestowed on the study of the natural sciences, while those modern linguistic achievements which opened the door to the treasures of French and German literature are still nothing accounted of in the great schools of England.

But (more marvellous than all) even the scientific acquisition of and familiarity with the literature of the mother tongue have been entirely neglected, because no room could be found for it in a time-table, three-quarters of which is confined for the great mass of boy students in the historic schools of England (whatever their tastes and capabilities) to the exclusive study of the grammar, literature, and composition in the languages of ancient Greece and Rome. And the particular methods pursued in this confined curriculum have rendered the course more straitened still. The acquisition of the literatures of the two dead languages and of the great thoughts buried with them has given place to a meticulous study of the subtleties of scholarship, and students are taught to wanton in the abnormalities of the words and phrases in which those literatures were enshrined, so that in the mind of the classical scholar the form has become, or at any rate became until quite lately, more important than the substance.

Nor is this all. Those who cannot find any stomach for such drenching doses of mediæval learning are actually driven away prematurely as lost souls from those moss-grown seats of learning, which we acclaim as the great public schools of England; and, with moral characters only half-fledged, have either been condemned to the limbo of private tuition or sent as "submerged tenths" to find, or lose, their fortunes in the great dependencies and dominions of the Empire like that in which I am speaking to-day. There has been no serious attempt made until the twentieth century by the leaders of our best-known places of secondary education to discover the bents and aptitudes of the boys committed to their charge and to give them any educational chance if they have not possessed that particular kind of perception which could find its way through the subtleties of a Euripides or a Horace. Boys have been entirely denied the opportunity of showing their mental powers in any other sphere of learning. How many unsung Hampdens or mute, inglorious Miltons of mechanical genius have been lost to the world by the non-elastic systems prevailing (even now) in our best-known educational institutions, is a tremendous responsibility for conscientious trainers of the young to contemplate and atone for.

In how many, or rather how few, places of learning in England, at the present time, can the establishment of scientifically equipped carpentering and engineering shops be found in which a young mind which finds it impossible to digest the crude morsels of Latin and Greek grammar can find resource and development? In how few schools has the connection between mind and hand and eye been scientifically trained? Such establishments, even in the first decade of the twentieth century, can be counted on the fingers of one hand.

And yet, in spite of it all, the surprising fact remains—a fact which speaks volumes for the innate vigour and originality of the English race—that, out of the stream of young men which flows out annually from our public schools[1] and colleges, so many accommodate themselves as happily as they do to the startlingly new conditions which confront them when they pass over the seas and swell the tide of population in great centres of industry and enterprise such as that in which we stand to-day. Their educational vision, however, has had such a narrow and limited horizon that no wonder a large proportion are not very adaptable to the practical life of the prairie and the forest, or even of the counting-house and the office stool. Am I, or am I not, correct in hazarding the conjecture that many specimens of this really fine English breed from the old country come to you here in this Dominion without an elementary knowledge of the

[1] It should be noted in the forefront of this address that the expression "public schools" is used throughout in its English (not in its more proper and American) sense—*i.e.*, as the educational centres of the upper classes.

laws of the world in which they live, full of antiquated prejudice and tradition, derived principally from the straitened area of their island-home experience, so that not seldom they put their hand to the plough (either literally or metaphorically) and look back, becoming wastrels instead of forceful citizens in this ever-widening Empire? "No English need apply" has been, if I mistake not, written as a memorandum inside the breast of more than one leader of industry in this great continent, and small wonder is it when the cramping character of the ultra-mediæval training which our young men have received at some of our historical public secondary schools in England is taken into account.

What remedy (you may ask) have I to propose? My answer is this: I want to force upon the attention of English educationists certain Imperial factors which should occupy an indispensable place in the educational curricula of the great schools in the Mother Country.

I would give a prominent place to the scientific teaching of geography, and particularly to historical geography, with special reference, of course, to the origin, growth, and progress of the British Empire. Such a volume as the "Sketch of a Historical Geography," by Keith Johnston, should be placed in the hands of every boy, and be known by him from cover to cover. It can hardly be realised that in many of our great classical schools to this day not more than one, or at most two, hours a week are devoted to this subject, and that it is often not taught at all beyond the middle classes in a school.

Again, I would enforce an elementary knowledge of science on every boy who passes through the stage of secondary education.

I am aware that many hard things have been said about the teaching of science in secondary education. A learned professor, who is the president of another section of the association, has passed his opinion that, as taught in our schools, it has proved of little practical or educational value. But because the methods employed have been halting, insufficient, and unscientific, it by no means follows that it should be left out of the category of school subjects. On the contrary, it appears astounding that two-thirds of the public-school boys of England should grow to man's estate without even an elementary knowledge of the laws of the world in which they live.

Lord Avebury, in his presidential address at the International Moral Education meeting held in London last autumn, told his audience an amusing story of how, walking back one beautiful summer night from the House of Commons arm-in-arm with a leading luminary on the Government benches, his companion, who had been at Eton and Oxford, gazing at the great luminary in the heavens, pensively observed: "I wonder, my dear Lubbock, whether we shall ever know why the moon changes her shape once a week at least?"

To one who aspires to seek his fortune in the wide and half-unexplored continents of Greater Britain the value of the knowledge of chemistry, geology, botany, and arboriculture can hardly be overestimated. And yet many present here could bear critical witness to the fact that a large proportion of young men go out to the North-West totally unequipped, after their public-school training, with even the most elementary knowledge of those departments of science to which I have alluded. No wonder, again, "No English need apply." Every youth we export to you ought educationally to bear this label on his back: "Every seed tested before being sent out."

But above and beyond all there should be brought into the foreground a co-ordinated study of English language and English literature. Nothing impressed me more in my visit to the United States in 1903 as one of the Mosely Commission than to observe how greatly the cultivated classes in the Federation outstripped our island-bred people in the facility and power with which they manipulated the English tongue. Awkwardness, poverty of expression, and stammering utterance mark many Englishmen of high academic distinction. But the American who, on account of the incessant tide of immigration, has to assimilate the congeries of all the nations of the earth in the shortest possible space of time, has so co-ordinated the study of his ancestral tongue in the schools of his country, that the pupil emerges completely equipped for the use of persuasive and oratorical language wherein to express his thoughts and wherewith to gain his ends.

In connection with this, may I add that it was indeed a happy augury that, at the eve of the meeting of the British Association in this great Dominion, there should have been a gathering of delegates of the Imperial Press in the centre of our small island home? "Little they know of England who only England know." The phenomenal, or rather abysmal, ignorance of the geography and of the vastness of the productive power of the British Empire which exists among the upper and middle classes in England would be ludicrous if it were not so deplorable. The loyalty and devotion of the Colonies, right unto the utmost corners of the earth, admit of no dispute. It is observable on every hand and in every national crisis. The doubt is of the loyalty of the centre of the Empire towards its extremities, through the crass ignorance which exists as to the geographical and political meaning of that Empire. I would annihilate that ignorance, as aforesaid, by putting political, historical, and physical geography in the forefront of our educational system; by lectures from your able men in Canada, or Australia, and South Africa, vivified by lantern-slides, and encouraged and endowed by the Mother Country. I would bring all visible means of presentment to bear on the education of childhood, boyhood, and youth in the Motherland.

Let me touch on one further educational factor of Imperialism. The sentiment of patriotism, unlike that of charity, is not equally capable of indefinite intension and extension. The peculiar system of education which finds vogue in England in most of our greatest institutions—the institutions from which are drawn the future leaders of the nation—is, as everyone knows, the barrack system, otherwise called the boarding system. It is not the time or place here to enlarge on the obvious advantages of that system, its unique characteristics, its power of moulding character and developing enterprise. But it has its cramping and confining side—it has a tendency to localise patriotism, to narrow a young man's mental horizon, and to ignore whatever lies outside its immediate survey. Hence the abnormal and gladiatorial devotion to games and comparatively selfish amusements, which absorb, and, in my opinion, not seldom paralyse and stifle wider, more generous, more enlightened—in fine, more Imperial instincts. However much in the field of sports the individual youth may subordinate his own self-regarding impulses to the welfare of the tiny community for which he is exercising his energies, his horizon is not wide enough to bid him rise to a sentiment of self-sacrifice and self-abandonment on behalf of a greater and more abstract ideal—love of Fatherland and loyalty to Empire.

But it is a welcome thing to be able to point to a larger sentiment lately awakened in this direction. There is no doubt that the patriotic spirit in our schools and colleges has, from whatever cause, received a great impetus in the last two years, and that the general principles of an intelligent defence of our shores from foreign aggression have been taught and construed into terms of scientific training and co-operative action with a rapidity equally surprising and welcome to those who, a few years ago, looked with something more than apprehension on the supineness of the youth of England in all patriotic regards.

"The flannelled fool and muddied oaf,"

though they have not yet received their quietus, have been less rampant lately in our educational institutions, and something like an Imperial instinct, born of increasing knowledge both of the glory and dangers of our vast Empire, has, at least in the more cultured classes, taken the place of apathy, disregard, and ignorance. In hours formerly lavished to an abnormal extent on trivial amusements, and even in hours hitherto devoted to more academically intellectual training, we find young men in our schools and colleges now with arms in their hands, shooting, signalling, scouting, and studying scientifically the art of defensive warfare. This, at least, is "a beam in darkness, of which we pray that it may grow."

Time and your patience will not allow me to touch on more than the fringe of the great educational problems which have to be solved before we can approach in English education to what I venture to call the ideal of Imperial responsibility.

In criticising the old mediæval system of education which prevailed in England until comparatively recent years, and which still has far too great a hold on the more venerable and important institutions of our island home, I would not have you suppose that I am an advocate of a complete, or even approximately complete, basis of utilitarian education. It is an easy charge for those who desire *stare super antiquas vias* to throw in one's teeth. I have little hesitation in expressing my belief that the time has come (and I speak as one whose training was that of a classical scholar, for I was brought up in the straitest sect of academical Pharisees)—I say I have no hesitation in expressing my belief that the time has come, not only that the study of the two ancient languages should be reduced to one for all except scholastic specialists, but also that both should yield pride of place in our educational system to the claims of English, modern languages, mathematics, natural science, and, not least, manual training, so that our young men should be fitly equipped to put their hand to any work which may confront them amid all the complex problems and critical situations to be found within the world-wide boundaries of the British Empire.

Germany, France, and the United States have been beforehand with us in the working out of such a reformed system of education. I am by no means one of those who believe that we should be wise in copying the methods in their entirety of any of these three peoples in their educational methods. Undoubtedly in all three there has been a more organised connection between the actual teaching given in their respective schools and the industrial, social, and political needs of the respective peoples. But no one nation is exactly like another nation in its temper and genius, and I should be sorry to advocate, for instance, the highly organised system of State education in Germany, under which it could be predicted to a certainty that boys and girls in every secondary or primary school on any given Friday morning should be studying (say) the geographical importance of Natal or the outlines of the coast of Lincolnshire. There must be many educational differences, because the idiosyncrasies of each nation differ from those of another, and I do not think we need ever fear that our intrinsic individuality will be crushed into any Teutonic cast-iron mould or ground down beneath the heel of some bureaucratic educational despotism. But that we ought to change our ways still more than we have, and adopt saner educational models, many searchings of heart through a long educational career have gradually, but overwhelmingly, convinced me. If we are apt to think, speak, and act Imperially, our education must take form from a strong Imperial sentiment, and must aim at instilling Imperial instincts in the young lives which that education is meant to control and develop.

I have spoken hitherto of this subject mainly from the point of view of secondary education, with which I am the most conversant; not only for that reason, however, but because most of those who are destined to proceed to the distant outlying parts of the British Empire, and, when there, to take prominent parts in the development of that Empire, obtain their educational equipment from the secondary schools of England. It is, therefore, on curricula offered or desiderated in them that I have exclusively dwelt. But I do not blink the fact that the proper educational organisation of our elementary schools on the one hand, and of our universities on the other, exercises a large influence on the solution of Imperial problems.

On elementary education, however, I do not propose to touch in this address, mainly because I look forward to experts in primary schools directing the thoughts of this association more directly to them. But I will touch with great brevity on the subject of university education.

Whether Oxford and Cambridge—particularly Oxford—will ever so reform themselves as to contribute largely to such solution remains to be seen. Personally, I look with far greater confidence to the more recently organised universities—those of London, Leeds, Sheffield, Manchester, and the like—to equip men educationally with those moral, physical, and intellectual qualities which are most in requisition in our great dependencies and commonwealths.

Such institutions, from their newness, their eagerness, their freedom from antiquated prejudices and vested interests, are more likely to be counted upon for many years to come to send forth a stream of young men who have learned in the school of hardness to face the difficulties and to adapt themselves to the austere conditions which are inseparable from life in unworked regions and half-discovered continents. And it is at once a hopeful and inspiring thought that the great Dominion of Canada will welcome such to herself as sufficient and efficient citizens of her all but boundless territories, that she will recognise in them "bone of her bone and flesh of her flesh," physically, mentally, and morally capable, in company with those of her own sons who have long settled in the land, of extending the borders of the Empire by enlarging its resources, and of lifting, securing, and consolidating thereby the destinies of the Anglo-Saxon race.

There is still one more educational factor on which I would ask attention before I close this address. It is this—the necessity of a closer touch educationally (in the sense of "academically") between the secondary schools and colleges of the Mother Country and similar institutions in the great Dominion and commonwealths which own her parentage. How this can be effected without great modification of our existing English system it is hard to see. But one point is quite clear. We must give up that part of our system which insists on choking the passage of the student from point to point in his education to the privileges of further education, if such examination on entrance and throughout his academical course. It would be of incalculable advantage to the Empire at large if an extension of educational intercommunion, such as was inaugurated by the noble benefactions of the late Cecil Rhodes, could be secured throughout the Empire. Undoubtedly examination would be the surest test for determining the question of the admission of a student to the privileges of further education if such examination could be conducted within a limited geographical area. But it is quite an impossible system if adopted as between the outlying parts of a great empire. The United States of America have taught us a better way. For instance, in the State of Minnesota, the university has legislated that if and when the principal of a high school of recognised position certifies that a student has successfully pursued for a specified length of time those studies in that high school that would entitle him to admission to the university, he should be admitted thereto without further delay or hindrance. What a paralysing curse the Charybdis of examination has been to all true learning only those who have suffered from it for thirty years can bear adequate testimony. It would be one of the most fertilising sources from which to secure good and progressive citizens if, instead of admitting within her borders all or any who came of their own spontaneity or from compulsion (leaving their country, perchance, for their country's good), the Government authorities in the Dominion could get into closer touch with the educational authorities of the Mother Country, who would act as guarantee that the material sent out by the Mother Country should be of an approved and first-rate quality. This might be worked on the American "accredited school" system, under which the authorities of the school sending the pupil should feel the *maximum* of responsibility in recommending his admission to the academical, or the technical, or the industrial organisations existing in the Dominion.

Since penning the first sentences of the above paragraph last June my eye has been caught by a notice which appeared in the columns of the *Times* on the 28th day of that month while I was engaged in the very act of correcting the proofs of this address; but I prefer to leave the paragraph written as it stands, as the notice in question is an eloquent commentary on my suggestion of educational intercommunion.

I may, perhaps, be allowed to read the extract from the *Times verbatim*, though it may be familiar to some at least among my audience. It is headed "International Interchange of Students—a New Movement."

"We have received," says the *Times*, "the following interesting particulars of a new educational movement to provide for the interchange of University students among the English-speaking peoples.

"The object is to provide opportunities for as many as possible of the educated youth of the United Kingdom, Canada, and the United States (who, it is reasonable to suppose, will become leaders in thought, action, civic and national government in the future) to obtain some real insight into the life, customs, and progress of other nations at a time when their own opinions are forming, with a *minimum* of inconvenience to their academic work and the least possible expense, with a view to broadening their conceptions and rendering them of greater economic and social value, such knowledge being, it is believed, essential for effectual leadership.

. . . .

"The additional objects of the movement are to increase the value and efficiency of, as well as to extend, present University training by the provision of certain Travelling Scholarships for practical observation in other countries under suitable guidance. These scholarships will enable those students to benefit who might otherwise be unable to do so through financial restrictions. It also enables the administration to exercise greater power of direction in the form the travel is to take. In addition to academic qualifications, the selected candidate should be what is popularly known as an 'all-round' man; the selection to be along the lines of the Rhodes Scholarships.

"The further objects are to extend the influence of such education indirectly among the men who are not selected as scholars (through intercourse with those who have travelled) by systematic arrangements of the periods' eligibility while they are still undergraduates.

"To promote interest in imperial, international, and domestic relations, civic and social problems, and to foster a mutual sympathy and understanding imperially and internationally among students.

"To afford technical and industrial students facilities to examine into questions of particular interest to them in manufactures, &c., by observation in other countries and by providing them with introductions to leaders in industrial activity.

"To promote interest in travel as an educational factor among the authorities of Universities, with a view to the possibility of some kind of such training being included in the regular curricula.

"To promote interest in other Universities, their aims and student life, the compulsory physical training, and methods of working their ways through college, for example, being valuable points for investigation.

"To promote international interchange for academic work among English-speaking Universities; and, in the case of the British Empire, to afford facilities for students of one division to gain, under favourable circumstances, information relative to the needs, development, and potentialities of other divisions; and to promote an academic interchange of students among the Universities of the Empire.

"As already indicated, there is a widespread interest in the movements so far as the United Kingdom is concerned; while in Canada and the United States there is also a widespread recognition of the value of the scheme; and although committees have not been actually organised there as in this country, a very large body of the most prominent educationists are strongly in favour of the plan, and have promised their co-operation if the scheme is financed.

"It is proposed to establish two students' travelling bureaux, one in New York and one in London; an American secretary (resident in New York) and a British secretary (resident in London), both of whom shall be college men appointed to afford every facility to any graduate or undergraduate of any University who wishes to visit the United States, Canada, or the United Kingdom for the purpose of obtaining an insight into the student, national, and industrial life of those countries. The bureaux will undertake the work of providing information relating to United States, Canadian, British, and other English-speaking Universities for the use of students, undergraduates, and others. They will also provide information relating to educational tours of any description in English-speaking countries, and the arrangement of tours suitable to the needs of the inquirer with a view to his obtaining the greatest facilities for education with a *minimum* of expense. Furthermore it will be their duty to provide information as to the best places for the study of educational, governmental, industrial, and social problems in the United States, Canada, the United Kingdom, and other parts of the Empire, as well as to provide introductions to leaders in the above-named spheres of activity, besides undertaking the organisation and conduct of special tours for educational purposes, if necessary.

"It is proposed to provide 28 travelling scholarships, 14 of these being available for Universities in the United Kingdom, 10 for Universities in America, and four for Universities in Canada. The arrangements will be controlled by general committees, one for the United Kingdom and one for Canada and the United States, unless it is found necessary to inaugurate a separate committee for each of the latter."

You will observe, then, that a scheme which I had ventured to suggest as being "of incalculable advantage to the Empire" had, before I wrote the words quoted, been advocated entirely without my knowledge by a body of influential educational leaders in England, whose names were appended to the notice which I have read; and I need only add that it is quite certain that I am interpreting the sentiments of all here assembled in wishing God-speed to the development of the scheme, which seems likely to prove, if carried into effect, a great, if not the greatest, educational factor of Imperialism.

But it may be objected here, Is not your own horizon circumscribed? Why should educational ideals be limited, even by so extended a conception as Imperialism? Should not the ultimate aim of all education be, not the federation of one race only, but the federation of the world at large—the brotherhood of man?

I am not concerned to deny that such a lofty conception is the true end of all physical, moral, and mental training.

But if the master mind of a Milton was content to define true education to be "that which fits a man to perform justly, skilfully and magnanimously all the offices, both public and private, of peace and war," it may well suffice us if we extend our (at present) too narrow conceptions (the aim of which seems to be the cultivation of a mere island patriotism) to a sphere which has for its end the imperialistic sentiment of a whole race.

It may, indeed, be well doubted whether a race-sentiment is not an ultimate factor beyond which it is impossible in an imperfect world to go. Universal philanthropy in its most catholic sense is a sentiment which the limited conditions of the earth's surface seem to render impossible. So long as men's ambitions are an unlimited quantity, and so long as the habitable globe remains, as it ever must remain, a limited quantity, so long will the populations of the world be continually liable to shifting movements and frequent dislocations. Practical educationists, then, must inevitably confine the scientific consideration of aims and methods in education to the development of the highest interests of their race rather than of mankind at large.

And that being so, the last point on which I would insist in dealing with the educational factors of Imperialism is to emphasise the importance of what the educationists of the United States call "civics" as the binding power which should fasten together all the separate educational faggots in any Imperial scheme of education—the duty of personal service to the State, the positive obligation which makes us all members incorporate in one Imperial system. In our love of individual freedom, in our jealousy of interference with our individual liberty of action, in our insular disregard and depreciation of intellectual forces working in our sister communities beyond the seas, we have lost sight of this civic responsibility which has ever lain on our shoulders and from which we can never dissociate ourselves, so long as our Empire remains as part of our ancestral heritage.

It is this positive duty towards each other and our race beyond the seas which those who live in our island home have been slow in realising, and it has been a real blot on our educational system that such ideas as Imperial responsibility and Imperial necessities have not been inculcated in the young people in our schools and colleges. As an illustration, I may observe that it has been even debated and doubted in some responsible quarters in England whether the Union Jack should wave over our educational institutions on the days of national festivity and national observance.

To sum up. By these and other kindred means I would urge a closer educational touch between the Mother Country and the Empire at large.

Long ago a great Minister was able to say: "Our hold of the Colonies is in the close affection which grows from common names, from kindred blood, and from similar privileges. These are ties which, though light as air, are strong as links of iron."

But times have changed. To-day we are confronted with the problems of a vast and complicated Empire—great commonwealths, great dominions, sundered from each other by long seas and half a world, and however closely science has geographically brought them together, we cannot in soul and sympathy, nor ultimately in destiny, remain attached, affiliated as mother and children should be, unless we grapple to each other and understand each other in the greatest of all interests—the educational training which we give to our children in the one part of our Empire to make them suitable citizens in another.

In suggesting reforms and modifications in which this educational unity may best be expressed, forgive me if I have but touched, and touched inadequately, on the fringe of a great subject, the transcendent importance of which it requires no elaboration of mine to impress on the earnest attention of the people of this great Dominion —which great Dominion may I be allowed to salute, without flattery or favour, as the most favoured by natural beauty and by virgin wealth of all the children of our common Motherland? May I salute her in terms which formed the old toast with which the two greatest of our English public schools, Winchester and Eton, pledged each other when we met in our annual cricket contest: *Mater pulchra, filia pulchrior!*

GEOLOGY AT THE BRITISH ASSOCIATION.

If the number of geologists from the British Isles who attended the meeting of Section C was somewhat limited, the number from the American continent was considerable, and it was greatly to them, and especially to those from Canada, that the markedly successful character of the sectional meetings was due. The Canadian geologists not only contributed a particularly interesting series of papers, but also arranged two excursions, which were largely attended.

The papers read before the section may be classified in four groups.

(1) *Stratigraphical Geology.*

Mr. J. B. Tyrrell's account of the geology of Western Canada, which followed the president's address, afforded an excellent introduction to the succeeding series of papers on local geology. *Pre-Cambrian geology* naturally occupied a good deal of the attention of the section, which had the advantage of hearing papers by Prof. A. P. Coleman on the bearing of pre-Cambrian geology on uniformitarianism, and by Prof. W. G. Miller on the pre-Cambrian rocks of Canada. Prof. Coleman described the somewhat complicated subdivision which Canadian geologists recognise in the pre-Cambrian rocks, and pointed out the varied nature of their origin, including as they do quartzites, sandstones sometimes passing into arkose, carbonaceous shale, limestone, igneous rocks both volcanic and intrusive, and metamorphic rocks in great variety. The most interesting point about Prof. Coleman's paper was the evidence he brought forward for the existence of glacial conditions in pre-Cambrian (Huronian) times, and the bearing of this on uniformitarianism. He exhibited stones which he had extracted from the pre-Cambrian conglomerate of the Cobalt district, the upper surface of which was scratched by the Pleistocene glaciation, while the lower (embedded) surface after extraction, also showed striæ which it was difficult to distinguish from those produced by the Pleistocene ice. In the subsequent discussion Drs. Fairchild, Strahan, Warren Upham, and Dwerryhouse expressed the opinion that Prof. Coleman had established his contention.

Prof. Miller's paper was chiefly directed to bringing into prominence the almost limitless mining possibilities of the Canadian pre-Cambrian rocks. He pointed out that although they have as yet been very imperfectly explored, they are already, in the Cobalt and Sudbury districts, the chief, or among the chief, world's source of nickel, cobalt, silver, and arsenic, while in the Michigan district their yield of copper and iron is one of the most important in the world. The same may be said with regard to the mica mines of Ontario.

The stratigraphy of the Palæozoic rocks of the British Isles was represented by the reports of several of the association's committees, including the following:—(1) Mr. E. S. Cobbold, on the Cambrian rocks of Comley, Shropshire; (2) Prof. S. H. Reynolds, on the igneous and associated rocks of the Glensaul district, Co. Galway; and (3) Dr. A. Vaughan, on the faunal succession of the Lower Carboniferous (Avonian) of the British Isles. The latter report included an important series of tables embodying Dr. Vaughan's latest views on the subdivision of the Lower Carboniferous rocks, and the correlation of the sequence in various parts of the British Isles. With the view of helping to bring Dr. Vaughan's work to the notice of Canadian geologists, Prof. S. H. Reynolds exhibited a series of lantern-slides of the two principal sections of the Bristol district, those of the Avon and of Burrington. He also contributed a paper on the lithology of the Burrington section. Another stratigraphical paper having reference to the Carboniferous rocks of the south-west of England was that by Mr. H. Bolton, on new faunal horizons in the Bristol coalfield, in which further evidence was brought forward of the occurrence of marine episodes in the Coal-measures of this part of the country. The only remaining stratigraphical paper was one by Dr. D. Woolacott, on the classification of the Permian rocks of the north-east of England.

(2) *Glacial Geology.*

Glacial geology naturally had much attention paid to it by the section when meeting in Canada, and the members were to be congratulated on hearing from Dr. Warren Upham an account of the glacial Lake Agassiz, in connection with which his name is so well known. At its maximum extent, according to Dr. Upham, it covered an area of about 110,000 square miles, exceeding the combined areas of the five great lakes tributary to the St. Lawrence. Lake Winnipeg forms its reduced representative at the present day. Dr. Upham's paper was followed by an interesting discussion, in which many leading Canadian and American geologists took part. Members of the section had, further, the opportunity of seeing some of the glacial and other deposits of Lake Agassiz on excursions which were made to Stony Mountain and Bird's Hill.

Prof. A. P. Coleman, in a paper on the extent of the ice sheets in the Great Plains, pointed out that while boulders from the Archæan region to the east are spread over the great plains as far west as Calgary, further to the west an older drift, derived from the Rocky Mountain region, is met with, this sometimes passing below the eastern drift. In places boulders from the eastern drift are found stranded 5000 feet up on the sides of the Rocky Mountains. These Prof. Coleman believes were stranded from ice-dammed lakes at a time when the Rocky Mountain region stood at a lower level than it does at present.

Glacial geology was further represented by a paper by Dr. A. Strahan, on the glacial geology of South Wales; by a lantern lecture by Dr. A. R. Dwerryhouse, on the glacial geology of Britain, as illustrative of the work of the committee on erratic blocks, and by the report of the committee for the investigation of the fossiliferous drift at Kirmington, Lincolnshire, and elsewhere.

(3) *Economic Geology.*

This subject, as might have been expected, was well to the fore, a series of most interesting papers on the ore deposits of Canada being given by Canadian geologists, Prof. W. G. Miller dealing with the gold, silver, and iron ores, Prof. A. P. Coleman with copper and nickel, Mr. J. B. Tyrrell with placer mining, and Prof. T. L. Waller with the rare metals. Prof. Miller prefaced his description of the gold and silver mining with a general account of mining in Canada. He pointed out that, until a few years ago, the central part of Canada was regarded as purely agricultural. The discovery of the rich ore deposits of Sudbury and Cobalt in 1908 completely changed this, and the value of the mineral produce rose from about a million dollars in 1901 to eighty-seven million dollars in 1908. The most interesting feature of the mineral wealth of Canada is its great variety. Canada is now the largest producer in the world of nickel, cobalt, asbestos, and corundum. As regards the immediate subject of his paper, Prof. Miller stated that the output of gold from the Archæan districts was not great, but it was found in British Columbia and the Yukon, the latter district standing third in the world's output. Gold is found also in Nova Scotia, and has recently been discovered at Prince Albert, in Saskatchewan. The great silver-producing region is Cobalt. The Canadian production of iron is as yet comparatively unimportant.

Prof. Coleman pointed out that copper is found in many parts of Canada, and in British Columbia some very low-grade ores are worked to a profit. Most of the copper of Ontario is found associated with nickel, the great locality for these substances being Sudbury, where the deposits occur in the marginal portion of a laccolitic mass of norite intruded between the Upper Huronian and the Animikie.

In dealing with placer mining, Mr. J. B. Tyrrell pointed out that it was almost confined to the mountainous region of the west, and that the industry had gradually spread along the river valleys from California northwards until eventually the Klondyke deposits were met with. These owed their value rather to exceptional conditions of erosion than to special richness. Mr. Tyrrell estimated that the Yukon district had yielded hitherto about six million ounces of gold, and might yield another four million.

Prof. T. L. Waller concluded the series of papers on the mineral resources of Canada with a description of the rare metals. Platinum and palladium are found in small quantities in the native state in placer workings at various points. Platinum has also been found combined with arsenic in the decomposed superficial deposits of the Sudbury district. Canada is also rich in undeveloped deposits of molybdenum and tungsten.

(4) *Palaeontology and other Subjects.*

In addition to the president's masterly address on the evolution of vertebrate life as shown by fossils, vertebrate palæontology was represented by two short papers, also by the president, recording the discovery of dinosaurian remains in the Cretaceous rocks of Australia and the Trias of Brazil, and by the report of the committee appointed to investigate the footprints of the Trias of Great Britain.

Other papers read before the section were by Mr. E. Dixon, on unconformities on limestone and their contemporaneous pipes and swallow-holes; by Prof. E. F. Chandler, on the rainfall run-off ratio in the prairies of Central North America; and by Dr. Tempest Anderson, on the volcano of Metavanu, in the Samoa Islands. The eruptive phenomena of this volcano closely resemble those of Kilauea, in the Sandwich Islands; but while the latter volcano, according to Dr. Anderson, is in its old age, the former shows the same phenomena with the exuberance of youth. A further interesting point in Dr. Anderson's paper was his confirmation by actual observation of the subaqueous production of the "pillow" structure in lavas.

The reports of the following committees were also presented:—on South African strata, by Prof. J. W. Gregory; on topographical and geological terms in South Africa; on geological photographs, this taking the form of an exhibition of lantern-slides illustrating certain aspects of British scenery; on the crystalline rocks of Anglesey; on the composition of the Charnwood rocks; on further excavations on Neolithic sites in north Greece; and on the salt lakes of Biskra. This latter report, which was represented merely by the title, refers to the work upon which the late recorder of Section C, Mr. Joseph Lomas, was engaged at the time of his lamented death.

ENGINEERING AT THE BRITISH ASSOCIATION.

THE proceedings in Section G consisted largely of papers by Canadian engineers on a closely related group of subjects, determined by the conditions of Winnipeg. Winnipeg occupies a peculiar geographical position, similar in some respects to Singapore or Buenos Ayres, as the gate of a great productive area. This position, and the bearing on it of the communications to the section, are most easily explained by recalling the geography of the country. Canada consists roughly of five sections.

(1) The Laurentian area, the so-called shield of Canada, is defined by the St. Lawrence and the chain of lakes which extends through Winnipeg, Athabasca, and the Great Slave and Bear Lakes to the polar regions. This vast district lying round Hudson's Bay is in the main a wilderness of lakes, rocks, and forests, swept clean of all cultivable soil by Glacial ice, except in certain areas where later Palæozoic rocks have been left over the Laurentian.

(2) The rich agricultural country between the Laurentian area and the Rocky Mountains. This, the modern provinces of Manitoba, Saskatchewan, and Alberta, is the northern section, reaching to 60° N. lat., of that geographical area of which the southern section is the basin of the Mississippi.

(3) The mountain region between the eastern foothills of the Rockies and the Pacific, a strip 400 miles wide extending up the whole coast.

(4) The fertile lands along the south of the St. Lawrence, New Brunswick, Nova Scotia, and the peninsula between Erie and Huron.

(5) The Arctic regions of tundra and ice.

To these five sections must be added for administrative purposes another of equal importance.

(6) The navigable route of St. Lawrence and the lakes.

Winnipeg is the gate between (2) and (6).

This section (2), 1200 miles long from north-west to south-east, and from 300 to 500 miles wide, is of extraordinary fertility, and especially adapted for growing wheat. The isothermals take a strong bend upwards in this region, and wheat has been ripened as far north as the Great Slave Lake, in 62° N. lat. The fertility of the soil is such that wheat can be grown remuneratively for many years in succession, and where the practice has obtained of allowing the land to be fallow one year in four to prevent exhaustion, it has to be sparsely tilled in the seasons following the fallow years to prevent the crops choking themselves by their own exuberance. Of this area, only 5 per cent. is yet cultivated, but in 1908 this produced 30 million quarters of grain, and carried nearly 4 million head of stock.

So long as the United States grows enough wheat for her own consumption, and until a new route is opened to the Atlantic by the Nelson or Churchill rivers on Hudson's Bay, the main trade of the provinces must pass east between Lake Winnipeg and Lake of the Woods. Here on the Red River, where the fertile lands end and the Laurentian wilderness begins, is Winnipeg, on the site of an old Hudson Bay Co.'s fort, Upper Fort Garry. A better site would have been at Selkirk or Lower Fort Garry, lower down the river and nearer the lake, but the site of the great depôt was ultimately fixed by the Canadian Pacific Railway for indirect reasons.

The great engineering questions of the city are to find the best means to develop the agricultural industry of the north-west, and to improve the trade routes, especially to the Atlantic. The papers presented to the Engineering Section dealt largely with these two subjects. Two papers on the grain industry, each of considerable length, were contributed by Mr. John Miller, an official at the experimental farm at Indian Head, Saskatchewan, and by Mr. George Harcourt, Deputy Minister of Agriculture of the Province of Alberta. The latter of these, especially, was a paper of exceptional ability and interest, the author being intimately acquainted with his subject and an admirable lecturer. He exhibited a map showing some of the extreme points in which wheat has been successfully ripened, and the area of potential grain-growing country. The subjects of these papers were not strictly those of engineers, but the urgent need for improved communications with which other papers dealt could hardly have been realised without them. These other papers fell into two groups, viz. deep water and railway communications. The problems of wheat transport are (1) to bring ocean steamers to the nearest possible point to the wheat fields, and (2) to handle and transport the grain to the ports as efficiently as possible. At present ocean-going steamers drawing not more than 27½ feet of water can reach Montreal at all tides, and this depth is being increased to 30 feet. Ships drawing 14 feet of water can pass between Montreal and Lake Erie by the lower Ottawa river, the Lachine and Rideau canals, Lake Ontario, and the Welland canal. Erie, Huron, Michigan, and Superior can be navigated by vessels drawing 20 feet of water, the depth of water in the Soo locks. If the depth of water in the lower Ottawa river, and in the Lachine, Rideau, and Welland canals, in all of which the depth is now 14 feet, could be increased to 22 feet, ocean steamers of, say, 7000 tons, by taking in or discharging the last 1000 tons at Montreal, could reach Lake Superior and charge or discharge cargo at Port Arthur, the nearest point to Winnipeg. Thus, subject to a small proportion being transhipped at Montreal, cargoes could be carried in bulk by ocean steamers of the size of ordinary tramps between Port Arthur, in the very heart of the continent, and any Atlantic port.

This route, however, is open to serious objection in that it lies through the Detroit River, and is liable to interruption by political difficulties with the United States. A new canal route which is not subject to this objection has been surveyed. The scheme, which is called the Georgian Bay Canal Scheme, provides for a canal between Montreal and Lake Superior by way of the Ottawa River, Lake Nipissing, and the Pickerel and French rivers, having a minimum depth of 22 feet and locks 650 feet long, at a cost of 20 millions sterling. This canal would accommodate ships of the type now used to carry ore and coal between Cleveland and Lake Superior, as well as ordinary ocean-going tramp steamers. As a set-off to the cost, the water-powers that would become available are put at one million horse-power, and the value of the country that would be opened up would be very large. It seems probable that the work will be started before long.

On this side of the subject three considerable papers were read. Colonel Anderson described the navigation works on the St. Lawrence up to Montreal, and showed maps of all the lights and buoys, and of the dredging accomplished and still to be done. Mr. St. Laurent placed in the president's hands copies of the Government reports and plans of the Georgian Bay Canal surveys, and the latter read a paper to the section on the subject. In addition, Major George Stephens contributed an admirable paper on the St. Lawrence River as an imperial highway, and on the importance of Montreal as a central port of distribution.

The Hudson Bay route is not likely to be developed in the immediate future, and little reference was made to it. The Canadian Northern Railway has surveyed a route to Churchill, on the Hudson Bay, though the mouth of the Nelson may ultimately be preferred, as it is said that this river, draining lands far to the south, even beyond the U.S. frontier, is very free from shore ice. In the future Canadians look to the Nelson River being made navigable up to Lake Winnipeg, and from there the Saskatchewan may carry ships to the foothills of the Rockies.

Mr. T. E. Schwitzer, assistant chief engineer of the Canadian Pacific Railway, contributed a paper on some important works on that railway. The Lethbridge Viaduct is an immense structure, more than a mile long and more than 300 feet high, and the mode of construction was strikingly bold and effective. The revision of the grades in Kicking Horse Pass, involving the construction of two long spiral tunnels in the rock, was also described, and the great increase obtained in the loads hauled by a given engine-power. Careful grading on lines where the heavy loads of grain and other material usual in Canada are hauled is of extreme importance, and much was said on the cost of rail transport both in this paper and in two others by Mr. Macpherson and Mr. Lanigan. Mr. Duncan Macpherson described the organisation of the surveying parties for the new line between Monckton and Winnipeg, to be continued to the Pacific coast as the Grand Trunk Pacific. It is this line which is interrupted near Quebec by the failure of the great cantilever bridge while under construction. Mr. H. W. Lanigan wrote on the organisation for the collection and transport of grain in the wheat area. As assistant manager of freight traffic on the Canadian Pacific Railway at Winnipeg he has an intimate knowledge of that subject. The policy of the Canadian Government is to forbid the owners of elevators to trade in wheat and to restrict them to the duties of collecting and despatching, much as railways are restricted to the work of carriers. The Government undertakes the inspection and grading of the wheat, and performs this work with extreme care, so that the wheat is sold by the farmer and bought by the ultimate purchaser strictly by grade, not by sample. That is to say, the quality of the wheat having been determined by the Government inspector, the price paid per bushel is the current price for that quality. The system is too complex for more than reference here, but the advantage both to farmer and purchaser of an authoritative determination of quality is obvious.

Besides the papers we have referred to, which are all mainly of Canadian interest, three electrical papers were contributed by Prof. Marchant, Prof. Thornton, and Mr. E. A. Watson respectively, all dealing with three-phase transmission lines. Other papers were by Sir John Thornycroft, on skimming boats; by Colonel Ruttan, the city engineer of Winnipeg, on the high-pressure water plant of the city; by Mr. C. B. Smith, on a new hydro-electric power plant now being erected by the city authorities; by Mr. C. E. Larard, on torsional tests on materials—a very elaborate and detailed paper; by Prof. Coker, on an optical method of exhibiting strain; by Mr. Dugald Clerk, on the work of the gaseous explosions committee; and by Prof. Foster, on a systematic examination of the properties of the different coals of Canada now being carried out at McGill University. We have left to the last a paper on the Panama Canal by Colonel Goethals and Sir William White's address. Colonel Goethals is engineer-in-chief and president of the Isthmian Canal Commission. The paper was a long one, and very fully illustrated by lantern-slides. Colonel Goethals himself was unable to come to Winnipeg to deliver it, but Lieut. Goethals, of the United States Army, who has been engaged on the canal under his father, gave an account of it and exhibited the illustrations. It will be remembered that the failure of the French operations was largely due to two causes, one of which was the excessive mortality among the labourers and staff from tropical fevers, and the other the violent floods of the Chagres river. Since that time the cause of tropical fevers has been traced to the mosquito, and the American engineers, with characteristic thoroughness, have extirpated the mosquito over the whole of the canal zone, thereby bringing the rate of mortality to the figure of a well-organised town in a temperate climate. The measures which have enabled them to do this are of extraordinary interest, and the results are almost romantic. The engineering difficulties, which were mainly the floods of the Chagres, mentioned above, and the enormous excavation of the Culebra ridge, have been met by a design which promises to be quite successful. The Culebra ridge is much nearer to the Pacific than to the Atlantic shore, and deep valleys run down from the divide to the Caribbean Sea, one of which carries the Chagres river. Across this an immense earthwork dam, the Gatun dam, is being constructed, forming a great lake 160 square miles in area in the centre of the isthmus. The floods of the Chagres and of the other rivers, its tributaries, flowing down these mountain valleys, can discharge themselves into this large body of water without doing any damage to the canal works, however violent the floods may be. The level of the water in the lake is regulated by a spillway, built in a natural hill which forms part of the Gatun dam, discharging below the dam into the old bed of the Chagres. The surface of the lake is 85 feet above the mean sea-level, and is reached by three locks on each side. The lake is amply sufficient to provide the necessary water for lockage and waste during the dry seasons. Lastly, this high summit-level has reduced very largely the necessary amount of excavation in the Culebra cut. Even then, however, this amounted to 150 million cubic yards. Besides photographic views of the works and machinery, there were exhibited copies of some of the working plans and surveys, and it is much to be hoped that the whole paper may be published in full. A recommendation to this effect was made by the committee.

Sir William White was expected to deal in his presidential address with problems of naval organisation and construction, peculiarly interesting at a time when the Imperial Naval Conference was sitting in London. His address was, however, an admirable preface to the series of papers on questions of water and railway transport which followed it, and was a masterly review of the position of Canadian commerce.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Birmingham.—Prof. Jordan Lloyd has accepted the invitation of the council to succeed Prof. Bennett May in the chair of surgery.

Prof. Peter Thompson, of King's College, London, has been appointed professor of anatomy in the place of Prof. Arthur Robinson.

The chair of zoology, rendered vacant by the death of Prof. T. W. Bridge, F.R.S., has been filled by the election of Dr. Frederick William Gamble, F.R.S.

The following appointments have been also made:—Dr. Jessie S. Bayliss, as lecturer in botany; Messrs. F. W. Aston and H. B. Keene, as demonstrators in physics; Mr. T. F. Wall, as assistant lecturer and demonstrator in electrical engineering; and Mr. Cyril S. Fox, as demonstrator in coal mining and lecturer in mine surveying.

Cambridge.—The professorship of zoology and comparative anatomy is vacant by the resignation of Prof. Sedgwick. The electors will meet for the purpose of electing a professor on Friday, October 29. Candidates are requested to send in their names to the Vice-Chancellor on or before October 22.

Notice is given that the Quick professorship of biology is vacant, as the period of three years for which Dr. Nuttall was appointed has now ended. The election will take place on Friday, October 29. Candidates are requested to send in their applications to the Vice-Chancellor on or before Friday, October 22.

Mr. F. A. Potts, of Trinity Hall, has been appointed demonstrator of comparative anatomy for one year from Michaelmas, 1909. Mr. L. A. Borradaile, of Selwyn College, has been appointed demonstrator of animal morphology for one year from Michaelmas, 1909. Mr. F. T. Brooks, of Emmanuel College, has been appointed senior demonstrator of botany for two years ending September 30, 1911, and Mr. D. Thoday, of Trinity College, has been appointed junior demonstrator of botany for the same period.

An anonymous benefactor has promised the sum of 100*l.* towards the construction of a field laboratory in the vicinity of Cambridge, in connection with the Quick Biological Laboratory. The sum of 100*l.* has been granted by the advisory committee of the tropical diseases research fund towards the expenses of the Quick Laboratory in the present year.

Glasgow.—The University is to benefit to the extent of 10,000*l.* from the estate of the late Dr. Robert Pollok. The amount in question is given for the endowment of a university lectureship for original research in materia medica.

Manchester.—The new chemical laboratories (to be known as the John Morley Chemical Laboratories, after the Chancellor of the University) were opened on Monday last by Sir Henry Roscoe, F.R.S., professor emeritus of chemistry in the University.

Oxford.—It is proposed to confer the degree of D.C.L., *honoris causa*, upon his Excellency Osman Hamdy Bey, director-general of the Imperial Ottoman Museum of Antiquities, Constantinople.

Mr. John Finnigan has been appointed secretary to the Senate of Queen's University, Belfast.

The new laboratories for physiology, chemistry, and physics of the London Hospital Medical College are to be opened on Friday of next week by Prof. W. Osler, F.R.S., who will afterwards deliver the Schorstein lecture.

Courses of lectures on the fermentation industries are announced for delivery at the Sir John Cass Technical Institute, Aldgate. The inaugural lecture (on chemistry in relation to brewing and malting) was given by Mr. A. R. Ling on Tuesday last.

Mr. H. A. S. Wortley, of Downing College, Cambridge, has been appointed assistant lecturer in the day training department of the University College of North Wales, Bangor. The inaugural lecture of the present session was delivered on Tuesday last by Prof. W. M. Flinders Petrie, F.R.S., who spoke on recent excavations in Egypt.

A course of ten lectures on economics, by Mr. Alfred Milnes, has been arranged for delivery at Bedford College for Women in connection with the course of scientific instruction in hygiene at the institution. The lectures are specially designed for women preparing to be factory inspectors or desiring to take part in other public work. They will be delivered on Mondays, beginning on October 11.

The new chemical laboratory of the Pharmaceutical Society's School of Pharmacy was opened on Wednesday of last week. On the same day began the new session of the school, when the opening address was delivered by Prof. Alexander Tschirch, of the University of Bern, who took as his subject "The Future of Pharmacognosy." At the conclusion of the address the Hanbury gold medal was presented to Prof. Tschirch.

The Leathersellers' Technical College, which has been erected at a cost of nearly 20,000*l.* in the Tower Bridge Road, was opened by the Lord Mayor of London on Friday last. In declaring the college open, Sir G. Wyatt Truscott said that no subject was of greater interest than the development of technical education and the splendid part which the city guilds had played in that development. The city companies had found, in assisting technical education, an opportunity of re-associating themselves with the interests of the trades that they represented. In the leather trade, unfortunately, the system of apprenticeship had somewhat died out, but he hoped that it might be revived.

In opening a new wing of the Leicester Technical and Art Schools on Thursday last, Prof. Silvanus P. Thompson, F.R.S., said the conclusion he came to after a tour of the industrial centres of Europe was that the most successful technical schools were those which carefully studied the needs of their own special industries. The disastrous tale of the manufacture of dyes from coal-tar products was not without its warning to this country. The trained brains sent out by German universities and technical colleges profited by the inventions of English chemists, and we paid 2,000,000*l.* a year for dyes manufactured abroad from coal-tar products. Thanks largely to technical education, a similar disaster was averted when the electrical engineering industry was developed.

According to a note in the *Engineer*, arrangements have been made with several of the leading engineering firms in Glasgow and elsewhere by which students of the South-western Polytechnic Institute are allowed to enter their apprenticeship. Students who satisfactorily perform the work in the mechanical engineering department in the first year may proceed at once and continue their work at one of the firms arranged for, and students who have satisfactorily finished the second-year course are allowed to proceed with their apprenticeship and return to the college and continue their third session. Furthermore, students who obtain the diploma of their college will have their apprenticeship reduced. Under these conditions a student can obtain a first-class training as an engineer, and apprentices who perform satisfactorily in the workshop are allowed to enter the drawing-office.

Attention has often been directed in these columns to the complete equipment and excellent arrangements of the London polytechnics. Among these institutions, the Battersea Polytechnic takes a prominent place. The calendar for the session which has just commenced shows that for this winter entirely new classes have been started in engineering estimates, electrochemistry, chemical engineering, dyeing and cleaning, analysis of foods and drugs, and sanitation. In addition to this, it is of interest to notice that new accommodation, in the form of laboratories, workshops, and equipment, is being provided in mechanical, electrical, and motor engineering, chemistry, natural science, art, and domestic economy, these extensions having been rendered possible by the assistance of the London County Council, and it is expected that they will be to some extent ready for use during the current session.

The following free courses of advanced science lectures are announced by the University of London:—the geographical distribution of plants, by Prof. Percy Groom and Mr. A. W. Hill; evolutionary aspects of palæobotany, by Mr. E. A. N. Arber; fertilisation, by Prof. J. B. Farmer, F.R.S.; the anatomy of plants in relation to external conditions, by Mr. L. A. Boodle; geology and evolution, by Prof. J. W. Judd, C.B., F.R.S.; the geology and physiography of Arctic Europe, by Prof. E. J. Garwood; a course by Prof. W. W. Watts, F.R.S.; dynamical meteorology, with special reference to the forecasting of weather, by Dr. W. N. Shaw, F.R.S.; recent researches on chloroform anæsthesia, by Prof. G. A. Buckmaster and Mr. J. A. Gardner; a course by Mr. W. B. Hardy, F.R.S.; the physiology of the peripheral nerves, by Dr. N. H. Alcock; protozoan parasites, with special reference to those of man, by Prof. E. A. Minchin; the distribution of the Oligochæta, by Mr. F. E. Beddard, F.R.S.; the phylogeny of calcareous sponges, by Prof. A. Dendy, F.R.S.; symbiosis, by Dr. F. W. Keeble; the Marsipobranchii, by Mr. F. G. Cole; Amphioxus, by Prof. E. W. MacBride, F.R.S.; the morphology of swim bladders, by Dr. W. N. F. Woodland.

The two universities created by the Irish Universities Act of 1908 came into existence on October 1. The *Times* Dublin correspondent last Friday described the state of preparation of the new universities. The commissions appointed under the Act to draft statutes and lay the foundation for the two new universities were given a period of two years for their work. They have sat often and worked hard, with the result that they are now well in advance of schedule time. The National University consists of a Senate and officers with large powers, but with no buildings of its own. The University has its concrete embodiment in the new University Colleges, formerly Queen's Colleges, at Cork and Galway. University College, Dublin, is so far only concrete in the sense that its governing body has been called into existence. At the present time it has no teaching and no college buildings. The commissioners will meet shortly to appoint a teaching staff, and the college will open early next month. As regards staffs, the Dublin College is differently situated from those at Cork and Galway, where teaching staffs exist in the staffs of the old Queen's Colleges, which are to be taken over in accordance with the provisions of the Act. Only a very few chairs remain to be filled. In University College, Dublin, it is taken for granted that most of the old staff will be translated to corresponding chairs in the new college. In this case, however, the commissioners will have also to fill a number of new chairs. Nothing has yet been done in connection with the buildings of the new college in Dublin, though various sites have been suggested. Meanwhile, the college will probably begin its work in the Royal University buildings, and will solve the immediate problem of class-rooms by renting the Roman Catholic University College and the buildings of the Roman Catholic Medical School. The cases of Queen's University, Belfast, and of the University Colleges at Cork and Galway present no difficulties. These institutions will have teaching staffs within a couple of weeks, and all their buildings and class-rooms are in going order. It may be taken for granted that by the middle of November, at latest, the work of the two new Irish universities in all its departments will have been organised and practically initiated.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 27.—M. Bouchard in the chair.—The existence of intrusive Pliocene rocks in the volcanic *massif* of Cantal: A. **Lacroix.**—Aniline antimonyl tartrate in the treatment of trypanosomiasis: A. **Laveran.** Experiments on experimentally infected guinea-pigs having given favourable results on treatment with this drug, M. Thiroux has tried it in Senegal on natives suffering with sleeping sickness. The immediate results were very satisfactory, the intra-venous injection of 15 centigrams causing the disappearance of the trypanosomes from the blood of an adult man. The action is more rapid than when atoxyl is used, two patients who had commenced to sleep recovering after the injection of 15 centigrams. It has still to be proved that the cure is permanent.—The Brownian movement of rotation: Jean **Perrin.** Einstein has deduced a formula for the rotation of a spherical particle in a fluid of a given viscosity. The author has succeeded in measuring the velocity of rotation experimentally, the result being in complete agreement with Einstein's theory. It appears probable that the molecular kinetic hypothesis affords a safe basis in the study of Brownian motion.—The electro-diapason: A. **Guillet.**—Thermochemistry of some phosphorus compounds: P. **Lemoult.**

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THURSDAY, OCTOBER 14, 1909.

SOME BOTANICAL BOOKS.

(1) *Die Pflanzenwelt Deutschlands*. By Dr. P. Graebner, mit Zoologischen Beiträgen von F. G. Meyer. Pp. xi+374. (Leipzig: Quelle und Meyer, 1909.) Price 7 marks.

(2) *Pflanzenbiologie. Schilderungen aus dem Leben der Pflanzen*. By Dr. W. Migula. Pp. viii+352. (Leipzig: Quelle und Meyer, 1909.) Price 8 marks.

(3) *Unsere Zierpflanzen. Eine zwanglose Auswahl biologischer Betrachtungen von Garten und Zimmerpflanzen sowie von Parkgeholzen*. By P. F. F. Schulz. Pp. viii+216. (Leipzig: Quelle und Meyer, 1909.) Price 4.40 marks.

(4) *Phanerogamen. Blütenpflanzen*. By Prof. E. Gilg and Dr. R. Muschler. Pp. 172. (Leipzig: Quelle und Meyer, 1909.) Price 1.25 marks.

(5) *Kryptogamen*. By Dr. M. Möbius. Pp. iv+164. (Leipzig: Quelle und Meyer, 1908.) Price 1.25 marks.

(6) *Zimmer- und Balkonpflanzen*. By P. Dannenberg. Pp. vi+160. (Leipzig: Quelle und Meyer, 1908.) Price 1.25 marks.

(7) *Clay's Successful Gardening*. Fourth Edition. Pp. 275. (London: Clay and Son, Stratford, n.d.) Price 9*d*. net.

(8) *Botany for Matriculation*. By Dr. F. Cavers. Pp. viii+568. (Cambridge: University Tutorial Press, Ltd., 1909.) Price 5*s*. 6*d*.

(9) *Beginners' Botany*. By Prof. L. H. Bailey. Pp. ix+208. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1909.) Price 3*s*. 6*d*.

(10) *Elementary Practical Botany*. By W. E. Clarke. Pp. xii+311. (London: The Normal Press, Ltd., n.d.) Price 3*s*. 6*d*. net.

(1) DR. GRAEBNER deals with the plant-world of Germany from an ecological standpoint, and thereby provides one of the first works on ecology confined to the limits of a single country. The subject of ecology is still in its infancy, and it is probable that it may gain stability when it is considered from a national rather than an international outlook. The difficulty in reducing ecological facts to a system, as the author points out, arises from the complexity of factors which influence the being of a plant. Dr. Warming bases his classification on soil conditions, but Dr. Graebner selects a more arbitrary standard, as his main divisions depend primarily upon the favourable or unfavourable characters of natural conditions, and, secondarily, on the modifications produced by special agencies, such as seasons or man. The arrangement works out better than might be expected. The first section is that of tropophilous formations found on sunny hills, on rocks and inland dunes. The second comprises formations on cultivated land. The succeeding sections refer to meadows, woods, river banks, plankton and aquatic vegetation. Finally, the author relegates heath and halophytic formations to separate categories. The two most prominent sections are those devoted to formations on cultivated land and to woods or forests. Under the former are gathered the vegetation of waste places (*Ruderalstellen*), fields and gardens, lawns and roadside trees. The importance of this section is extremely great, not only because of its extent, but because it lies immediately at our doors. Obviously the effect of human influence does not stop here, but the limit is that of man's most determined struggle to turn nature to his immediate purpose.

Under each section the author discusses the predominant factors, also any well-marked modifications, and describes the typical plant-formations with reference to their adaptations for nutrition and reproduction. The notes on animal life contributed by Mr. F. G. Meyer are added as postscripta to the sections. The book is a very desirable acquisition to the scanty literature on ecology, and can be recommended both for the philosophic argument of principles and causes, and also for the details. It also suggests the thought that there is a good opportunity for preparing a book on similar lines dealing with vegetation in the British Isles.

(2) The scope of Dr. Migula's "Plant Biology" is considerably wider than the preceding. It treats of bionomics as exemplified by reproduction and dissemination of plants, protective modifications and adaptations to external conditions; this leads to plant associations, and biology of nutrition precedes the description of federations between different plants, or plants and animals. It is, of course, impossible to deal comprehensively with these various subjects, and the author has merely endeavoured to present interesting sketches of plant-life. There is no striking originality in the early sections, but the author imparts his information in a clear and effective manner, notably in the introduction dealing with development, or, to put it more popularly, Darwinism. The chapters on adaptations of plants to climate and soil are in some respects the most attractive, as the author has elaborated these themes more fully. Plant communities are described under the divisions of forest, grass vegetation, heath and moor. Reference should also be made to the succinct accounts of root tubercles in the leguminous family, and the relationship between plants and ants.

(3) The horticulturist who is a deep thinker must often be puzzled to understand the idiosyncrasies of many plants that come under his care, even of stock plants in cultivation. For instance, how many can offer an opinion on variegation in a begonia-leaf and say how far it can be modified, or can explain why a pelargonium thrown on the dust-heap will retain its vitality for a long time? Further, there are the manifold variations in stem and leaf, the devices for pollination, and many other biological features which are not readily explicable even by those who have received technical training. To those who are anxious to gain an insight into these problems the book by Mr. P. F. F. Schulz will certainly appeal. He has wisely limited his notes to about fifty kinds. Plants in general cultivation are represented by begonias, the dahlia, perennial lupines, Aspidistra, sunflowers, and common ferns. Sauromatum, Aristolochia, and

various cacti are included because of their peculiar character, while the tulip tree and tree of heaven recall the plantations which beautify so many German towns.

(4, 5, 6) The next three volumes of which the titles appear above are units in a series of neat brochures dealing with all branches of knowledge. The publishers are entitled to great credit for bringing out such a series at the modest price of one mark per volume, as they have enlisted competent authors to deal with the various subjects. It may, however, be suggested that some of the volumes deal with subjects of too extensive a nature to be satisfactorily compressed within the limits permitted. The account of phanerogams, a systematic compendium, prepared by Drs. E. Gilg and R. Muschler, provides a case in point. About 120 families are dealt with in as many pages, with the result that there is only a bare reference to the botanical characters of each family, while the space is occupied by a mere enumeration of the more important plants and their properties. The same criticism applies to the volume on cryptogams, in which Dr. Möbius has made good use of the space at his disposal, but it is evident that each of the four groups of algæ, fungi, mosses, or ferns might with advantage have been taken separately. The cultivation of plants in living rooms and on balconies is a subject better suited to these small volumes, on which Mr. P. Dannenberg provides an interesting and useful book, essentially German as regards the minuteness of detail. Advice is given on methods of arrangement, ornamental pots, watering, pruning, transplanting, and propagation; also a useful list is supplied of plants suitable for growing at different seasons and under different conditions. Precise, accurate, and well arranged, the book admirably fulfils its purpose.

(7) A different type of floricultural book is that issued by Messrs. Clay and Son, primarily intended to advertise their special manures. The list of contributors includes Messrs. J. Hudson, J. Douglas, J. Udale, H. J. Wright, and E. H. Jenkins, who contribute articles on fruit-culture, carnations, begonias, sweet-peas, daffodils, and lilies. Sections are devoted to vegetable cultivation, indoor gardening, rock gardens, and garden pests. The volume contains much practical information for the cultivator, and more particularly for the grower of produce.

(8) It is not very long since Dr. Cavers produced a very successful elementary botanical text-book under the title of "Plant Biology," in which he indicated the methods adopted with his classes, and outlined a large number of experiments intended to instruct the student by his own personal observation and experiment. The success of this book and of "Life-histories of Common Plants" has presumably led to the compilation of the volume now under notice, which in many respects resembles the earlier books. Physiology is made the groundwork of preliminary study and explanatory of morphology; classification is dealt with in the descriptions of selected families, and a chapter is devoted to ecology. The range of the book is very much wider than is necessary for a matriculation course, although this is no disadvantage, as a teacher can select the portions immediately necessary. At the same time, many of the chemical and physical paragraphs might have been omitted, also the final chapter on the uses of plants. Apart from these criticisms, the book deserves the highest commendation, chiefly because the author conveys his information in a precise and well-ordered manner. The numerous experiments scattered through the text are admirably chosen to illustrate the points under discussion or observation, and for the most part require only simple apparatus.

(9) There is always a fund of originality in any book written by Prof. L. H. Bailey, and teachers will meet with not a few fresh ideas in his latest production. The opening is original, although Darwinian, that no two plants or parts are alike, that there is a struggle for life, and that the fittest survive; then follow chapters on plant societies and the plant body, after which ensues the ordinary gamut of elementary morphology, but treated in a fresh and inviting fashion. Another essential feature, also characteristic of the author's style, is the concise method of indicating facts or points without superfluous details; and finally it will be observed that the author introduces practical examples, so far as possible, as in the excellent chapter on bud propagation. The illustrations are bold, practical, and artistic. The studies in cryptogams, forming almost an appendix, do not make a very desirable addition, as they are perforce scrappy and introduce facts altogether beyond the scope of a beginner.

(10) The elementary practical book prepared by Mr. Clarke begins with external morphology and passes on to physiology, with the inclusion of chapters on soil, garden vegetation, distribution and cell structure. The experiments are collated in a separate part, and some account is given of selected flowering plants. Appendices are devoted to hints on the microscope and certain principles of chemistry and physics. It is apparent that the author has attempted to compress too much material into the book, more especially as he does not display that happy faculty of expression which combines conciseness with brevity; further, the information is somewhat ill-assorted, and there is a tendency to introduce ideas which are only partially relevant to the subject under discussion. There are also some inaccuracies, as in the use or explanation of various terms, such as pollarding, block, sucker, ivy root-tendrils and monosexual.

CLAYWORKING IN THE UNITED STATES.

History of the Clayworking Industry in the United States. By Dr. H. Ries and H. Leighton. Pp. ix+270. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 10*s*. 6*d*. net.

FEW realise the important *rôle* played by clay in the industries. It certainly ranks not lower than fourth in the value of its production in the mineral industries of the world, and it is only exceeded by iron and coal, and possibly copper. Very few industries, too, are not dependent in some way upon clay products. Every advance in the quality of these products has been followed by advances in other industries. The raising of the refractory qualities of fire-bricks, for example, gives the metallurgist greater power and scope, and the success of the electro-chemical industries is to a large extent dependent upon the capability of the potter.

Considering the importance of the subject, the list of books with trustworthy information is surprisingly small. We therefore turn with pleasure to the present work, which is a history of the various branches of the clayworking industry in the United States, from the building of the brick houses by the early colonists up to the close of 1907. Consequently, there is no more than a passing reference to the very curious pottery fashioned by the aboriginal Indians. The book is compiled from statistics collected in the main by the United States Census Bureau and the United States Geological Survey. The first portion of the history is a general *résumé* of the various stages in the development of the industry through the manufacture of common bricks, glazed bricks, terracotta, tiles, and pottery. In the second portion of the work, these stages are discussed State by State.

The author can seldom be charged with diminishing the value of his facts by entangling them in the meshes of hypothesis. Statistics are given showing the yearly value of the products made in the United States, and also imported. Using the word "consumption" with its broadest connotation, it is possible to calculate from the authors' tables the approximate proportion of the total yearly consumption of "pottery" which is actually manufactured in the States. We thus obtain 57 per cent. for 1870, and 68 per cent. for 1907. The influence of the ceramic schools is said to be a "strong factor" (pp. 6–7) in the evolution of the industry. The first of these was started in Ohio in 1894, under the capable hands of Prof. E. Orton; the fifth, in Iowa, in 1907. Quoting from Mr. J. Moses' "One Hundred Years of American Commerce" (p. 53), the authors state that it was not, indeed, until the first real protection by the tariff ever accorded the potters was enacted, as a war measure, that the American maker found himself able to enter the field against the English potter. The influence of imported workmen, on whom there is no tariff, is not indicated, although we find some curious evidence pointing in that direction from Messrs. Ries and Leighton's tables. In 1897, 41 per cent. of the total china clay consumed in the States was mined there, and in 1907, 68 per cent. The remainder was imported. This might be attributed to the dearth of china clay, but the Americans have splendid clays, better, indeed, than our own. The greater probability is that the "secret" recipes of the imported workmen are compounded with raw materials from Cornwall, &c., and a mysterious virtue is supposed to reside in a recipe for an "English" body or glaze. The workmen have not always the courage and skill to adapt imported recipes to local materials. The recipe is thus master of the situation.

J. W. Mellor.

A JOURNEY ACROSS VENEZUELA AND COLOMBIA.

The Journal of an Expedition across Venezuela and Colombia, 1906–7. An Exploration of the Route of Bolivar's Celebrated March of 1819, and of the Battlefields of Boyaca and Carabobo. By Dr. Hiram Bingham. Pp. viii+287. (New Haven, Conn.: Yale Publishing Association; London: T. Fisher Unwin, 1909.) Price 10*s*. net.

THE expulsion of Spanish power from the present State of Colombia was effected by Bolivar, who in the year 1819 conducted an army from near Caracas to Bogotá, across country that had been deemed to be impassable. All the saddle and pack animals, and many of the soldiers, succumbed to the hardships of the march, a distance of about 700 miles, traversed in about seven weeks. Spanish-American historians have compared this feat with the marches of Hannibal and Napoleon. Dr. Bingham, lecturer on Latin-American history at Yale, wanted to form a proper estimate of the actual obstacles that were overcome by the army of liberators, the backbone of which was the foreign legion of British veterans from the campaign of Waterloo. He therefore undertook the spirited and difficult task of following up the route of Bolivar through regions not easily visited and scantily known.

There is a regular overland route from Caracas to Bogotá which leads over the high plateau between the Central and the Eastern Cordilleras. The author and his companion, Dr. Hamilton Rice, however, went, like Bolivar, broadly speaking, parallel with this road, along the foothills of the Eastern Sierras, where they join the vast Llanos, at an average altitude of 600 feet to 700 feet above sea-level. The greater part of this route has been scantily described by but few travellers, and some districts were known locally only.

The travellers left Caracas at the beginning of January, 1906, and crossed the great Llanos with mules, and an ox-cart for the baggage. In time the cart had to be discarded. There were many rivers to cross, tropical forests, and the Llanos. These, never pleasant to traverse, were rendered more than difficult by the rains which set in about the middle of March, and continued with increasing force. The stiffest part of the journey began with the ascent to the plateau, to gain which the Paramo, a pass of 13,000 feet elevation, had to be negotiated.

For reasons only known to themselves, the travellers did not carry a tent. Consequently the diary is full of the troubles of getting accommodation in the wretched villages or occasional so-called towns, in rest houses kept by suspicious Indians or disobliging white men, often without sufficient food. The Western Venezolanos (why are they persistently called Venezuelans in the book?), white, mixed, and brown alike, are apparently not a very prepossessing people, and local officials were, of course, worse. The Colombians seemed to be more amenable, as being less beyond the reach of civilisation.

The whole journey took 115 days, more than twice the time required by Bolivar's army. The book is adorned with numerous photographs of characteristic scenery and scenes, *e.g.* Yaruro Indians between the Apure and Araura rivers. Although the travellers do not profess to be naturalists, they mention a good many birds and beasts which they came across. There are also some most interesting pictures of Iabiru storks on their nest, and of half-a-dozen Capybaras on the bank of a stream.

The reader will get a very good idea of the kind of country and its inhabitants.

A STUDY OF CHILD-LIFE.

Children in Health and Disease. A Study of Child-life. By Dr. David Forsyth. Pp. xix+362. (London: John Murray, 1909.) Price 10*s.* 6*d.* net.

THIS volume should appeal to a large number of readers, medical and lay, and its publication at the present time is opportune, for it brings a sane and experienced judgment to the assistance of those who in a public or private capacity are striving to solve the problems with which it deals. The vitality of the country depends on the health and training of the children, and while the duty of supervision rests with the physician, success can only be obtained through intelligent cooperation of parents and teachers.

The early chapters deal with the physiology of childhood. The food consumption of the infant, relatively to body weight, is considerably greater than that of the adult, but only one-fifth of the ingesta is used for purposes of growth, while the rest serves to maintain the temperature of the body. In proportion to bulk, the surface area is greater in a small child than in a man, hence increased loss of heat and more need for heat production. In early life appetite waits on surface area, and in the recognition of this fact lies the clue to the proper feeding of children. The amount of food should be determined by the weighing-machine rather than the calendar, and it should contain plenty of carbohydrate, the heat-producing ingredient in diet.

By the end of the second year a child's mind has acquired, in an elementary form, most of its principal faculties, so that its further progress consists in perfecting them rather than in the acquisition of new ones. Habit clusters round the lines of least resistance, and education is an attack on natural indolence. From the medical point of view school-life stands by itself. Opportunities for the transmission of infectious and contagious diseases are greatly increased, and the problem of class-room hygiene offers special difficulties. The evils of the examination system, defective ventilation, bad feeding arrangements, and insufficient hours of sleep exist in many higher-grade schools, as they do in elementary schools. The hygiene and curriculum of both require supervision. Medical inspection of schools is now recognised as a branch of public-health work. It has shown the prevalence of ill-health, much of which is preventable. The author notes with approval the value of invalid and "open-air" schools, and he also discusses the difficult question of the training and care of the mentally deficient.

Not the least interesting section of the book is that which deals with the causes of infant mortality. Most diseases of childhood are preventable, and yet 20 per cent. of children die before their fifth birthday. Infancy must always remain a critical period of life, but it should be relieved of many dangers which now decimate it. The statistical value of death certificates will not be great until they become confidential and cease to be framed so as to meet the susceptibilities of parents. Syphilis is scarcely mentioned in death certificates, although it is recognised as a potent cause of premature birth and death in early childhood.

The value of the volume is enhanced by the index, which is well arranged and adequate.

OUR BOOK SHELF.

Lehrbuch der Pharmakognosie. By Dr. George Karsten and Dr. Friedrich Oltmanns. Second edition. Pp. vi+358. (Jena: Gustav Fischer, 1909.) Price 9 marks.

IN the first edition of this work, published in 1903, Prof. Karsten explained his object to be the provision of a text-book that should treat pharmacognosy from a botanical point of view, and, considered in this light, it must be admitted that his object was successfully attained. But the second edition has more ambitious pretensions; it is intended to present a "clear survey of pharmacognosy and to introduce the young pharmacist to the varied provinces of that science."

The arrangement and treatment of the subject-matter are similar to those that were adopted in the first edition. The classification is on strictly botanical lines. Each drug is separately described, the description including the botanical and geographical sources, the morphology, anatomy, and constituents. In almost all instances the lion's share has fallen to the morphology and anatomy, these usually occupying some three-fourths of the entire description, but occasionally more, as with white hellebore rhizome, where only twenty lines out of six pages are devoted to the other points. This part of the descriptions is excellent, and doubtless many pharmacognosists will frequently refer to the very complete, detailed, and well-illustrated accounts of the morphology and anatomy of the drugs.

This, however, is all that can be said in favour of the work. The constituents of the drugs, for the young pharmacist a most important branch, are dismissed in three or four lines, in which sins of omission and commission are frequent and great. Take, for instance, gentian root and chamomile flowers, in which the bitter principles are entirely forgotten; opium, ipecacuanha, aconite, hydrastis, colchicum, and conium, all of them most important drugs, in which the proportion of the constituents is sadly inaccurate; ergot, liquorice, senna, euphorbium, in which they are not brought up to date. Indian and Turkey opiums are said to be made into balls about the size of the fist, and covered with Rumex fruits, while Persian opium is usually made into sticks! Seldom is any sufficient account given of the diagnostic characters of the genuine drug, of the adulterants, changes on keeping, preservation, preparation for the market, commerce, &c. Such a work fails to give a "clear survey of pharmacognosy," and cannot be recommended as a means of introducing the young pharmacist "to the varied provinces of pharmacognosy." It relegates that science to the position of a subordinate department of botany, and shows once more that the author of a work on pharmacognosy should be a trained pharmacognosist. As an account of the morphology and anatomy of drugs it might have been successful; as a text-book of pharmacognosy it is a failure.

Henry G. Greenish.

Catalogue of the Lepidoptera Phalaenae in the British Museum. Vol. viii., Catalogue of the Noctuidæ. By Sir George F. Hampson, Bart. Pp. xiv+583; pls. cxxiii–cxxxvi, and 162 text-figures. (London: British Museum, Natural History, 1909.) Text, price 15*s*.; plates, price 12*s*.

We have again to congratulate Sir George F. Hampson and the Trustees of the British Museum on the completion of another volume of the great catalogue of moths, which bids fair to surpass even the catalogue of birds in extent and importance. Vol. viii., now before us, is the fifth volume devoted to the Noctuidæ, and the second of the great subfamily Acronyctinæ, which it will require a third volume to complete. Fifteen subfamilies of Noctuidæ were indicated by the author at the commencement of his work; possibly he may find it necessary to increase the number before its completion. The Acronyctinæ, occupying three volumes, is only the fourth subfamily out of the fifteen, but, in the sense in which the author employs it, it is, perhaps, the most extensive of all. The remaining subfamilies, with three or four exceptions, appear likely to be of very much smaller dimensions.

Works of this character are far too costly to be undertaken by private enterprise, and though the price at which they are published by the museum cannot be remunerative, the cost of an extensive work issued in successive volumes soon becomes prohibitive to private students.

Hence we would urge on the librarians of public libraries and museums at home and abroad to secure sets of such publications as those of the British Museum before the volumes become too numerous, and before any of the earlier ones go out of print. Many of the earlier publications of the Museum were issued in comparatively small numbers, and several are now scarce and difficult to obtain. Sometimes early volumes have been exhausted even before the whole series has been completed. This is another reason why public libraries, to which they will always be valuable, should not neglect to add them to their shelves as soon as they appear.

The Geology of South Africa. By Dr. F. H. Hatch and Dr. G. S. Corstorphine. Second Edition. Pp. xvi+389. (London: Macmillan and Co., Ltd., 1909.) Price 21*s*. net.

The general scheme of the book remains the same as in the first edition, but the authors have skilfully rearranged portions of the original subject-matter and have made those additions which the rapid advance of geological investigation in South Africa since 1905 has rendered necessary.

To digest and sift the numerous official and unofficial reports dealing with the geology of South Africa is no easy task, and with respect to the stratigraphy of these regions, the authors have evidently spared no pains to bring the book up to date. They, however, almost entirely ignore the many interesting problems connected with the origin and development of the present physical features, of which striking examples have been illustrated and described in the reports of the surveys of Cape Colony, of the Transvaal, and of Natal, as well as in other publications. This is an obvious omission in a work entitled "The Geology of South Africa."

In dealing with the correlation of the widely scattered formations, the authors speak in a guarded manner, but their suggested correlation of the older formations will not pass unchallenged.

The illustrations, of which many are new, retain a high standard of excellence. The figures illustrating the fossils of the Karroo are the least attractive, and are hardly representative, especially with respect to the well-known and interesting reptilian remains. The general index is far too meagre, and the index of place-names is overburdened by a superfluity of mere page references of more annoyance than assistance to the general reader.

Handbook for Field Geologists. By Dr. C. W. Hayes. Pp. ix+159. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 6*s*. 6*d*. net.

The preface states that this work originated in a handbook printed in 1908 for distribution to members of the United States Geological Survey. Requests for copies of this were so numerous that it was rewritten, omitting those instructions which apply only to members of the Government Geological Survey, and enlarging upon certain features which will be of service to students preparing for work in field geology. In spite of this declaration the book still contains much which is only applicable to members of a Government Survey in the United States, but is, besides, a very practical little handbook, the treatment of the problems connected with the determination of dip, thickness, and depth of beds being perhaps the least satisfactory part. These problems, if properly put, are of great simplicity; but the beginner, trusting to Dr. Hayes, might well conclude that there was some subtle difference between the dip of a fault plane and the dip of a stratum, and that problems which may be tackled in the one case are insoluble in the other.

An attempt has been made to get over the difficulty of making the same work at once a beginner's guide and an expert's *vade mecum* by dividing it into two sections, and of the two the latter seems better done. The schedules of subjects to be noticed in special investigations have their use in refreshing the memory whenever a fresh piece of work is entered on, but the ideal geologist's pocket-book is yet unpublished. Engineers and architects have their little books crammed with information cut up into pieces, each complete in itself, so that temporary lapse of memory on any particular point can be rectified, or reference made to figures which the human brain cannot carry, but which must be accurately known if required at all. Geologists, on the other hand, whether on account of the smallness of their number or their supposed addiction to dilettante methods, are condemned to wade through a mass of matter, with which they are familiar, to obtain the particular piece of information of which they are in search.

Physiology: a Popular Account of the Functions of the Human Body. By Dr. Andrew Wilson. Pp. vii+128. (London: Milner and Co., Ltd., n.d.) Price 1*s*. net.

As a contribution to scientific literature this book is negligible; as a popular exposition of the elementary principles of physiology it is untrustworthy. It is no part of a reviewer's duty to enumerate the errors scattered through it; it will be sufficient to take one as a sample. "The red blood corpuscles are also carriers of carbonic acid gas to the lungs . . . and the darker colour of impure or venous blood is explained by the fact that when carbonic acid gas unites with the hæmoglobin a darker hue is produced" (p. 64). A first year's student knows better than this. It would be better to leave the writing of physiological text-books to those who know something of physiology.

W. D. 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.*]

Magnetic Storms.

IN supplement to my letter in the last issue of NATURE I may add that if a solar outburst, acting in the way supposed, causes a magnetic storm which lasts eight hours, the effective influence of the whole group of electric streams at the distance of the earth must extend over a breadth of about six million miles; so that if simply conical, with vertex at the sun's centre, the angle of the cone would be four degrees. Projected back to the surface of the sun, this would correspond to what we may call a "spot" about one-thirtieth of the visible disc in diameter; but, inasmuch as the trajectory of the particles in the beam would be slightly curved, the size of the actual solar eruption could be much less.

Until the main outlines of the view advocated are approved by those most competent to judge, it is useless to enter into further details.

I regret to notice a numerical slip—fortunately unimportant, since it affects nothing else—in the top line of my letter on p. 426, where the current equivalent should be expressed, not in hundred thousands, but in hundred millions of amperes—an order of magnitude which is "reasonable" rather than "surprisingly moderate."

October 9. OLIVER LODGE.

Magnetic Storms and Solar Eruptions.

I HAVE read Sir Oliver Lodge's letter (NATURE, October 7, p. 425) on the above subject with some surprise. The emission theory which he supports, and which he claims to have originated, regards kathode rays from the sun as the electric carriers, and so is presumably the same as has been actively advocated by Prof. Kr. Birkeland for a number of years. He seems, however, to be unaware of the existence of Birkeland's volumes [1] on the subject, and of the numerous numerical calculations therein contained. He also makes no reference to the important mathematical work of Prof. Störmer, which cannot, I think, be disregarded by anyone whose theory postulates the introduction of charged particles from without into the earth's magnetic field. The general idea that magnetic storms are due to some action arising in the sun goes back to at least the time of Broun and Balfour Stewart, and different forms of the emission theory have naturally presented themselves to various minds independently, as Röntgen, kathode, and other rays came successively under our ken. It is when we come to details that real troubles arise. Most people, I take it, have little difficulty in believing in a general way that the changes of declination experienced at a single magnetic observatory, say Kew, during a magnetic storm can be accounted for by a stream of electrons in the magnetic meridian, provided it is possible for the direction and intensity of the stream to be altered at frequent intervals. One doubts this just as little as that the motion of the magnet of the declination magnetograph at Kew on September 25 could be reproduced with the aid of a copper wire, a single battery cell, a commutator, and a resistance box. Those who have seen Störmer's calculations and studied Birkeland's volumes will realise, however, that to be regarded as an advance of knowledge at the present day, a theory must afford an explanation, not merely of what is taking place in a single magnetic element at a single station, but of what is taking place in all three elements at a number of stations. Coming, now, to Sir Oliver Lodge's own calculation, it seems based on an inadequate idea of the phenomena of the late storm, derived from a description of one or two of the more striking changes at Kew as recorded in your columns and those of the *Times*. It is rare for a disturbance to be limited to the declination, *i.e.* for the disturbing force to be wholly perpendicular to the magnetic meridian. The component in the magnetic meridian is, as a matter of fact, usually the larger. A vertical component is also usually present. A magnetic storm does not usually consist of a disturbing force in a fixed or nearly fixed direction, waxing and waning. Each of the three elements usually exhibits values both above and below the normal, and not infrequently there are many excursions on both sides of the mean. This will, I think, be readily recognised by anyone who consults the reproduction of the Stonyhurst curve of September 25 in your columns and of the Kew curves in the *Electrician*. After inspecting these curves it will, I think, be recognised that it is quite out of the question to limit the passage of the imaginary solar jet, as Sir Oliver Lodge does, to the fifteen minutes near the end of the storm, when there occurred the prominent declination oscillation to which he has confined his attention. Even whilst this oscillation took place, it was far from representing the total disturbance. Simultaneously with it, but partly overlapping, as is often the case, there was a very large change in progress in the horizontal force. Those looking at the curves will, I think, agree that if there was a jet such as Sir Oliver Lodge supposes, its time of transit took, not fifteen minutes, but at least nine hours. His estimate of the diameter of the cone thus requires multiplication by 36, with a consequent multiplication of the cross-section, if it were circular, by 1296. Large as this may appear, the jet theory requires it to be often exceeded, as the storm of September 25 was an unusually short one. The average duration of the storms in Mr. Maunder's Greenwich list, from 1882 to 1903, was almost exactly thirty hours, so that the cross-section of the average storm-jet would be naturally fully 14,000 times that given by the calculation in your columns. The really crucial thing is that the magnetic disturbances which occur simultaneously at different stations are inter-related. It is in accounting satisfactorily for these inter-relations that Birkeland, who has given years of thought to the subject, encounters his main difficulties.

In pointing out these facts, I am not expressing any opinion for or against any or all of the emission theories. What I think is really called for at the present moment is a reservation of judgment as to theories, and a more minute study and inter-comparison of the records from different observatories with a mind as unbiased as possible by preconceived ideas. C. CHREE.

October 9.

[1] "Expédition Norvégienne de 1899–1900," and "The Norwegian Aurora Polaris Expedition, 1902–3," vol. i.

Fireball in Sunshine.

WITH the sun shining in a beautifully clear sky on October 6, at about 9.40 a.m. a large meteorite passed over central England, and was well observed from many widely distant stations. People noticed it in Norfolk, Suffolk, Gloucester, Somerset, and other counties, but the observations, owing to the absence of visible sky marks, are not very definite.

The meteor was brilliant; it had a slow motion, traversing a long path in about four seconds, and it left a luminous trail of short duration. An observer at Bristol says it burst with rocket-like effect at the finish. The meteor had a radiant in the south or south-east sky, but the place is uncertain. At the time of the observation Leo was on the meridian and Virgo and Boötes near.

At Cottesbrook, Northamptonshire, a loud detonation followed the meteor in four minutes, which corresponds to a distance of fifty miles. At East Haddon, Holdenby, and other small towns and villages north-west of Northampton the noise of an explosion was heard, doors creaked, windows rattled, and people ran out of their houses in terror, thinking that an earthquake had occurred. The final disruption of the meteor evidently took place over the region ten or fifteen miles north-west of Northampton, and its direction of flight was from S.S.E., so it must have passed over, or nearly over, London.

Further observations will be exceedingly useful if they are sufficiently exact to be utilised. W. F. DENNING.

The Mansfield Automatic Water Finder.

CAN any reader of NATURE supply the names of the "leading scientists" who are stated to have "thoroughly investigated" this instrument "and vouch for the successful application of the invention"?

As stated by the makers, "the principle on which the instrument works is the measuring of the strength of the electrical currents which are constantly flowing between earth and atmosphere, and which are always strongest in the vicinity of subterranean water courses." It would be interesting to know whether there is any scientific basis for this statement.

The writer has applied to the makers of the instrument for particulars relating to it, but beyond sending him a circular embodying the above quotations, he has been unable to obtain from them much information.

A. A. Campbell Swinton.

66 Victoria Street, London, S.W., October 7.

MOVEMENTS OF THE EARTH'S SURFACE.

In the *Revue scientifique* of August 28 is an interesting address delivered by M. Ch. Lallemand to the Association française pour l'Avancement des Sciences. The address deals with two subjects:—(1) Tides in the solid earth; (2) gradual changes of level in large tracts of the earth's surface.

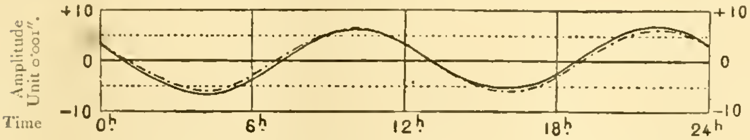


Fig. 1.—Semi-diurnal oscillation of a pendulum under the action of the moon.

—— Observed wave. - · - · - Calculated wave reduced in amplitude.

The first subject is introduced by a short historical account of the attempts made in the past thirty years to discover alterations in the position of the vertical relative to the earth's surface accompanying the changes of direction of the sun and moon. This is followed by a detailed account of the recent work of Dr. Hecker, of Berlin. An illustration of his apparatus is given, and an interesting account of the manner in which, by a mechanical and optical device, a horizontal pendulum, 0·25 m. in length, is made to produce effects such as could only be produced directly by a vertical pendulum of length equal to the height of Mont Blanc.

Dr. Hecker's apparatus was placed in a chamber, which was situated at a depth of 25 m. below the surface of the earth, and kept at constant temperature and humidity. The motions of the pendulum, greatly magnified, were registered continuously on a revolving drum. Roughly speaking, they amounted to a daily oscillation of the vertical of about 0·02″ north and south. The greater part of this oscillation was thermal in origin, being caused by the heating of the upper layers of the earth's surface by the sun's rays. It was possible to remove this term, and there was left as a residual effect a semi-diurnal oscillation, which could be traced to the varying attraction of the sun. More important, because it was more free from thermal disturbance and greater in magnitude, was the semi-diurnal oscillation of the pendulum, which Dr. Hecker found corresponding to half a lunar day. The close agreement between this observed oscillation and a theoretical curve for the deviation is shown in Fig. 1.

Whereas the phase and direction of the changes in the vertical agree closely with theory, the amplitude of the observed change is much less than that which theory indicates. Or, rather, we should say that the amplitude is about 2/3 of that which would be observed if the earth were perfectly rigid. The difference between this factor 2/3 and unity is a measure of the extent to which the earth's surface yields to the tidal force of the moon, and thus masks the deviation of the pendulum. It is interesting to note that in 1884 Sir George Darwin, from analysis of tidal records, found this factor to be 0·676, also that his and Lord Kelvin's earlier estimate of the rigidity of the earth accord closely with that now determined by Dr. Hecker, namely, 5/6 of the rigidity of steel. The difference between observation and theory is shown in Fig. 2.

One interesting fact is illustrated in Fig. 2. The reduction of amplitude from one curve to the other is different in different azimuths. Dr. Hecker has discussed this point, and shown it is in no way to be accounted for as an indirect effect of accompanying changes in the sea-level or the atmosphere. Whether it is due to local surface conditions at Potsdam, or whether it bears some relation to large structural deformations of the earth, these are questions which further research will alone elucidate.

The second question discussed by M. Lallemand is the examination of permanent or gradual deformations of the earth's crust. A short account of changes, which have been shown to have been caused by recent earthquakes, is followed by a discussion of attempts made in France to ascertain gradual changes of level. Accurate work of recent date has discredited Bourdaloue's result that the sea-level at Brest and Marseilles differs by a metre, that result being ascribed to systematic errors in the observations. The difficulty of ascertaining permanent changes of level is increased by secular alterations in the mean sea-level at the base of a level-line. Added to this are the errors of the actual work of levelling. M. Lallemand's estimate of the error that would probably be introduced in ascertaining the height of a hill-top 2000 m. above sea-level, at a distance of 600 kilom. from the sea-shore, is 12 cm. to 17 cm. even when the levelling is done by the most accurate methods at present available. In view of the slowness with which changes of level take place, an interval of at least thirty years ought to elapse between successive levellings undertaken to show changes of level.

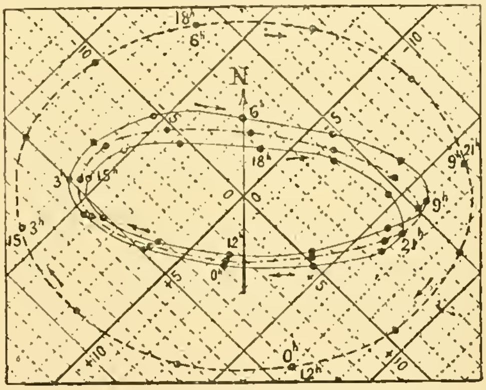


Fig. 2.—Daily apparent motion of the pendulum due to the action of the moon.

—— Observed oscillation.

· - · - Observed semi-diurnal oscillation.

- - - - Semi-diurnal oscillation calculated for a rigid earth.

In time we may hope to ascertain by repeated geodetical researches in what way countries, or even whole continents, are rising and sinking. In such work the geodesists will have the fullest support of all men of science. In particular they may expect sympathy from the astronomical world, which will soon be faced by an allied problem. The question must, before many years, come up for decision as to when a repetition of the chart of the heavens, which is slowly nearing completion, will be justified by the conclusions to be drawn from it.

SCIENTIFIC STUDIES OF DEW-PONDS.

An endeavour to solve the so-called mystery of the dew-pond has recently been made by Mr. E. A. Martin, and the results of some of his observations are shown in a paper which appears in the *Geographical Journal* for August. The paper was read before the Research Department of the Royal Geographical Society on April 22. Attempts were made by direct experiment to ascertain how the replenishment of such ponds takes place. During the autumn of 1908, Mr. Martin spent many nights and days on the Clayton downs, in Sussex, and thus was on the spot during the hours when, according to theory, the ponds should be receiving dew. The result of a large number of thermometrical observations went to show that very rarely does the temperature of the water of the ponds sink below that of the air above it, or below dew-point.

The term "dew" is widely used to mean any kind of condensation which does not fall as rain, hence "dew-ponds," "mist-ponds," and "cloud-ponds" are terms which are used for one and the same kind of pond. On the Sussex Downs no overhanging tree to condense moisture out of the air is found, as a rule. The bare down is all around, whilst in the water there is, as a rule, pond-weed, or reeds, sometimes projecting above the surface of the water. Where this happens, dew is undoubtedly precipitated on the reeds, and this helps to replenish the pond. But many ponds have no projecting vegetation, and yet do not suffer greatly in times of drought. It is pointed out that the measurements of some ponds and their surrounding basins give a receiving area sometimes double the area of the water. In one case the pond-area was 4120 square feet, whereas the shelving margin gave an area of 5795 square feet. Other similar examples are given, and it is this width of margin which has caused many observers to conclude that rainfall is the chief factor in filling the ponds; but not the only factor, as Mr. Martin points out, otherwise there would be little reason why the lowland ponds should dry up in times of drought, and leave the upland ponds fairly full.

Thermometrical observations show that the depth of a pond at the commencement of a drought has much to do with its continuance. A shallow pond was found rapidly to dry up by evaporation, the high temperature gained during the day being well maintained during the night. On the other hand, a deep pond will but slowly be heated, and may well be saved excessive evaporation until a break in the weather comes, and normal conditions again prevail. One pond which was but a foot deep was found so late as 8.20 p.m. in July to show no differences of temperature at 1 inch, 6 inches, and 9 inches, the thermometer registering 67·5° F., whilst that on the bank showed a reduction to 58·5° F. The water lost heat but slowly, and no doubt evaporation went on well into the night. Three weeks later it was dry. Another pond, 3 feet deep, showed, at 6 p.m., 76° F. at 1 inch, 74° F. at 6 inches, and 71° F. at 9 inches, and two hours later the 1-inch temperature had been reduced to 70¾° F., whilst the 6-inch and 9-inch temperatures were uniform at 71° F., the surface temperature showing a considerable loss. There was in this pond a large quantity of rushes, and the loss by evaporation was almost compensated for by the deposition of dew upon their exposed surfaces. This pond did not dry up.

Attention was given to the alleged chilling of the water below dew-point, but it was found that although such a circumstance rarely happened, it sometimes was seen that the temperature of the air resting on the water was below dew-point. Further observations in this direction are to be made. Numerous experiments were made to determine whether straw, wood, and woodwool were likely to effect a chilling of the water of a pond resting on a foundation of these materials, and the evidence pointed to these acting in the desired direction. A series of experiments showed that both "downward" and "upward" dew would be found on different nights according to certain atmospheric conditions, and it is pointed out that if a pond were to depend on the latter only for its replenishment, it would simply receive what it had previously lost by evaporation. The chilling effect of grass on the moisture-sodden lowest stratum of the atmosphere results in dew on the grass, but there is no such chilling of the air by the pond-water, and if dew is there deposited there must be some other cause at work.

It is found that out of seven localities quoted where straw has been used in the foundations of dew-ponds, in no case has it been used with the idea of inducing dew-deposition in the pond. Sections of dew-ponds are given in the paper, constructed according to various authorities. The most remarkable case seems to be that in Wiltshire, where foundations are laid in the form of six layers of straw and clay alternately, but here again the reason given is that the straw prevents the clay from cracking. Incidentally, Mr. Martin refers to the danger to clay-puddled ponds from the small red-worm, swarms of which were met with in some ponds. An estimate of dew-fall on grass was made, giving 0·77376 inch per annum.

So far as rainfall is concerned, it was found that in thirty-two days the amount measured on the downland was 2·57 inches, but a gauge placed in a hollow dug for an experimental pond measured 3·51 inches. This seems to show that a pond-depression on the downs would draw into it, by setting up currents and eddies of the wind, a greater quantity of rainfall. By experimenting with a gauge in the rim of which had been placed some straw and grass, in imitation of conditions which obtain in some ponds, it was found that when 0·37 inch was measured on the down, 0·54 inch was measured in the gauge; when the former showed 0·32 inch, the latter showed 0·69; when the former showed 0·46 inch, the latter showed 0·80 inch. The gauge with the straw and grass was placed in the hollow.

In order to determine whether the chemical composition of pond-waters would give any clue to their origin, a number of analyses of such waters was made at the South-Western Polytechnic, and the results are given in the paper. These seem to show that there is too much sodium chloride contained in the ponds to have come from rain-water, and in normal conditions dew certainly contains no common salt. The sea-mists may reasonably be held to be responsible for the saline qualities of the waters.

So far as the antiquity of the name and the idea of the dew-pond is concerned, Mr. Martin seems to think that puddling by cattle-trampling by accident may have caused artificial ponds first to have been made, and although proof must be lacking, it is possible that some may be of very ancient date. Wells are so rare in ancient camps on the downs that ponds were probably the chief source of water supply. Why straw was first used, and how it was first used, are likely to remain unanswered satisfactorily. A description is given of a small experimental pond which the author made. The foundations were composed of wood-wool resting on a chalk base, followed by straw and wooden planks, with puddled clay thereon. Further investigations are promised, and no doubt the success or otherwise of the pond will form the subject of a future paper.

In the discussion which followed the reading of the paper, Dr. H. R. Mill claimed that rain is the principal factor in filling the downland ponds, and suggested that the reason why the lowland ponds the more quickly dry up may be that they are not so carefully made watertight as those on the higher ground.

ARTIFICIAL PARTHENOGENESIS.[1]

THE development of biology into an experimental science is nowhere better illustrated than in the important researches on artificial parthenogenesis which we owe largely to Jacques Loeb, and biologists will welcome heartily the little book in which this distinguished author gives an account of the subject. Prof. Loeb informs us that the object of his investigations was to transfer the problem of the fertilisation (Entwicklungserregung) of the animal egg from the domain of morphology to that of physical chemistry. He recalls the fact that it is only about sixty years since it was first firmly established that the animal egg—with the exception of a few cases—can only develop into an embryo after fertilisation by the entrance of a spermatozoon. Various interpretations have been placed upon this process. O. Hertwig maintained that the essential feature of fertilisation was the union of the male and female pronuclei in the egg-cell, and the observation of this union was undoubtedly of the greatest importance, especially from the point of view of the theory of heredity, but it gave us no real insight into the nature of the stimulus which evokes as its response the segmentation of the egg. Boveri, indeed, maintained that the union of the two pronuclei had nothing to do with providing this stimulus, and was able to show that an enucleated egg may develop after fertilisation by a spermatozoon. According to Boveri the centrosome is the organ of cell-division, and the unfertilised egg cannot develop because the centrosome is wanting. A new centrosome is introduced by the spermatozoon, and then cell-division or segmentation commences.

Loeb, however, maintains that the development of the egg is a chemical process, depending mainly on oxidation, in which there takes place a synthesis of nuclear material from constituents of the cytoplasm. He accordingly regards the Boverian hypothesis, in which a purely mechanical *rôle* is assigned to the centrosome, as inadequate to explain the nature of fertilisation. His earliest experiments consisted in treating the eggs of a sea-urchin with sea-water, the alkalinity of which had been increased by the addition of soda-lye. In such water the eggs segmented once or twice, but did not develop further. On the other hand it was found possible to cause the unfertilised eggs to develop into larvæ by placing them for a couple of hours in hypertonic sea-water—sea-water, that is, the osmotic pressure of which had been raised about 60 per cent. by the addition of some kind of salt or sugar. This apparently purely osmotic stimulation of the egg was subsequently found to comprise two factors, viz., the loss of water by the egg, and the concentration of the hydroxyl-ions of the hypertonic solution. It was also found that the hypertonic solution can only stimulate the egg to development if it contains free oxygen in sufficient quantity.

The author next succeeded in producing larvæ from unfertilised eggs of Chætopterus by means of potash and acids without raising the osmotic pressure of the sea-water.

It has long been known that the eggs of many animals, immediately after the entrance of the spermatozoon, form a "fertilisation membrane" on the surface. We used to be told that this membrane served to prevent the entrance of additional spermatozoa. Loeb attributes to it a much deeper significance. He finds that in the case of osmotically "fertilised" eggs no membrane-formation takes place, but a short treatment with a monobasic fatty acid causes the formation of a typical "fertilisation-membrane" in all the eggs of Strongylocentrotus. If such eggs are then placed for a short time in hypertonic sea-water they all develop into larvæ. The artificial membrane-formation by itself, however, in this case only causes the eggs to commence their development without being able to continue it.

The membrane-formation is regarded as the most important factor in fertilisation. It has also, however, a deleterious effect, a tendency to cytolysis, which requires to be counteracted by treatment with a hypertonic solution, or in some other way. In some species the artificial membrane-formation alone is sufficient to bring about the development of the eggs to normal larvæ, the injurious cytolytic effects being less marked than in the sea-urchin. That it is the membrane-formation and not any other action of the fatty acid which brings about the development of the egg is evident from the fact that membranes produced in any other way have the same effect.

The author attributes a like importance to membrane-formation as the essential factor in the normal fertilisation of the egg by the spermatozoon, and proceeds to inquire what substances and agencies determine such formation. Membrane-formation may be regarded as a stage in the cytolysis of the egg, and all cytolytic agents will cause membrane-formation. Clearly the cytolysis must be arrested in some way after the membrane has been formed, otherwise it will lead to the destruction of the egg. Loeb maintains that in the natural fertilisation of the egg the formation of the fertilisation membrane is brought about by a "lysin," carried by the spermatozoon, which also brings with it a second substance which serves to counteract the evil effects of membrane-formation.

Such is the essence of the "Lysin Theory" of fertilisation. As an attempt to interpret biological phenomena in terms of chemistry and physics, it is of the greatest interest, though the point of view from which its author regards the phenomena of fertilisation may not be the one which appeals most strongly to students of biology.

We do not doubt that a new edition of this extremely interesting work will shortly be called for, and we hope that it may be found possible to publish it simultaneously in German and English. Not the least valuable feature of the book is, to our mind, the introduction of twenty-one pages, in which a concise *résumé* of the entire subject is given.

[1] "Die chemische Entwicklungserregung des tierischen Eies (Künstliche Parthenogenese)." By Jacques Loeb. (Berlin: Julius Springer, 1909.) Price 9 marks.

NOTES.

A MEETING to further the interests of the forthcoming expedition, under Captain Scott, to the South Polar regions, was held at the Mansion House on Tuesday last, the Lord Mayor presiding. Captain Scott laid the plans and objects of the expedition before the meeting, and stated that 40,000*l*. was required for the estimated cost of the first year's work. He further said that if that sum was contributed by this country he hoped that, with the cooperation of the over-seas dominions, they might raise a sum sufficient to carry on the work until it was finished, that was to say, if necessary, for a second and possibly a third season. He would prefer a request for support to the Government of the Commonwealth of Australia, because the scientific work of an expedition of that kind —its meteorological and magnetic observations—was possibly of greater use to the countries which lay adjacent to the region of research than it was to the homeland. A resolution in support of the expedition was passed.

ACCORDING to a Reuter telegram from Washington, the National Geographic Society has passed a resolution requesting Dr. Ira Remsen, president of the U.S. National Academy of Sciences, to appoint a commission to examine the records and observations of Dr. Cook and Commander Peary. This action is based on a proposal made by the Peary Arctic Club.

AT a meeting of the executive committee of the Zeppelin Polar Expedition, held at Friedrichshaven last week, it was decided that a preliminary expedition should be sent next summer to Spitsbergen in order to investigate the polar ice and determine the conditions affecting the management of airships in those regions. The committee laid great stress upon the importance of promoting the development of Zeppelin airships for long journeys, especially over the sea, for the purpose of scientific investigation. Plans are to be drawn up immediately for the construction of a suitable airship, which is to be ready at the beginning of 1911.

IT is stated by a *Times* correspondent that Mr. Evelyn Baldwin, the leader of the Baldwin-Ziegler expedition of 1901–2, announces his intention to make an attempt to reach the North Pole by drifting with the ice eastward on a parallel course to that taken by the *Fram*. He calculates that the voyage will last four years.

LIEUT. SHACKLETON delivered a lecture before the Danish Geographical Society on Saturday last on the work of his late expedition, and received from the president the gold medal of the society. He also had conferred upon him, by the King, the Commandership of the Dannebrog Order of the Second Class. It is the intention of the explorer to present a small collection of specimens of Antarctic rocks to each of the principal geological museums.

A SEVERE shock of earthquake was experienced in the island of Shetland at about two o'clock on Saturday morning last. The shock was accompanied by a dull rumbling sound, which many fishermen mistook for the sudden outbreak of a hurricane.

ACCORDING to a Reuter message, a severe earthquake shock was experienced at Reggio di Calabria in the morning of October 7.

A STORM of unusual violence broke over Havana and the coast of Florida on Monday last. The damage to property at Key West is estimated at 400,000*l*. At Havana five persons were killed and many injured.

WE note with regret the death, on Saturday last, of Dr. Hugh Blackburn, emeritus professor of mathematics at the University of Glasgow. Prof. Blackburn was born on July 2, 1823, and filled the chair of mathematics in the University from 1849 until 1879, when he was succeeded by Prof. Jack.

MR. RICHARD BANNISTER, whose death occurred at his residence in South Kensington on September 27, had held the position of deputy principal chemist in the Government laboratory for about twenty-five years. He attended the Royal College of Chemistry in 1862–3, obtaining full marks at the final examination of the students, and was attached to the small chemical staff then at Somerset House. Eleven years later he was promoted to the post of deputy principal, and continued to hold this office until his retirement from the public service in 1898. On such analytical matters as the detection of adulterations in tobacco or of methyl alcohol in spirituous liquors, Mr. Bannister in the earlier stages of his career was often required to give expert testimony. Later, however, in accordance with what his duties demanded, it was chiefly as an administrator and a shrewd man of business that his capabilities were shown. He gave evidence before several Royal Commissions, notably upon the questions of the materials used in brewing beer and the adulteration of food products. His knowledge, judgment, and sound common sense were also recognised outside strictly official circles. He was a Cantor lecturer on certain food-stuffs, such as tea and coffee, the lectures containing much useful technical information of a kind not easily found at that time in text-books. He acted as juror at the Paris and Chicago exhibitions, where his combined chemical and business experience—for he was a director of the Civil Service Stores, as well as an analytical chemist—was no doubt of exceptional value. Mr. Bannister, who was in his seventy-fifth year, was a member of the council of the Institute of Chemistry.

MR. JAMES BRITTEN has just retired from the botanical department of the British Museum after a period of service of thirty-eight years. Previously to joining the staff of the British Museum he was for two years an assistant in the Kew Herbarium, and has therefore completed forty years in the service of the State. Mr. Britten has recently been engaged in the preparation of a catalogue of the Sloane Herbarium, which will shortly be published by the trustees. The collections of Sir Hans Sloane, it will be remembered, were the foundation of the British Museum, and his herbarium contains some of the earliest botanical collections from many parts of the world, and is of great importance in connection with the systematic works of Linnæus and other botanists of the eighteenth and early nineteenth centuries.

ACCORDING to a *Times* correspondent, a further fossil human skeleton has just been discovered in the department of the Dordogne at Ferrassie, 5 kilometres from Bugue, in a layer belonging to the lower middle post-Tertiary period.

A CORRESPONDENT of the *Globe* states that the remains of a lake-dwelling (reputed to be 4000 years old) have just been discovered by Dr. Otto Froodis while excavating the hilly region near Lake Vettern, in Sweden. Weapons and primitive household utensils were found in stone, flint, bone, and horn.

THE demonstrations in connection with the museum of the Royal College of Surgeons of England, which were inaugurated last year, are to be continued by Profs. A.

Keith and S. G. Shattock. This year's course is to begin to-morrow. It will be open to all practitioners and medical students on presentation of their cards.

THE first monthly general meeting of the new session of the Institution of Mechanical Engineers will be held to-morrow, when a paper will be read by Prof. W. E. Dalby entitled "Heat Transmission." It will be remembered that in 1906 the members of the institution decided, by vote, that the subject of heat transmission was suitable for further research, and Prof. Dalby has therefore, at the request of the council, collated in an appendix to his paper information already published relating to the transfer of heat across metallic surfaces in contact with water and with gases.

THE syllabus of the first half of the 137th session of the Medical Society of London has reached us, from which we learn that on October 25 a paper is to be read by Dr. F. W. Hewitt on the need for legislation in regard to anæsthetics, and the lines upon which it should take place. Subsequent papers will be read by Prof. Arthur Keith and Dr. James MacKenzie. The Lettsomian lectures will be delivered on February 7 and 21 and March 7 by Dr. J. S. Risien Russell, on the cerebellum and its affections.

ACCORDING to the *Lancet*, a new edition of the catalogue of the pathological section of the Museum of the Royal College of Surgeons of England is to be prepared by Prof. S. G. Shattock, with the assistance of Mr. Alban Doran; a new edition of the catalogue of the Entozoa, by Dr. R. T. Leiper, is also in preparation.

NOTICE is given of the holding, in June and July, 1910, of an International Agricultural Exhibition at Buenos Aires. Communications respecting the exhibition should be addressed to the secretary, 316 Florida, Buenos Aires.

THE inaugural meeting of the China Philosophical Society was held at Tientsin on September 18, under the presidency of the president of the Pei Yang University (Mr. Wang Shoh Lian), who, in the course of his address, pointed out the importance of the existence of such a society in the present stage of China's development, when western learning is being spread over the Empire. The possibilities before the society are unlimited, as all branches of science and art present practically untouched ground, and it can do much to build up the new learning, to foster and organise research, to unite Chinese and foreign students in a common cause, and help these to understand each other better; to assist in the introduction of foreign methods and in the adaptation of these, and yet to protect and retain those older methods which are threatened with extinction. After the delivery of the address referred to, papers were read by Dr. G. Purves Smith, on agricultural possibilities of North China, and Dr. Wu Lien Teh, on a striking example of scientific farming in Chihli.

WE learn from the *Times* of October 11 that the shipments of salmon ova to New Zealand in the early part of this year have, so far, proved highly successful. Of the first consignment of some half-million eggs from Scotland and Ireland, only about 5·6 per cent. died on the voyage out. The second consignment consisted partly of English and partly of German eggs; the latter had to be re-packed in London, and about 7·8 per cent. of them perished on the voyage to New Zealand, while of the former only about 1·7 per cent. failed to reach their destination in safety. On their arrival in New Zealand the eggs were immediately sent to the hatcheries, where they commenced hatching out within a few hours of their arrival. There is clearly no difficulty about transporting salmon eggs to New Zealand in good condition. The difficulty is to rear the young fish after hatching. Hitherto all attempts to do this have failed in New Zealand, and we shall be much interested to hear what happens in the present instance. If they can once get established, there seems no reason why the salmon should not thrive in New Zealand as well as the trout, the acclimatisation of which has long since been successfully accomplished.

THE exploration of the fauna and flora of the waters of Lake Tanganyika has been carried out with important results during the last ten years owing to the efforts of Sir Ray Lankester. He obtained funds from the Government grant committee of the Royal Society, in the first instance, in 1895, which were employed in sending Mr. J. E. S. Moore on a preliminary expedition. The results obtained were so promising that in 1899 Sir Ray Lankester collected from those interested in the great lake and in African natural history a special fund amounting to more than 4700*l*. for further exploration, and obtained the assistance of a committee of naturalists in its administration. Mr. Moore was sent on a second expedition, well equipped and furnished with funds for the hiring of a steamer which had been placed on the lake by some enterprising pioneers. On Mr. Moore's return a third expedition was entrusted to Dr. W. A. Cunnington, of Christ's College, Cambridge, who has given special attention to the algæ and the smaller invertebrates of the lake. The money collected by Sir Ray Lankester has now been all spent, and an account rendered to the subscribers, together with a list (a copy of which we have received) of the numerous important publications on the fauna and flora of Lake Tanganyika, written by various experts who have undertaken the study of the collections brought home by Mr. Moore and by Dr. Cunnington. The most extensive results are those published by Mr. Boulenger, in five separate memoirs, on the fishes, which include a vast number of new species and genera; Mr. Moore's publications on the new gastropod molluscs and the anatomy of many of them, and on the reproduction of the fresh-water jelly-fish, Limnocnida; papers on the Crustacea, by Messrs. Cunnington, Calman, G. O. Sars, and Stebbing, and on the botanical collections by Dr. Rendle and Prof. G. S. West. All the collections have been placed in the Natural History Museum, although the trustees did not in any way contribute to the expenses of the expedition, which was a purely individual enterprise carried out by Sir Ray Lankester when director of the natural-history departments. It now remains for Dr. Cunnington to give a clear and concise illustrated account of the natural history of Lake Tanganyika so as to embody the results of all this recent investigation in a readable form, with indication to the reader as to where he may find the various scattered memoirs in which the detailed descriptions are published.

PART iii. (June) of the Ceylon Marine Biological Reports is devoted to an account, by Messrs. T. Southwell and J. C. Kerkham, of an inspection of certain pearl-banks situated between Dutch Bay Point and Negombo, which are at present under the control of the Ceylon Government. The inquiry was conducted by the Ceylon Company of Pearl Fisheries, Ltd., which at present holds the main fisheries in Ceylon; and the chief results seem to be that these southern banks are exposed to the continuous influence of adverse surface-currents, and that the nature of the sea-bed is less well adapted for oyster-culture than is the case in the leased beds. Further, the close proximity of the southern banks to the "overfalls" renders them unsafe as oyster-beds, although the actual *modus operandi* by which this is brought about is not at present understood.

In a note communicated to vol. xxxiii., No. 3, of the *Tropical Agriculturist*, Mr. E. E. Green states that an attempt is to be made to check the ravages on tea-plants in Ceylon of the beetle known as the "shot-hole borer" by introducing a predaceous beetle (*Clerus formicarius*), which is already well known as an enemy of pine-boring Scolytidæ. Mr. Green decided to try this beetle as an exterminator on account of the good reports of its value as a pest-ridder received from the United States. The experiment can, however, only be of a tentative nature, as the Clerus is an inhabitant of the temperate zone, and it remains to be seen whether it will thrive in the tropics. In a second note the Government entomologist states that in the Ambawella district of Ceylon camphor-plants are attacked by a scolytid allied to the shot-hole borer.

Several interesting additions to the British insect-fauna are recorded in the October number of the *Entomologists' Monthly Magazine*. Many years ago, it appears that Dr. David Sharp received from Chobham a water-beetle which he was unable to identify; this year he took a second example at Brockenhurst, and he finds both to belong to the continental *Laccobius scutellaris*. In the next article Mr. J. Edwards describes a new beetle from Horning, under the name of *Dryops anglicus*; later on, Mr. E. R. Speyer records the occurrence in Sussex of a number of specimens of the continental dragon-fly *Somatochlora metallica*, a species already known from Scotland, but not hitherto definitely identified in England. Finally, Mr. K. J. Morton mentions the occurrence in the west of Ireland of the trichopterid *Limnophilus fuscinervis*, which is quite new to the fauna of the British Isles.

C. Dawydoff contributes to the *Zeitschrift für wissenschaftliche Zoologie* (Bd. 93, Heft 2) a very elaborate memoir on the process of regeneration in the Enteropneusta. He considers that this group of animals, about which so much has been written recently from the morphological and phylogenetic points of view, affords an uncommonly convincing example of the untenability of Weismann's view that the power of regeneration is the result of natural selection. He states that when dredging for Ptychodera only the anterior portion of the body is usually obtained, the hinder end being commonly torn away, and concludes that under normal conditions the animal may lose its hinder end but hardly ever loses its head. He thinks that, according to Weismann's views, the animal should accordingly be able to regenerate the hinder end, but not the head end, while his own experiments show exactly the contrary to be the case, the anterior extremity being very readily regenerated after amputation, but not the posterior. The author's argument in this respect does not appear to us to be very convincing. The facts as stated suggest the possibility that anterior ends are cut off and collected by the dredge because they protrude, while the posterior ends remain buried, and that for the same reason the head ends are likely to be bitten off by fishes. If this be so, the fact that the anterior ends and not the posterior are regenerated fits in exactly with Weismann's views. We need to know something definite about the habits of the living animal before coming to a conclusion on this question. It will interest morphologists to know that Dawydoff finds in the mode of regeneration of the proboscis pores evidence in favour of Schimkewitsch's view that these organs are homologous with the "metanephridia" of annelids, consisting each of a mesodermal funnel and an ectodermal canal, the latter of which he regards as of more recent origin than the former.

Dr. W. F. Purcell contributes to the September number of the *Quarterly Journal of Microscopical Science* (vol. liv., part i.) a very interesting memoir on the development and origin of the respiratory organs in Araneæ. He finds that the first "leaves" of the "lung-books" in spiders appear on the free posterior side of the provisional abdominal appendages, quite outside of the pulmonary invagination, and deduces from this fact that the lung-books are derived from gill-books similar to those of Limulus. The tracheal system is supposed to have a two-fold origin, the pair of lateral tracheæ of dipneumonous spiders having been derived from the second pair of lung-books of tetrapneumonous forms, while the medial trunks of the tracheæ are equivalent in their entirety to metamorphosed entapophyses, *i.e.* to the invaginated ectodermal areas, lined by cuticle, which serve for the attachment of the ventral longitudinal muscles. Dr. Purcell's observations and conclusions should be of great value in settling the much-discussed question of the classification of the Arthropoda—if it ever is settled. The same number contains a further instalment of Mr. Goodrich's work on nephridia, dealing with these organs in Dinophilus and in the larvæ of Polygordius, Echiurus, and Phoronis, and some further notes on a trypanosome found in the alimentary tract of *Pontobdella muricata*, by Miss Muriel Robertson.

Among the shikar and natural-history notes contributed to the *Indian Forester* (August) is a note on the Burma mole rat, which, according to the writer, is a serious depredator of Para rubber trees, especially in young plantations, and is also reported to attack seedlings of teak, mango and jack trees. The animal, which is not definitely identified, but may be *Nesocia hardwickei*, is apparently confined to Burma and western Siam.

An important collation of the genus Cereus and its allies in North America, based upon observations in the field in Mexico and elsewhere, also of living material in the greenhouse in addition to herbarium species, is presented by Prof. N. L. Britton and Dr. J. N. Rose in the final part (No. 10) of the twelfth volume of Contributions from the United States National Herbarium. Following to a considerable extent the revision by Mr. A. Berger, except that they raise several of his subgenera to generic rank, the authors distinguish twenty-three genera, of which Cephalocereus, Echinocereus, and Lemaireocereus are the chief. The plant originally named *Cereus greggii*, that has a curious turnip-shaped root, is made the type of one of the new genera, Peniocereus. The same part contains descriptions of five new Mexican Crassulaceæ communicated by Mr. J. N. Rose, and a supplement to the monograph of North American Umbelliferæ by Drs. J. M. Coulter and J. N. Rose.

As might be expected, the officials of the Department of Agriculture in the Federated Malay States have been called upon for advice regarding pests of Para rubber trees. Mr. H. C. Pratt has collected further information on the ravages of the ants identified by him as *Termes gestroi*, which is published in Bulletin No. 3, together with methods of treatment. No insecticides can be recommended, but eradication of old tree stumps and carefully devised fumigation with arsenic and sulphur of the burrows leading to hollow stems have proved efficacious. Mr. W. J. Gallagher discusses in Bulletins Nos. 2 and 6 the root disease caused by *Fomes semitostus*, and a branch and stem disease which has not yet been traced to a specific fungus. The Fomes spreads from the old stumps of jungle trees, so that eradication of these is the only remedy, while excision of infected parts and treatment with Bordeaux mixture have proved effectual against the less dangerous stem disease.

A VARIED selection of microscopic accessories, apparatus for bacteriological and hæmatological investigation, and instruments for collecting natural-history specimens, is kept by Messrs. H. F. Angus and Co., 83 Wigmore Street, who have recently issued a well-illustrated catalogue of this part of their stock. The firm acts as agent for Messrs. Swift, Leitz and Zeiss, also for Dr. G. Grübler, of Leipzig. Another feature of the catalogue is the list of mounted specimens for the microscope, physiological, pathological, and botanical.

THE Francis Galton Eugenics Laboratory has published a lecture by its research scholar, Miss Ethel M. Elderton, entitled "The Relative Strength of Nurture and Nature," which was recently delivered in a course of lectures on national eugenics at the laboratory. By the method of correlation used by the lecturer and her colleagues, she claims to establish the fact that "overcrowding, bad economic conditions, bad physical and moral conditions of the parents, have practically no effect on the intelligence, eyesight, glands and hearing of the children." The results, indeed, show that the children of drunken parents are somewhat healthier and more intelligent than those of sober parents, and generally that the influence of environment is almost negligible compared with that of heredity. As the author admits, some of "these results are certainly startling and rather upset one's preconceived ideas."

IN a work entitled "Die Härte der festen Körper und ihre physikalisch-chemische Bedeutung" (Dresden: Theodor Steinkopff) Dr. Viktor Pöschl makes a valuable contribution to the study of an important physical character of solid substances, which has as yet scarcely received adequate attention from crystallographers and others interested in such matters. He describes a new form of sclerometer recently devised by him; in it the section under test is placed on a carriage and drawn under a diamond point, which may be lightly loaded, and the width of the resulting scratch is measured by means of a high-powered microscope. He gives the results of a series of experiments made upon various minerals and metals. It is interesting to note that the apparently wider scratch made perpendicular to the trace of the cleavage plane is due to incipient cleavage cracks, and that the direction parallel to the trace is really the one of least hardness. Dr. Pöschl discusses with considerable acumen the connection between hardness and solubility, chemical composition, crystal form, and density.

PROF. ECKERT publishes a new "isochronic" chart of the world in the September number of *Petermann's Mitteilungen*. The first part of an article on the construction of such maps, dealing with the history of their development and with modern methods of arranging and reducing the *data* upon which they are based, accompanies the chart.

THE October number of *Travel and Exploration* contains the first part of a paper, by Dr. M. A. Stein, on his journey through the Taklamakan Desert, entitled "Across the 'Sea of Sand.'" The paper gives a graphic account of the incidents of the journey, and is illustrated by excellent photographs.

MR. ELLSWORTH HUNTINGDON contributes an article on the Russo-Afghan frontier region to the September number of the *National Geographic Magazine*. The paper forms the first part of an account of the "Afghan Borderland," based chiefly on journeys made by the author in recent years. Speaking of eastern Persia, Mr. Huntingdon remarks that "the inhabitants stagnate and play no part in the present history of the country except as pawns to be harried by the Afghans, cowed by the Russians, or cajoled by the English."

THE British School of Archæology at Athens has made further important discoveries on the site of the city of Sparta. The great temple of Artemis Orthia has been now completely cleared. The site known as the Menelaion, at Therapne, about two miles south-east of Sparta, has been partially examined. The sanctuary of Menelaus and Helen, mentioned by Herodotus, Livy, Pausanias, and Polybius, was a favourite resort of the Spartan ladies, where the goddess was believed to confer the gift of beauty on her worshippers. The discovery of Mycenæan remains on this site suggests that this was the famous palace of Menelaus, and this provisional identification is corroborated by finds of bronzes, votive double-axes, lead figurines, and terra-cottas.

IN the fourth Bulletin of the Archæological Survey of Nubia for the current year Dr. G. A. Reisner continues his account of a group of prehistoric cemeteries at Koshtamna, in Nubia. The excavations disclosed two remarkable sets of graves, one simple archaic pits with contracted burials, and the second mud-cut chambers with mummies deposited in an extended position. Unfortunately, many of the former have been destroyed by cultivators in search of fertilising matter for their fields, but those which remain extend from the middle pre-dynastic period down to that of the late Empire. The mud-cut graves represent the period from the earliest Ptolemaic down to Christian times. Drs. G. Elliot Smith and D. E. Derry have, as usual, reported upon the physical characters of the human remains. These show a considerable intermixture of the Negroid with the indigenous type, which has resulted in a progressive shortening of the cranium. Three distinct negro types were observed—one small and relatively short-headed, the second taller and dolichocephalic, the third a big, massive, broad-faced, large-headed variety. The occurrence of spinal tuberculosis in this region is now definitely established, and the present investigations have pushed back the diagnosis of this disease another thousand years, as far back as the period of the Ancient Empire.

THE Transactions of the Royal Society of South Africa for July last contain a useful paper by Mr. R. T. A. Innes, in which he endeavours to show what reductions applied to the Transvaal air-temperatures will in the mean for the whole country reproduce the assumed temperatures at sea-level. On squared paper points were placed for the actual temperatures recorded at different altitudes; a curve drawn through these to the point at sea-level approximated closely to a parabolic form, and from this curve the reductions to sea-level were taken, the figures below 2500 and above 6000 feet being mostly derived by extrapolation. Three maps are given showing the distribution of sea-level temperatures during the warmest and coldest months of the year and for the mean of the year. The isotherms differ considerably from those drawn by Dr. Buchan; in the warmest month, for instance, Dr. Buchan gives the sea-level temperature of the western border as about $92\frac{1}{2}°$, whereas Mr. Innes gives it as $85°$. The author remarks that, in the absence of data, Dr. Buchan must have relied on the analogy with other continental areas, but that the effects of the South African plateau and of the great wind movement alter the circumstances. The present tables, based on data for two years, are, however, only considered as a first approximation.

With reference to suggested reforms in meteorological methods, we referred in a recent issue to a proposal made by Prof. A. G. McAdie in the *U.S. Monthly Weather Review* of November, 1908, to adopt the centigrade (not Celsius) scale and the metric system for temperature, wind, rain, &c., and 1000 on an arbitrary scale of units as the equivalent of the normal atmospheric pressure of 760 mm. This proposal has led to several interesting communications on the subject in the *Monthly Weather Review* of March last. Mr. M. E. J. Gheury (Eltham) prefers, for reasons given, the units at present generally adopted for meteorological observations in this country. Mr. H. H. Clayton (Blue Hill, U.S.) prefers the metric system, but with regard to temperature he renews a suggestion, made in Nature in 1899 (vol. lx., p. 491), that the Kelvin thermometer scale (freezing point 273°, boiling point 373°) should be used, and he points out that the adoption of this scale with the metric system was recommended by a committee of the British Association in 1904. Prof. Köppen (Hamburg) approves of the use of the metric and centigrade systems by England and America, but would express all barometric measurements by ordinary general units of force, taking as unit the product gram × acceleration of gravity. In connection with the above notes it may be stated that from the commencement of this year the Meteorological Office has adopted centigrade degrees on the absolute scale (from $-273°$) and pressure in C.G.S. units, or megadynes per square centimetre, as most suitable for the publication of values in the investigation of the upper air.

No. 15 of the *Verhandlungen der deutschen physikalischen Gesellschaft* contains two contributions from Prof. W. Nernst and his pupil, Dr. H. Levy, dealing with the physical properties of water from the thermodynamic point of view. Assuming that the deviations of water vapour from the "perfect gas" laws are due to the formation of a certain proportion of double molecules in the vapour, they show that it is possible to give expressions for the density and pressure of the vapour and the latent heat of evaporation of the liquid, within the interval 0° C. to 100° C., the latent heat of fusion of ice, and even for the variation of the specific heat of water with temperature, which show an accuracy far greater than has been attainable with the help of any previous theory.

Some experiments by Prof. Rateau on fluid pressure on inclined planes are discussed in an article in *Engineering* for September 17. The mathematical solution for an ideal fluid shows that a portion of the fluid is always deviated so as to pass over the leading edge, whatever may be the inclination of the plane. Rateau's experiments show that, for considerable angles of incidence, the fluid actually spills over both edges, whilst for smaller angles the flow takes place wholly past the trailing edge. Using a rectangular plane 30 by 50 centimetres by 1·25 millimetres thick, from 0 to 29 degrees the flow is solely over the trailing edge; from 29 to 36 degrees the conditions are absolutely unstable; afterwards a proportion regularly escapes past the leading edge. Further, the smaller the angle of inclination the nearer does the centre of pressure lie to the leading edge of the plane, the limiting value for the above plane being 0·236 of the width of the plane for zero inclination. A plate having a flat ship-shaped section shows a very marked retrogression of the centre of pressure at inclinations less than 7 degrees, the centre of pressure moving rapidly towards the trailing edge. A blast of air was used in these experiments, and results were also obtained for the total pressure and for the friction.

From an article on the Paris Aviation Exhibition in *Engineering* for October 1 we note a point which may possibly require more attention than it has hitherto received. In the case of an engine running with no fly-wheel except the propeller, the blades near the root may be subject to a considerable stress alternating with every revolution of the engine. The amount of this stress will depend on the number of cylinders the engine has, and it may be necessary to make the propeller-blades considerably stronger with two- and three-cylinder engines having no fly-wheel than with others having a more even turning moment. Wooden propellers seem more in favour than those of metal, and probably are more suitable, as wood is well able to withstand the above-mentioned stresses, and it is easy to make the blade strong at the root without excessive weight. The wreck of the dirigible *République* and the death of four men composing her crew, owing to a broken propeller, shows that danger from this cause is not imaginary, and the results in an aëroplane would probably be at least equally disastrous. We also note from the same article that although the cross-Channel flight and the record for distance have been performed with air-cooled motors, the water-cooled engines are in a very large majority at the exhibition. Weights per horse-power range from 2·2 lb. in the Gnome to 7·5 lb. in the Renault, both being air-cooled. The water-cooled engines range from 4 lb. in the Darracq to 6·1 lb. in the Bayard, excluding radiator and water.

The Carnegie Institute of Washington has now published the eighth volume of the "Index of Economic Material in Documents of the States of the United States." It deals with the State of Illinois, and covers the years 1809–1904. This index has been prepared by Adelaide R. Hasse, of the Librarian Department of Public Documents in the New York Public Library, and deals only with the printed reports of administrative officers, legislative committees, special commissions, and governors' messages. The term "economic" has been given a liberal interpretation, and the index will constitute a useful addition to the resources of students of American history.

We are asked to state that a new edition (the third) of "A List of Official Chemical Appointments" is being prepared by the registrar and secretary of the Institute of Chemistry, and that corrections and additions should be sent as soon as possible to the registrar of the institute, 30 Bloomsbury Square, W.C. Suggestions which may increase the usefulness of the list will be carefully considered.

Since the appearance in the last number of Nature of particulars as to forthcoming books of science, information has reached us of the following additional works:—In *Agriculture*.—"Principles of Agriculture: a Text-book for Lecturers on Agriculture, Rural Schoolmasters, Young Farmers, and Students of Agriculture," J. M'Cutcheon, illustrated (E. and S. Livingstone). In *Biology*.—"Window and Indoor Gardening," T. W. Sanders; "Mushrooms and their Cultivation," T. W. Sanders; "Bees for Profit and Pleasure," H. Geary (W. H. and L. Collingridge); "The Mammals of Somaliland: a Book for Naturalists and Sportsmen," R. E. Drake-Brockman, illustrated (Hurst and Blackett, Ltd.); "The Mutation Theory," Dr. H. de Vries, 2 vols., illustrated (Kegan Paul and Co., Ltd.).

In *Geography and Travel*.—"The Basutos: the Mountaineers and their Country," Sir Godfrey Lagden, 2 vols., illustrated (Hutchinson and Co.); "Mediæval Researches from Eastern Asiatic Sources: Fragments towards the Knowledge of the Geography and History of Central and Western Asia, from the Thirteenth to the Seventeenth Century," E. Bretschneider, 2 vols. (Kegan Paul and Co., Ltd.). In *Mathematics and Physical Science*.—New volumes of the International Scientific Series:—"Music: its Laws and Evolution," J. Combarieu; and new editions of "Light and Photography," Dr. H. Vogel and A. E. Garrett; and "Colour-blindness and Colour-perception," C. W. Edridge-Green, illustrated; also "An Easy and Concise Guide to the Starry Heavens," D. M'Ewan, illustrated (Kegan Paul and Co., Ltd.).

OUR ASTRONOMICAL COLUMN.

EPHEMERIS FOR HALLEY'S COMET, 1909*c*.—A corrected ephemeris for Halley's comet is published by Mr. Crommelin in No. 4359 of the *Astronomische Nachrichten* (p. 249, September 28). This ephemeris, like that published in No. 4330 of the same journal, is based on the elements published, for the Astronomische Gesellschaft prize, under the pseudonym "Isti mirantur stellum," Messrs. Cowell and Crommelin, it transpires, being the calculators. The new observations do not yet cover a sufficiently long arc to permit of an independent determination of the orbit, but they do show that the previously published elements are correct except that the date of perihelion passage must be advanced 3·4 days, thereby making it 1910 April 20·0 (G.M.T.); this modification has been taken into account in preparing the present ephemeris, which covers the period August 28 to December 26 in five-day steps. An extract follows:—

Ephemeris.

Berlin M.T	R.A. (1910·0) h. m.	(decl. 1910·0) ° ′	log *r*	log Δ	Magnitude
Oct. 17·4	6 9·7	+16 57	0·4785	0·3982	14 7
,, 22·4	6 5·1	+16 56			
,, 27·4	5 59·1	+16 54	0·4608	0·3447	14·2
Nov. 1·4	5 51·7	+16 52			

From this we see that the comet is at present in the northern limits of Orion, and is some 280 and 230 million miles from the sun and earth respectively; also that it is approaching the sun and the earth at the respective rates of about 1·12 and 2·7 million miles per day. The accompanying chart shows its positions in relation to the constellations so far as Mr. Crommelin's ephemeris gives them.

CHANGES ON MARS.—In No. 4359 of the *Astronomische Nachrichten*, M. R. Jonckheere, of the Observatoire d'Hem (Roubaix), gives a drawing of the south polar cap of Mars, executed on September 2, showing the new "land" which he discovered in longitude 120°. He points out that the crevasse and greyish region observed by M. Jarry Desloges are produced by the emersion of the two "lands," Argyre II. (longitude 60°) and the new one, from the polar snows. For the newly discovered area in longitude 120° he proposes the name "Stella," suggested by its brilliant appearance.

In the same journal M. Antoniadi records his observations, on September 19, of the Mer du Sablier, which to him appeared as Dawes recorded it in 1864. As Prof. Lowell's observations and photographs show it of a very different form during the period 1894–1907, M. Antoniadi suggests that periodic changes of form, probably irregular, may take place in this feature.

A number of interesting observations of the planet are recorded in No. 22 of the *Gazette Astronomique*, by M. P. L. Dupont, of Hoboken, Antwerp.

REMARKABLE METEORS.—No. 22 of the *Gazette Astronomique* contains the records of three remarkable meteors seen in Denmark during August. The first was at 9h. 25m. (C.E.T.) on August 19, and it was bright enough to illuminate the surrounding landscape. Apparently its actual path was from 128 km. above the town of Sorö, in Zealand, to 30 km. above a point on the coast about 22 km. west of Sorö; thus the path was nearly vertical, and the velocity was about 33 km. per second. The other two meteors were seen on the same night at 9h. 17m. and 9h. 38m. respectively. The former was attended by a noise similar to that made by escaping steam, whilst the second one was extraordinarily slow, and was seen for fifteen seconds, during which it passed, nearly horizontally, from 190°, +23° to 152°, +32°.

THE URSA-MAJOR SYSTEM OF STARS.—Following up Dr. Ludendorff's conclusion that the stars β, γ, δ, ϵ, and ζ Ursæ Majoris belong to a definite system of stars moving along parallel lines in space, Mr. Ejnar Hertzsprung has investigated the conditions for other stars having similar proper motions, and finds that a number of other stars probably belong to the same system. Among these may be noted β Aurigæ, Sirius, α Coronæ, 78 Ursæ Majoris, and Groombridge 1930, while κ Boötis is suspected. A number of the stars, nine out of fifteen given, are double, and a tabulation of the magnitudes and spectral classes suggests a development of spectrum, from one star to another, with an attendant decrease of brightness (*Astrophysical Journal*, vol. xxx., No. 2, p. 135).

SEARCH-EPHEMERIS FOR WINNECKE'S COMET.—A continuation of the search-ephemeris for Winnecke's comet is published by Herr C. Hillebrand in No. 4360 of the *Astronomische Nachrichten*. As the present southerly declination (−20°) is increasing, it is not likely that the comet will be generally observed in the northern hemisphere.

THE NATURE OF SOLAR FACULÆ.—An important result concerning the nature of bright faculæ seen on the sun's disc is published by M. Deslandres in No. 11 of the *Comptes rendus* (p. 493, September 13). The main conclusion is that the vapours in the bright faculic areas are, relatively to the surrounding dark areas, descending. This result has been deduced from the measures of the motion-displacements shown on negatives taken with the Meudon spectro-register of radial velocities, the pure K_3 line being employed.

Exhaustive measures of the absolute velocities have not been made, because to measure completely the whole disc on one negative would entail some 36,000 settings, and the Meudon staff is not sufficiently large for such an enterprise. But the measures of a number of displacements on bright areas near the centre of the disc, where the line-of-sight motions are independent of the solar rotation, indicate that the result is general. A diagram which accompanies the paper shows this result for a faculic area photographed on June 4.

M. Deslandres discusses this result in comparison with atmospheric movements on the earth, and suggests that it is in accordance with theory. When a mass of vapour descends it becomes compressed, and therefore brighter; when ascending, its pressure is decreased, and consequently the vapour becomes cooled and less bright.

The investigation of the nature of spots, on the same lines, has not yet been undertaken, M. Deslandres looking upon spots as a secondary phenomenon following the production of faculæ.

PERCY SLADEN MEMORIAL EXPEDITION IN SOUTH-WEST AFRICA, 1908–9.

I.

The Percy Sladen Memorial Expedition was the outcome of a recent study of Welwitschia, that most remarkable of West African plants. Its primary object was the investigation of the biology and morphology of *Gnetum africanum*, the only immediate relative of Welwitschia known to occur south of the Congo. It was further proposed to examine, so far as circumstances would allow, the flora of the desert-belt and of the regions adjacent to it. The expedition was under the auspices of the trustees of the Percy Sladen Memorial Fund, and was assisted by a grant of 200*l.* from the Royal Society. During the first section of the journey (Cape Town to Lüderitzbucht) I was fortunately able to travel in company with the magnetic survey expedition of the Carnegie Institute under my colleague, Dr. J. C. Beattie. A saving of half the ordinary cost of transport was thus effected. The route followed was very largely determined by the distribution of the usually widely separated water-holes. What would certainly have proved a very interesting part of the journey (viz. from Keetmanshoep to Windhuk) had to be abandoned owing to the necessity of arriving in central Angola before the end of the season in which suitable stages of the ovules of Gnetum were likely to be obtainable.

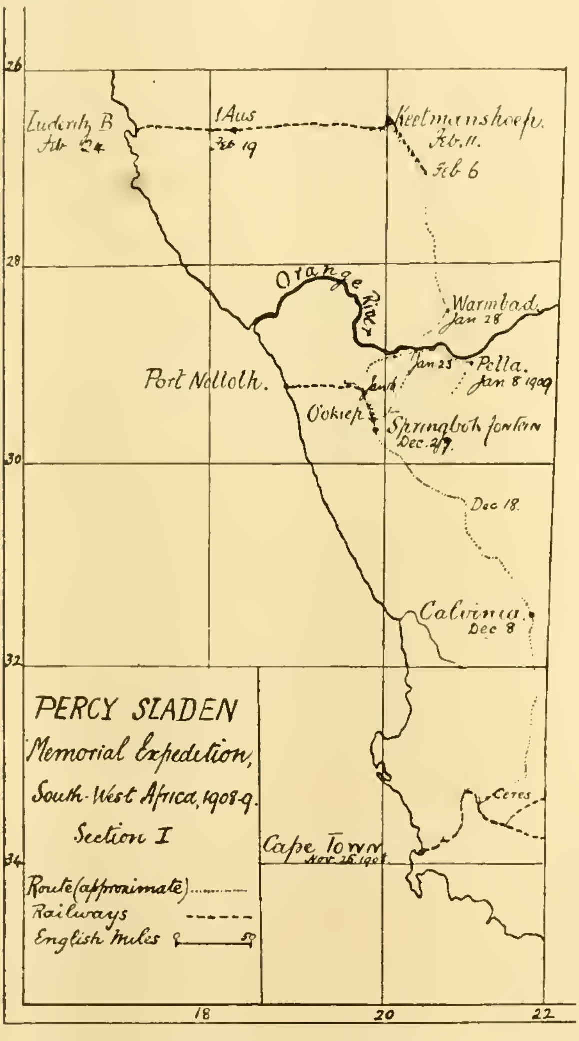
Fig. 1.—A view across the Orange River near Raman's Drift, looking North. The river itself is concealed by the lowest zone of vegetation.

Leaving Ceres Road Station on November 26 with a waggon drawn by twenty oxen, we ascended to the Ceres Plateau (1100 feet) through Mitchell's Pass in the Langeberge Range, and travelled for four days over an undulating tableland rising to 2500 feet, the flora of which is closely related to that of the mountainous districts of south-western Cape Colony. Unfortunately, most of this country was suffering from drought, and the botanical results were poor. At Karoo Poort we suddenly emerged upon the western tongue of the Karoo (November 30), which was crossed in six days. Here also the ground was parched; in some districts, it was stated, no rain had fallen for four years, and many of the farmers had migrated with their families and flocks into Bushmanland and other more favoured localities leaving their homesteads unoccupied. Over large areas all the non-succulent vegetation had disappeared and the flora consisted almost entirely of *Augea capensis* with a few species of Mesembrianthemum. Ascending the Blauwkrantz Pass in a spur of the Roggeveld Range on December 6, we came upon a plateau the flora of which is closely related to that of the Nieuveldt Mountains in the neighbourhood of Beaufort West. On December 10 a somewhat sudden descent to 1600 feet brought us again into a karoid region, in which species characteristic of the dry, low-lying plateaux of Great Namaqualand were encountered for the first time. Prominent among these were *Tamarix articulata*, *Aloe dichotoma*, *Statice scabra*, *Galenia articulata*, *Didelta annua*, *Exomis albicans*, and *Vogelia africana*. This southern extension of the flora of tropical and subtropical Namaqualand seems to be confined to sheltered valleys at elevations not exceeding 2000 feet.

From O'okiep a detour to the north-east across the sandy plains of Bushmanland was rewarded by an unexpectedly rich collection, for unusually heavy rains had recently fallen. The plains were gay with the flowers of *Hoodia Gordoni*, *Rhigozum sp.*, and a tall bushy Hermannia. A shrubby Aristida and some smaller species of the same genus were also very abundantly represented, while trees of *Aloe dichotoma* and large symmetrical bushes of species of Euphorbia were conspicuous on the "kopjes." The natural vegetation along the banks of the Orange River forms a narrow belt, in which a distinct arrangement in subordinate zones can usually be traced. The lowest zone (Fig. 1) consists of a dense scrub of *Salix capensis*, *Acacia horrida*, *Zizyphus mucronata*, and a few other bushes, with some grasses, reeds, and sedges. Above the primary bank of the river the mountains rise steep, rugged and barren, or, between them and the stream, are stony flats (Fig. 1) all but devoid of vegetation. Having returned to O'okiep to refit, we arrived at Raman's Drift for the second time on January 22, and crossed to the German side on January 24. The river at this time was in flood, and its muddy waters were some 600 yards wide at the drift. A few hours of heavy travelling brought us upon a plateau (2300–4000 feet)

Fig. 2.—Great Namaqualand south of Warmbad, *Aloe dichotoma*, *Euphorbia sp.* The native is a Bondelzwaart.

where the vegetation proved to be richer than any hitherto met with. It was said that the rains which had fallen a few months earlier were more copious than any experienced during the previous fifteen or twenty years. It was no doubt a consequence of this that the annual constituents of the flora were unexpectedly abundant. Warmbad is noted for a number of warm springs (35° C.) the waters of which—like so many of the natural waters of the south-west coast—are impregnated with sulphuretted hydrogen. The railway between Keetmanshoep (3300 feet) and the sea ascends to nearly 5000 feet at !Aus, where the vegetation presents many karoid features. From !Aus the descent—at first gradual, later more rapid—is uninterrupted. About 30 km. west of !Aus (110 km. from the coast) the desert commences very abruptly at 2700



feet. In this latitude there appear to be few forms peculiar to the desert itself and its flora consists very largely of the more resistant of the species found at higher levels and under less arid conditions. Nevertheless, the eastern boundary of the desert is remarkably sharp, and approximately coincides with the western limit of precipitation from clouds condensed upon the neighbouring highlands. Within 50 km. of the sea the sharp, bare mountain peaks and ridges are frequently more or less buried in sand-dunes, the materials of which are blown up from the lower-lying flats, leaving behind the worn gravels from which diamonds are now being obtained over an extensive area. Nearer the coast the scenery is remarkably gaunt and rugged and the wind-swept surface is frequently quite bare of vegetation.

Leaving Lüderitzbucht by sea on February 26, I arrived in Swakopmund eighteen hours later, and on March 2 reached Welwitsch (lat. 22°), a Welwitschia locality previously visited in 1907 in company with Mr. E. E. Galpin.[1] The object of this visit was to obtain later stages of the Welwitschia embryo than were present in material collected in 1907. The flora in general was this year very much poorer than two years earlier. Not only were many of the smaller plants then collected not found at all, but woody species formerly obtained in flower or fruit now showed no signs of reproductive activity; this also applies to some extent to Welwitschia itself, for only a small proportion of the plants had coned. The explanation of this very striking difference seems to be contained in the meteorological records. Between[2] November 1, 1906, and January 31, 1907, 12·8 mm. of rain were measured at Welwitsch; in the corresponding period of 1908–9 the rainfall was 5·9 mm. In December, 1906, the fall was 12·5 mm., an amount very much in excess of that recorded for the whole of each of the years 1907 and 1908. We have here, then, another example of the remarkable influence of a small additional rainfall upon both the annual and perennial constituents of a desert flora.

A large number of the Welwitschia plants present in 1907 in this easily accessible locality have been removed in the interval, and, at the same rate, a few years would probably have seen the complete disappearance of all plants from the vicinity of the railway, for there is here no sign of seed-reproduction. It is therefore very satisfactory to note that His Excellency the Acting Governor has issued instructions for the protection of the plants that remain.

H. H. W. Pearson.

RESEARCHES ON THE ACTION CENTRES OF THE ATMOSPHERE.[3]

In the domain of world meteorology, that is, the comparison and discussion of meteorological data of widely distributed stations over the earth's surface, Prof. H. Hildebrand Hildebrandsson has, during the last decade or so, been making some very important communications. He has clearly emphasised the fact that the laws which rule the general movements of our atmosphere will never be found if observations are only made in civilised countries on the earth's surface. Our atmosphere is a mass of air resting both on the continents and the oceans, and modern researches have shown that a large perturbation at one time in one area may be intimately associated with a perturbation of an opposite nature in the antipodal part of the world. Although several workers many years ago intimated the positions of isolated areas which behaved in a reverse or see-saw manner meteorologically, it was Prof. Hildebrandsson who first directed attention to a great number of such areas. In more recent times these isolated instances of barometric see-saws have been found to be part of really one general law applying to the movements of our atmosphere. This general law has yet to be more minutely investigated, for it is, as Prof. Hildebrandsson states, "une verité avec des grandes modifications." There is little doubt, nevertheless, that world meteorology has made a considerable advance since the discovery of these simultaneous reverse-pressure changes, and one is now in a much better position to state where on the earth's surface observations should be made.

Every attempt should therefore be made to utilise islands in the large oceans, even if the sole occupants of the islands are the meteorological observers themselves, for until the air movements over the oceans are carefully observed and recorded we shall still be left to a great extent in the dark.

Prof. Hildebrandsson's most recent memoir deals chiefly with the northern latitudes of the northern hemisphere, and is devoted to a discussion of data with respect to the simultaneous compensation between types of seasons in different regions. The meteorological data here dealt with relate mainly to certain regions between the east coast of

[1] Nature, vol. lxxv., p. 536.

[2] Meteorological observations at this station were commenced in November, 1906.

[3] Kungl. Svenska Vetenskapsakademiens Handlingar, Band 45, No. 2. III. "Sur la Compensation entre les Types des Saisons simultanés en différentes Régions de la Terre." By H. Hildebrand Hildebrandsson.

North America and Siberia, but some more southern stations are included.

Without going into any great detail, the investigation may be summarised as follows. Prof. Hildebrandsson regards the state of the ice of the polar sea as being the principal cause of the different types of the seasons of different years. Thus a high summer temperature in the arctic sea to the north of Europe will set free a large amount of ice, and consequently the polar current arriving on the north coast of Iceland in February and March, and a branch of which, after skirting the east coast, is directed towards the North Sea, will bring much ice and will be surrounded by a layer of cold water. This current will cool the air in its neighbourhood. The result of the movement southward of these specially cold currents is that the land areas around the Arctic Circle and North Atlantic Ocean suffer *successively* from them by the lowering of their air temperatures. Prof. Hildebrandsson accompanies his statements with tables and an excellent series of curves, which are very convincing. He specially refers to the investigation of M. Peterson, who showed that a variation of 2° or 3° in the surface temperature of the sea is sufficient to create changes of considerable magnitude in the air temperature over very large areas.

The main result of this research is to indicate that in certain cases a means is afforded of making forecasts for seasons. Thus, to take an example, he shows that, with two or three exceptions, in twenty-five years the temperature of the summer at the North Cape was in the following spring in opposition to that of Europe, represented by Debreezin.

THE NATURE AND EXTENT OF AIR POLLUTION BY SMOKE.[1]

IN a former paper read at the Congress of the Sanitary Institute held at Leeds in 1897 an account was given of the quantity of soot suspended in and deposited from the atmosphere of Leeds. It was then shown that, on the average working day, 20 tons of soot are sent into the air of Leeds, of which half a ton falls on an area of four square miles, and of the latter from 20 lb. to 25 lb. stick, that is, are not removable by rain. The present paper contains a record of the atmospheric impurities carried down by rain and the effect of this rain water on vegetation. It also contains an inquiry into the diminution of daylight caused by suspended particles of soot.

Ten representative stations were selected in Leeds and one at Garforth, about $7\frac{1}{2}$ miles due east of Leeds. The impurities, in the form of suspended matter, consist of soot, tar, sand, mineral substances, and, in solution, of sulphurous and sulphuric acids or their salts, chlorides, largely in the form of hydrochloric acid or common salt, and nitrogenous matter, in the form of nitrates or free and albuminoid ammonia. The results are embodied in the following table:—

ANALYSES OF RAIN WATER, LEEDS AND GARFORTH.

Total for Year, expressed in Pounds per Acre.

	Collecting station	Suspended matter	Tarry matter	Mineral matter	Free acidity as H_2SO_4	SO_3	SO_2	Chlorine	Nitrogen as NH_3	Nitrogen as N_2O_5	Nitrogen as albuminoid ammonia	Total nitrogen
Industrial	1. Leeds Forge.	1836	110	1113	35	123	34	164	13·0	0·0	4·7	17·7
	2. Hunslet ...	1565	69	655	90	185	24	198	15·5	0·0	2·9	18·4
	3. Beeston Hill.	1163	149	709	30	269	54	101	14·4	0·5	3·5	18·4
	4. Philosophical Hall (Town)	849	78	423	45	149	38	75	14·1	0·3	2·2	16·9
Residential	5. Headingley..	650	43	199	11	118	32	41	11·1	1·1	0·8	13·0
	6. Armley ...	593	34	216	29	110	37	108	9·9	1·0	3·2	14·1
	7. Observatory.	399	32	146	26	85	39	51	8·4	0·8	1·6	10·8
	8. Kirkstall ...	352	28	141	8	77	56	57	7·7	0·2	2·3	10·2
	9. Weetwood Lane	147	26	54	11	82	13	34	8·3	1·1	2·1	11·5
	10. Roundhay ...	90	14	49	0	53	16	38	5·3	0·7	1·3	7·8
	11. Garforth (Country)	—	—	—	28	65	21	22	5·0	3·2	1·1	9·3

[1] Abstract of a paper by Prof. J. B. Cohen and Mr. A. G. Ruston read at the Health Congress held at Leeds on July 17.

The solid impurities were found to diminish rapidly in passing northwards from the centre of the town. Within the distance of a mile the quantity fell to less than half, and at $2\frac{1}{2}$ miles to less than one-fifth.

The influence of the industrial centres upon the solid impurities stands out most conspicuously, as a glance at the table will show, *i.e.* in the chief industrial centres the solid impurities are roughly twenty times as great as in the purer atmosphere of Roundhay, about three miles north-east of the centre of the town (Fig. 1).

The quantity is also determined by the prevailing winds, which are west, south-west, and north-east, and the drift of the impurities is consequently more towards the east than the west. Of the three constituents of the total suspended matter, the one which is least injurious is the mineral matter. This is abnormally high at the Leeds Forge, and consists principally of oxides of iron, lime, alumina, and silica, either escaping with the fumes from the furnace or thrown out mechanically.

In a former series of experiments the amount of soot deposited was determined by collecting daily from a fresh surface a square yard of snow (which lay for several days), melting, filtering, and weighing the soot. The total deposit on the first day represented 16 cwt. to the square mile, and the daily increase was, on the average, 4 cwt. Taking a four-square-mile area covered by the town, and

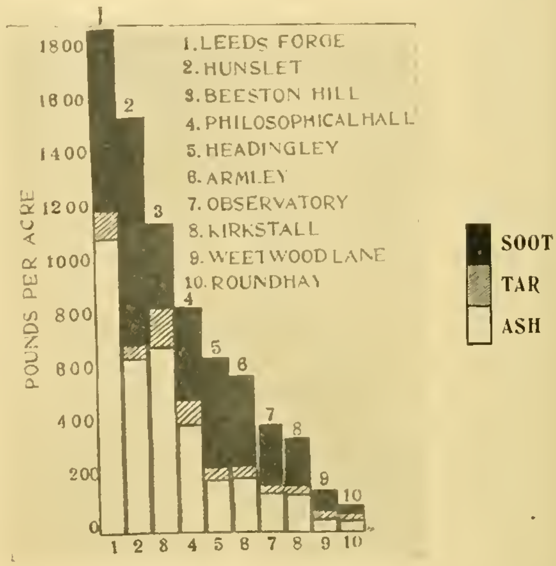


FIG. 1.—Suspended Matter.

allowing for a diminishing fall on the fringe of the area, the amount carried down by the first fall of snow may be represented roughly by 10 cwt. to the square mile, and the daily increase as one quarter of this amount. Later results, as determined from the soot deposited with the rain water, are in close agreement with these figures. The analyses of the total deposit for the whole year show that at Hunslet (industrial centre) the soot amounts to 300 tons per square mile, at the Leeds Forge (industrial centre) to 250 tons, whereas at Woodhouse Moor (one mile north-west of the centre) it dropped to 80 tons. Taking the average of the stations which lie within the central four-square-mile area, we get 190 tons per square mile per year, or roughly half a ton per square mile per day.

The amount of tar deposited with the soot was previously demonstrated by exposing glass plates 1 foot square at different points situated in and at distances from the town. These plates at intervals were washed under running water, and the residual deposit analysed. The amount of soot thus remaining, as determined from its carbon content, was found to be twenty-four times greater in the town than at a distance of nine miles. In the present experiments the tarry matter was estimated by extraction with ether. The quantity dropped from 80 lb. per acre per annum in the centre to 14 lb. per acre at a distance of three miles north-east of the town. The waste of fuel in the form of unburnt coal passing into the atmosphere is represented each year by about 300 tons per square mile in the centre of the town, or, over the whole area of four miles square, about 100 tons per square mile. The effect of these suspended impurities in diminishing the amount of sunlight in Leeds may be gathered from the fact that in 1907 the number of hours of bright sunshine was 1167 in the town, whilst four miles north-west it reached 1402 hours. The amount of daylight has also been recorded at two different periods by the quantity of iodine liberated from an acid solution of potassium iodide. On the first occasion, over a period of four winter months, it was shown that the smoke in an industrial centre absorbed one-quarter of the daylight as compared with a station one mile to the north-west. In the present investigation, carried out during the month of June of this year, the amount of daylight often fell to one-half in the centre of the town as compared with Garforth several miles away. The relation of soot deposit (black column) to daylight (light column) is shown in the diagram (Fig. 2).

It is the tarry matter in the soot which causes the latter to adhere to and blacken buildings and vegetation. It is sometimes stated that it is the domestic smoke rather than industrial smoke which is injurious to plant life, on

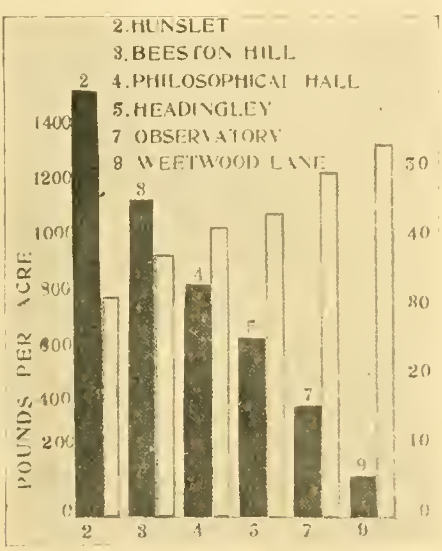


FIG. 2.—Influence of Suspended Matter on Intensity of Light.

account of its higher content of tar. There is a certain justification for this statement, for the percentage of tarry matter in the total solid impurities is highest in the residential and lowest in the industrial areas, varying from 18 per cent. in the former to 4 per cent. in the latter. When, however, account is taken of the total tarry matter deposited each year, the industrial centres are responsible for the greater quantity, which reaches in some cases ten times the amount in the residential districts. The total sulphur, either as sulphurous or sulphuric acid, is everywhere high, but particularly in and near the chief manufacturing areas. A large portion of the free acids is neutralised either by the alkaline fumes of the blast furnaces or by the ammonia of the burnt coal. Still, free acid is present in considerable quantity, and in Hunslet (industrial centre) represents an annual deposit of 90 lb. per acre, or 25–30 tons per square mile.

It is the sulphurous acid which imparts to town fog its choky and irritating effects. The large amount of this acid present in fogs may be gauged from the fact that the hoar-frost collected during the dense fog of January 27 contained acid corresponding to 10·29 parts per 100,000, or more than ten times the average acidity of the same station.

To demonstrate the detrimental effect of sulphuric acid upon vegetation, Timothy grass was sown on May 12, 1908, in boxes 1 foot square, the soil being uniform. The seed was watered at a rate corresponding to the average rainfall of 25 inches with water containing different amounts of sulphuric acid. In addition to this, three other samples were watered with Garforth rain water in which the acidity was neutralised, the second with ordinary Garforth rain water, and the third with Leeds rain water. The results were very instructive. In the case of Leeds rain water and of those waters containing a higher degree of acidity, germination was distinctly checked, and the delicate green of the young grass quickly changed to yellow or brown. Grasses watered with water containing 32 parts per 100,000 were killed in a little more than three months, and with 16 parts per 100,000 in less than a year.

Chlorides are found in large quantities, especially in the industrial centres, where, expressed as common salt, they sometimes reach as much as 3 or 4 cwt. per acre, a quantity which must be distinctly prejudicial to vegetation.

The nitrogenous impurities, on the other hand, would be beneficial by acting either as direct stimulants and fertilisers or by neutralising the acidity of the sulphur and chlorine compounds.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

THE proceedings of Section A began on Thursday, August 26, with the address of its president, Prof. E. Rutherford, F.R.S., which has already been printed in full in these columns (NATURE, August 26, p. 257).

A paper followed, by Prof. J. H. Poynting and Mr. Guy Barlow, on the pressure of radiation against the source. The authors employ thin slips of material which become heated by incident radiation. Those black on both sides experience a pressure equal to the energy-density, P, of the incident radiation; those black on the incident side and brightly silvered on the other experience a pressure 1·67 times as great, the excess being due to the radiation which is emitted by one side only of the plate. Plates which are bright both sides experience a pressure 2P, because they do not become heated. Experiments, which are in progress, give good accord with theory. In a short discussion which followed, Prof. Hull intimated that he was alive to the possibility of this reaction when making his experiments on the pressure of incident radiation, but his experiments had been devised carefully so as to prevent its occurrence.

Prof. T. Lyman then gave a summary of the ascertained properties of light of very short wave-lengths ("Schumann rays"), including their ionising and photoelectric effects. To these Prof. Bumstead added that one of his students had shown that the velocity of the electrons emitted photoelectrically increases directly as the frequency of the light up to a wave-length $\lambda = 1250$—a result which Ladenburg had previously shown to hold good for ordinary light.

Prof. Percival Lowell followed with an account of the photographs of Jupiter taken at the Lowell Observatory. The slides exhibited showed a wonderful amount of detail, the most noteworthy features being faint wisps that criss-cross the several belts, particularly the bright equatorial one. He explained the belts and wisps as gaps in the clouds formed by condensing of uprising vapours from Jupiter's heated interior (he being still a semi-sun), and strung out by his rotation. Prof. Larmor added greatly to the interest of the paper by exhibiting some early drawings of Jupiter made by Sir W. Huggins, and stated that Sir William's opinion from the first was that the wisps were the edges of cumulus clouds. He noted that the high albedo of Jupiter (72) indicates that the Jovian atmosphere acts like a bright cloud; it follows that very little of the meteorology of Jupiter can be due to the sun if heat is only absorbed like light. Other planets with a low albedo would have surface markings more like terrestrial ones. The day's proceedings concluded with a paper, by Prof. E. E. Barnard (read by Prof. E. W. Brown), on the motion of some of the small stars in Messier 92 (Herculis). Two of the stars in this cluster are shown to have proper motion; the first (No. 11 of Schultz's list) is moving away from the centre of the cluster; the second one is moving towards the centre. Several others in the cluster appear to have a slight motion.

On Friday, August 27, owing to the large number of papers presented to the section, it was divided into three departments, which met concurrently. In the mathematical department, Prof. E. H. Moore dealt with fundamental analogies existing in diverse branches of mathematics, and proposed a method for unifying these branches in a more general theory embracing all such analogous branches. Further information with regard to Prof. Moore's theory will be found in a paper by him on a form of general analysis with applications to linear differential and integral equations (*Atti del IV. Congresso Internationale dei Mathematici*, vol. ii., pp. 98–114), and in a memoir entitled "Introduction to a Form of General Analysis," which will shortly be published by the Yale University Press. Prof. E. H. Hobson, in a paper on the present state of the theory of aggregates, considered a number of points in connection with the theory, and indicated the desirability of a new and more adequate definition of an aggregate of a more restricted character than the one due to G. Cantor, and of such a character that no difficulties would arise from the ascription of a cardinal number to each such aggregate, and also of an ordinal type in case the aggregate is an ordered one. Prof. G. A. Miller, in a paper on generalisations of the icosahedral group, considered the group the two generating operators of which satisfy one of the following three sets of conditions:—

$$t_1{}^2=t_2{}^5, \quad (t_1t_2)^3=(t_2t_1)^3;$$
$$t_1{}^2=t_2{}^3, \quad (t_1t_2)^5=(t_2t_1)^5;$$
$$t_1{}^3=t_2{}^3, \quad (t_1t_2)^2=(t_2t_1)^2.$$

Amongst other theorems, Prof. Miller proves the following:—There is an infinite number of groups each of which may be generated by two operators satisfying one of these conditions. Each of the possible groups generated by t_1t_2 contains either the icosahedral group or the group of order 120, which is insoluble and does not contain a subgroup of order 6n, and it must have one of these groups for its commutator subgroup. Prof. G. A. Bliss followed with a new proof of a theorem of Weierstrass concerning the factorisation of power series which states that any convergent series in $p+1$ variables, $F(x_1, x_2, x_3, \ldots x, y_n)$ in which the lowest term in y alone is of degree n, can be expressed as a product

$$(y^n+a_1y^{n-1}+\ldots+a_{n-1}y+a_n)\,\Phi\,(x_1\ldots x_p, y),$$

where $a_1, a_2 \ldots a_n$ are convergent series in $x_1, x_2 \ldots x_p$, which vanish with these arguments, while Φ is a convergent series in all $p+1$ variables with a constant term different from zero. The author also gave formulæ by which the coefficients in the different series may be computed. Mr. J. H. Grace read a paper in which a treatment was given of ideals in a quadratic field, and Prof. W. H. Metzler one on a continuant of order $n+1$ which is expressible as the product of $n+1$ factors. Prof. Ellery W. Davis gave a complete representation of the elements of the central conic the axes of which are non-similar complex quantities. In a paper on the invention of the slide rule, Prof. F. Cajori sifted the evidence in connection with this subject bearing on the rival claims of Gunter, Oughtred, and Wingate. His conclusion is that the slide rule was undoubtedly invented by William Oughtred in 1832. Papers by Major P. A. MacMahon on a correspondence in the theory of the partition of numbers, and by Mr. J. W. Nicholson on the asymptotic expansion of Legendre's functions, were read in title only in the absence of the authors. The like fate overtook the report of the committee on the further tabulation of Bessel functions. This committee has made further progress during the year. Using the notation of previous reports, values of $Q_n(x)$ have been calculated for integral values of n from $n=1$ to $n=6$. From these the values of $\sin^{-1}(Q/R)$ have been computed for the same values of n, and the values for $n=\frac{1}{2}, 1\frac{1}{2}, \ldots 6\frac{1}{2}$ have been added. From the tables of the present report and those of the 1907 report, the values of $J_n(x)$ for values of n from 0 to $6\frac{1}{2}$ at intervals of $\frac{1}{2}$, and for values of x greater than 10, can be computed to six places without sensible error. The Neumann function $Y_n(x)$ can be calculated from the same data.

Meanwhile, the department of general physics was holding a joint meeting with Section B (Chemistry). The papers of more particularly chemical interest will be referred to in the report of the proceedings of that section. Prof. E. Goldstein led off the physical papers with one on the three-fold emission spectra of solid organic compounds, which the council has ordered to be printed *in extenso*. Prof. Goldstein finds that aromatic substances solidified by liquid air can emit three discontinuous spectra, which are quite different from one another, when they are exposed to kathode rays. First, the *initial* spectra are observed at the beginning of the luminescence; when these become fainter the *chief* spectra, which are very characteristic for each substance, appear; the *solution* spectra are observed when the aromatic substance is dissolved in another medium and the frozen mixture is exposed to kathode rays. All three spectra commence in the red; the initial spectra extend to the ultra-violet; the chief spectra are shorter. Very characteristic solution spectra are given by naphthalene and its derivatives. The solution spectrum varies with the solvent medium. Very small quantities of aromatic bodies are sufficient to give marked solution spectra; on the other hand, the phenomenon gives a very sensitive method of detecting slight impurities. In this way it may be stated that until now no aromatic substance has been prepared in a really pure state. In the consequent discussion Sir J. J. Thomson pointed out that the results would have been clearer if kathodic rays of only one velocity had been employed. Changes come in very abruptly as the energy of the rays passes a certain value. Experiments are in progress in the Cavendish Laboratory upon lithium chloride. With ordinary kathode rays ($v=10^9$ to 6×10^9) the chloride exhibits a steely-blue appearance, and gives a continuous spectrum; but with positive ions the spectrum shows the lithium red line and very little continuous background. As to the origin of these phosphorescent spectra, he emphasised the fact that phosphorescence is not so much a question of ionisation as of the breaking up of complex aggregates, *e.g.* iodine vapour phosphoresces without showing any sign of ionisation. You can freeze out the phosphorescence, thereby making these complexes stable. Prof. H. E. Armstrong raised the point as to whether something of the same sort as Goldstein had brought forward goes on in a Welsbach mantle. Experiment shows that you can obtain phosphorescent spectra by inserting traces of rare earths. The next paper was by Mr. E. F. Burton, on the influence of electrolytes on colloidal ferric oxide solutions. A commercial ferric oxide solution was dialysed in conductivity water, and the velocity with which the particles moved in a unit electric field was observed from time to time. As the purification continued the velocity at first increased, but afterwards decreased in almost linear relation with the amount of chlorine found. A comparison of the coagulating powers of monovalent, divalent, and trivalent ions on the colloidal particles indicates that the Linder-Picton-Hardy law holds good. This paper was followed by one by Dr. Otto Hahn, on methods of separation of radioactive products. These methods are based on the working hypothesis that single radio-active products emit only one type of radiation, either homogeneous α particles or homogeneous β particles. This hypothesis requires that thorium C and actinium B be complex. Also, radium C must be complex, and consist of three products, one emitting α particles and two emitting different β particles. Experiments using a "recoil" method seem to support these conclusions. The author also has found that radium itself emits β as well as α particles; it also must be complex; and experiment seems to show that the β particles come from radium itself, the well-known α particles being due to a new body, radium X. Prof. Rutherford, in commenting upon the paper, pressed the bearing of the results upon the supposed purity of ordinary "chemically pure" bodies. Sir J. Larmor asked for an explanation of the well-known difficulty in connection with the emanation being positively charged after emitting a positively charged body, and in reply Dr. Hahn expressed his belief that δ particles are simultaneously expelled. In answer to a question of Prof. Bumstead's, Dr. Hahn replied that he had not made any magnetic experiments to test the homogeneity of his various rays. Prof. J. C. McLennan then read a paper on the secondary rays excited in different metals by α rays. He finds that the secondary rays emitted by a selected metal when bombarded by the α particles from polonium deposited on copper are proportional to the α radiation, but that different metals are not equally active, the secondary radiation varying from 62 for platinum to 47 for aluminium. δ radiation excited by polonium appears to be independent of the metal which carries the polonium, and is probably produced by and accompanies the α particle in the course of its expulsion from the polonium atom. Prof. McLennan continued with a paper by Mr. V. E. Pound, on some phenomena associated with the radiations from polonium. By measuring the electrical charge acquired by an insulated metal plate B placed close to and facing an insulated copper plate A bearing a deposit of polonium, it was made clear with the aid of moderate electric and magnetic fields that there are present (1) α rays emitted by the plate A; (2) an easily absorbed secondary negative radiation emitted by B; and (3) an easily absorbed δ radiation emitted by A. An additional negative stream seemed to arise from the polonium in stronger fields; from its behaviour it is considered to consist of streams of rest-atoms from the active product RaG or polonium. Dr. O. Reichenheim followed with an important paper, ordered to be printed *in extenso*, on anode rays and their spectra. He explained that the conditions for the production of anode rays, or striction-anode rays, are:—(1) the presence of positive ions, produced by heated salts of the alkalis or alkaline earths serving as anode; (2) a high fall of potential at the anode, which is produced by the presence of halogen vapours in the tube, and is the origin of the high velocity acquired by the ions, so that they appear as rays in the tube. A new kind of positive rays passes through a perforated anode under a high gradient of potential. These are called A_1 rays, because they are analogous to the K_1 rays or retrograde rays which leave the kathode. The spectra of anode rays are very simple, often simpler than the arc or spark spectra. The rays show the Doppler effect; in the case of the earth-alkaline rays shifted lines only were found, without any line in the unshifted position. This seems to arise from the fact that we have here to deal with moving particles which emit other lines than the surrounding luminescent gas. A paper by Dr. H. L. Bronson and Mr. A. N. Shaw, on Clark and Weston standard cells, was taken as read owing to lack of time. It dealt with the accuracy and reproducibility of these cells. The mean of five set up in the National Physical Laboratory differs from the mean of the cells set up in Montreal by 5 microvolts. The maximum deviation of their own cells from their mean was only 31 microvolts. The ingredient of main importance is the mercurous sulphate. The ratio of their Weston cells to their Clark cells is 0·716953 as against the value 0·716958 determined by Wolff and Waters. Prof. Rutherford concluded with a paper on the action of α rays upon glass, in which he detailed results analogous to the naturally occurring action due to specks of beryl in rock which had been microscopically detected by Prof. Joly.

In the department of cosmical physics, which met simultaneously, Dr. L. A. Bauer gave a *résumé* of some of the chief results of interest obtained in the magnetic work of the past ten years carried out under his direction by the U.S. Coast and Geodetic Survey and the Carnegie Institute of Washington.

From the detailed magnetic survey of the United States he found that it would not be possible to represent the observed quantities satisfactorily by a general series of spherical harmonics without using a prohibitive number of terms. He found, moreover, by calculating the line integral of the magnetic force around closed circuits, one of which enclosed the whole of the United States, that a part of the magnetic force, 1/300 to 1/500, must be due to non-potential systems, *e.g.* vertical electric currents. Further calculations to test the existence of such currents are being made with the data obtained by the Carnegie Institute in the Pacific, 1905–8, and with the recent resumption of the ocean magnetic work by the *Carnegie* it will soon be possible to make some circuits completely round the earth.

Various types of magnetic disturbances recorded at the five coast and geodetic survey observatories were briefly discussed. An investigation of the relation between solar activity and terrestrial magnetism, carried on in cooperation with Prof. G. E. Hale, showed that the absolute magnetic effect, connected apparently with an *increase* in solar activity, is equivalent in general to a *diminution* in the earth's mean intensity of magnetisation. Between February 1, 1907, and February 1, 1908, this amounted to about 1/1000th part.

The author emphasised the need in such researches of including all the magnetic elements and of differentiating between effects resulting from internal and external magnetic systems.

Mr. R. F. Stupart read a paper on the distribution of pressure over Canada. He pointed out that the world charts of pressure distribution give an inadequate and even inaccurate representation of the pressure conditions in the dominion. He found that relatively high pressure in the north-west at Dawson City is accompanied by relatively mild winters, and low pressure by severe winters, a fact which is directly contrary to the prevailing idea that in winter the higher the pressure the lower the temperature over continental areas. Dr. Shaw read a paper, by Mr. J. I. Craig, on the surface motion of air in certain circular storms. The paths of the air in travelling storms were obtained from theoretical considerations, and compared with the paths found by actual observation.

Mr. J. W. Shipley showed photographs of large hailstones observed in western Canada shortly before the meeting. In the centre of one of the stones he discovered a small fly which had apparently been carried upwards and had formed a nucleus of condensation.

Dr. A. A. Rambaut detailed some of the results of stellar parallax observations carried out at the Radcliffe Observatory, Oxford, with the equatorial instrument acquired about six years ago employing Kapteyn's photographic method. The immediate object of the research was to demonstrate the feasibility of a photographic "Durchmusterung" for parallax extending to stars of the thirteenth and fourteenth magnitude. A paper by Messrs. Plaskett and Harper on two curiously similar spectroscopic binaries concluded the sitting.

On Monday, August 30, the section met in undivided sessions, which began with a discussion on positive electricity, opened by the president of the association, Sir J. J. Thomson. The questions he asked were:—(1) Is there a definite unit of positive electricity? (2) What is its size? The same negative units are obtainable from both oxygen and hydrogen; is the same true for positive electricity? Attention is concentrated on kanalstrahlen and on the motion of positive ions through mixed gases. Sir Joseph Thomson outlined the evidence afforded by the magnetic and electric behaviour of the kanalstrahlen. He concludes that the ratio e/m is the same for the positive rays of all gases and vapours (including uranium chloride) at very low pressures, although at high pressures it does depend upon the nature of the gas, and that therefore there is a positive unit of electricity. This is confirmed by Wellisch's experiments on the velocity of the positive ions through mixed gases; their velocity is the same whether they arise from hydrogen or from methyl-iodide. The value of e/m is of the order of 10^4; no evidence of smaller particles has been obtained. Some observers, on the other hand, find easily deflected positive rays. It must be remembered that the magnetic field may alter the conditions of the starting of rays, and, secondly, that deflection depends, not only upon e/m, but also upon the velocity; the easily deflected rays are probably secondary rays. In the discussion which followed many points were raised dealing with side-issues, but the main question did not receive much fresh elucidation, and in the end the predominant feeling was probably that we are still a long way from obtaining as definite experimental knowledge of positive electricity as we at present possess of negative.

Mr. A. S. Eddington next read a paper on the law of distribution of stellar motions, in which he obtains the constants of Schwarzschild's velocity ellipsoid by making use of the mean proper motions of stars instead of the numbers of stars moving in the various directions as the observed data. The following sufficiently exact result is stated. The radius of the velocity ellipse in the direction

θ is the geometric mean between the mean P.M. of stars moving in the direction θ and the mean P.M. of stars moving in the direction $\theta+180$. A paper by Prof. H. T. Barnes dealt with the variation of the specific heat of mercury at high temperatures. Prof. Barnes, employing the continuous-flow method, has now determined the specific heat up to a temperature of 268° C. with an error (for the higher temperatures) of not more than one or two parts per thousand. The results are specially interesting inasmuch as they show that the specific heat of mercury passes through a minimum at about 140° C., and then increases fairly rapidly up to the boiling point. The minimum for water occurs at about the same relative position between the freezing and boiling points. During the discussion on the paper Prof. Perry emphasised the great need there is for an accurate determination of the specific heat of superheated steam. Dr. T. Proctor Hall exhibited an apparatus for making enlarged tracings of sound waves from a cylindrical graphophone record, and showed some of the results obtained with it. Prof. A. W. Porter exhibited some transparencies of electric discharges upon photographic plates. A paper by T. Kinoshita was read in his absence by Prof. Rutherford, on the photographic action of α rays, and Prof. A. S. Eve contributed one on secondary radiation by γ rays on different metals. Prof. J. C. McLennan then read one by Mr. W. T. Kennedy, on the active deposits from actinium in uniform electric fields. The deposits were obtained on both of two plates 2 mm. apart, under a field of 250 volts at various atmospheric pressures. As the pressure is decreased from atmospheric the amount of active deposit on both electrodes gradually increases, passes through a maximum value, and then rapidly decreases. The maximum on the kathode is about 2·7 times that for the anode, and is formed at a different pressure. The total deposit is independent of the electric field until potentials higher than the sparking ones are applied. The coefficients of diffusion of the emanation from actinium into CO_2, air, and hydrogen are in the proportion 1/1·3/4·2. On Dr. O. Hahn stating that in the case of actinium emanation it is difficult to know what we are dealing with, the reply was elicited that in all probability a number of products are concerned in the experiments described. A paper by Mr. F. W. Bates, on the effect of light on sulphur insulation, was read by Prof. A. S. Eve. The author concludes from some electroscope experiments that sulphur in the presence of light becomes to a slight degree a conductor of electricity to an extent depending upon the intensity of the incident light. In the discussion the resemblance to selenium was pointed out. Dr. Hahn elicited the statement that the effect exhibits no time-lag. Dr. P. Pringsheim mentioned that Röntgen had found a similar effect for paraffin. A paper followed by Dr. T. Franck and Dr. W. Westphal on the charge upon gaseous ions. The authors consider from their experiments that Townsend's doubly charged ions are only a small part of the total ionisation, and that generation in an electric field, contrary to Townsend's view, has nothing to do with their formation. The two kinds can be separated by fractional diffusion if a piece of wire gauze be interposed in their path. The coefficient of diffusion of the double ions is found to be half that of the single ones. With α, β, γ rays and point discharge no doubly charged ions were found, though in the last case big charged clusters, due to chemical processes, were proved to occur. A paper on the re-combination of ions in air at different temperatures, by Dr. P. Phillips, was read by the recorder. In the experiments outlined in this paper Langevin's method is adopted. The rays produced by a single discharge in a Röntgen bulb ionise a layer of air between two parallel electrodes, one of which is connected to a Dolezalek electrometer and the other raised to any desired potential. These plates are 3 cm. apart, and the layer of ionised air is 1·5 cm. thick; in these circumstances diffusion is probably negligible. The whole is surrounded by a vapour jacket. The experiment consists in measuring the charges received by the electrometer with different electric fields and temperatures. The following values for α, the coefficient of re-combination, were obtained, and are put alongside Prof. Erikson's values recently obtained (*Phil. Mag.*, August) for ions produced by radium:—

Temperature	α	Erickson
15° C.	1·00	1·00
100	0·50	0·51
155	0·40	0·405
178	0·36	0·38 (extrapolated).

The day's session was concluded with a paper by Prof. John Zeleny and Mr. L. A. McKeehan, on the terminal velocity of fall of small spheres in air. Experimenting with spherical spores, the authors find divergences from Stokes's law for the limiting velocity as follows:—

Substance	Radius	Velocity	Theoretical
Lycoperdon	0·000207 cm.	0·0465 cm./sec.	0·0757
Polytricum	0·000478	0·228	0·417
Lycopodium	0·00158	1·77	3·52

These experiments have an important bearing upon determinations of the numbers of nuclei in cloud condensations. Sir Joseph Larmor attributed the divergences to the inapplicability of the usual theory to particles comparable with the length of the mean free path, and recommended that experiments be made in air of different densities. Prof. Hull agreed that the theory must fail, but expected that the divergences should tend the other way. In answer to Prof. E. W. Brown, it was stated that no Brownian motion or rotation was visible, and the fall was quite steady.

On Tuesday, August 31, the section began with a discussion on earth tides, opened by Prof. A. E. H. Love. Prof. Love stated that Lord Kelvin had shown (1863) that if the earth could be regarded as homogeneous and absolutely incompressible, and possessed of the same degree of rigidity as steel, the oceanic tides of long period would be reduced, owing to the yielding of the earth, to about two-thirds of the theoretical heights which they would have if the substance were absolutely rigid. Sir G. Darwin (1881) estimated the actual height of the fortnightly tide as about two-thirds the theoretical height. Attempts to measure directly the lunar disturbance of gravity were made by several observers; and recently Dr. O. Hecker, by using two horizontal pendulums mounted in an underground chamber, has demonstrated the existence of the corporeal tide, and has shown that the deflection of such pendulums is about two-thirds what it would be if the earth were absolutely rigid. This means that, besides the tide-raising force, F, of the moon, there act on the pendulum other forces arising from the deformation of the earth. These forces are (1) the component of undisturbed gravity tangential to the deformed surface, denoted by hF; (2) a genuine disturbance of gravity, consisting in the attraction of the tidal protuberances and other related changes of the attraction of the mass of the earth, denoted by kF. The results obtained by Darwin and Hecker, and confirmed by Schweydar, show that the two numbers h and k are connected by the equation $h-k=1/3$. To find h and k separately we must have recourse to hypothesis or to new observations. If we adopt Kelvin's hypothesis we find $k=3h/5$, and thence $h=5/6$, $k=1/2$, and the corresponding estimated height of the corporeal lunar tide is about 46 cm. If, however, we bring in the fact of observation, discovered by Dr. S. C. Chandler, viz. that the period of variation of latitude (about ten months if the earth were absolutely rigid) is actually about fourteen months, we can determine k in terms of known quantities. Variations of latitude imply an adjustment of the earth's figure to rotation about an instantaneous axis which does not quite coincide with a principal axis. The corresponding inequality of "centrifugal force" has the same effect as a certain external force producing a deformation of the earth and a genuine disturbance of gravity. If the force in question is denoted by F, the genuine disturbance may be denoted by kF, where the coefficient k is necessarily the same as in the tidal problem. It has been proved independently by Sir J. Larmor and Prof. Love that k is about 4/15. It thence appears that $h=3/5$ approximately, and that the height of the corporeal lunar tide is about 33 cm. The earth would therefore appear to be more rigid than Lord Kelvin estimated it to be, a result confirmed by the interpretation of seismographic records. In the discussion which followed Sir J. Larmor asked whether there was any evidence for Wiechert's theory of the constitution of the earth, viz.

a central metal nucleus surrounded by a viscous layer and an outer shell of rock. On Clairaut's ellipsoidal theory the internal structure is not determinable from outside effects. Observation of the propagation of earthquakes is a direct experiment on the interior; but even here you cannot go far, because of ignorance of the properties of materials under enormous stresses. The phenomena of terrestrial magnetism are also concerned with the interior. He asked how the weight of mountain chains is supported. To avoid crushing, the basal material must have the strength of steel. A rival theory is based on the survey of India, viz. that the mass of a mountain is compensated by less dense material underneath; but Burrard's recent researches show that the defect underneath is not nearly so great as was thought. He pointed out that there was room for a fresh calculation. The presence of a mountain chain supported without collapsing necessitates also that the supporting material shall not have any fluidity at all, or else the mountain chains would gradually settle down. He asked if the necessary calculation had been made. He pointed out that Hecker's curve, being of the right shape though of the wrong size, was in conflict with a supposition of unequal rigidities in different directions. Finally, he propounded a conundrum of Lord Kelvin's: It is possible for any person in this room, if he lived long enough, to turn the earth upside down! Dr. L. A. Bauer directed attention to the semi-diurnal variation of the earth's magnetism, which has so far not been explained. In reference to Wiechert's theory, Prof. Love stated in reply that if it be adopted the rigidities of the supposed metal nucleus and rocky shell required to satisfy the two conditions $h-k=1/3$ and $k=4/15$ are respectively about three times and about one-tenth the rigidity of steel. Attention was also directed to the scooped-out beds of the ocean as being much more important than mountains. More than half the surface is 2000 fathoms below the sea-level. The earth is not an ellipsoid; it is the ocean that is so approximately. At the close of the discussion the section again divided.

In the department of general physics two papers were given by Prof. Poynting:—(1) on the lengthening of loaded wires when twisted; (2) the angular momentum in a beam of polarised light. These have appeared in a recent number of the Royal Society Proceedings. Prof. Frank Allen followed, dealing with the effect on the persistence of vision of fatiguing the eye with red, orange, and yellow. The persistence is measured by finding the speed at which flickering ceases when a sectored disc is rotated in front of a source, and a curve is drawn representing the whole spectrum. This persistence is measured when the eye has been fatigued with light of definite wave-length. When fatigued with light of 680 μ and 670 μ, only the red part of the curve is affected; fatigued with green only the green part; but when the fatiguing colour lies between 577 μ and 650 μ, the curves differ in both red and green. With wave-length 660 μ the two curves coincide completely. This means that the fundamental red sensation is at least beyond wave-length 660, and that yellow and orange cannot be simple primary sensations. Prof. Allen also contributed a paper on a new method of measuring the luminosity of the spectrum. The principle of the method is that the persistence of a colour sensation is a function of the luminosity only. The next paper was by Profs. E. L. Nichols and E. Merritt, on the effect of low temperature on fluorescence spectra. The measurements consisted in comparing the brightness of the fluorescent spectra of natural willemite, commercial anthracene, an alcoholic solution of fluorescein, and one of resorufin at various temperatures from 20° C. to −185° C., these being excited by a quartz-mercury lamp any portion of the spectrum of which, dispersed through quartz, could be focussed upon the fluorescent body. The results were shown by means of curves. In response to a query by Prof. Rutherford, Prof. Nichols stated that the fluorescent bands tend to become narrow as the temperature is diminished. Sir J. Larmor expressed his opinion that fluorescence was due to molecular creeping, but Prof. Nichols replied that though there *is* hysteresis (thermoluminescence), his experiments were all conducted slowly so as to eliminate it. A paper on an analogous subject, the absorption and fluorescence of canary glass at low temperatures, was contributed by Mr. R. C. Gibbs. The glass, of known composition, exhibited a main fluorescence band extending from 0·48 μ to 0·59 μ. With decreasing temperature the fluorescence for the most part increases, the maximum increase being about 100 per cent. The band, which at ordinary temperature shows a faint indication of two maxima between 0·51 μ and 0·535 μ, shows at the lowest temperature (−175° C.) two narrow overlapping bands with maxima at 0·514 μ and 0·533 μ.

In the cosmical physics department, which was sitting simultaneously, Prof. W. J. Humphreys communicated some results he had obtained from a consideration of European *ballons-sondes* observations, while Mr. E. Gold presented the report on the present state of our knowledge of the upper air drawn up by Mr. Harwood and himself. One of the most interesting facts was that both Prof. Humphreys and Mr. Gold found that in areas of high pressure (above 770 mm.) the temperature up to 9–10 km. was greater than in areas of low pressure (below 750 mm.), while at greater heights the conditions became reversed. So long as this condition holds and the isothermal or advective region exists, it appears impossible that there should be anything in the nature of circulatory interchange between cyclones and anticyclones, and the intensity of these systems cannot be maintained.

Gold and Harwood found remarkable minima in the height at which the advective region begins in March and September, and an attempt was made to connect these minima with the general circulation of the atmosphere.

On Wednesday, September 1, the section again bifurcated. In the department of cosmical physics Prof. A. L. Rotch gave an account of the highest balloon ascent in America. He found a remarkable result, which occurred in at least two ascents, that the temperature *increased* in a cumulus cloud in passing from the base upwards. Considerable discussion took place, and doubt was expressed as to the reality of the phenomenon, but Prof. Rotch stated that the observations were unexceptionable. The fact adds further difficulties to the explanation of cloud-formation and its connection with atmospheric motion.

Dr. Shaw showed photographs of models illustrating the temperature distribution in the free atmosphere over the British Isles in the international week in July, 1908. The models show the gradual production or pushing forward of a wedge of cold air at a height greater than 10 km. The wedge had just reached Limerick on the first day, but two days later extended well over England. It may be noted that the construction of the models was only made possible by the observations obtained near Limerick, in Ireland.

Mr. Gold read a paper by Mr. A. Harwood on the results of hourly observations with registering balloons, June 2–3, 1909. At heights above 10 km. there was a diurnal variation of 6° C. to 8° C., with the maximum in the middle of the day, but the values were irregularly distributed, and it was impossible to say how far the variations were real or instrumental.

Prof. W. J. Humphreys described an arrangement for obtaining a record of the ultra-violet part of the solar spectrum (below 0·2 μ) at very great altitudes.

Mr. Stupart read a paper by F. Napier Denison on the connection between atmospheric pressure and the motion of the horizontal pendulum of a Milne seismograph.

Simultaneously, in the department of general physics, a paper was given by Mr. R. F. Earhart on the effect of temperature variations on the luminous discharge in gases for low pressures. The potentials were measured which are required to produce, and also those required to maintain, a luminous discharge for pressures varying from 0·2 mm. to 5 mm., and for temperatures from −78° C. to 325° C. Up to 300° C. Paschen's law holds good for air; for higher temperatures it does not hold even approximately. Prof. Rutherford considered the paper important, because it raises the whole question as to the dependence of ionisation upon temperature. Prof. H. M. MacDonald gave the results of his calculations on the diffraction of electric waves round spherical obstacles. Prof. Love inquired whether the propagation of Marconi waves round the earth could, in the light of these calculations, be attributed simply to the great length of wave employed. Sir J. Larmor reminded the meeting of the effect of conduction, which probably played a considerable part in the Marconi system. In Lodge's method the antennæ are not earthed, and the result is that much better resonance is obtained. Prof. MacDonald did not think his results would account for Transatlantic transmission, and pointed out that Lodge's method differed also in the use of shorter wave-lengths and antennæ with a much less distance above the surface. In a paper by Dr. T. H. Havelock, on the instantaneous propagation of a disturbance in a dispersive medium, an attempt was made to remove an apparent anomaly in the results obtained by Lord Rayleigh in a recent paper in the *Philosophical Magazine*. A paper followed by C. W. Chamberlain, on the relative motion of the earth and æther and the FitzGerald-Lorentz effect. Analysis shows that the total effect of the relative motion is a displacement of the interfering rays in the line of sight, and one at right angles to it. In the interferometer the former should be detected (in the absence of shrinkage); the latter should not. The author suggested an arrangement, called a diffractometer, which he considered should detect the transverse change. Interference is to be produced between two rays travelling at right angles to one another, and the effect will be analysed by a diffraction grating. A change in the length of the path of one of the interfering systems will produce interference bands either in the spectra to the right or to the left. A shift of a whole band is expected for the length of path used in the Morley-Miller experiments and a grating of 30,000 lines to the inch if the apparatus is rotated through ninety degrees. The failure of many experimentalists to find any effect depending upon the earth's motion through the æther has served so much to strengthen the belief of those who hold that it is undetectable that the meeting seemed inclined to receive the proposal with reserve. Prof. Hull pointed out what he considered a flaw in the reasoning. We must therefore await the results of the actual performance of the experiment or a thorough examination of the calculations upon which the belief in its suitability is based. In a somewhat technical paper Prof. E. W. Brown outlined some new methods under trial for tables of the moon's motion. Lieut.-Colonel J. W. Gifford followed with a description of a new cemented triple devised by him for spectroscopic use, the peculiarity being the possession of a ratio of 7·5 of focal length to effective aperture and great freedom from tertiary colour-aberration. Dr. H. G. Dorsey, in an interesting paper on magnetostriction, said that he finds from experiments on eight steel rods of known composition that the maximum elongation due to magnetisation is a function of the carbon content, the curve being similar to a curve in the iron-carbon phase diagram; there is also a relation between it and the maximum susceptibility of a specimen. The maximum retraction bears an inverse relation to Young's modulus. The results tend to straighten out the somewhat chaotic data obtained by other observers. One more paper now remained on the programme, but the inexorable clock pointed out that the time had arrived for the compulsory closing of the sessions. So the final rites were performed, and then an interested group informally examined some remarkable vibration curves of speech exhibited by Prof. D. C. Miller.

CHEMISTRY AT THE BRITISH ASSOCIATION.

Bearing in mind the special local conditions attaching to a meeting of the association out of England, the work of the section was organised so as to include the consideration of broad problems of general and local interest rather than the reading of specialised papers. Accordingly, the section sat jointly with the physicists for one session, with the physiologists and agriculturists for another, and with the botanists and agriculturists for a third. These joint discussions were all exceedingly successful and attracted large audiences.

It was regretted that a larger number of the younger English chemists did not make the journey to Canada, and still more that so few of the chemists from eastern Canada were present, though the section was particularly indebted to Mr. F. T. Shutt, of Ottawa, for his contributions to the discussions. The section was strengthened by the presence of a number of American guests, in particular Prof. W. A. Noyes, Prof. G. B. Frankforter, and Dr. A. Springer.

Stress was laid throughout the meeting on the importance and necessity of Winnipeg and the province of Manitoba possessing a university fully up-to-date in every respect. In particular, attention should be devoted in Winnipeg to agricultural chemical research and to the higher training of agriculturists. Wheat must always be a pioneer crop, as it requires less capital, less labour, and less skill than most other types of farming. With fuller development or with some change in the world's requirements a change will come in the farming, and wheat may become a by-product, as often in England now. Such a change comes very quickly, and the farmer will go under unless he is prepared for it and has the highest scientific advice.

In the United States the farmer has realised very definitely the benefits he has obtained by following the results of the experimental stations; in consequence he supports the State universities, and has the greatest belief in the schools. On the western excursion there was abundant opportunity of remarking that the Canadian is equally far-sighted in regard to the schools, but it is none the less necessary to urge that the university work, and above all university research, be not neglected.

Following the president's address, which was delivered at such an hour that members of the section could also attend the addresses delivered by the presidents of Sections A and G, the work of the section was opened by a short paper from Prof. W. A. Noyes dealing with his recent work in connection with camphor. A very full report on combustion, by Prof. W. A. Bone, was taken as read. Prof. E. H. Archibald outlined the method followed by him in a new determination of the atomic weight of iridium. Potassium chloroiridate was analysed by weighing the dry salt, reducing it in hydrogen, and estimating the hydrochloric acid formed, the potassium chloride and the metallic iridium set free. The results show a value of 192·9 for the atomic weight. His further paper, contributed jointly with Mr. W. A. Patrick, dealt with the electrical conductivity of solutions of iodine and platinum tetraiodide in ethyl alcohol. The conductivity of solutions of iodine in ethyl alcohol increases rapidly with time, reaching a maximum in about twenty-five hours at 25°. Platinum tetraiodide forms good conducting solutions with alcohol.

A paper of very considerable interest, on the anti-putrescent effects of copper salts, in particular towards the bacteria of milk, was contributed by Dr. Alfred Springer. Copper salts are selective in their action, greatly retarding or inhibiting the putrefactive bacteria such as *Proteus vulgaris*, *P. mirabilis*, *P. Zenkeri*, and *Clostridium foetidum*, but having little effect on the lactic bacteria. Consequently, milk treated with copper salts retains its sweet odour even when the acidity becomes sufficiently high to curd it. On the other hand, moulds such as *Penicillium glaucum*, *Aspergillus niger*, *Eurotium repens*, and others, grow more freely on milk containing copper salts, probably because they are left a freer field for development. The origin of small traces of copper in the milk supplied by a Cincinnati firm was traced to contamination of the sterilising cloths, pails and other utensils with the boiler compound used to soften the water. Copper salts have an anti-putrescent effect on blood albumen, egg albumen, meat, milk and sewage solutions.

The report of the committee for the study of hydro-aromatic substances (secretary, Prof. A. W. Crossley, F.R.S.) describes the preparation of nitro-derivatives of *o*-xylene and the synthesis of *iso*phorone.

The transformation of aromatic nitroamines committee (secretary, Prof. K. J. P. Orton) summarises the results obtained by the study of the transformation of chloro-aminobenzene into nitroaniline.

The report of the isomorphous benzene sulphonic acid derivatives committee (secretary, Prof. H. E. Armstrong, F.R.S.) contains the crystallographic data of a number of *para*-dihalogen derivatives of benzene; these afford confirmation of Barlow and Pope's conclusion as to the existence of columns of carbon spheres in crystalline benzene derivatives, and support the confirmation previously obtained by Jerusalem by the study of the picrates and styphnates.

The electro-analysis committee (secretary, Dr. F. M. Perkin) reported on experiments upon a new design of potentiometer, on the general simplification of the apparatus, on a method for the electro-deposition of metals by means of graded potential, and in connection with the electro-deposition of mercury upon gold, silver, platinum and mercury kathodes.

A joint meeting with the general physics department of Section A took place on Friday, August 27. A large attendance was attracted, and the communications were discussed by members of both sections. Only the more purely chemical papers are noted in the following. Dr. T. M. Lowry presented the report of the committee on dynamic isomerism in the form of a general discussion on dynamic isomerism in relation to luminous phenomena. Attention was in the first place directed to the decisive evidence adduced that the presence or absence of a band in the absorption spectra of a camphor derivative is in no way dependent on the occurrence or non-occurrence of isomeric change. Certain luminous phenomena, *e.g.* mutarotation and phosphorescence, have been shown to be manifest only in presence of a catalyst, and not when pure materials are used; they are therefore dependent on chemical change. Refraction, dispersion, and optical rotatory power do not appear to be dependent on the presence of foreign substances, and are to be referred to physical characteristics of the molecule. Colour, fluorescence, and triboluminescence are still subjects of controversy. The last two are probably dependent on chemical structure, but it is difficult to resist the conclusion that colour is an essentially physical phenomenon in which chemical change plays no essential part. The conclusion is one which is confirmed by the study of crystallisation in relation to phenomena.

This paper provoked considerable discussion. Sir J. Larmor remarked that phosphorescence is due, not to the formation of ions, but to complex molecules forming and breaking up, and instanced that iodine vapour, which is strongly phosphorescent, shows no conductivity, and therefore contains no ions.

In three further notes Dr. Lowry put on record some useful improvements in the technique of optical investigations. Measurements of rotatory dispersion have been made with light of twenty-six different wave-lengths, and the green mercury line Hg 5461 has been selected as the principal standard in place of the sodium doublet on account of its brilliance and purity.

The optical and magnetic dispersions produced by quartz are identical, but optically active liquids have the optical dispersion usually, though not always, higher than the magnetic dispersion. It is suggested that the magnetic rotatory power of liquids depends upon a spiral packing of the molecules of the same general character as that which produces the optical rotatory power of quartz.

To produce a cadmium spectrum of sufficient intensity for polarimetric work, use is made of the silver cadmium alloys; these have high melting points, and give a steady arc which can be kept true to centre by rotating the electrodes in opposite directions. The silver and cadmium lines are so far separated that no overlapping takes place even when the spectroscope slit is opened to its full width. Mercury and cadmium lines are suggested as standards in refractometry.

Two papers by Dr. C. J. J. Fox were taken as read. The constancy of the hydrogen-gas electrode in sulphuric and hydrochloric acids has been investigated when gold or platinum coated with either platinum or palladium black are employed; in a very few minutes values concordant to less than 0·05 of a millivolt were obtained. Palladium coated with palladium black gave a value 4 to 5 millivolts too high. A new method of preparing trustworthy mercurous sulphate for standard cells is described; this consists in heating commercially pure mercurous sulphate for a day or so at 120°–150° in a sealed tube with a little mercury and dilute sulphuric acid. The sulphate is thus obtained free from nitrate and basic sulphate.

The joint discussion with the botanists and agriculturists on wheat and flour had been carefully organised previous to the meeting, so that the contributions might be made in logical sequence and present as full a picture as possible of the exact position of our present knowledge of wheat and flour from every point of view. The present problems are quite clear; the chemist has to map out the wheat soils and to watch the quality of the product; the botanist has to breed wheats that suit local requirements and command a good price in the market.

The subject was particularly appropriate for discussion at Winnipeg, and the discussion, which throughout was very technical in character, was closely followed by an expert audience. The first paper, by Dr. Stapf, on the history of the wheats, dealt with their classification and characteristics. The great economic importance of the wheats proper lies in the fact that the looseness of the grain in the husk enables threshing to be quickly and cheaply accomplished. Dr. E. J. Russell followed with a paper by A. D. Hall and himself on the factors determining the yield of wheat, based on the experiences at the Rothamsted Station since 1851. The chief elements of nutrition derived from the soil or manure are nitrogen, phosphoric acid, and potash; other elements also play their part, but are supplied in sufficient quantity by all ordinary soils. The yield of grain is proportional to the nitrogen supplied, but two sets of factors may be traced in the results. At first the root system of the plant increases with the supply of nitrogen, and the yield is more than proportional to the supply; subsequently other limiting factors come into play, and the increase is smaller for the third and fourth increments of nitrogen.

Wheat does not require large quantities of phosphoric acid; the effects of this manure are secondary, and dependent upon season. A deficiency of potash is shown by a reduced yield, especially in dry seasons, and by increased tendency to disease, rust, &c.

Wheat is one of the crops best adapted to dry regions. High temperatures are not necessary excepting at the time of maturation. The type of soil in relation to climate is a very important factor. To each type there is a limiting yield, beyond which the crop will not go. This limit is not the same for all varieties of wheat.

Mr. F. T. Shutt, chemist to the Dominion Experimental Station, Ottawa, followed with an account of the influence of environment on the composition of wheat. The factors which might be supposed to influence composition are heredity, environment and soil. Soil, however, has very little effect on the composition, as distinct from the yield, of wheat. The shorter the period which elapses from the formation of the kernel until it is ripe the higher the nitrogen content. High temperatures, long days, and absence of excessive moisture during the ripening process hasten the maturation of the grain and increase the percentage of gluten. These are the conditions which prevail in the Canadian North-west.

Experiments were described in which the same wheat was grown on old land and recently cleared land, the older land being the drier and yielding wheat with a higher percentage of protein. It is suggested that the quality of the wheat as measured by the quantity of gluten it contains is dependent on the amount of soil moisture during development and ripening of the grain. The quality of the gluten, however, is considered to be controlled by heredity.

The subject was next developed from the point of view of the miller, a paper by Mr. A. E. Humphries being read by the recorder of the section. This dealt with the vexed question of quality in wheaten flour. Good quality is the sum of excellence on several points, and is technically denoted by the term "strength." Strength is defined as the capacity for making large, shapely, and therefore well aërated loaves. This is a very complex conception, and it is now admitted that at least five separate considerations are included in the term quality; these are (1) flavour; (2) colour; (3) stability of dough; (4) size and shape of loaf; (5) yield of bread per sack of flour. A pleasant flavour is an essential, but the exact flavour desired is chiefly influenced by fashion. Colour in bread is largely a question of optics, a strong flour making a whiter loaf than a weaker flour. A large loaf indicates a high gas-making capacity and a high diastatic power, but this is not a true index of strength. It is the gas evolved in the later stages of panary fermentation which is of importance, and the gas-retaining power of the dough which is the most important factor in strength. This is apparently a function of the quality of the gluten, and dependent on the proportions of various acids and salts which affect the physical properties of the gluten.

Dr. E. F. Armstrong followed with some notes on the chemical properties of flour and an account of the recent work on strength. Flour is composed of (1) starch; (2) several kinds of proteins; (3) mineral matters present only in small quantity; (4) a little sugar; (5) a little fat; (6) moisture; (7) enzymes. It has been the object of the chemist to seek to correlate the chemical properties with baking qualities. Most attention has always been paid to the gluten of flour; generally the strongest flours have the most gluten, but this test is not absolute. Attention has further been directed to measuring the quality of the gluten either by physical or chemical means, such as the amount of water it will retain or the proportion of gliadin in it. The total nitrogen of a flour is another rough indication of quality; latterly the distribution of nitrogen in its various forms has also been studied. To make a light loaf the flour must be one which will give rise to sufficient gas during fermentation; it must contain enough diastatic enzyme or have its starch in a form which is easily attacked. Whymper has found that the largest starch grains are those first attacked by enzymes, and it appears that different flours contain different proportions of large starch grains. The mineral matters and enzymes of flour are likewise of the very greatest importance in affecting quality.

Mr. W. B. Hardy, who followed, dealt with the influence of the minerals of flour on its quality. Gluten owes its tenacity and elasticity to the presence of salts and acids in certain proportions, pure gluten having no tenacity.

Prof. R. Harcourt, of Guelph, directed attention to the comparative milling and baking qualities of a number of Canadian wheats. Though the Manitoba spring wheats do not contain more gluten than the Alberta winter red wheats, they give a better yield of bread and a larger loaf. Blends of Alberta red with soft Ontario winter wheats give a flour superior to either of the constituent flours baked singly. This confirms the common practice of English millers. The discussion then turned to the breeding of wheats. Dr. C. Saunders gave a most valuable account of wheat-breeding experiments in Canada, and a highly suggestive paper on the influence of good seed on wheat production was read by Prof. C. A. Zavitz. A paper by Prof. L. S. Klink dealt with individuality in plants. A general discussion of great interest followed, and it was subsequently agreed by the general committee that the discussion be printed in full in the report of the meeting.

Tuesday, August 31, was devoted to a joint meeting with the representatives of physiology and agricultural chemistry to consider the subject of "food." The views developed were of the very greatest importance, more especially as indicating the lines on which future work in this field should proceed. After some introductory remarks by the chairman, a paper on "Proteins: the relation between composition and food value," was read by Dr. E. Frankland Armstrong. The quotient of the amount of nitrogen in a food material multiplied by the factor $6\frac{1}{4}$ is commonly spoken of as protein without any reference to its nature, although it has long been realised that proteins of different origin are not the same. The proteins have been proved in the main to be built up of amino-acids, belonging both to the aliphatic and aromatic series, or derived from cycloids containing nitrogen, of oxyamino-acids, and of diamino-acids. In different proteins these structural units are present in varying proportions, and, since the amino-acids are very different from one another in their chemical structure, it must be supposed that they each fulfil somewhat different functions in building up the tissues of the body. It thus becomes important to see that each is supplied in the proper proportions required by the body. Further, the analytical results point to the impossibility of entirely replacing a diet composed of one kind of protein—for example, meat—by another diet composed, let us say, of nuts, since the two proteins, though made up of the same structural units, contain these in entirely different proportions.

It remains to solve such problems as the precise function and significance of each amino-acid in metabolism, how far they may replace one another or be absent altogether without injurious effects; further, to what extent each is concerned in the maintenance of a particular tissue. Probably the presence of most, if not all, of them is necessary in a food if health is to be maintained. Tryptophane, for example, has been shown to be essential by Willcock and Hopkins. The ideal diet should contain as much variety of protein as possible in order to provide sufficient of all the possible units of constructive metabolism.

Prof. Starling, F.R.S., suggested that it was possible to attach too much importance to protein as a mere source of nitrogen. In reality, four-fifths of the protein of food is not connected with the nitrogen question. Proteins may decompose in two ways; in the one nitrogen is immediately eliminated, and a residue produced which contains as much energy as the fats or carbohydrates, and furnishes this energy on oxidation. Only a small amount of the protein is built up into the body. A protein diet is never stored as fat, neither is the above-mentioned carbonaceous residue stored as fat. A protein meal is followed by a large output of carbon dioxide and intake of oxygen, the residue being more easily oxidised than the original protein. The value of proteins as a food is due to this, and it is important that the fate of the residue in the body should be investigated.

Proteins also undergo decomposition in another manner, namely, the carboxyl group is eliminated and amines are formed. These amines have a marked physiological action; for example, those from tyrosine and phenylalanine have an action like that of adrenalin. A big meat-eater usually has a high blood pressure, whilst the constant formation of such amines causes the various disorders of middle age.

Dr. E. J. Russell, of the Rothamsted Experiment Station, next dealt with the problems of the stock feeder, who asks for methods by which he can determine the relative food value of various agricultural products. Experience has shown that animals fed on barley meal or cotton cake singly do not do so well as those fed on a mixed diet of both ingredients. A single food is not enough, but it is not known what the ideal mixture should be. Swedes grown on chalk loam have not the same feeding value as those grown on sand. There is a similar difference in the value of grasses grown under substantially the same conditions. Fibre is of very little value as a food—it acts merely to distend the stomach. The mineral constituents are of great importance, and may account for some of the facts recorded. Pigs fed on maize give a low-grade bacon; a diet of maize and minerals gives a better bacon; and the best article is obtained by feeding with barley meal. The food has an effect on the character of the beef and on the production of milk. Cotton cake, for instance, causes the production of milk, whereas with linseed cake the cows lay on flesh instead of producing milk. Prof. Cushny, F.R.S., alluded to the influence of taste and the importance of the mineral constituents.

Mr. F. T. Shutt described some experiments on pig-feeding. The Canadian pork was originally found to be too soft for the packers owing to the quality of the fat. This was got over by the addition of skim milk, which, together with corn, was found to afford an ideal diet. An increase in the proportion of corn softens the fat; too much actually kills the pigs. The fat of the animal and of the cereal is stated to be the same.

Dr. F. N. Alcock alluded to the changes in the habits of the women of the upper middle classes during the last fifty years. Their diet to-day contains less protein and less malted liquors, and this is probably to be associated with the fact that they no longer have large families or are able to nurse their offspring. Infants commonly get too little protein, which necessitates that they receive only a minimum quantity of some—probably essential—residue.

Prof. J. Wilson indicated in historical sequence the views which had in turn prevailed on the feeding of stock. In early days the cattle practically starved during the winter on a large amount of straw, and had no energy left in the spring. A great improvement was experienced about the middle of the eighteenth century, when turnips were added to the diet, and the introduction of oil cake about 1797 made it possible to fatten during the winter. It is found that a linseed-cake feed gives the results most desired by the butcher, a cotton-cake feed giving a poorer bullock. The oil was long considered to be the valuable constituent; later, most importance was attached to the albumenoids. Maize was introduced in 1875, brewers' grains a few years later, and the carbohydrates are now regarded as a most important constituent.

In the subsequent discussion the minimal protein was defined as that sufficient to supply the units for tissue formation. Dr. E. F. Armstrong alluded to the importance of the mineral constituents in a colloidal state and their analogy to enzymes. Prof. Starling pointed out that the physiologists diet for health, whereas the agriculturists feed for fattening purposes.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE meeting of Section H at Winnipeg, apart from being one of the most enjoyable of recent years, was also fruitful of much good work, and was undoubtedly in every respect a great success. It was hardly to be expected that the audiences would be as large as at an English meeting, but although the numbers attending the section were at first few, they increased daily, and at the end were well up to the average. Last year a great diminution in the number of papers dealing with physical anthropology had to be recorded. Unfortunately, this was still more apparent at Winnipeg, and only one paper on the subject was presented. It is to be hoped that this is only a temporary falling off, and that in future years the papers on physical subjects will be as numerous as in the past.

The address of the president, Prof. J. L. Myres, on "The Influence of Anthropology on the Course of Political Science," need only be mentioned here, as it has already appeared in the pages of NATURE. The last few paragraphs of it, however, in which the president urged the importance and necessity of undertaking an ethnographic survey of Canada, must have particular attention directed to them, as, in a way, they struck the keynote of the meeting.

When the association met at Montreal in 1884 Prof. Tylor presided over the newly formed anthropological section, and the chief result of the meeting was the foundation of an ethnographic survey of Canada, under the auspices of the association, which appointed a committee and gave liberal grants. This committee did much good work and published annual reports, but the lamented death of Dr. George Dawson brought work to a standstill. Since then, with the notable exception of Mr. Hill-Tout's work on the Salish of British Columbia, practically nothing has been done by Canadians towards a systematic study of the natives inhabiting the Dominion. It was felt, therefore, that the time was ripe for endeavouring to organise an ethnographic survey, and a whole day was accordingly set apart for papers and discussion on this important subject.

This discussion was opened by Mr. Sidney Hartland, who gave a *résumé* of the work that had been done in the past from the times of the Jesuit fathers onwards. This retrospect made it apparent how small had been the part taken by Canadians in contributing to our knowledge of the natives of the Dominion, and how little interest had been taken by the Dominion and provincial Governments, which had been content to leave inquiries, which have a bearing, not only on scientific questions, but also on the practical problems of government, to the Government and museums of the United States, and to individual effort.

Mr. Hartland was followed by Dr. Franz Boas, of New York, who, in a paper on the ethnological problems of Canada, urged the immediate importance of undertaking such a survey at once, before it is too late. Primitive life is rapidly disappearing before the economic progress of Canada, and unless the work is undertaken at once the opportunity will be gone for ever, and information which will have a most important bearing upon general anthropological problems will never be obtained. Dr. Boas then directed attention to some of the problems awaiting solution, and pointed out what an important field Canada offered to the investigator.

Dr. G. B. Gordon, of the Philadelphia Museum, explained the work which is being undertaken by the Smithsonian Institution and the various museums in the United States.

But the native question, although the most pressing, is not the only ethnographic problem in Canada which requires study. The problem of the white immigrants is in many respects even more important, and a strong feature was therefore made of this side of the question. Dr. Shrubsall, who opened the discussion on this aspect of the problem, pointed out the great importance of collecting careful statistics so as to be able to ascertain the effect of Canadian environment upon immigrants of European origin. He urged the vital importance of a survey of physical characters, mental conditions, and physique, so as to discover what type was best suited to the Canadian environment, and he also pointed out how necessary it was that the Dominion should take preventative measures now to stop the landing of the physically or mentally unfit, rather than remedial measures later. The task before the Dominion was to prevent these problems, which are now facing the great centres of population, from arising in Canada rather than to let them arise and then to attempt to remedy them.

As a result of this discussion a committee was appointed by the association to consider what steps can be taken to organise an ethnographic survey of Canada, and a memorial has also been drafted urging upon the Government the importance of undertaking the work before it is too late. It is hoped that this memorial will be presented in due course.

As was natural at a meeting in Canada, many papers dealing with American, and particularly Canadian, ethnology and archæology were presented to the section.

To take first of all those dealing with Canadian ethnology. Mr. Hill-Tout, whose reports on the various British Columbian tribes have appeared from time to time in the Journal of the Royal Anthropological Institute, presented a further instalment of his work in a report on the ethnology of the Okanagan of British Columbia. These people are the most easterly division of the Salish of the province, but they are not confined to British Columbia, but extend southwards into the United States, the international boundary dividing them into two fairly equal divisions. The material culture and language of the stock was discussed, and from the linguistic and cultural evidence a most important conclusion was arrived at, namely, that the original home of the stock, before its division into its present sections, was not the rivers and bays of the Pacific coast. The staple food of these people is now, and as long as they lived where they do now must have been, the salmon. If, therefore, they had inhabited their present districts before their language was divided into its present groupings, we would expect to find the same word for salmon among the different stocks; but this is not the case, and, in addition, their myths as to the origin of the salmon differ. It seems clear, therefore, that, before the division, the people cannot have inhabited their present district. Where they came from is another matter, but it is noticeable that the linguistic evidence points to a connection with Oceanic stocks.

An interesting paper on the Blackfoot Medical Priesthood was presented by Dr. John Maclean. The paper dealt with every aspect of the subject, with the initiation ceremonies, dress, and facial decoration, and with the causes of disease, especially the influence exerted on the mind and body of the native by his belief in evil spirits. Native medicines and remedies were also discussed, and the value of the work of the medicine-men among the natives and the influence exercised by them on the native religion.

Mr. William McIntosh presented a paper on the present native population and traces of early civilisation in the Province of New Brunswick. At the present time the native and half-breed population numbers about 1500, and is composed of two tribes, the Micmacs, on the east coast and part of the shores of the Bay of Fundy, and the Malecites, on the St. John River valley, which is approximately the site of their ancient habitations. There are abundant traces of the prehistoric occupation of the district by peoples in the Stone age of culture. Kitchen middens and camp sites are abundant; stone implements, almost invariably of the type common to the Algonquin areas, are numerous, while there is a considerable amount of pottery which in material and shape closely resembles Algonquin wares, but shows interesting varieties of ornamentation.

An interesting series of copper implements from a site in western Ontario was exhibited by Prof. E. Guthrie Perry. The collection consisted of a large number of fish-hooks and of spear- and arrow-heads. All were of cold-hammered copper from the Lake Michigan district.

In a paper on the archæology of Ontario and Manitoba, Prof. H. Montgomery, who has spent many years in excavating mounds and other early sites in America, gave a general account of his work on the antiquities in this part of Canada, and exhibited many of the objects discovered.

Miss A. Breton presented a paper on race types in the ancient sculptures and paintings of Mexico and Central America. There is an enormous mass of material available for study, including terra-cotta or clay statuettes, small jadeite heads and figures, archaic stone statuettes, portrait statues and reliefs, stelæ, MS. frescoes and vases. Among distinctive types are the chiefs on the reliefs at Xochicales, the shaven clay heads at Teotihuacan, the priests, with protruding lower lip, of the Palenque reliefs, the caryatid statues, in feather mantles, at Chichen Itza, and the sixteen warriors, at the same place, of a type similar to some of the modern Indians of the villages near Tlaxcala. Portraits of the Mexican kings are on the border of a picture map, representing the western quarter of the town of Tenochtitlan. Of female types there are the painted clay figures of Jalises with compressed heads. The figures of some of these are short and broad, while others are slender, and it is interesting to note that the type still survives. Finally, on the Guatemalan stelæ two female types are shown, the women-chiefs being obviously of a different caste to the victims prepared for sacrifice.

In another paper Miss Breton described the arms and accoutrements of the ancient warriors at Chichen Itza, where the walls of the Temple of the Tigers are covered with sculptured rows of chiefs, carrying a variety of weapons. Among these are stone implements, harpoons, spears, and the throwing stick. For defensive armour the warriors wear protective sleeves in a series of puffs, breast plates and helmets, and carry round or oblong shields.

Dr. G. B. Gordon gave an account of his recent expedition to Alaska on behalf of the University of Pennsylvania. The tribes investigated were those inhabiting the Koskokwim valley, who preserve to a marked degree their aboriginal characteristics. In the upper valley were found Dené tribes preserving the characteristics of the Dené stock. Seven hundred miles from the mouth of the river Eskimo culture began, and two hundred miles further Eskimo culture had entirely replaced the native customs, even in those communities where there was little or no admixture of Eskimo blood. The tendency of the Dené in this region to adopt Eskimo culture, which has intruded from the Bering Sea district, is most marked, and shows the aggressive nature of the Eskimo civilisation. At the mouth of the river the Eskimo have retained in full vigour their peculiar customs and mode of life, because that part of the coast has not been visited by trading vessels or whalers.

As is usual at meetings of the section, papers dealing with Mediterranean archæology and with the work of the British Schools at Athens and Rome were again a prominent feature.

In a paper on recent Hittite research, Mr. D. G. Hogarth gave a most valuable *résumé* of the present state of our knowledge of this interesting subject, and summarised the results of the explorations which have taken place. At first the general opinion was that the Hittite race and civilisation were Syrian, but gradually opinion has changed, and it is now held that the original home of the Hittites must be looked for in Cappadocia, and that only at a later period were they domiciled south of the Taurus. At Boghaz Koi has been discovered what amounts to the collection of royal archives, among them a duplicate of the treaty between Rameses II and Khetasar, inscribed on the wall of Karnak; this discovery shows that Boghaz Koi was the centre of the Hittite confederacy as early as 1280 B.C., and proves that the Hittite power was centred in north-west Cappadocia long before it is mentioned as being at Carchemish by the Assyrian records.

In their paper on prehistoric antiquities of Malta, Dr. Ashby and Mr. Peet, of the British School at Rome, described the excavations on the Corradino Hill, now being conducted by the Maltese Government with the active cooperation of the British School at Rome. The excavation of the rock-cut hypogeum at Halsaflieni shows that its architectural features imitate in a most surprising way the sanctuaries above ground, and it has, moreover, produced an adequate series of Maltese pottery of the Neolithic period. Excavation has shown that the Megalithic buildings on the Corradino Hill are of irregular plan. They were constructed of rough masonry, with large slabs at the bottom and smaller ones higher up. The walls converge as if to form a roof. The use of standing slabs at the base of the walls, with coursed masonry above, is paralleled by the giants' tombs in Sardinia and the prehistoric huts of Lampedusa.

In the report of the committee appointed to carry out archæological and ethnological researches in Sardinia, Dr. Duncan Mackenzie showed that the tombs of giants were the burial places of the dwellers in the Nuraghi, and that these tombs, with their elongated chamber and crescent-shaped front, were derived from the more ancient dolmen type. In one case the chamber of an original dolmen tomb had been elongated so as to resemble a giant's tomb. In another example the large covering slab was supported by upright slabs at the sides and back, and behind are traces of an apse-like enclosing wall, a characteristic of some of the dolmens of northern Corsica and Ireland, where giants' tombs do not exist. A new type of giant's tomb was also discovered in which the mound was entirely faced with stone, upright slabs being used below and polygonal work above. Another feature, hitherto unique, is the discovery of a hidden entrance into the chamber on one side in addition to the usual small hole in front, through which offerings were probably introduced.

The work of the British School at Athens on the site of the shrine of Artemis Orthia at Sparta was fully described by Mr. R. M. Dawkins, the director of the school. At previous meetings of the association the work of excavation for the past year has been described in detail, but in this paper Mr. Dawkins gave a general *résumé* of the work on this interesting and important site.

Two other important contributions to Mediterranean anthropology were the reports of the committees to conduct researches in Crete and on Neolithic sites in Thessaly. The former committee issued an interim report by Mr. C. H. Hawes, who has been conducting somatological investigations. He reported the discovery of human remains certainly not later than Middle Minoan I. These remains consisted of four skulls, two portions of other crania, and several pelvic and long bones. All were in a wonderful state of preservation, and it is hoped that complete measurements will be published at an early date. Mr. Hawes has also been investigating the craniology of the modern population of the island with the view of comparison with that of the ancient population, and it is expected that most important results will be obtained from this investigation.

The work of excavating Neolithic sites in Thessaly has been continued during the past year, and it is now quite clear that there existed, in this isolated part of Greece, a people who were unaffected, until a comparatively late period, by the bronze culture around them, and who remained in the Stone age almost until the beginning of the age of Iron. It is important, too, to note that an analogous state of culture has been discovered in similar latitudes in southern Italy.

A paper on excavations at the Nubian cemetery at Anibeh was presented by Dr. Randall-MacIver. The cemetery, which dates during the first five centuries A.D., exhibits a culture, apparently of negro origin, but strongly influenced by Egyptian, Greek, and Roman art. A most important feature was the discovery of a form of script which has not up to the present been deciphered.

Other papers which call for passing mention are one by Mr. Sidney Hartland, on a cult of executed criminals in Sicily; another, by Mr. W. H. S. Jones, on a study of malaria in ancient Italy, which will shortly be published in the Liverpool Annals of Archæology and Anthropology; and one by Dr. Shrubsall, on the influence of geographical factors on the distribution of racial types in Africa, in which he showed that the trend of the migrations was from the north southwards, and also directed attention to the importance in the problem of the presence of the tsetse-fly in certain areas, which, by modifying the conditions of animal life in those districts, influenced their occupation by the native population.

Among the reports of the various research committees special attention should be directed to that on stone circles, which reported that excavations had been continued at Avebury, with the result that additional evidence had been collected which tended to confirm the opinion, arrived at in the course of the previous year's excavations, that the monument was of Neolithic date.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Colonel Sir T. H. Holdich, K.C.M.G., will deliver a lecture on Thursday, October 21, on some aspects of political geography. The lecture will be given in the large lecture-room of the Sedgwick Museum of Geology. Lieut. Shackleton will lecture on Thursday, October 28. The lecture will be given in the examination hall.

Dr. Breul, the reader in Germanic, will conduct practical exercises in reading scientific German for students of natural science at the literary lecture-rooms on Tuesdays and Thursdays, beginning on Thursday, October 14.

London.—University College:—A course of lectures in electrochemistry will be begun by Dr. Wilsmore on Monday, October 18. The lectures on vertebrate palæontology, by Prof. J. P. Hill and Dr. Woodland, began on Tuesday last. It is announced that Dr. Woodland will deal with fishes in the first term, and Prof. Hill with Amphibia, Sauropsida, and Mammalia in the second and third terms.

Oxford.—Mr. Walter Brudenell Gill, formerly scholar of Christ Church, has been elected to a fellowship at Merton College to undertake research work in physics, and to act as a demonstrator in one of the laboratories of the University.

Dr. G. B. Longstaff, of New College, has, through the trustees of the endowment fund, presented the sum of 2400*l.* to be invested as an additional endowment for the Hope Department of Zoology. A decree will be introduced in Convocation on October 26 to record the gratitude of the University for the gift, and to sanction regulations for the employment of the fund. The regulations contemplate the endowment of an assistantship to the Hope professor of zoology, but the curators of the Hope collections are empowered to make other arrangements with the sanction of the donor.

Miss Alice Parkin has been appointed organising secretary for the courses in home science and economics at King's College, London, for Women.

A special course of lectures by Mr. A. P. Thurston on aëronautics is announced by the East London College, Mile End Road. The first lecture will be given on Monday, October 18.

A lakh of dollars (8750*l.*) has been collected in the Canton district, and forwarded to the Governor of Hong Kong, as a contribution towards the endowment fund of the Hong Kong University.

In addition to the men of science referred to on p. 419 of Nature (September 30), the Bohemian University of Prague has conferred the honorary degree of Doctor of Philosophy upon the following:—Prof. H. B. Dixon, F.R.S., Prof. J. Burnett, and Prof. W. R. Morfill.

The Ottawa correspondent of the *Times* states that Mr. Andrew Carnegie has given 20,000*l.* to the general funds of the McGill University, Montreal. The offer was made upon the condition that 100,000*l.* should be raised from other sources, and this has been done largely through the generosity of Lord Strathcona.

At the inauguration of Dr. A. L. Lowell as president of Harvard University on October 6, the honorary degree of Doctor of Letters was conferred upon the Right Hon. James Bryce, the British Ambassador to the United States, and the following representatives of British universities:—Prof. W. A. Herdman, F.R.S., Dr. W. N. Shaw, F.R.S., Dr. G. A. Gibson, Prof. J. Biles, and Mr. J. Willis Clark.

The opening meeting of the autumn session of the Eugenics Education Society was held last week in the Caxton Hall, Westminster, when Lieut.-Colonel C. H. Melville delivered a lecture on eugenics and military service, in the course of which he stated that one of the objects of eugenics was to improve the individuals of the present generation. He contended that military service, by strengthening character, was a positive benefit to the individual, who was physically improved by better food and housing, while moral advantages accrued from discipline and association with comrades.

The Board of Education has published (Cd. 4875) the fifteenth volume of reports from the universities and university colleges which participated in the year 1907–8 in the annual grant, now amounting to 100,000*l.*, made by Parliament for "University Colleges in Great Britain," and from the three colleges in Wales which received a grant of 4000*l.* each. For the first time a report is included from the London School of Economics, which was in 1907 awarded a grant of 1150*l.* The individual reports are exhaustive and full of information on every matter of importance in connection with higher education in the districts served by the participating institutions; but the value of the bulky Blue-book to students of educational administration is impaired seriously because nothing is attempted by the Board of Education in the direction of summarising the scattered information, or of tabulating the facts concerning the various colleges, so that it may be possible rapidly to compare, say, the local support for higher education in various parts of the country, the cost of such education per head in different districts, and so on. The attention of the Board may be directed to similar reports issued by the U.S. Bureau at Washington, in which reference and comparison is made easy for the student.

An examination of the calendars of the newer universities shows how completely their governing bodies realise the importance of providing, in addition to the more ordinary courses of academic training in arts, pure science, medicine, and law, lectures and laboratory and workshop practice in the higher branches of technology of special importance in the districts in which their universities are located. The current calendar of the University of Leeds, for instance, shows that its students may attend technological courses, and, if they so elect, graduate in, civil and mechanical engineering, electrical engineering, mining, gas engineering, fuel and metallurgy, applied chemistry—whether having reference to leather or colour manufacture or dyeing—and agriculture. The textile industries, too, are catered for in a very complete manner. Facilities for research work also are provided in each of these departments. Similarly, the new calendar of the University of Sheffield gives full particulars of the faculty of applied science in the University. This department provides lecture and laboratory courses of instruction in the subjects of applied science required in the engineering, metallurgical, and mining industries, and awards degrees in engineering and metallurgy. It is a noteworthy sign of the times, also, that each university has a professor of education, and that modern attempts to place educational methods upon a scientific basis are receiving encouragement.

The report of the principal of the Bradford Technical College for the session 1908–9 shows that the total number of students in attendance during the session was slightly greater than in 1907–8. In the day classes the total reached 221, fifty of these being apprentices. The total number of students in the evening classes was 887; 324 were concerned with the textile industries, 169 with chemistry and dyeing, and 394 with engineering. Of the 171 day students other than apprentices, it is satisfactory to find that more than a hundred had previously attended secondary schools. The standard of the entrance examination, which admits new students to the diploma courses, is being raised gradually, and should soon secure adequate and suitable preliminary training for the students. Tenders for the extension of the college have been accepted by the City Council, and the building is now in course of erection. The scheme provides for an entirely new building for the department of textile industries, which is to be equipped with complete plants for the carding, combing, and weaving of textiles. There is also to be provided a small practical dyeing and finishing plant, capable of dealing with the material produced in the textile department. The committee has further decided to erect a power house equipped with various types of modern power-producing plant arranged for experimental use. These extensions constitute the most important developments of the institution within recent years, and, when completed, will place the college in the front rank as regards the facilities offered to students for experimental work in the textile and engineering industries.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 4.—M. Bouchard in the chair.—A method permitting the measurement of the effective temperatures of the stars. First results: Charles **Nordmann.** A development of the photometric method described by the author in a previous paper. Values are given for fifteen stars, ranging from 2980° C. for the absolute effective temperature of ρ Perseus, 5990° C. for the sun, to $>60,000$ for λ Taurus. It is noted that the numbers found, with slight exceptions, are arranged in the order predicted by Sir Norman Lockyer from considerations based on the appearance of the *enhanced lines* of the spectrum.—The hypergeometric equation: Mme. V. **Myller-Lebedeff.**—The differential equations the general integral of which is uniform and admits mobile essential singularities: J. **Chazy.**—The measurement of high pressures deduced from the variations of resistance of conductors submitted to the pressures to be measured: A. **Lafay.** The change of resistance with pressure has been studied for platinum, mercury, and manganin. The first of these is not practicable for pressure measurements, since the temperature coefficient is more than 1900 times the pressure coefficient, and there are variations with different wires. Mercury gives more satisfactory results, but on account of its low temperature coefficient manganin is better.—The thermal properties of silver nitrate: M. **Guinchant.** Cryoscopic determinations with solutions of the nitrates of lithium, potassium, and thallium in fused silver nitrate gave cryoscopic constants agreeing closely with that deduced from the latent heat of fusion. Determinations were also made with lead nitrate, silver chloride, iodide, fluoride, iodate, and sulphate.—The examination of essence of turpentine: Paul **Nicolardot** and Louis **Clément.** Mixtures of pure essences with known quantities of resin oil, petrol, and white spirit were made, fractionally distilled both under ordinary and reduced pressure, and the physical properties of the fractions measured.—The decomposition of silver tetrachlorplatinate by water, and the preparation of fulminating platinum: Jules **Jacobsen.**—The magnetic disturbance and aurora borealis of September 25, 1909: Alfred **Angot.** This magnetic disturbance is the greatest that has been observed since the commencement of observations at the Parc-Saint-Maur Observatory in 1883.

NEW SOUTH WALES.

Linnean Society, August 25.—Mr. T. Steel, vice-president, in the chair.—Contribution to a knowledge of Australian Hirudinea, part iii.: E. J. **Goddard.** Three species are dealt with:—*Glossiphonia intermedia*, n.sp., from a creek near Fairfield; *G. heteroclita*, a European and North American form, now recorded as Australian also; and the common species, usually known as *Hirudo quinquestriata*, Schmarda, but which should bear the name *Limnobdella australis*, Bosisto, of which no adequate account had been published.—Australian fresh-water Polyzoa, part i.: E. J. **Goddard.** Six named species, representing six genera (including Alcyonella), and several unnamed forms, have been recorded from Australia and New Zealand, of which three species are endemic:—*Victorella pavida*, Sav. Kent; *Lophopus lendenfeldi*, Ridley; *Paludicella ehrenbergii*, van Beneden (New Zealand, *teste* Hamilton); *Plumatella Aplinii*, McGillivray; *P. princeps*, Kraepelin; P. sp., and Alcyonella sp. To these are now added *Fredericella australiensis*, n.sp., which grows luxuriously in the screening tank at Potts' Hill Reservoir, near Rookwood, and also in the 72-inch main from the end of the lower canal to Potts' Hill.—Mollusca from the Hope Islands, North Queensland: C. **Hedley.** In continuation of former investigations as to the coral-reef fauna of Queensland, the author organised another party to examine the reefs several degrees further north. The exact position selected was close to the scene of Captain Cook's misfortunes in the *Endeavour*. A week's work dredging and shore-collecting provided a series of about seven hundred molluscs. Of these, one hundred of the more interesting are discussed in the present communication, about half of which are introduced as new species. The novelties are distributed among the genera Chlamys, Cuna, Rochefortia, Sportella, Phacoides, Gafrarium, Chione, Tellina, Arcopagia, Semele, Theora, Liotia, Cyclostrema, Obtortio, Triphora, Cerithiopsis, Epitonium, Vermicularia, Odostomia, Turbonilla, Glyphostoma, Eulima, Marginella, Mangilia, Nassaria, and Retusa.

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 15.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.

WEDNESDAY, OCTOBER 20.

ENTOMOLOGICAL SOCIETY, at 8.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Microscopical Structure of an Inoceramus Limestone in the Queensland Cretaceous Rocks: Frederick Chapman.

FRIDAY, OCTOBER 22.

PHYSICAL SOCIETY, at 5.—On Cadmium Amalgams and the Normal Weston Cell: F. E. Smith.—The Production of Helium from Uranium and Thorium: Frederick Soddy.—The Production of Radium from Uranium: Frederick Soddy.—Note on a Gravitational Problem: Dr. C. V. Burton.

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THURSDAY, OCTOBER 21, 1909.

THE SPECIES QUESTION RE-OPENED.

The Making of Species. By Douglas Dewar and Frank Finn. Pp. xix+400; 15 illustrations. (London: John Lane, 1909.) Price 7s. 6d.

IF this work fails to bring about that revolution in biological science which its announcement led us to expect, it is not for lack of confidence on the part of the authors or their publisher. We were informed (by advertisement) that with the exception of a certain well-known treatise by de Vries this book was "the most important contribution to biological science which has appeared since Darwin's 'Origin of Species.'" We were further told that "the authors have no difficulty in demolishing some of the theories which are most cherished by biologists of to-day—notably those of mimicry and recognition markings in birds," and that "the facts which they have brought together undermine the whole of the massive superstructure which Neo-Darwinians have erected on the foundation of the theory of natural selection." A few extracts from the preface will suffice to reveal the tone which pervades this latest attack upon the theory of natural selection:—

"We fear that this book will come as a rude shock to many scientific men. . . . We are endeavouring to save biology in England from committing suicide, to save it from the hands of those into which it has fallen. . . . The Wallaceians (*sic*) continue on their course and give to the world a spurious Darwinism . . . we were both of opinion that biology is in an unhealthy condition, especially in England, and that the science sorely needs some fresh impetus."

After such a flourish of trumpets we naturally turn eagerly to the text for the "fresh impetus," but fail to find inspiration. There are many gibes aimed at and epithets attached to "Wallaceians" and "Neo-Darwinians," and there are some very remarkable perversions of the history of organic evolution. The authors set out, in fact, with an attempt to explain the reasons why the "Origin of Species" was accorded a "rapturous welcome . . . by the more progressive biologists," and how

"the man in the street was able to comprehend the theory of natural selection. This was greatly in its favour. Men are usually well disposed towards doctrines which they can readily understand."

Those who are familiar with the history of the publication of Darwin's great work and the difficulty which he experienced in making even the expert naturalists of his time fully grasp the principles of the selection theory will wonder from what source the authors have derived their information. As another example of historical perversion, attention may be directed to the statement (p. 198)

"that all the opposition to the theory of protective colouration comes from those who observe nature first hand, while the warmest supporters of the theory are cabinet naturalists and museum zoologists."

From this the reader will infer that the founders of that theory, Bates and Wallace, Trimen, Belt, Fritz Müller and Weismann, were not, in the judgment of the authors, observers of nature at first hand.

Within the limits of an ordinary review in these columns it is impossible to discuss in any detail the large body of evidence which the authors bring together in order to "demolish" those whom they dub "Neo-Darwinians," "Wallaceians," or even, when their scorn reaches its highest pitch, "Neo-Wallaceians." The general drift of the work is purely destructive, and its main object is apparently to disprove the all-sufficiency of natural selection. There is nothing very novel in this position, and by attributing to the followers of Darwin and Wallace a highly exaggerated and super-exalted doctrine, which no Darwinian has ever upheld, such refutation is naturally a very simple matter. The authors appear to imagine, for example, that somebody holds the belief that the theory of natural selection has been seriously held "to explain all the varied phenomena of nature" (p. 28). Of course, the very obvious and flagrant cases of adaptational colouring coming under the designations "protective resemblance" and "mimicry," which have generally been looked upon as reasonably explicable on Darwinian principles, come in for a large share of attention, and here is the verdict with respect to these theories:—

"We have examined these mighty images of gold, silver, and brass and iron, and found that there is much clay in the feet. We shall devote this chapter to lifting the hem of the garment of sanctity that envelops each of these images, and so expose to view the clay that lies concealed" (p. 172).

It must be left to the reader, whose flesh has been made to creep by this preliminary threat, to find out how far the authors have succeeded in damaging the evidence which has been accumulated by the joint labours of some of the most acute observers of nature ("at first hand"!) since Darwin gave us the key to the explanation of the phenomena in question, half a century ago. Prof. Poulton, as one of the most prominent of recent workers in this field, comes in for much castigation. The methods of demolition adopted by the authors have been made quite familiar by anti-Darwinians ever since the publication of Mivart's "Genesis of Species." Cases of convergent characters which are non-mimetic are marshalled against the selection theory of mimicry, the facts of mimicry are altogether denied or said to be much exaggerated, and cases of obvious adaptation, such as Kallima, are said (virtually) to be too good to be true, or, in other words, that the imitation is elaborated to an unnecessary extent.

It will naturally be asked whether this great array of objections and difficulties is a purely destructive attack, or whether it is a prelude to some great constructive generalisation. The reader who looks for new light will, we fear, be disappointed, judging from the following specimen of an "explanation" of the mimicry of butterflies by diurnal moths:—

"When two species adopt the same method of obtaining food, it not infrequently happens that a professional likeness springs up between them" (p. 250).

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In so far as there is any positive declaration to be found in the volume the authors may be classified with the "mutationists." They are at great pains, in fact, to define their precise position as members of that school "of which Bateson, de Vries, Kellog, and T. H. Morgan appear to be adherents" (p. 26). They state further that, "like Darwin," they "welcome all factors which appear to be capable of effecting evolution" (p. 27). What these factors are beyond natural selection (to which they assign some value) it is not quite easy to gather from the present work. Isolation, correlation, variation, and heredity have been considered very seriously by all evolutionists from Darwin down to the present time, and it cannot be said that Messrs. Dewar and Finn have shed any new light on these subjects. They tell us (p. 387) that species are made by

"the inherent properties of protoplasm and the laws of variation and heredity. These determine the nature of the organism; natural selection and the like factors merely decide for each particular organism whether it shall survive and give rise to a species."

This will seem to the reader who is not a "mutationist" to be very like pure Darwinism with a dash of "inherent properties of protoplasm" thrown in. The introduction of "biological molecules," which are defined (pp. 157–9) as the units of which the germ cell is composed, may be considered as the substitution of a vague conception for the very definite mechanism which has been introduced into the theories of heredity associated with the names of Darwin, Herbert Spencer, Weismann, Mendel, and others. One example of the use of this conception will suffice to show its vagueness:—

"Thus the phenomena of 'mimicry' and 'reversion' are, we believe, due to the fact that in the fertilised egg of both the pattern and its copy a similar arrangement of biological molecules obtains. If we regard the sexual act as resembling in many respects a chemical synthesis, the phenomenon need not surprise us" (p. 293).

The reasons for associating mimicry with reversion and sexual reproduction are not very obvious, even from the authors' own point of view. Dealing with the first set of phenomena only, if the "explanation" means that in a mimic and its model the similarity of colour and pattern is due to an identity either of physical structure or chemical constitution, or of both, it is untrue in fact. If it means that the resemblance has arisen because the units (*i.e.* "biological molecules") of which the ovum is in each case composed give rise to a similarity of colour and pattern on development, this appears to be a mere paraphrase of the description of the facts and no explanation at all.

It is to be regretted that Messrs. Dewar and Finn have made this aggressive incursion into the domain of biological theory. They are favourably known as popular writers on Indian ornithology and other natural-history subjects. Although in the present volume none of the objections brought against natural selection are new in principle, it must be placed to the credit of the authors that, unlike so many of the earlier critics of Darwin's work, they are able to give a certain number of illustrations derived from personal observation and experience. But the work as a whole will not add to their reputation; with the majority of readers it will probably have the reverse effect. If the general object of the book is simply to emphasise the point that the theory given to science by Darwin and Wallace need not arrest further research in the domain of bionomics, there will be a very general unanimity among workers of all schools as to the soundness of their contention. But if the authors attribute any neglect, real or imaginary, of the study of bionomics to the direct influence of the teachings of Darwin and Wallace and their followers, they are inverting the truth. No greater stimulus was ever given to research in this domain than that given by the theory of natural selection. Any neglect with which English biologists can be charged is due to their ignoring and not to their acceptance of the teachings of the founders of that theory.

R. Meldola.

THE GEOGRAPHICAL DISTRIBUTION OF LEPIDOPTERA.

Die geographische Verbreitung der Schmetterlinge. By Dr. Arnold Pagenstecher. Pp ix+451. (Jena: G. Fischer, 1909.) Price 11 marks.

THE author of this work is one of the older German entomologists, who has been working for many years in the formation of a collection of Lepidoptera, and has published many valuable lists and monographs of the species found in various limited regions. He has now utilised his materials in a work which cannot fail to be interesting, not only to entomologists, but also to all naturalists who direct their attention to the numerous problems connected with the present geographical distribution of animals over the surface of the globe.

Dr. Pagenstecher remarks that the geographical distribution of Lepidoptera, like that of plants, is closely connected with certain physical and organic factors. The most important physical factors are (1) soil; (2) temperature and light; (3) moisture; (4) atmospheric conditions. The first portion of this work is therefore devoted to general observations on the geographical conditions of the continents, and the influence of mountains, desert or fruitful plains, the neighbourhood of rivers and seas, continental and oceanic islands, &c., on distribution. The influence of temperature, moisture, atmosphere, &c., is then briefly described; then vegetation, carnivorous habits, commensalism, &c. This is followed by sections on the distribution of Lepidoptera as affected by altitude, notes on migration, cosmopolitan species, and season-dimorphism and local variation. After this, the organic (physiological) factors of the subject are discussed, with special reference to former geological and climatic conditions, and some reference to fossil Lepidoptera. After some remarks on structure, and on the enemies of Lepidoptera, the section concludes with a summary of the Macro-lepidoptera of Central Europe (1626 species, according to Lampert), and a table of the species of Papilio found in the more important districts of the world.

The second section of the work is devoted to the regions and subregions of the world as defined by Wallace, Sclater, and others, with some reference to the views of other zoologists and botanists on the subject. After this, the various regions and districts of the world are discussed, first with regard to their climatic conditions, and secondly with reference to the species of Lepidoptera known to inhabit them, of which, in many instances, very full lists are given. This portion of the work contains an enormous amount of valuable detail, and much scattered information is brought together which it would be very difficult to utilise in its original form. This portion of the work is the most extensive, but cannot here be discussed in detail.

The concluding section deals with the geographical distribution of Lepidoptera under their families and genera, and this also is very completely set forth. The book is illustrated by two outline maps, one (facing p. 62) indicating the regions and subregions of the world, as mapped out by Wallace and Sclater, and the other (facing p. 217) representing the Malay Archipelago from the Nicobars and Malacca to the Philippines, New Guinea, and North Australia.

Dr. Pagenstecher has not indulged in much theorising, but his book forms a great quarry from which philosophical speculators will be able to extract a vast amount of material. It is not a book that either systematic lepidopterists or philosophical naturalists can afford to ignore, and they will have reason to be very grateful to the author for the conscientious care that he has devoted to this most laborious and useful book.

W. F. K.

AGRICULTURAL FERTILISERS.

Fertilisers and Manures. By A. D. Hall, F.R.S. Pp. xvi+384. (London: John Murray, 1909.) Price 5*s.* net.

MR. HALL has again succeeded in producing a work which will appeal with equal force to the practical and to the scientific agriculturist, and will do much to overcome that innate prejudice of the ordinary practical farmer against science by showing him the enormous influence science has had in determining a rational system of manuring, and in giving him the knowledge of a variety of substances of use to him in his business of food production, as well as in securing for him a safeguard against adulteration by unscrupulous traders. In the history and evolution of the practice of keeping up the crop-producing power of the soil Mr. Hall examines critically the various theories of manuring adduced from time to time, and the experiments upon which they are based, and the study of merely this part of the work will be of supreme importance to the practical man and to the student in showing how experiments may be misconstrued and conclusions of the most erroneous description drawn.

The recommendations as to the manuring of farm crops are tempered with sound advice, and the impossibility of prescribing more than a generally suitable method of manuring without a careful study of soil and climatic conditions extending over some years is well demonstrated. Mr. Hall gives some timely warnings as to deductions from field experiments, of which there has been such a plethora in recent years, with their unscientific methods both of carrying out and of deduction. The importance of taking into account the experimental error, which is estimated at ±10 per cent., and of neglecting results within these limits should be taken to heart by all who carry on these so-called "experiments."

The chapter on farmyard manure is eminently practical and useful, and recent work on such subjects as root excretions, effect of fertilisers on tilth, and on residual values of manures, brings the book well up to date. It is sought to distinguish between manures and fertilisers, the former designating more or less complete plant foods, the latter those materials which supply one element in the plant food, nitrogen, potash, or phosphoric acid. The perversion of the meaning of the word manure from its original significance, hand work, is no less curious than the use of the word tillage to mean artificial manures, which use still persists in the eastern Midlands. The part of the work relating to lime is worthy of serious attention from all agriculturists, as it is probable that the lack of carbonate of lime in a soil is more often than any other cause an explanation of the comparative infertility or absence of satisfactory results from manuring. A chapter on the valuation and purchase of fertilisers puts this important method of calculation simply and accurately, and a concise statement of the Fertilisers and Feeding Stuffs Act will be useful to all users of manures.

Mr. Hall's remarks on the soil-inoculation question supplement and strengthen the advice he gave in his work on the soil, and the experiments on the new nitrogenous fertilisers, cyanamide and nitrate of lime, show the values of these fertilisers in terms of their competitors, nitrate of soda and sulphate of ammonia. The Rothamsted experiments are, of course, freely drawn upon to provide data, and in the hands of the present director of that station these results are being endowed with fresh life and excellently practical applications. The tables of results are concise and well arranged, so that the reader is not faced with an immense array of figures and tables, and bewildered without being enlightened. To sum up, this is a sound and scientific book which should be in the hands of every practical agriculturist as well as in those of the student, the teacher, and the manufacturer.

M. J. R. D.

THE NATURE OF ATTENTION.

Attention. By Prof. W. B. Pillsbury. Pp. x+346. (London: Swan Sonnenschein and Co., Ltd., 1908.) Price 10*s.* 6*d.* net.

IN 1906 Prof. Pillsbury published a book on attention in the "Bibliothèque internationale de Psychologie expérimentale." This work, with substantial additions, now appears in English as the latest volume of Prof. Muirhead's Library of Philosophy. It may be welcomed as a useful member of the series, though it can hardly compare in importance with some of its brilliant predecessors.

Prof. Pillsbury, like his former teacher, Prof. Titchener, in a still more recent book, defines attention as "an increased clearness and prominence of some one idea, sensation, or object." His first thirteen chapters are devoted to the illustration of this description from general psychological processes; to an analysis of the part played by attention in the phenomena of perception and ideation, of memory, action, reason, emotion, and the self; and to a study of the conditions which determine the incidence of attention. With regard to the latter, he contends for a simplification of current classifications. The "forms" of attention generally recognised are distinguished either by the presence of elements (such as strain sensations) which are extraneous to the sensation-process or else by the nature of the objects to which attention is directed. There is really only one kind of attention, though the conditions of its emergence are two-fold. These are: objective conditions which consist in characteristics of the stimulus, such as its intensity, extent and duration; and subjective conditions, such as the momentary mood and past experiences of the individual. Finally, it must be noted that these conditions never or rarely appear in entire separation.

The later chapters are mainly given to theories of attention, grouped as physiological theories, theories that treat attention as a phase of mental activity, and theories that seek in some particular feature or accompaniment of the attention-process the cause of the predominant "clearness" of certain sensations and ideas. As a critic of preceding theories Prof. Pillsbury's best work is his interesting and useful treatment of apperception. His own theory is a physiological one, and assumes "localisation" of the activity of attention in the so-called anterior association centre of Flechsig. By a kind of "drainage," for which there is experimental evidence, the discharge through a given neuronic system may be heightened by the coexistence of less energetic discharges in connected systems, or depressed by a still more energetic discharge in such a system. The association centre provides lines of irradiation along which reinforcement and inhibition may in this way spread from one sensory centre to another. By such a concept Prof. Pillsbury believes that the determination of attention, both by strong stimuli and by past experience, can be explained in accordance with the postulate of psychophysical parallelism, and without the hypothesis of an unverifiable agent "that stands behind consciousness."

The book ends with a chapter on pedagogical applications. The author attacks the doctrine that makes "interest the measure of what shall be taught" to a child. He argues for the use of "social pressure," and the appeal to duty in education. "They are just as important as the conditions which we ordinarily call interest in governing attention, and it is quite as justifiable to make use of them in practice." This warning of a psychologist against making education "soft" is not untimely, although (owing to the lamentable ambiguity of the word "interest") he is condemning a theory of teaching which no responsible pedagogical writer—at least in this country—would dream of defending.

In addition to a good index the book contains a bibliography of the subject for which the student will be grateful.

TABLES FOR MATHEMATICIANS AND PHYSICISTS.

(1) *Five-figure Logarithmic and other Tables.* By Frank Castle. Pp. 58. (London: Macmillan and Co., Ltd., 1909.) Price 1s.

(2) *Taschenbuch für Mathematiker und Physiker.* 1 Jahrgang, 1909. By Felix Auerbach. Pp. xliv+450. (Leipzig: B. G. Teubner, 1909.) Price 6 marks.

(1) MR. CASTLE is well known as the author of a series of elementary text-books on mathematics. He now gives us a new set of five-figure mathematical tables. So many tables of this sort have appeared of late years that innovation in this field is rather difficult. Mr. Castle's tables are very similar in contents to Dale's five-figure tables, with the advanced functions cut out. One happy alteration is that, in the early part of the table of logarithms, mean differences are calculated for every five entries instead of for every ten. This renders possible the use of mean differences in all parts of the table without loss of accuracy. Another good point is a table of degrees and circular functions for equal intervals of radian measure; this should be most valuable for advanced work.

On the other hand, there seems a needless amount of repetition in printing. Thus the table of sines is printed separate from the table of cosines, although the one table is merely the other read backwards. The same holds of tangents and cotangents, secants and cosecants. It may be argued that this makes the tables easier to handle for readers with little theoretical knowledge, but it seems doubtful whether it will not encourage rather than check the common fault of *adding*, instead of *subtracting*, differences for the cosine, cotangent, and cosecant.

A more serious defect is the omission, from the table of cube roots, of the cube roots of numbers from 100 to 1000. This means that the present tables cannot be used to find rapidly the cube root of, say, 0·3.

(2) A pocket-book of reference for mathematicians and physicists will strike most mathematical readers, at all events in this country, as a novelty. Such a pocket-book was recently brought out in Germany by Dr. Felix Auerbach, working in collaboration with Drs. Knopf, Liebmann, and Wölffing. Facing the title-page is a portrait of Lord Kelvin, and the volume opens with a notice of his life and work.

It is intended that this shall be an annual publication. For this reason, Dr. Auerbach tells us in his preface, many matters have been only lightly touched upon, or even omitted altogether, in the hope that further details concerning them may be included in a later issue.

As it is, the initiated reader must be amazed at the amount of useful information which has been compressed into 450 small octavo pages. In every branch and sub-branch of mathematics all the fundamental definitions, theorems, and formulæ have been given, sufficient explanation being added to make the whole intelligible to the average mathematician. A similar plan has been adopted for the physical and astronomical parts, numerous tables of constants being given, as well as descriptions of apparatus. At the end of the book is a useful list of mathematical and physical books and periodicals.

We have noticed a few errata, *e.g.* p. 44, the first theorem of the mean is incorrectly stated, and p. 46, $\int_0^\infty \frac{\sin bx}{x} dx$ is equal to $\pi/2$ only if $b>0$. These, however, are slight blemishes, inevitable in a first issue. In conclusion, we wish the "Taschenbuch" all the success it undoubtedly deserves.

OUR BOOK SHELF.

An Introduction to the Science of Radio-activity. By C. W. Raffety. Pp. xii+208. (London: Longmans, Green and Co., 1909.) Price 4s. 6d. net.

THE aim of this book is to present a concise and popular account of the properties of the radio-active elements and of the theoretical conceptions which are involved in the study of radio-active phenomena. With this object in view, the treatment throughout is purely descriptive, and no attempt is made to develop the mathematical side of the subject. Nevertheless, the author has succeeded in describing and discussing most clearly the various phenomena of radio-activity.

The book is divided into three parts. The first part is descriptive, and, after a general note on the radio-active elements, is devoted to the consideration of the nature of the various radiations emitted by radio-active bodies. The characteristics of the α, β, and γ radiations are carefully explained.

In the second part of the book the author deals with the subject of radio-active transformations, and describes in detail the various disintegration products produced from thorium, uranium, and radium. Chapter iv. in this section contains an account of the theory of atomic structure from the electron point of view. The evidence drawn from various phenomena shows large variations in the number of electrons associated in the atom. The author gives the numbers calculated from experiments on kathode rays. The third part of the book is devoted to kathode, canal, and X-rays, and gives experimental details which should enable an amateur to carry out successfully a number of experiments with a small amount of apparatus. A feature of the book is the appendix, in which the author has collected and tabulated the physical constants of the α, β, and γ rays, the products of decay of the radio-active elements, with their rates of decay, and the absorption coefficients of the radiations emitted by the radio-active bodies.

Altogether the book can be heartily recommended to mathematical, as well as non-mathematical, readers who desire an acquaintance with the subject of radio-activity.

British Mountain Climbs. By George D. Abraham. Pp. xvi+448. (London: Mills and Boon, Ltd., 1909.) Price 7s. 6d. net.

MR. ABRAHAM here provides the lover of British mountaineering with a conveniently small and concise guide to the British rock-climbs. The climbs are grouped around the most convenient centres, and detailed instructions as to how to perform the various expeditions safely are given. The book is provided with eighteen illustrations and twenty-one outline drawings, showing the principal routes. It is written in a bright, interesting style, and is sure to become a favourite among mountaineers who are willing to learn from it the beauties and difficulties of climbing at home.

The Pond and other Stories. By Carl Ewald. Translated from the Danish by Alexander Teixeira de Mattos. Pp. 320. (London: Everett and Co., 1909.) Price 6s. net.

THIS series of eleven stories deals with animal and plant life in a way dear to children. The birds and beasts talk to one another, and incidentally supply the reader with many familiar facts of nature-study. Each story is provided with a good illustration, and the easy colloquial English of the translator will be understood by the young children for whom the book is evidently intended.

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.*]

Magnetic Storms.

DR. CHREE contends that magnetic observations have now reached a high pitch of perfection, and that their discussion is not lightly to be undertaken by outsiders. That is no doubt so, and there must be many features about magnetic storms which are known only to experts. But when we find experts in doubt on such a fundamental matter as whether the cause of those storms is to be found in the sun or in the earth, it appears to be worth while to emphasise some comparatively simple and fundamental considerations which may possibly have become rather covered up by a mass of information.

The simple points that I venture to emphasise, with all due deference to specialists, are:—

(1) That by reason of the high temperature and convulsions of the sun it is almost bound to emit electric projectiles.

(2) That when the visible sign of a solar eruption is aimed at the earth, magnetic storms are often felt, while they are not so frequently experienced from eruptions the emissions of which may be reasonably supposed likely to miss the earth.

(3) That, taking into account the varying aspect of places on the earth to a solar beam, such a stream of particles is well qualified to produce changes in all the magnetic elements during the course of a day—even though deflection by magnetic lines, and the effect of currents induced in the conducting layer of the upper atmosphere, were ignored. (I do not say that the details of a storm fit so greatly simplified a theory.)

(4) That a great beam of this kind is not likely to be uniform, but may be supposed to contain rays of special intensity, the passage of which will cause well-marked and rapid reversals, such as are observed.

(Of course, I never thought that the recent storm was over in fifteen minutes; it was common knowledge that it lasted for hours. I must have expressed myself badly if I conveyed such an idea.)

(5) That detection, in storm-recurrence, of any periodicity which corresponds at all closely with the period of the sun's relative axial rotation—such as is maintained by Mr. Maunder and apparently *half* admitted by Dr. Schuster—would surely be conclusive as to something solar in origin.

(6) And, especially, that simple calculations from known laboratory data show that the magnitude of the effect observed is not unreasonably great to attribute to local solar radio-active emissions.

Hesitation as to the truth of this last proposition was, I understand, Dr. Chree's basis for his most anxious doubts; and the object of my letter was to try to remove at least this form of doubt from the minds of astronomers and responsible magneticians.

One more quite minor point I may take the opportunity of mentioning, though it is connected rather with a letter of Dr. Chree's in the *Times* than with his letter in NATURE.

(7) Disturbance of terrestrial rainfall—say an increase for a short period due to influx of cosmic nuclei—need not be supposed to modify the usual local *distribution* of rain, but only to increase its amount in the customary localities.

This I only venture to say very tentatively, and with no dogmatism at all. It is clear that the total rainfall all over the earth during a long period cannot exceed what the sun can evaporate in approximately the same period, and therefore depends more on the sun's total activity than on anything else. It is also clear that rain is a local circumstance, and that the conditions which determine whereabouts rain shall fall are mainly local. But I question whether either of these propositions really negatives the idea that cosmic causes may occasionally affect the rainfall during any given month, even in a specified locality.

OLIVER LODGE.

Why has the Moon no Atmosphere?

PROCTOR ("The Moon," p. 334) says:—"It has been held, and not without some degree of evidence in favour of the theory, that in our Moon we have a picture of our Earth, as she will be at some far distant date . . . when her oceans and atmosphere have disappeared through the action of the same circumstances (whatever they may be) which have caused the Moon to be airless and oceanless."

The following considerations suggest what the circumstances referred to may have been, and present what seems a possible cause for the absence of an atmosphere.

(1) Apart from all theory, we know that the sun exerts a repulsive force on matter around him. The phenomena of comets' tails show this as clearly as the streamers from a flagstaff show that a wind is blowing. Kepler first suggested the existence of this force. Sir John Herchel, in his essay on comets, said, more than forty years ago, that "they have furnished us with a proof, amounting to demonstration, of the existence of a repulsive force directed . . . *from* the Sun."

(2) Maxwell in 1873 deduced from his electromagnetic theory the pressure of light, which Arrhenius in 1900 applied to explain the formation of comets' tails. Each particle projected from the comet, under the influence of the sun's heat when nearing the sun, being submitted to two opposing forces, viz. gravitation and the pressure of light, he pointed out that since the pressure varied as the surface, while the weight varied as the volume, *i.e.* one compared with the other, varied as the square of a number compared with its cube, then, when the particles were small enough, the repulsive force of the pressure might be many times as great as the force of attraction, and drive away the particles with great velocity.

As a common example of such action, I may remark that we have the case of a wind blowing on a newly macadamised road or on a single stone on the road. While the stones are unbroken the wind cannot move them, but when they are crumbled to powder it sweeps them away in clouds.

(3) In this way the sun exercises a sort of sifting process in space, sweeping away very small particles and drawing the larger ones towards him.

(4) Assuming that the moon had an atmosphere for many ages, the particles would be acted on by the repulsive force of the sun radiating from its centre, and by gravity directed to the centre of gravity of the moon. During the time that the moon retained its atmosphere it is evident that gravity must have been the preponderating force. The atoms, as Dalton called them, were not small enough to allow the pressure of light to prevail over the weight.

(5) But the atmosphere has disappeared, and we have to account for this fact. Can the particles have been in any way reduced in size?

If we are sure that the chemical atoms, as Dalton called them, despite the protests of such men as Davy, Wollaston and Berzelius, cannot be decomposed or disintegrated, then an hypothesis to the contrary must be rejected.

(6) But the recent discoveries in radio-activity are opposed to this. It has been shown that the radio-active elements are disintegrating slowly and gradually from their own internal energy. The process has been going on for indefinite time, although only lately discovered accidentally because of certain radiations. Have we reason to believe that it is limited to these elements? Prof. Rutherford has pointed out that the existence of rayless changes in these elements "indicates the possibility that undetected changes of a similar character may be taking place in the non-radio-active elements" ("Radio-activity," p. 455, 2nd edition). If we suppose that such changes took place at the outer surface of the moon's atmosphere, resulting in particles sufficiently small, then part after part of the atmosphere may have been stripped away until the present condition has been reached.

(7) The same process may be going on now with the earth's atmosphere, notwithstanding the greater force of gravity.

Briefly, if the atmosphere of the moon was ever driven away—the repulsive force of the sun (pressure of light) is the only driving force we know of—the component particles must have been originally too heavy to be driven off, and were therefore in some way reducible; the transformations in the radio-active elements suggest a possible process.

Thus the present condition of the moon is an argument for the disintegration of some of the non-radio-active elements, and the argument is the stronger in proportion to the difficulty of finding a solution otherwise to this old astronomical problem.

ALEXANDER JOHNSON.

Montreal, Canada, September 30.

A "Canaan Stone."

CAPTAIN B——, of the Brixham (Devon) trawler fleet, recently showed me what he termed a "Canaan stone." He told me that in the hands of his wife's mother it had effected many miraculous cures of diseases of the eye, and that by its use she had been especially successful in curing cataract. The stone was a polished sphere of agate, translucent, and of a faintly greenish-yellow tint, containing several red-brown patches due to the presence of iron. It was about ¾-inch in diameter, and had been drilled through the centre, as though it had at one time formed part of a necklace. The treatment simply consisted in "striking" (*i.e.* gently rubbing) the eye with the stone. No prayers or incantations were used, but it was essential that different parts of the stone should be used in different diseases, and the part used also varied with the colour of the patient's eyes. The stone was rubbed actually on the conjunctiva, not on the lids. The secret of the exact method of treatment died with the old lady, who is reported to have had quite an extensive ophthalmic practice, and I was appealed to in order that I might explain the secret to the present owners of the stone. Beyond the fact that the stone had been bought by its late owner from a man in Cornwall for 40*l.*, no history was available.

The following extract from the Book of Tobit suggested itself to me as a possible explanation of the origin of the belief in the curative value of the stone:—

"When Tobias and Raphael came to the river Tigris, a fish leaped out of the water and would have devoured him, but the young man laid hold of it and drew it to land. The Angel bade Tobias open the fish, and take the heart, and the liver, and the gall, and put them up safely. . . . And the Angel said . . . As for the gall: it is good to anoint a man that a whiteness in his eyes shall be healed. . . . Tobias met his father at the door, and strake of the gall on his father's eyes . . . and Tobit recovered his sight."

It does not require a great stretch of the imagination to see a resemblance between this translucent, greenish-yellow stone, with its red-brown patches, and the distended gall-bladder of a fish, excised with small portions of liver adherent to its surface. The expression "to strike," for to anoint or rub, is still quite common in Devon. In the country districts a usual treatment for sprains or abrasions is to "strike them with fasting spittle," *i.e.* to apply saliva when rising in the morning, before any food has been taken. G. Harold Drew.

Marine Biological Laboratory, Plymouth.

Orthite in North Wales.

In March, 1908, an unfamiliar mineral was discovered by Mr. W. G. Fearnsides in a narrow vein which traverses the intrusive granophyric mass of Tan-y-grisiau, near Ffestiniog, and was submitted to me for identification.

It has proved to be the somewhat rare silicate *orthite*, and its occurrence will be of considerable interest to mineralogists both on account of the amount of material available and for the large size of the crystals, which range up to $1\frac{1}{2}$ inches in greatest dimension.

Hitherto orthite, which contains a number of the rarer elements, such as cerium, lanthanum, didymium, yttrium, &c., has not been found in any quantity in Britain, and then only as microscopic crystals and grains. The crystals from Tan-y-grisiau are well-formed, black to dark grey, submetallic tables with bright faces; they are conspicuously tabular, parallel to the form T{100}, and are modified by narrow prism and dome faces.

It is the "unknown and very interesting mineral" to which the attention of those members of the Geologists' Association who took part in the long excursion to North Wales this year was directed.

The exact locality is the north-west face of a quarry at Cefn-bychan, south of Tan-y-grisiau, Blaenau-Ffestiniog, belonging to the Ffestiniog Granite Quarries Co., Ltd.

The physical properties of the orthite are undergoing investigation, the results of which will be published at a later date. Herbert H. Thomas.

Geological Survey and Museum, Jermyn Street, S.W.

Drought in South-west Ireland.

Whilst all round us have been reports of wintry weather and unceasing rain during the summer months, we in this small south-westerly area of Ireland have been passing through a period of abnormal drought, in fact a record season, accompanied by high temperature throughout.

I have recorded the annual rainfall here (Bandon) for some years, but I have never had anything approaching a similar experience, and the oldest inhabitant here cannot recall so continued an absence of rain as we have felt this season, that too in a country where the rainfall is generally excessive. I am bound to say, however, that the elements are *now* distinctly making up for lost time, as though in revenge for letting us off so easily before.

I give you the rain-gauge readings for the months June, July, August, and September, which speak for themselves, and may perhaps prove of some interest to your readers.

The readings were taken with a 5-inch Negretti and Zambra gauge, and registered daily:—

June.—Total for month, 1·08 inches. Twenty-five days absolute drought. Highest reading=0·47 inch, on June 24.

July.—Total for month, 1·02 inches. Twenty-three days absolute drought. Highest reading=0·34 inch, on July 10.

August.—Total for month, 0·54 inch. Twenty-five days absolute drought. Highest reading=0·32 inch, on August 1.

September.—Total for month, 0·41 inch. Eighteen days absolute drought. Highest reading=0·08 inch, on September 28. Geo. A. Armstrong.

Ardnacarrig, Bandon, Co. Cork, October 13.

The Meteor in Sunshine, October 6.

The great daylight meteor of October 6 was observed by many persons in various parts of the country. The particulars to hand are not, however, very definite, and it is scarcely possible to compute the real path of the object. From a comparison of about fifteen descriptions, there seems little doubt that the meteor moved in a direction from south to north over Reading, Thame, and on to a termination near Market Harborough.

The radiant point was in Leo, and it is hoped that more observations of an exact character will be supplied. The sky was clear over a large extent of England, and hundreds of persons saw the meteor, though only a small proportion of that number have reported their observations.

The great daylight meteor of 1900 January 9 was directed from Aquila, that of 1894 February 8 emanated from Hercules. It is seldom that meteors appearing at such times can be suitably observed, as the sky does not afford any reference objects such as is furnished by the stars at night. W. F. Denning.

An Aurora Display on October 18.

I witnessed last night one of the finest displays of the aurora borealis which it has been my good fortune to see in this country. It happened at about 9 p.m., and I was at the time upon one of the highest summits of the Cotteswold Hills, close upon 1000 feet above the sea-level, so that I had an uninterrupted view of the magnificent spectacle. The first I saw of it was several streamers and an indistinct band low down on the northern horizon, with a detached red, cloud-like portion almost due west. These resolved themselves eventually into two bands, the uppermost stretching right across the sky from north-west to north-east, and during the maximum phase of the phenomenon was a truly grand spectacle, with numerous streamers connecting the two bands. The uppermost band finally faded away, leaving the lowermost one still visible but very indistinct, with two or three faint streamers shooting upwards.

I take this opportunity of inquiring what is the most austral or equatorial limit from whence the aurora borealis is visible, or rather has ever been observed? This subject is of particular interest to me from the circumstance that when I was at Darjeeling some years ago I was informed that the phenomenon had been seen from thence, although this well-known hill station is so far south as 27° north latitude. Although it is not impossible for it to be seen from the altitude of Darjeeling (which is 7500 feet above the sea-level), for far away are seen the tops of the Himalayas, I feel convinced that what has been seen from thence, and mistaken for the aurora, is nothing more than the afterglow or reflection from the snow-fields and glaciers upon exceedingly thin masses of aqueous vapour, or rather spicules of snow, floating upwards to 1000 feet or more above the summits of the highest Himalayan peaks. This latter phenomenon I frequently witnessed after sunset, and it certainly possessed the appearance, upon many occasions, of the aurora, hence the mistake, possibly, of unscientific observers. W. Harcourt-Bath.

October 19.

Jupiter's South Tropical Dark Area.

All the transit estimates, numbering fifty-two, of the south tropical dark area on Jupiter, obtained during the apparition of 1908–9, have been reduced to longitude. The area in 1908 December was found to be more than 50° in length at the south equatorial belt. From this date to the close of the observations in 1909 June its dimensions exhibited a gradual increase, and in the latter month it covered considerably more than 90° of longitude. This longitudinal growth was due chiefly to a marked difference in the observed rate of velocity of the two ends of the area. While the preceding end drifted at a pretty normal rate of 15° per month in excess of the adopted zero meridian of System II., the following end exhibited a monthly drift of only 9°. The following part of the area, therefore, was not keeping pace with the preceding portion, and accordingly the object itself became distended in longitude.

The mean rotation period of each end, as well as the middle, of the area would seem to have been as under:—

Number of observations	Number of rotations	Mean daily drift (°)	Mean rotation period h. m. s.
20	430	−0·4823	9 55 20·8
16	295	−0·3754	9 55 25·3
16	379	−0·2989	9 55 28·3

The above period for the following end is the longest that has been recorded, either for this or any other part of the area, the existence of which became known in 1901 February.

Leeds, October 15. Scriven Bolton.

FURTHER EXPERIMENTS WITH THE GRAMOPHONE.

In NATURE of April 15 I described a number of experiments with the gramophone. Since then I have continued to work on this interesting subject, and have at last succeeded in transcribing the vibrations of tones or chords as these are produced by the gramophone; that is to say, during the time that the sounds are given forth. The method is illustrated in the figure accompanying this paper (Fig. 1), and I also give several illustrations of the tracing so obtained. The sounds of the gramophone are carried by a tin tube from the end of the arm of the instrument to which the horn or trumpet-resonator is attached, to a physiologists; but, taking a hint from the use of elasticity in the construction of the reproducer of the gramophone and improved phonograph, I arranged thin india-rubber bands so as to hold the keeper of the tiny electromagnet about one or two millimetres from the small soft iron cores, and so placed that the keeper was kept in equilibrium between two forces, at the distance I have mentioned. I found that with this arrangement, when the gramophone was played, the electromagnetic recorder gave forth the tune with perfect accuracy, and when one touched the keeper it could be felt thrilling on the finger.

The electromagnetic recorder acted like a little telephone. After many contrivances, I found the best method was to place the recorder on the well-known

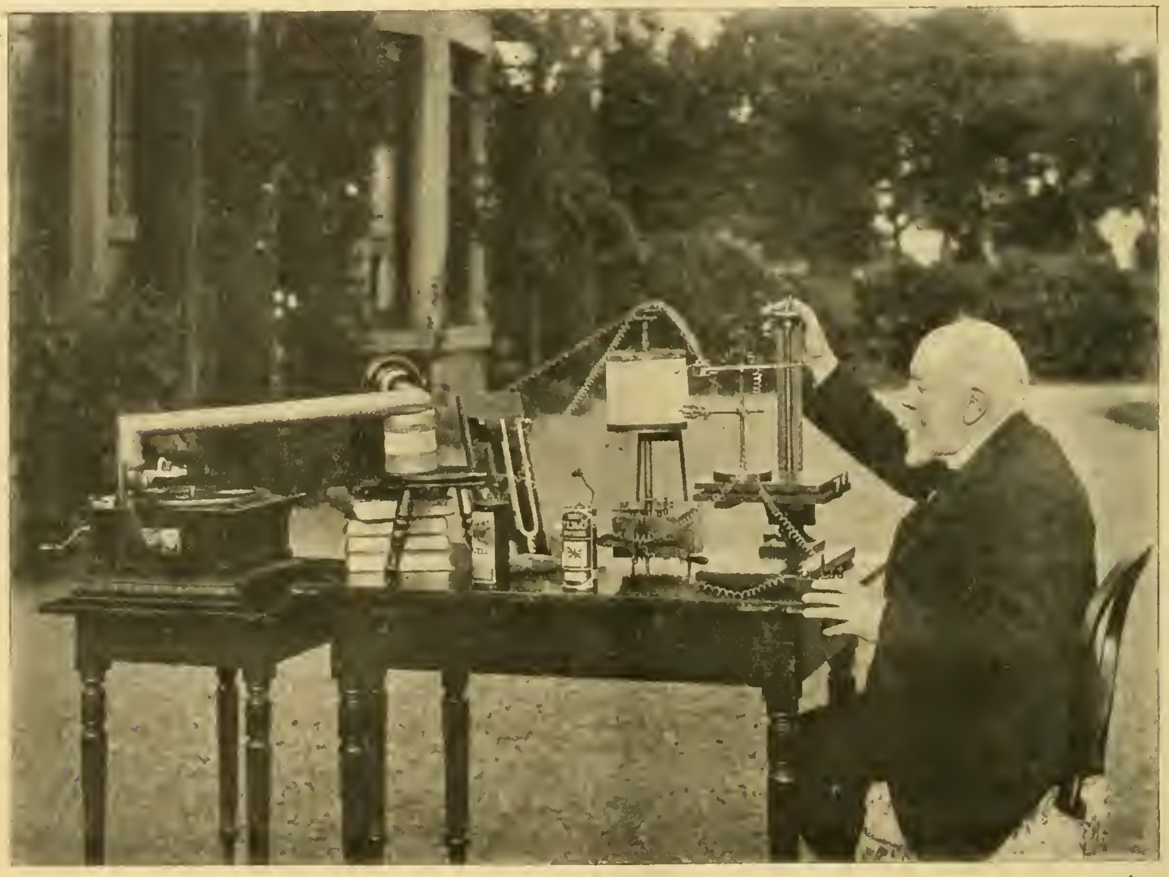


FIG. 1.—Arrangement of apparatus. Gramophone to the left. Observe the tin tube carrying the sound waves to the microphone. The operator is on the right controlling the movable stage. The upper electromagnetic marker adjusted to the cylinder (revolving drum) registers the vibrations of the 1/100th per second tuning fork seen in the middle of the table. The lower electromagnetic marker writes the vibrations of the sound waves as these act on the microphone. While it is registering the lower marker gives forth the sounds played by the gramophone.

sensitive microphone. The microphone used was made by Herr Müller-Uri, of Brunswick, and was intended to be used in the experiment of the singing-arc flame and also for a loud-speaking telephone. In the circuit of the microphone I have five or six dry cells giving a current of about five volts. In the same circuit is the recorder, which is a very small electromagnet having a marker attached to the keeper.

In early experiments I used a large electromagnet acting on a spring that carried a marker, but such an arrangement only recorded notes or chords, as regards intensity, but without showing the constituent vibrations. It was not quick enough. Accordingly I adopted a small electromagnetic arrangement, like a "Deprez-signal," known to Cambridge platform-stand, which can be moved up or down by a finely cut strong screw (see Fig. 1). On the platform I placed a device of my own, by which I could adjust the marker on the smoked paper with great nicety. On the same platform, as shown in the illustration, I placed an electromagnetic recorder controlled by a 100 vib. tuning fork, so as to register on the tracing 1/100ths of a second. The drum used was an old-fashioned Hawksley drum, well known to physiologists, and it rotated at a speed that gave 12 inches per second. The paper was smoked in the usual way over a camphor flame, and, after the tracing was taken, it was fixed by clear shellac varnish. The tracings shown are from slightly enlarged photographs of a portion of each tracing, and the length of each line, from side to side, represents in time 0·3 second. Short descriptions of the tracings are printed below the figures.

The experiment was performed thus:—After carefully adusting the markers on the smoked paper, the cylinder was allowed to rotate until it reached its maximum uniform speed. By closing a key, a time record was taken. Then the gramophone was started; the sound waves acted on the microphone, and the little electromagnetic marker began to sing or play; finally, by having my right hand at the top of the screw, as shown in the figure, I was able slowly to raise the platform, carrying the recorder, so as to describe a long spiral line, about 135 feet in length, from the bottom to the top of the cylinder. On reaching the top, the experiment came to an end. To secure good results, great care had to be taken to secure nicety of adjustment. It must be explained that in the tracings so taken the recorder traverses 12 inches per second. The waves in my tracings are thus compressed laterally. To obtain waves at the speed of the gramophone, I had a wooden cylinder made which was attached to the circular plate of another gramophone, and having a circumference such that the recorder traversed from 21 to 24 inches per second. The two gramophones, one to play, the other to carry the wooden drum, were driven at the same speed. Tracings were thus obtained similar to the indentations or waves on the gramophone record. Trouble arose, however, from the oscillations of the gramophone plate (one of the conditions of the success of the gramophone, in which all the arrangements are more or less mobile), but this difficulty was easily surmounted. Finally, I found that with my arrangement it was not necessary to use the gramophone, as it was easy to record the vibrations of a human voice by causing the singer or speaker to sing or speak direct to the microphone. The arrangement is an excellent phonautograph. About five minutes are occupied in taking a tracing, the average length of which is 135 feet.

An inspection of these tracings shows the wonderful variety of pressures pouring in upon the ear as we listen to music. Three or four or more notes differ-

Fig. 2.—Small portion of tracing of the Westminster chimes. The tracing begins at the left-hand corner at the bottom, runs along the line to the right, then is continued in the next line above, again at the lower left-hand corner, and so on. The length of time represented by the length of one line from left to right is about one-third of a second. The tracings of the 1/100th of a second are seen at the top. The tracing is from the portion of the record giving the strokes of twelve o'clock. Near the top little groups of waves indicate the beats, &c., after the last stroke.

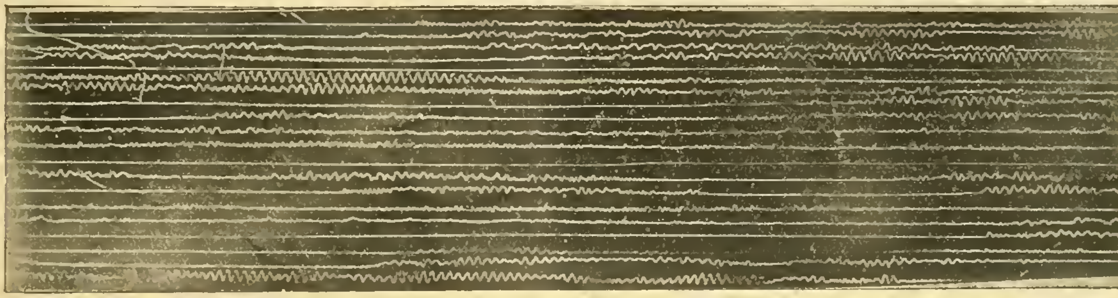


Fig. 3.—Small portion of tracing of a number of male voices singing the "Soldiers' Chorus" from *Faust*. From the La Scala Theatre, Milan. The time relations, &c., are the same as in Fig. 2. Observe the complicated form of the curves.

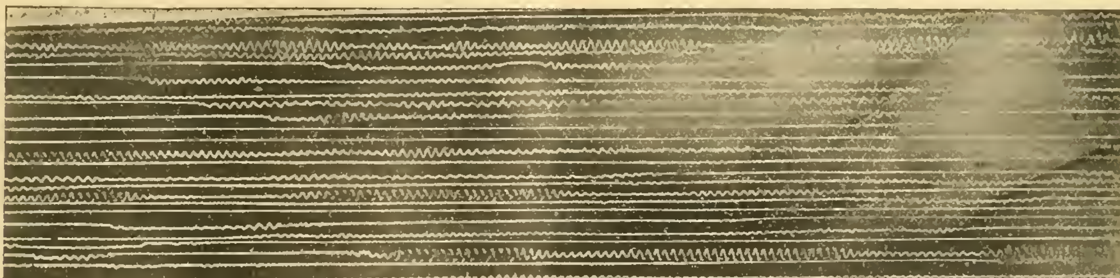


Fig. 4.—Small portion of a tracing giving the vibrations of the voice of Signor Caruso in singing "Spirito Gentile." Time relations, &c., same as in Fig. 2. Observe the crescendo and diminuendo of certain notes, the high pitch of others, and the regularity in form of the waves.

ing in pitch may affect the ear in a second of time. From ten to twenty vibrations, falling on the ear at a certain rate, are sufficient to arouse the sense of pitch of a tone of that frequency. It would seem that with notes of low pitch, within limits, fewer vibrations are required to enable the ear to appreciate pitch, and the opposite holds good with notes of high pitch. This corresponds with the fact that differences of pitch are difficult to detect both in the upper and the lower limits of the scale of audibility, whereas a skilled ear in the middle ranges of the scale can appreciate a difference of one sixty-fourth of a semitone. The tracings also indicate approximately the pitch of any note registered. Suppose three small waves correspond to the wave of the one-hundredth of a second, then the pitch of the note will be about three hundred per second, or (taking the middle *c* at 256) a little below *f*. The highest pitch I have mentioned is g'', or more than 1500 vibs. per second, in the "Bell Song," Lakmé (Delebes), by Madame Tetrazzini. I have also observed that the tracings show intervals in which there is a straight line, with no vibrations. If those intervals are very short, then the interval may not be appreciated by the ear, even with the most careful attention. In all the tracings the wave form is compound, not only owing to the existence of overtones, but also because the voice is usually accompanied by an instrument, the piano, or an orchestra. I took one tracing of voice-tones (a bass voice) with no accompaniment.

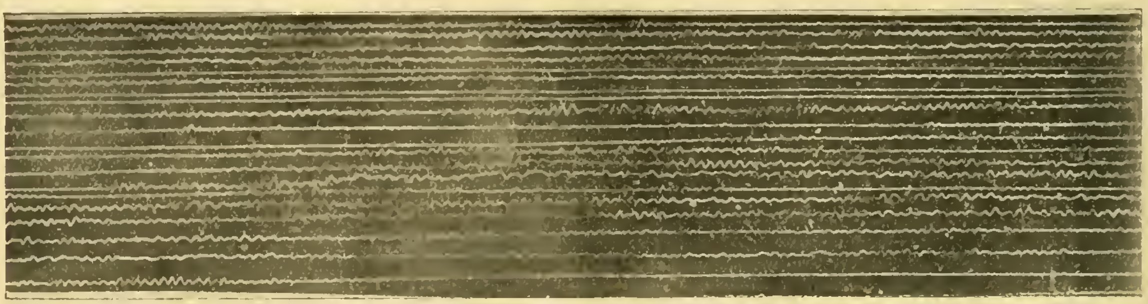


FIG. 5.—Small portion of a tracing from the record of the overture to *Tannhäuser* played by the band of the Coldstream Guards. Time relations, &c., as in Fig. 2. Observe the variations in pitch as indicated by the number of waves in a short period, and the irregularity in form of the waves.

The most complex waves are those produced by the blending of many voices or by an orchestra (see Figs. 3 and 5). Here again there arises a curious consideration. Suppose that in an orchestral piece all the instruments do not *attack* at the same instant, or if one lingers after the rest the fraction of a second, in both cases the wave form and the tracing picture in general will be affected. If the want of coincidence passes beyond a limit, which it is difficult to define, a musical ear finds the result defective, although one can scarcely tell why. Nothing has excited more in my mind a feeling of wonder at the powers of the ear than the inspection of these tracings. Is there a damping mechanism, or is a damping mechanism necessary? May it not be, after all, that our perceptions of musical tones, as in a musical composition, are the result of different *modes* of stimulating the ends of the cochlear nerves? May not innumerable varieties of pressures act on the nerve-endings, possibly as a whole, and send corresponding impulses to the brain? I confess that in the face of these tracings I find it more difficult to realise an analysis in the cochlea; but if not there, where does it take place? That there is an analysis when we make an effort of attention there can be no doubt.[1]

JOHN G. MCKENDRICK.

[1] I have to thank Prof. Noël Paton, of Glasgow, and Prof. MacWilliam, of Aberdeen, for the loan of some portions of the apparatus.

PEAT IN NORTH AMERICA.

FOR many years peat was looked on as a source of fuel in poor countries only, where communications were undeveloped, and where cottagers extracted it by their personal labour for use in their own household fires. To this day, the economist will probably find that this is the best and most practical treatment of a peat-bog. It becomes idle in such cases to speak of relative calorific values, and to point out that, even under present conditions of transport, coal would form a more effective fuel. Where the right of digging peat over a certain area is included in the rent of a small holding, this peat is dug at odd but suitable times, when the crofter or his family might otherwise have remained idle. The cost of labour thus becomes insignificant, especially where creels are used for transport; and even the horse or ass must be fed, whether or no he is engaged in drawing the red cart along the ridges between cutaway boglands, or down the grooved hillside from the high-level deposit on the plateau.

But from time to time capitalists have turned longing eyes towards these stores of carbonaceous matter, and have sought to get rid of the 80 or 90 per cent. of water in the peat, and to produce a fuel economically capable of transport. Others have proposed to produce gas at the bog itself; while others, often with marked success, have manufactured moss-litter for use as an absorbent bedding for city stables and dairy barns.

The various uses of peat have now attracted attention even on the North American continent. Messrs. E. S. Bastin and C. A. Davis have provided an introductory manual on the subject in their description of "The Peat Deposits of Maine" (Bulletin No. 376 of the United States Geological Survey, 1909, pp. 128). They acknowledge that they have been preceded by Mr. Erik Nyström's treatise on "Peat and Lignite: their Manufacture in Europe," issued a year previously by the Canadian Department of Mines. Messrs. Nyström and Anrep have now also published the results of their "Investigation of the Peat Bogs and Peat Industry of Canada, during the Season 1908–9" (Bulletin No. 1, Department of Mines, Canada, 1909, pp. 25).

The deposits in Maine are at present so little utilised that Messrs. Bastin and Davis direct attention to the various ways in which peat has become profitable elsewhere, and, we must admit, to the various ways in which it has been worked without profit to anyone except the makers of machinery. The buildings and heaps of scrap-iron lying derelict beside the bogs of Europe have not yet served to warn those who are fascinated by some fancy process, put before them under seductive influences in the glamour of a well-lit exhibition. The authors of the United States bulletin have no false enthusiasms, and they lay proper stress on the really practical results obtained in the manufacture of peat-coke, power-gas, and moss-litter. They point out the agricultural capabilities of decomposed black peat soils in Maine (p. 57), and the use of dried peat as an auxiliary fertiliser in composts with barnyard manure, and they especially urge the introduction of air-dried peat as an absorbent in stables and as a deodoriser. Descriptions of special bogs follow, accompanied by neat maps in the text. These bogs have been tested with an ordinary ship-auger (p. 60), fixed on 21 feet of ½-inch gas-pipe, and an improved form is described, by which, as in many soil-testers, samples can be still more safely collected at any particular depth. The bogs in Maine appear rarely to be 30 feet deep. As is customary in publications of the United States Geological Survey, sufficient explanations are given of technical terms to enable any intelligent citizen to utilise this handy and scientific treatise.

In the case of the Canadian Survey, general principles have been dealt with in the earlier memoir to which we have referred, and the present bulletin describes in considerable detail certain bogs which possess commercial possibilities, and which lie not far from Ottawa. Lines were run across the bogs, usually 1000 feet apart, and drillings were made in each of these lines at intervals of 500 feet. The samples thus collected were often put together in groups, as representing, when combined, certain areas of the bog; but special local features of interest were noted wherever necessary. An ingenious system of lettering on the maps shows the character of the peat at each point, and its relative suitability for moss-litter or for fuel. The Canadian mode of gathering is by breaking up the surface of the bog so as to promote air-drying, and then stripping off this surface-layer. The bog is thus in most cases worked horizontally, and not vertically, as in Europe. The large scale of the maps inserted in the bulletin, and the completeness of the descriptions, remind one of the fine old bog-survey of Ireland published some eighty years ago, which still remains a standard work of reference. The peat industries of Canada, like those of the United States, are still mostly in an experimental stage, and little more can be said of those organised from time to time in Ireland. Meanwhile, in Europe, at any rate, the humble tiller of the soil, with his old-fashioned hand labour, continues quietly to remove the peat, in which he possesses a clean and economic fuel.

G. A. J. C.

AN ANTHROPOLOGICAL SURVEY OF THE SUDAN.

THAT the study of anthropology is of great scientific and practical importance has been acknowledged of late years by various Governments within the Empire. Our readers will remember that the Indian Government assisted Mr. A. R. Brown in his investigation of the Andamanese, and the Ceylon Government two years ago invited Dr. C. G. Seligmann to study the Veddas. The Anglo-Egyptian Administration, as is well known, fully recognises the far-reaching interest which attaches to the natural and human history of Egypt and the Sudan, and directly and indirectly it has done a great deal to extend our knowledge of the meteorology, geology, geography, zoology, botany, and archæology of these regions. In continuance of that enlightened policy, arrangements have been made to organise an ethnographical survey of the Sudan. Those in authority realise that it is impossible to educate or govern a people without some knowledge of their psychology, and no mere facility with their language will suffice without a knowledge of native customs, ceremonies, ideas, and ideals. Especially is it necessary to record the unwritten laws and usages which regulate private and public life and to appreciate the safeguards for personal and social morality which occur in every community. The native conceptions of the relation of the individual to his fellow and of the authority of the head of the local state are very different from those of Europeans, and it would be disastrous suddenly to break up the structure of native society, to weaken authority, or to promulgate revolutionary ideas. It is also recognised by the Sudan Government that failure in the past has been due to lack of scientific knowledge, and they seek to avoid mistakes in the future by acquiring that knowledge upon which a firm and just administration alone can rest.

In the spring of last year the Sudan Government stated that they were prepared to contribute a sum of money sufficient to enable anthropological investigations to be undertaken in the Sudan for at least two years (a part of this sum is set aside for the publication of the results), and Dr. and Mrs. Seligmann were appointed to conduct these investigations. At that time the Seligmanns were still in Ceylon, and as it would take them several months to work up their field-notes, the Sudan expedition was postponed till this year. The Seligmanns leave England on November 2nd, and will proceed with as little delay as possible to investigate the Dinkas and Shilluks in the Upper Nile Province. Probably they will also study the pagan Nubas of Southern Kordofan, and possibly some other tribes as well.

Those who are conversant with recent anthropological literature are fully aware of the competence of Dr. Seligmann to undertake this work. It is significant of the times that Mrs. Seligmann is officially recognised as a co-investigator with her husband. Judging from what Mrs. Seligmann did in Ceylon, there is no doubt that this enlightened new departure of the Sudan Government will be fully justified. During a part of the time that the Seligmanns are in the field they will be accompanied by Dr. W. H. R. Rivers, who will thus be enabled to compare from personal knowledge the systems of kinship and the sociological conditions of Papuans, Melanesians, Polynesians, and Todas with those of various North Sudanese tribes.

Dr. Seligmann hopes to initiate an anthropometrical survey of the Sudan during the work of the following season.

A. C. HADDON.

NORTH SEA FISHERY INVESTIGATIONS.[1]

THE Blue-book before us, which has recently been issued by the North Sea Fisheries Investigation Committee, completes the second report of the Marine Biological Association on the investigations which they have been conducting in the southern part of the North Sea and in the English Channel, in connection with the international investigations of the fisheries of northern Europe.

A memoir by Mr. J. O. Borley describes the experiments which have been made on board the s.s. *Huxley* in order to determine the probability of survival of trawl-caught fish if they are returned to the sea. From the point of view of the fishery legislator this is a matter of considerable importance, since the probable effect of any law regulating the size at which fish might be placed on the market would depend very largely upon whether or not fish below the legal size, which had been caught in the trawl,

[1] North Sea Fisheries Investigation Committee. Second Report (Southern Area) on Fishery and Hydrographical Investigations in the North Sea and Adjacent Waters, 1904–5. Part ii. Pp. v+345; 8 plates. (London: His Majesty's Stationery Office, 1909.) Price 8s. 9d.

would survive if returned to the sea. The experiments were conducted with both otter- and beam-trawls, and show that fish from long hauls of the trawl are much less likely to survive than those from short hauls, and that the otter-trawl, which is now practically exclusively used by steam trawlers, inflicts much more serious injury on the fish than does the beam-trawl. The effect of exposure of the fish on the deck of the vessel for different periods of time has also been studied.

Dr. W. Wallace writes on the subject of the size and age of plaice at maturity. The method used for determining age has been the examination of the otoliths or ear-stones of the fish, the alternate dark and white rings of which form a record of seasonal growth. The most striking result of Dr. Wallace's work is the determination of the fact that the average size and age of plaice at first maturity varies in different regions. In the central part of the North Sea, around the Dogger Bank, female plaice are, on the average, 16 inches long, and the majority are just six years old when they become mature for the first time. In the southern bight of the North Sea the average size of the females at first maturity is only 13 inches, and the age five years; in the western part of the English Channel the average size is about the same as in the southern North Sea (13 inches), but the average age is four years instead of five, owing to the more rapid growth of the young plaice in the Devon bays. Similar differences are found for the male plaice also, which mature at a smaller size than the females.

The report on records of catches furnished by the captains of Lowestoft sailing-trawlers, which is written by Miss R. M. Lee, shows the value of such records provided by fishermen in supplementing and extending the work done by the scientific steamers. The area worked over by the Lowestoft men corresponds roughly with the southern bight of the North Sea. The analysis of the figures, which Miss Lee has been able to make, indicates that in the northern part of this region plaice occur in maximum quantity by weight during the summer and in minimum quantity during the winter months. In the southern part of the area, on the other hand, the maximum is in winter and the minimum in summer, whilst in the intermediate region there are maxima in spring and autumn. These records, therefore, clearly confirm the southward migration of plaice for the purpose of spawning in winter, which marking experiments in this part of the North Sea had already foreshadowed.

An account of the hydrographical investigations in the English Channel for the years 1904–5 is contributed by Mr. D. J. Matthews, and is illustrated by a series of very valuable plates, which set forth the results in graphic form by means of coloured charts and sections. The importance of these hydrographical investigations in the English Channel in connection with the problems of North Sea fisheries can scarcely be exaggerated, since the Atlantic water which reaches the southern area of the North Sea comes practically exclusively by way of the English Channel. In both the years 1904 and 1905 the salinities in the English Channel reached a maximum in the early months of the year, and fell to a minimum in the summer. The evidence indicates, further, that the movements of the water were more frequent and rapid in 1904 than in 1905. Special attention was given to the conditions prevailing at the mouth of the English Channel, where the two conflicting currents already demonstrated in 1903 were again encountered, a low salinity current flowing southwards from the Irish Channel across the mouth of the English Channel, and a current of high salinity entering the Channel from the south-west.

The volume, as a whole, contains a large mass of data of the greatest importance for the solution of many of the problems dealing with marine life, and more particularly with the natural history of fishes. It must be borne in mind, however, that it is essentially a contribution of data to the much wider and more comprehensive scheme of investigation which is being carried out in connection with the International Council, and not until the whole work which the various countries have done has been brought together and the results duly correlated can the full fruit of these researches be gathered.

DOUBLE-STAR STUDIES.[1]

A COMPLETE record and discussion of the double-star measures made at the Potsdam Observatory by Prof. Lohse, the director, during the period 1899 to 1908 is given in Publication No. 58 of the Observatory. Prof. Lohse employed a refractor made by Schroeder about twenty-five years ago. The objective is eleven inches, and the flint is dark green. It may be described as a good instrument, but not of the highest quality. Nevertheless, we notice that Prof. Lohse was able to secure measures of some difficult pairs, notably δ Equulei, κ Pegasi, and Sirius. The filar micrometer has one fixed and one movable thread. Generally the power employed was 550, but occasionally one of 800 was used. The power ordinarily used with the Greenwich 28-inch refractor is 670, and occasionally 1120. Setting out with a definite programme, he chose a working list of 166 double stars made up of known binaries and others of interest, and during the nine years he was making measures of these systems he collected those made by other observers, and hence was in a position to make a useful discussion of his results.

The present volume is therefore divided into two portions. Part i. contains the measures made at Potsdam, and part ii. their discussion in combination with measures made since the discovery of each pair. Prof. Lohse uses the method of Zwiers to determine his orbits, and discusses altogether thirty. The actual elements arrived at in most cases differ little from previous orbital elements, and do not call for special remark, except, perhaps, in the cases of η Cassiopeiæ and 70 Ophiuchi. The apparent orbit given for η Cassiopeiæ does not seem the most suitable, and brings out a period of 345 years, or 100 years larger than that generally accepted. In the case of 70 Ophiuchi, Prof. Lohse has done a good piece of work in attacking one of the anomalies often found in double-star orbits. It is found that the differences between the computed and observed positions of the companion tend to periodicity. This may be due to some fault in the gravitational theory, to errors due to personality, or to the effect of some disturbing body. The binaries ζ Herculis and 70 Ophiuchi are excellent examples of this, and Prof. Lohse, who favours the personality explanation, has taken great pains to compute the relative areas swept out by the companion to 70 Ophiuchi every six months, and obtains figures in agreement with those deduced by quite independent methods. He is, however, unwilling to admit the reality of the figures, and remarks that by a judicious selection of observations the deviations from the law of equal areas may be reduced. This is the method advocated by Prof. Burnham, but it is not easy to

[1] Publikationen des Astrophysikalischen Observatoriums zu Potsdam, No. 58. Zwanzigsten Bandes, Erstes Stück. Doppelsterne von O. Lohse (Director). Pp. 168. (Potsdam, 1908; in Kommission bei W. Engelmann in Leipzig.)

understand such an attitude in so experienced a computer as Prof. Lohse. However, this only emphasises the thoroughness with which his work has been done. It is a well-planned and complete work, and Prof. Lohse is to be congratulated on making so real a contribution to double-star astronomy.

The following predicted places for 1910·0 for a few of the more interesting binaries may be found useful:—

	°		″
η Cassiopeiæ	241·1	and	6·24
Sirius	89·4	,,	8·87
Castor	220·5	,,	5·44
α Centauri	215·3	,,	19·41

NOTES.

THE third International Congress of Physiotherapy will be held in Paris on March 30 to April 2, 1910. The congress is to be divided into seven sections.

A PRIZE of 160*l.* has been awarded to M. W. Haffkine by the Paris Academy of Medicine for his work on inoculation against cholera.

THE Bradshaw lecture of the Royal College of Physicians of London will be delivered on November 2 by Prof. J. A. Lindsay, who will take as his subject Darwinism and medicine. The FitzPatrick lectures will be delivered by Sir T. Clifford Allbutt, K.C.B., F.R.S., on November 4 and 9. The subject will be Greek medicine in Rome.

THE Société d'Hygiène de l'Enfance of Paris, we learn from the *Lancet*, is offering prizes for essays on the punishments of children. The essays, which must be original, and written in French, German, English, Italian, or Spanish, will be received by the society not later than December 31 next. The papers are to become the property of the society, which reserves the right of selecting from them material for a pamphlet.

ACCORDING to the *Times*, the exhibit of British chemical industries at next year's International Exhibition at Brussels promises to be of great interest and importance. It is stated that the new exhibitions branch of the Board of Trade is already experiencing some difficulty in providing for the requirements of would-be exhibitors, although the area originally allotted to the exhibit has been largely added to.

PRIZES to the value of 1500*l.* are offered by the National Medical Academy of Mexico for work on typhus fever. Of the sum named, 1000*l.* will be awarded to the discoverer of the cause of typhus, or of a curative serum, and 500*l.* to the investigators whose work is judged most useful in helping towards such discovery. The competition is international, but all essays must be written in Spanish. They can be received up to February 28, 1911.

THE annual "Fungus Foray" of the Essex Field Club will be held on Saturday, October 30, at High Beach, Epping Forest, under the direction of Mr. George Massee, of the Kew Museum. Botanists wishing to attend should apply for programmes to Mr. W. Cole, the Essex Museum of Natural History, Romford Road, Stratford, Essex.

THE death is announced of Prof. J. Scott, author of various text-books on farm engineering, and formerly professor of agriculture and rural economy at the Royal Agricultural College, Cirencester.

THE death is reported, in his sixty-third year, of Dr. Irving Stringham, professor of mathematics in the University of California since 1882. He was a graduate of Harvard, and also spent some time in study at European universities. He was the editor of the American edition of C. Smith's "Elementary Algebra," and was the author of a "Uniplanar Algebra."

DR. GEORGE E. POST, whose death was recently reported at the age of seventy, was for many years head of the Medical College established at Beirut, Syria, by the American Presbyterians. He was the author of several medical and scientific text-books in the Arabic language, as well as of a flora of Syria, Palestine, and Egypt in the same tongue. His "Plantæ Postianæ" was written in Latin and French, and published at Geneva. He contributed also to the leading English and American Biblical dictionaries a large number of articles on the flora of Bible lands. In recognition of his work at Beirut Dr. Post received decorations from the Turkish and German Governments.

Science reports the return of the Peabody Museum Expedition, which for the past three years has been exploring the headwaters of the Amazon River in the interior of Peru and Bolivia. The primary object of the expedition was the study of the native tribes of those regions, but, incidentally, collections were made in natural history; meteorological observations were taken, and topographical work was done. A map of the entire region, based on traverses and astronomical observations, was made for the Peruvian Government.

DR. ALLAN KINGHORN has been sent by the Secretary of State for the Colonies to West Africa to investigate sleeping sickness there, with the view of recommending measures for the prevention of the spread of the disease into certain of the British West African colonies. Dr. Kinghorn recently returned from north-east Rhodesia and Central Africa, whence he was sent with Mr. R. E. Montgomery by the Liverpool School of Tropical Medicine to prosecute inquiries into sleeping sickness, and has just completed a report, with Mr. Montgomery, of the Zambezi Sleeping Sickness Expedition.

THE following courses of free public science lectures are announced for delivery in the Manchester Museum:—some forms of vegetation, by Prof. F. E. Weiss, on November 6, 13, and 20; some problems of embryology, by Prof. S. J. Hickson, F.R.S., on January 8, 15, and 22; and the structure of a crystal, by Sir T. H. Holland, K.C.I.E., F.R.S., on February 5, 12, and 19. In addition to the foregoing, Prof. Boyd Dawkins, F.R.S., has begun the delivery of a course of twelve short addresses on geological subjects on Saturday and Sunday afternoons.

WE learn from the *Revue scientifique* that the Institute of France has received a gift of 50,000 francs from M. Patouillard to found two Montyon prizes, one literary and one scientific, of equal value. The latter is to be reserved for some man of science distinguished in electricity chosen by the Paris Academy of Sciences. From the same source we learn that Dr. Von Brunck, formerly director and a member of the committee of management of the "Badische Anilin," has made a gift of 50,000 marks to the Munich Academy on the occasion of the fortieth anniversary of his entry in the industry.

A MEETING was held on October 13 at Christiania to consider plans for the proposed Zeppelin Polar Expedition, at which, the *Times* reports, Prof. Hergesell explained the object of the expedition, which, as at present planned, will last one Arctic summer. It will not be undertaken until the development of the airship has given it an effective scope of 2500 kilometres, or a journey of three or four days without landing. The pioneer expedition may be expected to take place in two or three years' time. Meanwhile, a ship will proceed next summer to Spitsbergen to make preliminary investigations for the purpose of discovering suitable airship anchorages. During 1911 an airship will make long experimental cruises over the sea from a port on the north coast of Germany. In 1912 two airships will proceed to Spitsbergen and establish a central station, equipped with wireless telegraphy, in Cross Bay. The second airship will remain in reserve.

The Royal Scottish Museum has recently acquired by purchase the well-known collection of Scottish Carboniferous fossils formed by Mr. James Neilson, Glasgow. This collection contains more than twenty thousand specimens, among which are many type-specimens of lamellibranchs and brachiopods, which have been figured in the publications of the Palæontographical Society and elsewhere. These are remarkable for their wonderfully perfect state of preservation, many of them showing delicate internal structures, such as the spires of Spirifer. The collection also contains Gyracanthus spines, of remarkable size, and other valuable fish fossils, including the unique *Cladodus neilsoni* (Traquair). Some time must elapse before the specimens can be arranged for exhibition, but, in the meantime, facilities will be given, so far as possible, to experts who wish to study the collections.

A Reuter message from Simla states that the Imperial Malaria Conference, which has finished its sittings, has drawn up a series of conclusions and recommendations under the following heads, among others:—(1) The appointment by the Government of India of a scientific investigation committee, to be linked up with special organisations for dealing with malaria in each province, the investigations to be specially directed to (*a*) the distribution of malaria in India; (*b*) the epidemiology and endemiology of the disease; and (*c*) the actions of quinine and other remedies for malaria. (2) Practical measures, including (*a*) the extirpation of anopheles, regarding which further investigation is recommended in order to discover how this can be done at a reasonable cost; (*b*) minor drainage operations, which are recommended when they are certain to be effective; (*c*) the restriction of wet cultivation near towns when the lands cultivated are known to be a source of anopheles; (*d*) the introduction of fish into tanks and other collections of water; and (*e*) the oiling of small collections of water which cannot be filled up. (3) (*a*) On the suggestion of the president of the conference, Sir Herbert Risley, it is recommended that committees of officials and non-officials, directed by the elected members of the new councils, be formed to spread among the people knowledge regarding malaria and the measures which it is possible to take against it; (*b*) it is also recommended that the subject be taught in the schools. (4) Local Governments should be invited to make an annual assignment of funds for malaria investigation and prevention.

The project of organising and bringing into existence in 1911 a "Scottish Exhibition of National History, Art and Industry" is rapidly taking shape. The object primarily aimed at is to aid, and finally complete, the raising of a fund for the endowment of a chair of Scottish history and literature in Glasgow University; but, according to the *Engineer*, the executive council is considering a scheme of exhibits which takes account of the following:—that there should be a collection of exhibits showing the varied nature of Scotland's industries and of those carried on by Scotsmen in the colonies and abroad, and that in many industries a contrast should be made between the old and the new; that there should be an electricity exhibit, dedicated to the memory of Lord Kelvin; that there should be a shipbuilding and marine engineering exhibit of a historical nature, showing the development of steam navigation in its home on the Clyde; that the river Kelvin should be taken advantage of to represent historic episodes in Scottish life and industry; that the colonies, so largely peopled from Scotland, be invited to tell of the progress of the Scot abroad.

Dr. L. A. Bauer informs us that the magnetic survey vessel, the *Carnegie*, arrived at Falmouth on October 14, twelve days after leaving St. John's, Newfoundland. Magnetic observations were secured every day except one. The *Carnegie* will remain at Falmouth until the end of this month. Having completed the harbour observations and the tests ashore of the instrumental constants, the *Carnegie*, under the command of W. J. Peters, who was in charge of the Pacific Ocean vessel, the *Galilee*, from 1906–8, will go to Madeira, returning to New York, *viâ* Bermuda, about March 1 of next year. The September number of *Terrestrial Magnetism and Atmospheric Electricity* contains an account of the launch of the *Carnegie* at Brooklyn in June last, and her departure on this—her first—cruise to Newfoundland, Hudson Straits, and England. There is a further article, by Mr. J. Craig, jun., on the non-magnetic gas engine with which the vessel had to be provided to enable her to continue her voyages when the wind was not strong enough for sailing. It appears that the cheapest power plant would have been a gasoline engine, but that the cost of maintenance would have been greater than for a gas-producer plant, which was finally selected as best. The material used in construction was mainly manganese bronze, a few of the valves being the only parts of steel or nickel-steel. The engine is of the four-cylinder type, and resembles the regular Craig air-starting engine.

The second Model Engineer Exhibition is now being held at the Royal Horticultural Hall, and will remain open until October 23. The opening ceremony was performed by Sir Hiram Maxim on October 15, and the appropriateness of the selection of this distinguished experimenter in aviation is evident from the very large number of model aëroplanes exhibited. These constitute a special competition class, in which there are more than fifty entries. Many of the designs are original, others are copies of well-known successful types, and we noticed some in which the workmanship was excellent. Considerable variety is shown in the selection of the material for the supporting surfaces; generally fabric is employed, but others having wooden, aluminium, and mica planes are to be seen. There is also a very fine collection of steam and other engines, model yachts, and electro motors. An interesting feature of the exhibition is the completely equipped model engineering workshop in operation. Several firms also show their specialities in machine tools, &c., for model-making. Perhaps the most noteworthy advance in model work recently has been in connection with model motor-boats. At the time of the first exhibition, in 1907, the speed record was 8·76 miles per hour; the present record is above 15 miles per hour, a result which is very creditable to the ability of amateur engineers.

Prof. C. Lombroso, professor of criminal anthropology and psychiatry in the University of Turin, died on October 19 at seventy-three years of age. From an interesting notice of his work and career in the *Times* of

October 20 we derive the following particulars as to his work and career. After graduating at Padua he went for some time to Paris and Vienna to continue his studies. At the very outset of his medical work he was attracted by nervous and mental diseases, and while still a student he published two treatises, one on "Insanity in Antiquity" and the other on "The Insanity of Cardan" (the sixteenth-century mathematician). In the latter essay he first advanced the theory of the relation between genius and crime, which was to form the chief purport of his later work. While serving as a surgeon in the army his attention was attracted at Calabria by the diversity of type exhibited by the soldiery, who were drawn from all parts of Italy. He conducted a series of studies, which he endeavoured to make the basis of an anthropological chart of Italy. He measured and examined no fewer than 4000 individuals, and gained an invaluable experience, which stood him in good stead in his subsequent criminological investigations. The removal of his regiment to Pavia, a university town, gave Lombroso an opportunity of continuing his study of nervous diseases at the district asylum, but his military superiors did not look with favour on these scientific labours; difficulties were placed in his way, and Lombroso finally determined to leave the army. Shortly after, he was appointed professor of psychiatry at the University of Pavia at a small salary. He prepared a short inaugural address entitled "Genius and Insanity," in which all the main ideas of his *magnum opus* were outlined. In 1872 he made a discovery which proved to be of considerable scientific and economic importance. He noted the fact that a large number of the inmates of the asylum were suffering from "pellagra," a curious disease, which first affected the skin and afterwards attacked the brain and nervous system. Lombroso discovered that the disorder was to be traced to a poison contained in diseased maize. Upon his appointment to the chair of psychiatry at Turin Lombroso continued his criminological studies. He was the first to apply the anthropometric method to the study of criminology, and his collection of skulls was unique. He showed that the overwhelming majority of criminals suffered from some form or other of nervous disease. These views are embodied in his great work entitled "L'Uomo Delinquente," published in 1889. Lombroso had a somewhat similar theory for the existence of genius, which he declared was a form of larvate epilepsy; this somewhat fantastic thesis was presented in his "L'Uomo di Genio," which has been translated into several languages.

In Witherby's *British Birds* for October Messrs. W. Davies and F. Coburn record the breeding, during the past season, of the marsh-warbler in Worcestershire. The nest was attached to the stems of cow-parsnip and nettles. Mr. Coburn was of opinion that this was the first record of the breeding of the species, but, as the editor points out, a pair nested in the valley of the Avon in 1892.

The *Selborne Magazine* for October opens with a short biography, accompanied by a portrait, of Sir Joseph Hooker. In connection with the discovery of fossil bones near Crayford, referred to in the report of the Selbornian excursions, the editor will perhaps permit us to point out that no such species as *Canis domesticus* is known to science, and that none of the bear-skulls found in English Pleistocene deposits belongs to the American *Ursus horribilis*.

At the conclusion of a paper on the birds of the mountains of the Malay Peninsula, published in vol. ii., No. 4, of the Journal of the Federated Malay States Museums, Mr. H. C. Robinson expresses the opinion that the fauna is of Indo-Malay origin, and that the species have spread in comparatively recent times north-west from the Sunda islands rather than south-east from Burma. Secondly, that the mountain-fauna is composed of a continental and a Sumatran element, and that the connection with the mountain-fauna of Burma is remote. On the other hand, there appears to be evidence of a recent land-connection with Sumatra, and also that the southern portion of the peninsula has been disconnected from the land to the north.

Considerable interest attaches to the discovery of large quantities of shells of the pearl-mussel (*Unio margaritifer*) in gravel of apparently Pleistocene age in the Thames near Mortlake. Messrs. J. W. Jackson and A. S. Kennard, who record the fact in the October number of the *Journal of Conchology*, state that "at the close of the Pleistocene period the land stood at a much higher level than it does to-day, and the Thames was then a quick-flowing stream in a deep and narrow gorge. . . . The cause of the extinction of the species is explained by the fact that as the land sank the river became more sluggish, and silt and mud commenced to accumulate. Such conditions would prove highly detrimental to its welfare, and the species soon ceased to exist."

Taking as his text the apparent fact that a nematode worm effects an entrance into the swim-bladder of rainbow-trout by burrowing through the intestinal wall, and thereby likewise permits the entrance of bacteria, Dr. A. E. Shipley, in the September issue of the *Journal of Economic Biology*, brings forward additional evidence in support of his view that the appendix vermiformis is a functional, and not a decadent, organ, and that appendicitis is probably due to the presence of entozoa. Messrs. Berry and Lack are cited as evidence in support of the contention that the appendix is a functional lymph-gland, and the author expresses his disbelief in the existence of any functionless organs. The remarkable increase of appendicitis in modern times is attributed by him to the practical cessation of the administration, from time to time, of vermifuges, and certainly no other satisfactory explanation of the phenomenon has been given. If this suggestion be substantiated, it tends to prove that our forefathers were not such fools as we often imagine.

The importance and interest of large and properly classified and arranged collections of photographs—whether these subjects be nature or art—were emphasised by Sir Martin Conway at the Museums' Conference recently held at Maidstone, and his address is published in full in the September number of the *Museums Journal*. Many difficulties must be encountered in forming extensive collections of this nature; but, provided the necessary funds are available, they are not insurmountable, and Sir Martin urges that series of photographs relating to particular subjects ought to be collected by the various museums in the country. If private collectors would also devote themselves to photographs, a system of exchanges could probably be established which would greatly facilitate matters.

The common fresh-water Hydra was one of the first subjects upon which the experimental zoologist exercised his special genius. More than a century and a half ago Trembley demonstrated the remarkable power of regeneration of lost parts which this little animal possesses, and not a few experimenters have followed in his footsteps. Of late years there has been quite an outburst of activity in this direction, and some highly remarkable results have been obtained. The latest contribution is a paper, by Miss

E. N. Browne, in the August number of the *Journal of Experimental Zoology* (vol. vii., No. 1), dealing with the production of new hydranths by the insertion of small grafts from another individual of the same species. This paper is particularly interesting on account of the ingenuity of the methods employed. In order to determine the exact origin of the regenerating material, the author makes use of Whitney's discovery that the green colour can be entirely removed from *Hydra viridis*, without killing the animal, by keeping it for some weeks in a 0·5 per cent. solution of glycerin. The artificial white hydras thus produced form perfect grafts with ordinary green forms, giving rise to parti-coloured colonies in which the boundaries between the tissues of the green and white components remain clearly defined.

Irish Gardening (October) contains various seasonable articles, notably on the cultivation of seakale and the gloxinia. A very charming bell-shaped ericaceous plant, *Zenobia speciosa*, is recommended for the garden by Mr. C. F. Ball; in the variety *pulverulenta* it attains to the dimensions of a good-sized bush. It requires a peaty soil or the nearest equivalent, and is propagated from seed or by layers.

THE *Country Home* (October) appears in an enlarged form from the offices of the *Sphere* and *Tatler*. The botanical and zoological articles are chiefly utilitarian or popular. The intensive cultivation of asparagus is explained by Mr. L. Terasse, and vegetative propagation forms the subject of an article by Mr. W. M. Webb, while Mr. H. B. Buchanan gives advice on the breeding of pigs.

FOLLOWING up a line of work instituted in the United States of America, the examination of parasitic fungi that attack scale insects has been taken up by the Department of Agriculture for the West Indies. Three species of Ascomycetes, *Sphaerostilbe coccophila*, *Ophionectria coccicola*, and *Myriangium Duriaei* are specified in the *Agricultural News* (September 18) as having been taken on scale insects infesting lime or citrus trees in Dominica, St. Lucia, and other islands, and a fourth fungus is noted, but not identified. It is proposed to experiment with cultures of these fungi on nutrient media which could be distributed to cultivators.

THE most striking point in a description of fungus maladies of the sugar-cane, prepared by Dr. N. A. Cobb, and published in Bulletin No. 6 of the division of pathology and physiology in connection with the Hawaiian Sugar-planters' Association, is the attribution of parasitism to the phalloid fungi *Ithyphallus coralloides* and *Clathrus trilobatus*. The mycelium of Ithyphallus was found attached to cane trash and the roots, while the mycelium of Clathrus passed in among the roots of canes where disease was abundant, so that the author classes them with species of Marasmius as sources of root disease. With the view of identifying the mycelium of these Phalloideæ, a special study was made of their sphæro-crystals.

IN connection with a visit of German systematic botanists, Dr. E. Issler prepared an account of vegetation conditions in the Central Vosges Mountains, which is published in Engler's *Botanische Jahrbücher* (vol. xliii., part iii.). The formations distinguished in the montane region are spruce, beech, mixed fir woods, and the vegetation of the forest streams. It is a curious fact that the beech in many places ascends higher than the conifers, the reason being that the upper tree limit, at the low altitude of 4000 feet, is determined by the wind, which the beech is better able to withstand. In the subalpine region different types of flora are provided by the rocks, meadows, and swamp, and in certain parts there are areas of ling and sphagnum moors. Among the rare plants to be found are *Mulgedium alpinum*, *Rhodiola rosca*, *Luzula spadicea*, two species of Isoetes, and *Subularia aquatica*.

THE *Bio-chemical Journal* for September (iv., No. 8) contains a paper, by Dr. Otto Rosenheim, on the nomenclature of lipoid substances. He proposes to classify them in three main groups, the cholesterins, the cerebrogalactosides, and the phosphatides. Prof. Moore and Drs. Wilson and Hutchinson contribute a paper on the biochemistry of hæmolysis.

PROF. HALLIBURTON, in the *Journal of Hygiene* (vol. ix., No. 2, September), directs attention to the fact that large quantities of flour, both in this country and abroad, are artificially bleached. Some experiments he has performed distinctly indicate that both the starch and the gluten are rendered less digestible by the process of bleaching, though whether the change is sufficient to be serious to children or invalids is a question on which there is at present no evidence.

IN the Bulletin of the Johns Hopkins Hospital for September (xx., No. 222), Dr. Charles White discusses in a suggestive manner the municipal management of tuberculosis. He points out that our struggle must be for an immune race, not for the extermination of the last tubercle bacillus. More and more we see the evidence of protection of *small* doses in healthy resistant bodies. In municipalities the aim should be to get rid of sources of large doses of tubercle bacilli, and to establish resistant bodies by healthy lives, mainly in the children.

AN account of the mathematical work of Sully Prudhomme is given by Prof. H. Poincaré in the *Revue générale des Sciences* for August 15. Sully Prudhomme received a scientific education in his youth, but was prevented by ill-health from attending the École polytechnique. That he nevertheless gave a large amount of attention to mathematics is evidenced by the numerous manuscripts left by him, including the rough drafts of a memoir on geometry. It appears, however, that the manuscripts now in existence cannot be regarded as more than rough drafts of ideas which Prudhomme had further developed and considerably modified after writing them. Prof. Poincaré concludes that it would be undesirable to publish them *in extenso*, and he therefore devotes the concluding portion of his paper to a general account of their salient features.

UNDER the title of "The Gambler's Ruin" (*Annals of Mathematics*, x., 4), Prof. J. L. Coolidge discusses certain problems connected with games of chance which have not hitherto received complete treatment. It is pointed out that while the problem of determining the odds that one player may ruin another has been worked out thoroughly for the case where the amount staked at each turn is the same, the case where the stakes are varied, whether they be limited or unlimited, has been less fully discussed. The author considers the "systems" proposed at Monte Carlo and elsewhere, and gives a deductive proof that no such system can have more than an easily calculable chance of success. He concludes with the quotation from Sir Hiram Maxim's book :—"Je me rends parfaitement compte du désagréable effet que produit sur la majorité de l'humanité, tout ce qui se rapporte, même au plus faible degré, a des calculs ou raisonnements mathématiques."

A SYSTEMATIC study of the influence of the surrounding medium on the lines of the spark spectrum has been undertaken by Dr. H. Finger at the suggestion of Prof.

Konen, of Münster, and his principal results are summarised in No. 17 of the *Verhandlungen der deutschen physikalischen Gesellschaft*. A comparison has been made between the spectra of more than twenty metal electrodes in air and in water, the spark being produced by an induction coil of 40 cm., having a capacity of 0·02 microfarad in parallel with its spark gap. The spectra in air and in water were photographed on the same plate, a concave grating of radius 180 cm. being used. The spectra in water show no air lines, but a large proportion of them show a more or less extended continuous spectrum with the lines of water vapour reversed. Some lines are unchanged, while others are broadened on one or on both sides, lines belonging to the same series being modified in the same sense. No trace of the spectra of salts in solution in the water has in any instance been detected.

PART iii., vol. xvi., of the Proceedings of the Cotteswold Naturalists' Field Club maintains the high standard of style and illustration which distinguishes this publication. A large part is concerned with the record of excursions chiefly to places of geological or antiquarian interest, and is illustrated by no fewer than nine plates of photographic reproductions. Of the papers published, the longest is on "The Lower Severn: Valley, River, and Estuary from the Warwickshire to the Bristol Avon," by Mr. T. S. Ellis. The principal aim of the author is to show that the generally accepted views of river development associated with the name of Prof. W. M. Davis are not applicable to the district with which he deals, and by inference to other districts also. His position is indicated by the following sentence:—"As I believe, we cannot have a right conception of the development of rivers unless we keep our minds free from all idea of original lines of streams or of any principal line as the initial condition. In my view, a river system is evolved not *into*, but *from* a network of streams, formed in the drainage area before any definite line of principal stream has been settled." Accounts are given of places and objects of scientific interest visited during excursions, and among these is a record of an excursion to Shepton Mallet and Vallis Vale, which is well known for its romantic scenery and geological unconformities. The report contains the accompanying illustration, reproduced by permission of the council of the Geological Society, of the classic section showing Oolite resting upon Carboniferous Limestone, which was pictured by Sir H. de la Beche. Short papers by Messrs. L. Richardson and C. Upton, and a report by the Rev. H. J. Riddelsdell, on the progress made in connection with the flora of Gloucestershire, complete the issue.

View of Quarry, showing the Inferior Oolite resting unconformably upon the Carboniferous Limestone in Vallis Vale. Photograph by Prof. S. H. Reynolds.

Le Radium for August contains a very useful table of the principal minerals containing uranium and thorium, prepared by M. B. Szilard, of Madame Curie's laboratory. It occupies seven pages of the periodical, and gives the name, the composition, the percentages of uranium and of thorium, the localities in which the mineral is found, and its crystalline form. In addition, a map of the world, in which the localities are shown, is given.

MR. HAROLD MOORE, of Woolwich Arsenal, read a paper on the Brinell method of determining hardness at the International Association for Testing Materials. We note from an abstract in *Engineering* for October 8 that the author's results show that the thickness of the test specimen has no influence on the result provided that the depth of the impression made by the ball does not exceed one-seventh the thickness of the specimen. A safe rule to be adopted is that the distance of the centre of the impression from the edge of the specimen should not be less than 2·5 times the diameter of the impression. For calculating the hardness number, 30° should be chosen as the standard angle of impression, this giving a diameter of impression equal to one-half the diameter of the ball. The hardness number then becomes the mean pressure per unit area when the diameter of the impression is one-half the diameter of the ball. In practice it is convenient to employ a known load, and measure the diameter of the impression obtained. The hardness number is then calculated from the formula

$$H=\frac{16PD^{n-2}}{\pi(2d)^n},$$

where P is the load in kilograms, D is the diameter of the ball, d is the diameter of the impression, and n is a coefficient determined by making two impressions with the same ball and different loads, and applying the formula

$$n=\frac{\log P_1-\log P}{\log d_1-\log d}.$$

A revised impression of Sir Robert S. Ball's little work "Time and Tide" has just been issued by the Society for Promoting Christian Knowledge.

A cheap edition of "Extinct Animals," by Sir E. Ray Lankester, K.C.B., F.R.S., has been published by Messrs. Constable and Co., Ltd. The original edition of the work was reviewed in Nature of November 2, 1905 (vol. lxxiii., No. 1879).

We are in receipt of a new catalogue of books and papers (more than 1400 in number) dealing with ornithology which Messrs. John Wheldon and Co., of Great Queen Street, W.C., have for disposal.

The October classified list of second-hand scientific instruments offered for sale or hire by Mr. Charles Baker, of High Holborn, has reached us. The catalogue, which contains upwards of 1300 items, will be sent free of charge upon request.

MM. A. Hermann et Fils, of Paris, have published a translation into French, by Dr. Paul Lemoine, of Prof. James Geikie's "Structural and Field Geology," which was reviewed in these columns on July 6, 1905 (vol. lxxii., p. 223). M. Michel-Lévy has contributed a preface. The price of the French work is 15 francs.

A new edition (the eighth) of "Quantitative Chemical Analysis," by Clowes and Coleman, has been published by Messrs. J. and A. Churchill at 10*s*. 6*d*. net. The work has been revised and enlarged, but the size of the page having been increased the thickness of the volume remains as before.

Messrs. Constable and Co., Ltd., have sent us a cheap edition of "Time and Clocks," by H. H. Cunynghame, C.B. A review of the first edition appeared in the issue of Nature for January 17, 1907 (vol. lxxv., No. 1942).

OUR ASTRONOMICAL COLUMN.

Mars.—The advisability of watching Mars closely, at this period of favourable opposition, and seasonal changes on the planet itself, is illustrated by a brief message communicated to the *Astronomische Nachrichten* (No. 4362, p. 303, October 9) by M. Jarry Desloges. Whilst the planet was being observed at 9h. 15m. on October 6, a projection was seen on the terminator in the neighbourhood of Electris. This projection lasted for ten minutes only, whilst a similar one observed by Messrs. Lowell and Slipher, on May 25, 1903, endured for only thirty-one minutes; the latter was ascribed to a cloud of dust some 300 miles in length.

In No. 4361 of the same journal M. Jonckheere announces the discovery, on September 28, of a canal which is probably a new one, and extends from Cyclopum Lucus to Hephæstus; the same observer records a further observation of the new land "Stella" on October 7.

A large number of observations of different features are recorded and illustrated by MM. Quénisset and Antoniadi in the October number of the *Bulletin de la Société astronomique de France*. Numerous canals were observed, the Solis Lacus was seen to be divided, and important changes in the colour and visibility of various regions were closely followed. M. Antoniadi is confirmed in his opinion that these changes are caused by the passage of Martian clouds across the various features, and, from the yellowish tinge which colours the indistinct areas, he confirms the opinion expressed by Prof. W. H. Pickering in 1905, that these Martian clouds are probably yellow.

Solar Observations: a Novel Spectroscope.—In order to continue his solar observations, Mr. W. M. Mitchell found it necessary, at the Haverford College Observatory, to devise a large spectroscope which might be used in conjunction with a small equatorial. The telescope at Haverford is of 10 inches aperture and 12 feet 6 inches focal length, and cannot, therefore, carry a large, and consequently heavy, spectroscope of the ordinary type. Acting upon a suggestion from Prof. Hale, he has erected a spectroscope which is mounted upon, and is parallel to, the telescope tube, and finds that the device answers very satisfactorily. The beam from the 10-inch objective is reflected on to the slit of the spectroscope by a 90° prism, and, passing through the slit, is again reflected by a similar prism on to a 3-inch collimating lens of 39 inches focal length. Thence it passes to a grating and back through the 3-inch lens to the eye-piece, the grating and lens being slightly tilted. A negative lens placed between the 10-inch objective and the first reflecting prism gives a larger image, which in Mr. Mitchell's observations was of 3·2 inches diameter. The spectroscope tube is constructed of wood, saturated with hot paraffin before assembling to obviate subsequent warping.

With this instrument Mr. Mitchell gets a resolving power of 70,000 in the third-order spectrum, and was able to observe visually the Zeeman effect in sun-spot lines. An interesting observation on May 11 showed that at one end of a spot "bridge" certain lines were doubled, whilst at the other end, the farthest from the centre of the spot group, the same lines were triple; other lines were double in both regions. A list of lines, recorded as bright in a chromospheric outburst on January 21 7h. to 9h. G.M.T., is also given, and Mr. Mitchell urges the necessity for more laboratory work in connection with chromospheric radiations.

We regret to learn that astronomical observations are to be suspended at the Haverford Observatory, and, consequently, Mr. Mitchell's observations cannot be continued.

The Aurora of September 25.—In No. 4361 of the *Astronomische Nachrichten* (p. 287, October 7) Herr Torvald Köhl records that a fine display of the aurora was observed at Odder, Denmark, on September 21, and adds that a similar display was observed in Stockholm on September 25.

September Meteors.—The appearance of a magnificent fireball on September 27d. 7h. 20m. is recorded by Herr Köhl, who observed it at the Carina Observatory, Odder, in No. 4361 of the *Astronomische Nachrichten*. Herr Köhl finds from his meteor-catalogue that he observed similar apparitions on September 27–28 in ten different years between 1870 and 1909. He also has records of meteors on December 12–13 for eleven years between 1875 and 1908.

Hydrogen Layers in the Solar Atmosphere.—In the *Comptes rendus* for September 20 (No. 12, p. 521) MM. Deslandres and d'Azambuja review the work which has been done in separating the various layers of calcium vapour in the sun's atmosphere, and describe the results of similar researches on the hydrogen and iron vapours recently carried out at Meudon.

The image, obtained by using the centre of the Hα line, differs from the Mount Wilson photographs, and shows the details, exactly, of the K_3 calcium images, the same dark filaments and the same bright areas. The authors suggest that the Mount Wilson images were produced by mixtures of the different parts of the Hα line, and that the sinuosities in the edges of the various sections might produce this effect. In the dispersion used at Meudon 1 mm. = 6 Å.

PERCY SLADEN MEMORIAL EXPEDITION IN SOUTH-WEST AFRICA, 1908–9.[1]

II.

IN the latitude of Loanda (8·9° S.), behind a dry, sparsely populated coastal belt about 150 miles wide, lies a mountainous zone, for the most part densely forest-covered to an elevation of 4000 feet. Within this zone is the historic locality of Golungo Alto, where Welwitsch lived for two years, and in which a large part of his rich collection was obtained. Here he discovered *Gnetum africanum* in 1855.

FIG. 1.—A glade in the Bauhinia forest showing a Baobab just before the beginning of leaf-fall

A few miles to the south-east of Queta, a station on the railway within the forest zone and not far from its eastern edge, is situated the Government experimental plantation (Granja San Luiz), under the energetic direction of Mr. J. Gossweiler, to whom I am indebted for valuable advice and assistance during my residence there from April 1–12. The forests are here very dense and the undergrowth thick and very varied in character. After an unsuccessful search of some days' duration, Gnetum was eventually found on April 7 in a very dense and dark forest on the coffee and rubber estate of Montobello (2600 feet), some thirty miles to the west of Granja San Luiz and ten miles south west from the railway station of Queta. It was very abundant within a strictly limited area and its occurrence is clearly "sporadic," as described by Welwitsch. It may be noted that the native name "N-coco" given by Welwitsch is now applied indifferently to various plants of climbing habit; of Gnetum itself the natives seem to have no special knowledge.

Leaving Loanda on April 16, I arrived on April 21 at Mossamedes, where the third section of the journey commenced. Quite exceptional rains had recently fallen here, as in so many other districts to the south, and the gently rising plains behind the town resembled a waving cornfield rather than a desert. They supported a thick, uniform growth of a tall Aristida (? *A. prodigiosa*, Welw.), among which there flourished a considerable number of small annuals. In sandy places, especially in shallow, dry water-channels, dense crops of the erect plumose awns of Aristida seeds, forced beneath the surface by their hygroscopic movements, were commonly seen. So unusual a supply of food had tempted into the vicinity of the town springbok, gemsbok and other antelopes, while ostriches had reappeared after an absence of many years. Very large Welwitschia plants were found in abundance about eight miles to the south of Mossamedes in the direction of Cape Negro, the locality in which it was discovered by Welwitsch. The plants had coned freely, but almost without exception the cones, severely attacked by a fungus (probably a Cladosporium), were in a state of decomposition—no doubt another consequence of the excessive atmospheric humidity earlier in the season. A large number of young seedlings were found. The Damaraland localities previously referred to, in which no Welwitschia seedlings have been found within recent years, are about forty miles from the sea. But even in these southern latitudes normal seed-reproduction seems to occur on the coast. A recent letter from Dr. Hintrager, Acting Governor of German South-West Africa, contains the interesting statement that "wenige Kilometer nordöstlich von Cape Cross[1] die Welwitschia noch häufig und in fast allen Alterstadien, also auch in jungen Pflanzen vorkommt." It is not improbable that a condition of its seed-germination in nature is a degree of atmospheric humidity which is constantly realised near the sea though now usually absent from desert places inland.

On April 27 I left Mossamedes with the intention of crossing the Huilla plateau and reaching the Cunene River. I was accompanied by Mr. H. G. Mackie, H.B.M. Consul in Angola, to whose kind support the success of this part of the journey was very largely due. The light railway, at present working to the 107th kilometre, leaves Mossamedes in a northerly direction and crosses the broad beds of the periodical rivers Bero and Giroual, in which, near the sea, a few tropical and subtropical crops are cultivated. So far inland as the present railhead, the rainfall is small and inconstant and, in normal seasons, the country is practically waterless. At about 80 km., however, the typical desert vegetation mingles with shrubs and a few dwarf trees, which are found in greater luxuriance on the lower

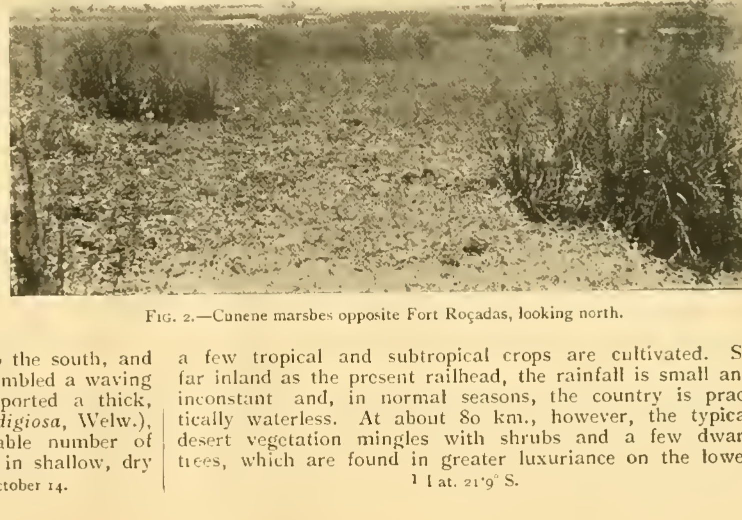


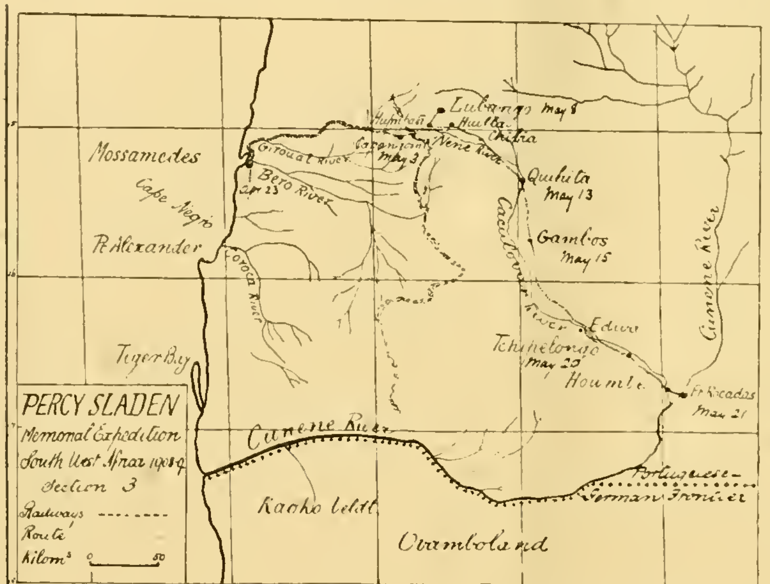
FIG. 2.—Cunene marshes opposite Fort Roçadas, looking north.

[1] The first article appeared in NATURE of October 14.

[1] Lat. 21·9° S.

slopes of the Chella Range. The railhead is situated in an open forest of stunted trees, among which Acacias, a Bauhinia and the Baobab are prominent, with wide, grass-covered glades. This formation extends to the lower slopes of the Chella Range becoming denser as it ascends until, near the summit, it effects a junction with a Savannah, the characteristic species of which include a number of Proteaceæ and other southern forms. The western face of the Chella Range rises sheer to some 3000 feet from the forest which clothes its base, above which the bedding planes of its grey, lichen-covered sandstone are plainly visible. Except for its great extent, the whole range bears a striking resemblance to Table Mountain as seen from Table Bay. Opposite Capangombe there is a gap, the entrance to a kloof up which winds a steep footpath to the top through an increasingly dense, dripping forest, with a magnificent undergrowth of maiden-hair and other ferns. Near the summit a tall Euphorbia with the habit of *E. grandidens* occurs in great abundance.

Leaving the Boer village of Humpata (6000 feet) on May 10, we approached the Cunene along the now well-known track down the valley of the Caculovar. On descending the eastern slopes, which are less steep than the western, we passed through the same changes of flora, in the reverse order, as those already observed



on the other side. Passing the Huilla Mission—the scene of the botanical labours of Fathers Antunes and Dekindt—we arrived on May 13 at Chibia (4500 feet), where the proteaceous flora thins out and gives place again to the open, dry forest, in which the Bauhinia and Acacias in turn predominate. Henceforward the surface, frequently broken by tumbled heaps of gneiss and ironstone, 50 feet to 500 feet high, slopes gently down to the Cunene. From Gambos (4100 feet) the water-supply, after the end of the rainy season (April), is meagre and its quality bad, and the whole district is fever-stricken. The temperature becomes very high after mid-day, and whirlwinds of great violence spring up very suddenly, and carry columns of dust and other light objects to great heights. Three hours by waggon from Houmbe brought us to the Cunene marshes, which are here confined to the right bank of the river. Owing to the unusually late rains they were still nearly two miles wide, and it was with great difficulty that a crossing to Fort Roçadas on the opposite bank was effected. This stronghold is placed upon the high calcareous cliff forming the left bank of the river. Its neighbourhood, the scene during recent years of many engagements between the Portuguese and the trans-Cunene Ovambo tribes, has become so extremely unhealthy that it will in future be manned entirely by native troops.

The country at its foot is thickly studded with small Baobabs and away to the east the open Acacia and Bauhinia forest again prevails, and undoubtedly merges farther south into the thorn-bush of Ovamboland and the Acacia park-formation which extends far to the south of Okahandya and Windhuk.

I take this opportunity of acknowledging the effective support which has been very kindly given to the objects of the expedition by Their Excellencies Sr. Capt. H. de Paiva Couceiro, Acting Governor-General of Angola; Herr Regierungsrath Dr. Hintrager, Acting Governor of German South-West Africa; and the Hon. W. F. Hely-Hutchinson, G.C.M.G., Governor of Cape Colony.

H. H. W. PEARSON.

MODERN METHODS OF ILLUMINATION.[1]

A GREAT change has come over the methods of lighting within the last few years. We have now at our disposal means of lighting which would have seemed incredible a few years ago. Step by step with these developments has taken place the progress of education and the increase of printed matter, with the result that we use our eyes to-day far more than in the past. Our main object, therefore, should be to consider the subject of illumination from the point of view of the impression received through the eye. After emphasising this aspect of illumination, Mr. Gaster proceeds with a summary of recent developments in electric lighting.

Electric Glow-lamps.

It has long been known that a carbon filament glow-lamp could be made to yield more efficient results by bringing it to a higher temperature, *i.e.* running it at a pressure higher than that ordinarily utilised, but such a gain in efficiency has only been found possible at the expense of life and durability.

Within the last few years we have seen the development of lamps with filaments made of other and more refractory materials, such as the Nernst lamp, and the various metallic filaments, such as osmium, iridium, tantalum and tungsten, &c. The two last-named lamps, of course, now play a great *rôle* in electric lighting.

In addition, attempts have been made to improve carbon filaments in the United States by the graphitising process of Mr. Howell, by the aid of which a consumption of 2·5 watts to 3 watts per candle was attained. Another interesting attempt in this direction is the Hopfelt lamp, in which the carbon filament burns in an atmosphere of mercury vapour, with, it is stated, a consumption near 1·5 watts per candle. The Helion lamp, again, is believed to utilise a filament mainly composed of silicon; it is claimed to run for 1000 hours at 1 watt per candle, and even in the open air, without requiring to be enclosed in an evacuated globe; but it has not yet come upon the market. Perhaps the best known metallic filament lamps in use at the present day are those utilising the metal tantalum and those described by various names, but generally believed to contain as the main constituent the metal tungsten. Tungsten lamps are burned at a consumption approaching 1 watt per candle-power, and are generally stated to have a life, under good conditions, of 1000 burning hours. One great difficulty, however, has been the manufacture of lamps of moderate candle-power for high voltages, and capable of being used in any position; very recently, however, lamps having as low a candle-power as 25 or 30, and for pressures extending to 200 volts to 260

[1] Abstract of a series of four Cantor lectures delivered by Mr. Leon Gaster before the Royal Society of Arts and published in the Journal of the Society for August 6, 13, 20, 27; September 3, 10.

volts, have been produced; one company has even professed to manufacture a 200-volt 16-candle-power 25-watt lamp.

Attention may also be directed to the cooperation between the lamp-makers and the electrical supply companies characteristic of the United States, and to the work of the National Electric Lamp Association in that country. A large number of lamp-makers belong to this association, determine standard prices, and support a laboratory for the purpose of carrying out common tests on lamps for their mutual benefit. In addition, the cooperation between lamp-maker and supply company is naturally very beneficial to both parties in pushing the sale of lamps in desired directions.

Electric Arc-lamps and Vapour-lamps.

The most marked development in arc-lamps of late years has been the introduction of flame carbons, that is, carbons such that the light comes from a bridge of incandescent vapour instead of the tips of the electrodes. By this means consumptions so low as 0·2 watt to 0·3 watt per mean spherical candle-power are said to have been obtained. Flame carbons, however, burn away very quickly, and in order to extend their life lamps in which a succession of carbons is automatically used have therefore been introduced. Another development, the enclosed regenerative lamp, involves methods enabling the access of air to the carbons to be restricted, so that a high efficiency, and yet a fairly long life, is obtained. Mention must also be made of the new Blondel flame carbons, yielding a very white light, which have been stated to yield a polar curve of light-distribution specially well adapted for street lighting, and are burned vertically one above the other.

Another direction of progress has been the improvement of small candle-power enclosed arc-lamps, which formerly served to bridge the gap between high candle-power flame arcs and glow-lamps. By securing more complete exclusion of the air from the globe, the Regina Arc Lamp Company claims to manufacture a lamp consuming only 0·8 watt per candle, and lasting for 250 hours without recarboning. High candle-power metallic filament incandescent lamps, which are manufactured up to 1000 candle-power, now also serve to fill this gap.

The chief drawback of mercury-vapour lamps is, of course, the peculiar colour of their light, there being practically no red rays. It has, therefore, been proposed to mix certain salts with the mercury, to use fluorescent materials, &c., in order to improve the spectrum, but few such devices have come to a practical issue. A recent advance has, however, been achieved by Dr. Küch, of Germany, by the use of a tube composed of special quartz-glass, which can stand a very high temperature. By this means a consumption of only 0·27 watt per mean spherical candle-power is said to have been obtained; an incidental advantage is that the luminescence in the tube seems to be partially replaced by temperature radiation, and therefore the light contains a distinct red element, the spectrum broadening out into a more or less continuous band instead of consisting of isolated lines.

In addition, quartz-glass allows ultra-violet light to pass through with special ease, and the lamp is therefore believed to have special uses for the destruction of bacteria, photographic purposes, &c. For ordinary illuminating purposes a special absorbing glass envelope restricting these rays is used. The Moore tube utilises gases in a rarefied condition and subjected to a high-tension alternating discharge. The essential feature of this arrangement is the use of a valve which automatically keeps the condition of the gas within the tube constant.

Gas Lighting.

Great advances have been made in the efficiency of gas burners since the early flat-flame burners yielding only about 3 candle-power per cubic foot. The most recent figure is furnished by the Keith high-pressure light, for which 60 to 70 candles per cubic foot have been found by some observers.

Improvements have been made in the incandescent mantle both in the direction of the colour of the light and through durability. Even so, manufacturers in England have stated that, as a rule, mantles require renewing every 200 hours.

A new departure was introduced some years ago by the Plaissetty soft mantle, and more recently the Cerofirm Company is stated to have made advances in the same direction. For such mantles it is claimed that their softness renders them convenient for package, and that they naturally burn into the shape of the flame, and are thus used under the most efficient conditions. The introduction of the inverted mantle has, of course, also been a great advance, although only two years ago there were many who doubted its commercial possibilities.

At the same time, steady improvements in the design of inverted burners have proceeded. Many types on the market are specially designed to avoid discoloration of the fitting through heat, to secure all the conditions most favourable to complete combustion. Whittaker and Litle in the United States, and, more recently, Lebeis in Germany, have described thermostatical methods of automatically regulating the access of air to the burner, which frequently requires adjustment, as the burner after lighting gradually becomes heated.

Perhaps the greatest advance has been in the direction of *high-pressure* gas lighting, which serves to promote an intimate mixture of gas and air, favouring complete combustion. To this end gas at high pressure may be used, or air at high pressure led into the burner, or a mixture of gas and air at high pressure. In any case, however, special external arrangements are needed with an existing low-pressure installation. Self-contained, highly efficient lamps, which can be run off the ordinary low-pressure supply, have therefore been designed. For instance, the Lucas lamp employs a small fan driven by an electric motor, which receives current from a thermopile near the mantle. In the Chipperfield lamp, a small hot-air engine placed above the burner automatically pumps air under pressure into the burner.

An important field in gas lighting is the use of automatic ignition devices. These may consist of electric sparking apparatus, of clock-work arranged to turn on and off the gas by means of a bye-pass at specified hours, or automatic devices of the same type manipulated by a rise or fall in pressure. Clock-work systems are very trustworthy, but, of course, do not take account of peculiar atmospheric conditions, such as fog. Apparatus of the last type can be controlled from the station, and lamps can be lighted up or extinguished as the engineer desires.

Mention must also be made of the special Norwich system for interior lighting and of the pneumatic methods; these, too, involve the use of the pilot flame.

The subject of street lighting formed the object of study of a deputation to the Continent recently appointed by the Corporation of London, and was subsequently investigated by the lecturer in a visit to Germany. A novelty of considerable interest, with which experiments are being made at Stuttgart, consists in slinging gas lamps on wires spanning the street, just as is done in the case of electric arc-lamps in Cannon Street at present. Lastly, in this section of the subject, the lecturer refers to the recognition of the importance of the heating power of gas, which is now regarded as more vital than its "illuminating power," according to the prescribed tests with flame-burners, for modern methods of lighting, and discusses the suggestion of a calorific standard in the future.

Gas, Oil, Acetylene, and other Self-contained Methods of Lighting.

The simple method of lighting by petroleum lamps, the author points out, should not be neglected. It is used, for instance, in the Church of St. Sophia of Constantinople, where it is preserved on account of its decorative value and because of religious tradition. In addition, petroleum lamps are still used in the country, and give good results when properly handled; in this connection the researches of Mr. Guiselin, who has demonstrated the advisability of keeping the reservoir in oil lamps well filled, are of interest. For instance, the illuminating power was found to be improved by 20 per cent. when 700 cubic centimetres instead of 500 were retained in the reservoir.

Recently many methods of incandescent oil lighting, that is, the use of vaporised fuel with an incandescent mantle, have been devised. The Kitson system and the Empire light are stated to be very efficient for lighthouse work and for the illumination of large outdoor areas in remote localities. Other types of lamps are the Blanchard, the Petrolite, &c., which are described in detail.

A special account is also given of petrol air-gas lighting, three typical systems, the Machine Gas Syndicate (Cox's system), the Aërogen, and the National Air Gas, being exhibited. This system of lighting has attracted great attention recently for the lighting of private houses in districts where gas or electricity are not available. A mixture of a small percentage of petrol vapour with air is generated outside the building, and passed through pipes to the burner in the usual way.

The method of lighting by alcohol lamps is worth consideration in agricultural districts where petroleum may not be available, but alcohol is readily manufactured. There are also a number of liquid-gas systems in which gas is stored under pressure in liquid form, and has been effectively used for railway-carriage lighting, &c.

Acetylene Lighting.

Mr. Gaster deals briefly with the historical development of acetylene lighting, and describes the modern form of generator and several types of portable acetylene lamps; these are frequently used in mines, for motor-cars, &c.

Acetylene, like petrol-air gas, finds its main application where gas and electricity are not available. A recent development of considerable interest is the method of dissolving acetylene in acetone, which, at a pressure of ten atmospheres, absorbs about 240 times its own volume of acetylene, but liberates it when the pressure is released. Tubes of dissolved acetylene have been widely used for portable lighting, on motor-cars, railway trains, and even in emergencies for interior lighting. Perhaps one of their most successful applications, however, is for the lighting of buoys and beacons in remote localities.

There are several types of ingenious valves which are very effective in saving the consumption of acetylene in the above circumstances. For instance, the Dalen solar valve automatically cuts off the main supply of acetylene in daylight, leaving only the bye-pass burning, and rekindles it at night.

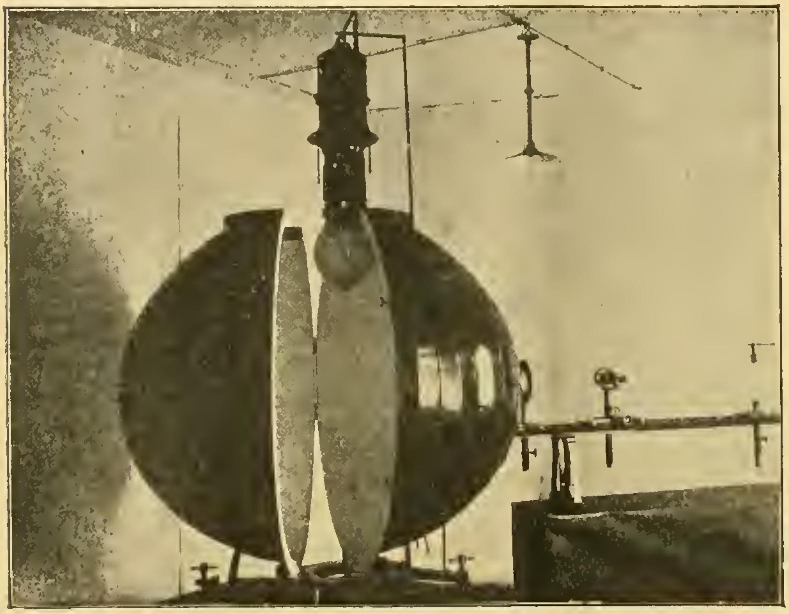
General Problems in Illumination.

In the last of these four lectures Mr. Gaster discusses the question of illumination in general terms. He again directs attention to the increasing brilliancy of modern illumination, and points out that the eye must have developed mainly in compliance with daylight conditions, and therefore we ought not to utilise artificial methods of lighting differing too widely from diffused daylight. The importance of providing for proper access of daylight in the design of buildings, particularly schools, is insisted upon. In this connection, the choice of wall-papers and the scheme of decoration are of considerable importance.

It is pointed out, too, that the intrinsic brilliancy of illumination has gradually increased of recent years. The effect of gazing directly upon such bright sources is very fatiguing and distressing to the eyes, and the author suggests that the time is now ripe for Governmental recommendations on this point.

In order to reduce the intrinsic brilliancy of light sources, suitable shades may be employed, and special reference is made to the Holophane diffusing globes and reflectors, which enable the light to be distributed and concentrated in any desired direction.

Some particulars are given of recent progress in photometry. The line of development of special consequence has been the introduction of so-called illumination photometers, which measure, not the actual intensity of the source, but the actual illumination on the pavements or at the desk at which we read. Sir William Preece so long ago as 1883 emphasised the value of such measurements. Another interesting development is the Globe photometer, an example of which is shown in the accompanying illustration.



The Ulbricht globe photometer, by the aid of which the mean spherical candle-power of a source can be determined by a single measurement.

Perhaps an exceptionally important development during the last year has been the establishment of the international unit of light between England, France, and the United States, and the recognition of a simple relation connecting this unit with the value in use in Germany. The success of co-operation in this direction in this country is felt to be largely due to the fact that representatives of the gas industry and the gas referees were invited to act with those connected with electricity on the commission studying this subject.

Turning next to some practical examples of illumination, the author insists upon the importance of adequate school lighting, quoting many authorities to show that the eyesight of school children deteriorates during school life; he suggests that tests of the children's condition should be accompanied by the preservation of data relating to the methods of illumination employed in such schools, as this is believed to have a very vital influence on the health of the child.

In the same way the lighting of factories, hospitals, libraries, &c., should receive very careful study, for good illumination is as much a necessity as the provision of adequate sanitation and good ventilation; it is hoped that in the future, conditions of illumination, like the matters referred to above, will become the subject of Government inspection and recommendation. In addition, it is pointed out that even from the point of view of expediency employers would do well to pay attention to this matter, as a relatively small expense involved in securing good lighting is more than counterbalanced by the improvement in the quality and output of work. In hospitals it is obvious that the lighting should be exceptionally perfect, since people in an invalid condition are specially liable to feel the effect of bad methods of lighting.

Libraries, again, are frequented by people engaged in strenuous work and taxing their eyes severely; it is therefore suggested that in this case also no pains should be spared to make the methods of lighting convenient to the workers, and that when great expense is incurred in collecting valuable books and housing them in handsome buildings, the provision for the necessary illumination by the aid of which the books alone can be read should not be grudged.

A subject on which cooperation between different authorities is badly needed is street lighting. It is pointed out that there is room for the establishment of some central testing department where thoroughly trustworthy and impartial tests could be carried out and used for the common benefit of those interested. In particular, it is suggested that it cannot be decided by the mere personal impression of a non-technical body of observers whether the lighting of the street is good or bad. This must be determined by the aid of precise scientific tests, carried out by impartial experts, who have made a thorough study of the subject, and can provide records by which experiences can be checked and subsequently repeated.

Other instances of problems in illumination in which there is great field for scientific treatment are shop-window lighting, stage lighting, and light-house illumination; in the two former fields, in particular, there is ample scope for the ingenuity of those who are up-to-date in their knowledge of the different illuminants, and possess, in addition, the requisite taste.

In the next section of this lecture Mr. Gaster deals with the scientific basis of light production, pointing out how the nature of the radiation from an illuminant depends in general upon its temperature, and indicating some of the possible lines of future development. The figures of authorities in this matter differ very greatly, but it is generally considered that the percentage of energy radiated in the form of light is very small indeed. The problem of light production is complicated by the fact that some invisible kinds of radiation seem to exert a prejudicial effect on the eye. The author describes some experiments showing the nature of the ultra-violet rays, which some authorities consider to be injurious.

In conclusion, Mr. Gaster points out that the problem of illumination is a complex subject which deserves special consideration by itself. There is a need for men who are not connected with any particular illuminant and who are able to take a wide view of the different aspects of the matter, so as to deal with modern problems of lighting. In order to focus interest in this subject and to bring into contact the engineers, architects, oculists, and others interested in illumination, a society has been formed this year which will, it is hoped, gradually lead to the solution of the important questions on which further exact data are felt to be desirable; this is termed the Illuminating Engineering Society. The first president of the society is Prof. S. P. Thompson, and the opening session will commence in November.

ANNUAL METEOROLOGICAL REPORTS.

THE Deutsche Seewarte has issued part xvii. of its over-sea meteorological observations for 1907, containing very carefully prepared summaries, and in some cases individual readings, at some thirty stations. The principal localities include Labrador, Morocco, Shantung, German East Africa, and some islands in the Pacific Ocean; there are also some isolated stations, including one recently established at Babylon. Scientific investigators will be grateful to the Seewarte for references which are given in all cases to the periodicals in which previous observations and results have been published.

The annual report of the Philippine Weather Bureau for 1907, part i., contains hourly readings at the Manila Observatory, together with means deduced therefrom. The tables also show the extreme values recorded, and the departures of the monthly and yearly means from the average. The mean temperature of the year, 79·5°, was practically normal; the absolute extremes were 98·1° in April and 59·0° in January. The rainfall, 72·5 inches, was 3·3 inches below the average; of this amount 64 inches fell from June to October inclusive (the period of the south-west monsoon). An appendix shows the greatest daily and hourly rainfall registered at the observatory in past years; the greatest daily falls were 13·3 inches and 12·1 inches, on September 24 and 25, 1867.

The report of the Liverpool Observatory for the year 1908 has been received from Mr. W. E. Plummer. This useful establishment is maintained by the Mersey Docks and Harbour Board in the interest of shipping, and is well provided with meteorological and astronomical instruments. In addition to the continuous use of the transit instrument for the determination of time, observations of selected stars and of comets visible from the observatory formed the chief astronomical work of the year. A Milne seismograph for the registration of tremors in the earth is kept steadily at work; during the Messina earthquake (December 28) the duration of disturbance was 1h. 41m., and the amplitude (half the complete range of maximum motion) was 15 mm. The meteorological results are very complete, *e.g.* the wind observations show the maximum velocity for each day recorded by Dines's apparatus, the extreme pressure on the square foot by Osler's anemometer, the horizontal motion by Robinson's anemometer, and the number of hours that the wind blew from different points of the compass. The mean temperature of the year (49·2°) was practically normal, and the rainfall (28·9 inches) slightly above the average.

The annual report of the United States Weather Bureau for the fiscal year ended June 30, 1908, shows that the research work at Mount Weather Observatory has been carried on without material curtailment, notwithstanding the destruction by fire of the administration building in October, 1907. Investigation of the upper air by means of kites and captive balloons is made daily (except Sundays), and the data are telegraphed to Washington for the use of the forecast division. The work on solar physics includes the measurement of solar radiation and the degree of absorption by the atmosphere. Considerable discrepancies exist in the values of the solar constant, even computed from observations on the same day at Mount Weather and at Washington; in most cases these are traceable to the unsteadiness of the atmosphere. Great activity exists in the divisions dealing with land and ocean meteorology; the number of climatological stations now exceeds 3700, and more than 1600 vessels cooperated with the Bureau during the year. All data referring to the Indian Ocean are lent to the Indian Meteorological Department, where they are copied and returned. In the forecast division isobaric charts are prepared from daily telegraphic reports from selected stations throughout the northern hemisphere, and forecasts for about a week in advance were published during the last three months of the year. The library now consists of about 28,000 books and pamphlets. In addition, meteorological articles contained in periodicals and transactions are catalogued under both author and subject; this bibliography is said to be more frequently consulted than the catalogue of books.

The Survey Department of Egypt has published its meteorological report for 1907, containing hourly readings at Helwan and climatological tables at thirty-five stations of the second and third order; the monthly tables give tri-daily readings in the form adopted by the International Meteorological Committee, and also include the daily amount of evaporation, as that element is of considerable importance in Egypt and the Sudan. Additional tables include hourly observations by Dines's pressure anemometer at Alexandria, rainfall and wind direction for a number of stations, and river-gauge observations. In compliance with a desire expressed by the International Meteorological Committee in 1907, tables of normal values are also given. Rainfall was in excess in Egypt and in North Sudan, but in considerable defect throughout the rest of the Sudan, and, as we have previously stated, the Nile flood was worse than any recorded during the past fifty years.

The meteorological year-book of the Bremen Observatory for 1908 has been received. From small beginnings this institution, under the superintendence of the late Dr. P. Bergholz, has attained a position of considerable importance; the observations, which include hourly readings and means, with monthly and yearly summaries, have been reduced by Prof. Grosse in the same thorough manner as heretofore, with the addition of hourly tabulations of sunshine records and monthly means of earth temperatures. The valuable materials, which now extend over many years, await a general scientific discussion; this desideratum is urgently pointed out by Dr. Grosse, but under present arrangements, while the director has to divide his energies between the observatory and other official duties, this important work has to be postponed.

WORK OF THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT IN 1908.

FROM the annual report of the above institution for last year, recently published, we find that the same steady progress is made in research work of a varied nature; the following notes give some particulars of a few of the more interesting investigations completed or in progress in 1908.

The saturation pressure of water vapour between 50° and 200° was determined as a continuation of the experiments in the previous year, the resultant pressures being tabulated in the report. The limit of accuracy over the whole range depended on the measurement of temperature, and the greater part of the work was devoted to such measurements. In the neighbourhood of 100° the temperature scale could be considered as trustworthy to 0·01°, and at 200° to 0·02°. The platinum thermometers used were compared at 150° and 200° with the nitrogen thermometer, after the constants of the latter had been determined, the comparison being made in an electrically heated oil-bath.

The experiments on the heat of evaporation of water, which were previously made between 30° C. and 100° C., have been continued for temperatures above 100°. Up to the present it had only been possible to obtain the values for the evaporation-heat from Regnault's observations of the total heat by calculating the heat of the water. It therefore appeared desirable to make direct measurements of the evaporation-heat. The experiments were carried out between 100° C. and 180° C. The results show that in the first approximation it is admissible to extrapolate beyond 100° the formula

$$L = 94{\cdot}210(365 - t)^{0{\cdot}34129} \text{ Cal. } 15,$$

which has been drawn up for the evaporation-heat L between 30° C. and 100° C. as limits for t.

The work connected with the silver voltameter was brought to a conclusion, and a paper published dealing with the subject. The object of the measurements was (1) to compare with the aid of the voltameter and a resistance the E.M.F. of the Weston normal cell, which was last determined by means of the silver voltameter in 1898; (2) to determine the accuracy attainable in measurements with the silver voltameter (*a*) under conditions which are as regular as possible, and (*b*) with a variation of the factors in connection therewith. It was found (as at the National Physical Laboratory) that the differences obtained by Richards and by Schuster, attributable on the one hand to the influence of the anode liquid, and on the other to that of the oxygen, could not, within the errors of observation, be confirmed.

Particulars of the changes in shellacked manganin coils due to varying humidity were published in 1908. The changes in question are so slight in the German climate as only to be of importance for resistances equal to or greater than 100 ohms, and even then only for measurements of the highest precision. For resistance standards of 1000 and 10,000 ohms the changes during the summer of 1908 amounted to 5 parts in 100,000 only. By taking the precaution of keeping resistances in a hygrostat of 50 per cent. humidity the constancy of all resistances up to a 100,000-ohm coil was secured. A comparison of the mercury standards with the manganin coils is in hand.

Various institutions (*e.g.* the National Physical Laboratory, Teddington, and the Bureau of Standards, Washington) have issued specifications for the setting up of standard cells, and detailed instructions are given for the preparation of the mercurous sulphate. It is directed that this salt shall not be washed with water, but with dilute sulphuric acid or with a saturated solution of cadmium sulphate. The Reichsanstalt is of opinion that the manner of washing the preparation is without influence on the result. It follows from this that the same E.M.F. results whether the salt be hydrolysed or not.

In connection with the research on anode rays mentioned in the last report, it was found that when in the presence of substances which emit intense anode rays the electro-negative bodies such as iodine, bromine, &c., considerably favour the formation of the rays. It was found that the red and blue fluorescent tints of glass which can be produced by slow kathodic rays can also be caused by sufficiently dense kathodic rays. For the blue fluorescence it was shown that they are connected with the emission of negative electrons. A fixed point for the presence of the positive electrons could not be ascertained.

The experiments commenced in 1907 on the electrolytic properties of silver and copper were concluded, and show that silver in the aqueous solutions of HCl, HBr, and HI, and copper in the aqueous solutions of HF indicate an electrolytic valvular action which does not appear, as in the other metals, to be caused by a gas stratum, but by a solid stratum.

For the determination of the absolute values of standards of self-induction, which are made by comparing with capacities measured absolutely, a standard air condenser was constructed. The new air condenser consists of 107 magnalium discs of 20 cm. diameter, 1 mm. thickness, and 1 mm. apart. It has a capacity of about 0·03 mfd. Amber is used for insulating, the insulation resistance being of the order 10^{15} ohms.

The work done in the magnetic laboratory includes a comparison of the methods of testing magnetic materials and experiments on initial permeability. An exhaustive series of measurements of self-induction was carried out with high-frequency alternating currents, and papers bearing on this subject have been published. A rotating interrupter for absolute capacity measurements by Maxwell's method is described.

A number of tests were made on various forms of flicker photometer which could be used on a straight photometer bench, with the view of determining whether the use of the flicker photometer is to be advocated for tests. It was found, however, that the flicker photometer offered to the skilled operator no advantage over the usual method of measurement as regards rapidity and certainty of adjustment.

Nearly seventy official and private papers of a scientific nature by members of the staff were published during 1908, particulars of these being given in an appendix to the report.

ZOOLOGY AT THE BRITISH ASSOCIATION.

BY arrangement between the organising committees, the presidents of the biological sections gave their addresses at different hours, so as to make it possible for members to attend them all. The address in Section D was delivered by Dr. Shipley on Friday, August 27.

The programme for Thursday, August 26, was opened by Dr. E. Goodrich with a paper on the origin of the vertebrates. The object of this paper was to show that none of the theories of the origin of vertebrates hitherto brought forward, deriving them from some existing class of the invertebrates, was satisfactory, because the theories violated the sound principles of phylogeny based on the combined evidence of comparative anatomy and physiology, embryology and palæontology. This evidence enables us to trace back the Gnathostomes to a primitive shark-like fish, the Gnathostomes and Cyclostomes to a common form of much more uniformly segmented structure, and, finally, the Craniata and Cephalochorda to an ancestor of very simple structure, without dermal skeleton and without pronounced cephalisation, which probably became extinct even before the Silurian age.

Mr. C. L. Boulenger followed with a paper on certain subcutaneous fat-bodies in Bufo. These structures are to be found in a number of different species, and consist of masses of adipose tissue situated at the junction of the hind-limbs with the trunk.

On Friday, August 27, after the presidential address, Prof. H. Jungersen read a paper, illustrated by lantern-slides, on the osteology of the Lophobranchii. The author pointed out that the skeletons of these fishes have hitherto been most unsatisfactorily examined, and the cranial structures, especially the suspensory apparatus, the gill-arches and the scapular arch, have been incorrectly interpreted by all previous authors. In the skull, parietals and opisthotics are wanting, the pterotics are greatly developed, reaching below to the basioccipital, and preventing the exoccipitals from meeting the prootics. These two features, together with the prolongation of the anterior part of the skull (mesethmoid and vomer), the Lophobranchii have in common with the Solenostomidæ, the Fistulariidæ, the Aulostomidæ, and the Centriscidæ, these families forming with the Lophobranchii a natural group, the "Solenichthyes" of Regan.

The scapular arch is cartilaginous to a much greater extent than is the case in other Teleosteans, but a small ossified scapula is to be found as well as a coracoid.

The three anterior vertebræ are immovably joined together, their neural arches being firmly bound by sutures with long dentations; in addition, the two anterior ones are fixed to the expanded clavicle. The vertebræ bearing the interspinous bones for the dorsal fin are provided with secondary transverse processes behind the primary ones, thus enlarging the surface which gives attachment to the powerful muscles of the dorsal fin, the chief agent in swimming.

After a paper by Dr. S. Hadwen on Texas fever in cattle, and its cure by the use of drugs, the day's programme closed with the reports of the special committees on grants.

The meeting on Monday, August 30, was opened by Prof. A. B. Macallum, who read a paper, illustrated by numerous lantern-slides, on palæobiology and the age of the earth.

Prof. C. J. Patten followed with two papers:—(1) on the pre-nuptial plumage in *Calidris arenaria*, illustrated by lantern-views of the sanderling at different periods; (2) on the germinal disc in naturally incubated eggs of *Passer domesticus*. Due reflection of the facts that nests (or, in the case of those birds which make no nest, the soil on which the eggs are deposited) vary to an extraordinary extent in their heat-retaining properties; that the protecting egg-shells vary strikingly, not only in their thickness, but in their porosity and other structural peculiarities; and, lastly, that avian embryos vary to a considerable extent as regards their vitality when heat is withdrawn from the shell, has led the author to think that the method of studying avian embryology by means of the artificial incubator is not always the most trustworthy. He therefore described the changes which he observed during the first six hours in a clutch of naturally incubated eggs of the house-sparrow (*Passer domesticus*).

The next paper, on the *rôle* of visual function in animal and human evolution, was, in the absence of the author, Dr. G. M. Gould, taken as read.

Prof. S. H. Reynolds read a paper on the British Pleistocene Canidæ. Three species are found, the wolf, the fox, and the Arctic fox. There is no evidence of the existence in Britain in Pleistocene times of any animal that could be called a dog. The jaw described as *Lycaon anglicus* is thought by the author to be better regarded as a somewhat abnormal wolf. While, apart from any difference in size, the skull of a fox is readily distinguished from that of a wolf or dog by the depressions in the post-orbital processes of the frontals, it is extremely difficult, if not impossible, to find any valid distinctive character between dogs and wolves. The most useful character, for which we are indebted to Studer, is the orbitofrontal angle. He regards as belonging to wolves skulls in which this angle measures 40°–45°, and as belonging to dogs skulls in which the angle is greater than 45°. The author's measurements, while confirming Studer's contention that the angle in question tends to be decidedly less in the wolf than in the dog, show that the distinction is not absolute, and cannot be relied on in all cases.

The programme for the last day of the meeting, Tuesday, August 31, opened with a paper by Mr. C. F. Rousselet, on the geographical distribution of Rotifera. The author showed that the results of recent investigations point more and more to the fact that the Rotifera enjoy a cosmopolitan distribution, which is not limited to continents, but extends to all places on the surface of the earth where suitable conditions prevail. Wherever search has extended in Europe, America, Africa, India, China, Australia, and even the north and south polar regions, the same genera, and even species, have been met with, and it is not possible to speak of any typical or peculiar rotatorian fauna for any continent, zone, or region.

The very erratic appearance of rare or uncommon species in widely separated places seems to show that distance is no obstacle to their distribution, provided only that they find suitable conditions. To account for such a distribution over the whole of the globe, it has been supposed that most species of Rotifera can be dried up and their bodies carried by the wind, as dust, for long distances, and then come to life again on landing in suitable surroundings. This Mr. Rousselet showed to be a very erroneous generalisation of the fact that a very few species of bdelloid Rotifera, and in particular *Philodina roseola*, are capable of secreting a gelatinous envelope in which they can resist drought for many months, and come to life again on being placed in water. The author's experience has shown him that the vast majority of rotifers die immediately on being dried, and do not revive after complete desiccation; but their eggs, and in particular their resting eggs, can stand a prolonged state of desiccation and also freezing, and can therefore readily be transported by the wind or by aquatic birds and other animals, and will hatch when deposited in suitable pools of water. In his opinion it is by this means that the cosmopolitan distribution of the Rotifera over the world has in the course of time been brought about.

Dr. J. Pearson read a paper on the processes of autotomy in the Crustacea, and Prof. H. Jungersen communicated an account, by Dr. J. Schmidt, of the distribution of the fresh-water eels (Anguilla) throughout the world.

The following papers were, in the absence of the authors, taken as read:—Dr. F. A. Dixey, on the parallelism between the nymphaline genera Adelpha and Chloríppe; and Mr. W. J. Dakin, histology of the eye of Pecten.

In the afternoon Mr. J. Stanley Gardiner delivered a lecture on coral-reefs, illustrated by numerous lantern-views.

Two resolutions were passed by Section D during the meeting at Winnipeg:—

(1) "The zoological section of the British Association wish to record their sense of the danger caused by the approach of the Norwegian rat, which threatens the wheat industry of western Canada, and to urge the Governments concerned to take immediate steps to organise the extermination of this dangerous pest."

(2) "In view of the enormous importance of the fisheries of Canada in connection with her prosperity and her rapidly developing position as the great source of the food supply of the Empire, and appreciating the danger of exhaustion which menaces certain of the fisheries, the members of the zoological section of the British Association for the Advancement of Science, now in meeting in Winnipeg, desire to congratulate both the Dominion and the Provincial Governments upon the work already accomplished in connection with the study of the food-fishes, upon the establishment of a marine biological station on both the Atlantic and Pacific coasts, and upon the cooperation with the Government of the United States in an International Commission from whose labours much may be expected. At the same time, the members of the section are of the opinion that further and more extensive efforts in all these directions are urgently needed if certain of the fisheries, notably that of the Pacific salmon, are to be maintained even at their present condition of productiveness. For the framing of satisfactory and effective regulations for the utilisation and conservation of the food-fishes a complete knowledge of their life-history is absolutely necessary, and the section desires to impress on the Governments concerned the immediate need for an extensive prosecution of investigations along this line, for greater facilities for the scientific study of the fisheries, especially those of the Pacific coasts, and for a continued cooperation of the Dominion Government with the governments of the provinces and also those of the United States in all efforts looking towards the conservation of the fisheries, one of the most valuable natural resources of Canada."

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THIS section was presided over this year by Colonel Sir Duncan A. Johnston, K.C.M.G., C.B., formerly director-general of the Ordnance Survey of the United Kingdom, and, as usual, the opening address dealt with matters of which the president had been made intimately cognisant through his life-work. After briefly referring to the additions made to geographical knowledge during the year by the journeys of Dr. Sven Hedin, Dr. Aurel Stein, and Lieut. Shackleton, Sir Duncan Johnston devoted the bulk of his address to the subject of topographical maps, considering specially the preliminary triangulation for such maps, the methods of detail survey, the scale of the map, the scale of the field survey, the methods of representing details on the map, and the methods of reproduction. The address was printed in NATURE of September 9.

The remainder of the first morning sitting of the section was taken up with the reading of papers by Miss Luella A. Owen, of St. Joseph, Mo., on floods in the great interior valley of North America; by Mr. James White, head of the Geographical Department of the Dominion of Canada, on the nomenclature of the islands and lands of Arctic Canada; and Dr. Robert Bell, formerly head of the Geological Survey of Canada, on the Hudson Bay route in its present aspect. The first of these papers, written by an eye-witness of the flood of 1903, when at the end of May and the beginning of June the valley at Kansas City "was filled from bluff to bluff with the turbulent muddy waters, which on June 2 completely submerged the entrances to the main waiting-room of the Union station," gave in a compact form an account of the conditions which produce floods in the region in question and of the diversified character of their consequences, and then considered the possibility of their future control as a subject of vital interest to the United States, and one involving a careful examination of the methods of control in order to avoid the possibility of bringing about evils more disastrous than the floods themselves. Mr. White's paper necessarily consisted entirely of details, but as these are of no little interest in the history of geography, geographers will be glad to learn that they will be made available in the pages of the *Geographical Journal*. In the third of the morning papers Dr. Bell reiterated the views he has long held and urged as to the practical importance of the Hudson Bay route for the development of the north-west of Canada, emphasising on this occasion the urgency of the problem in view of the rapidity with which that development is taking place and the effect which it may be expected to have in promoting more intimate commercial relations between that region and the mother country.

No separate meetings of Section E were held in the afternoons, but the afternoon of Thursday, August 26, was devoted to a joint meeting of that section with the subsection on agriculture, at which a paper contributed to Section E by Prof. A. P. Brigham, secretary of the American Association of Geographers, on the development of wheat culture in North America, was followed by one contributed to the subsection on agriculture by Prof. Mavor, of Toronto, on the agricultural development of Canada, 1904–9. The first of these papers will be published in full in the annual report of the association, as well as in the *Geographical Journal*. Here, therefore, it will be enough to say that it laid stress on the enormous possibilities still remaining for the expansion of wheat production even in the United States, directing attention, among other things, to the large production of wheat relatively to population in some States not generally thought of as wheat States, such as Maryland, which this year produced eleven bushels of wheat per head. Prof. Mavor's paper was a continuation of his well-known report to the Board of Trade on the same subject, coming down to the year 1904, and, like it, protested against some of the more sanguine estimates of the possibilities of wheat production in Canada, although he admitted that his estimates of 1904 ought to be increased. An animated discussion followed the reading of the two papers. The prevailing note of that discussion was sanguine, both as to the possibility of enormously extending the area under wheat in North America and increasing the production in the area already placed under that crop. Major Craigie, chairman of the subsection on agriculture, directed attention, however, to the dependence of that increase on the distribution of population, and thus implicitly raised the question of the future rate of increase of wheat production in North America, and the possibility of maintaining that increase without a concurrent advance in prices.

The first paper read in Section E on Friday, August 27, was also by Prof. Mavor—a summary sketch of the economic geography of Canada. Mr. J. Stanley Gardiner, F.R.S., then gave a semi-popular account, illustrated by many beautiful lantern-slides, of the Seychelles, a subject on which he sent a report to the association as secretary of the committee for the investigation of the Indian Ocean appointed by the association. Two papers relating to physical geography followed. The first of these, by Prof. W. H. Hobbs, of the University of Michigan, Ann Arbor, developed an interesting theory of the cycle of Alpine glaciation, showing how many of the phenomena of glacial erosion found their explanation in the alternation of the conditions bringing about the advance and retreat of glaciers. This paper will also appear in the pages of the *Geographical Journal*. The other was by Prof. Dodge, of Columbia University, on the formation of arroyos in adobe-filled valleys in the south-western United States. The origin of these arroyos, or wadis, as they would be termed in arid regions frequented by Arabic-speaking peoples, was attributed in this paper to the introduction of sheep, the grazing of the herbage by which in gently sloping valley floors first gave the water an opportunity to become concentrated in streams instead of running off the surface in sheets, a theory which confirms an observation of the Navajos, the native race of the region. The last paper read that morning was by Mr. Lawrence J. Burpee, of the Carnegie Library, Ottawa, on the water route from Lake Superior to the westward. Of the three routes, that of the Kaministikwia, that by Grand Portage, and that by way of Lake Nipigon, the first-mentioned was the first to be discovered, but was neglected and forgotten after the discovery of the Grand Portage route, and remained forgotten until the Canadians ascertained that Grand Portage lay in the territory of the United States. Search for another route led to the re-discovery of that by the Kaministikwia, and rendered the nearly simultaneous discovery of the Nipigon route of no practical importance.

Two hours of the morning of Monday, August 30, were taken up with a discussion on the teaching of geography in secondary schools at a joint meeting of Sections E and L, held at the meeting place and under the chairmanship of the president of the latter section. The discussion was opened by an informatory and helpful paper by Prof. R. E. Dodge, of Columbia University, New York, and followed by one (read in the absence of the writer by the recorder of Section E) by Dr. C. H. Leete, principal of the Sachs School for Girls, New York, who has been engaged in the secondary teaching of geography for upwards of a quarter of a century. Several professors and teachers of geography took part in the discussion that followed, and almost all these coincided with the view expressed by Prof. Dodge, that the teacher of geography should look upon it as his business to let the relation of the earth to man dominate his presentation of the subject. The remainder of the morning was taken up with a lecture by Mr. A. O. Wheeler, president of the Alpine Club of Canada, on some characteristics of the Canadian Rockies, which attracted a larger audience in Section E than was assembled on any other occasion during the meeting.

The meeting on Tuesday, August 31, was opened by a carefully prepared and instructive paper on the influence of mechanical transportation upon the framework of cities, by Mr. George E. Hooker, civic secretary to the City Club of Chicago. It was, unfortunately, read to a very meagre audience, but there is reason to hope that it will appear somewhere in a permanent form. Prof. A. P. Coleman, of Toronto University, followed with a paper on the Yellowhead Pass and Mount Robson, an adjacent peak, the highest in the Canadian Rockies. Prof. J. W. Gregory, of Glasgow, then gave a brief but very illuminating account of the remarkable success which has attended the replacement of kanaka by white labour on the sugar plantations of Queensland. The last two papers read that morning furnished two illustrations of the action of waves and currents in bringing about changes in shore-lines. The first was by Prof. Douglas W. Johnson, of Harvard University, and dealt with the physical history of Nantasket

Beach, a spit running northwards from the east end of the south shore of Boston Harbour. This beach consists of sand, gravel, and cobbles deposited by wave action between several drumlins which formerly existed as islands, and with the aid of a series of lantern-slides the reader of the paper showed how the form of the beach ridges and their relation to abandoned marine cliffs on the drumlins prove the former existence of several drumlin islands now entirely destroyed by the sea. The second of these papers was by Dr. F. P. Gulliver, secretary to the geographical and geological section of the American Association for the Advancement of Science, and dealt with what he called the Wauwinet-Coscata Tombolo, Nantucket, Mass. The term tombolo, the Italian for a "pillow," applied in Italy to the low ridges or necks connecting Mt. Argentario with the mainland, Dr. Gulliver proposes as a general designation for such necks. The paper described and illustrated by lantern-views the opening of the neck referred to by a storm in December, 1896, when a channel navigable by small boats was formed, and the closing of this channel by waves and currents nearly twelve years later—November, 1908.

Some of the most interesting papers read in the section during the meeting were reserved for the last day, Wednesday, September 1, which was so far fortunate that the winding up of several other sections on the previous day allowed of the gathering of a larger audience in this section than was present on most of the other mornings. The first two papers were by Mr. James White, of Ottawa, one of them on the progress of the geographical knowledge of Canada from 1497 to 1909, the other on the economic development of Canada from 1867 to 1909. The subject treated of in the first of these two papers, which will appear in full in the *Geographical Journal*, was illustrated by a number of maps for different dates, for the most part at intervals of fifty years, illustrating for the earlier years the extent of exploration within the territory of the present dominion, and for the later years the extent of territory that remained unexplored. The subject of the second was illustrated mainly by means of statistical diagrams. These were followed by a very interesting paper by Mr. J. B. Tyrrell, formerly of the Geological Survey of Canada, on a remarkable forgotten, or nearly forgotten, geographer, Mr. David Thompson, a native of London but of Welsh parentage, who, in the latter part of the eighteenth and the early part of the nineteenth century, travelled more than fifty thousand miles in the western wilds of Canada, making surveys wherever he went, and producing a map which was for many years the only one available, and was distinguished by such accuracy as to induce the reader of the paper to claim for its compiler the designation of the greatest practical land geographer who had ever lived. This paper also will appear in full in the *Geographical Journal*. Dr. L. A. Bauer, director of the department of terrestrial magnetism at the Carnegie Institution of Washington, then gave a brief general account of the progress of the general magnetic survey of the earth in recent years, a subject dealt with more fully in a paper read by the same author to Section A. It may here be mentioned, however, that the author stated that since April 1, 1904, the declination and dip of the magnetic needle and the intensity of the magnetic current had been determined at some 900 land stations in different parts of the world, and a general magnetic survey of the Pacific Ocean had been made, in the course of which the non-magnetic cruiser *Galilee* had made cruises amounting to about 60,000 nautical miles. The last paper read before the section was by Mr. Allorge, of the Oxford School of Geography, on the eastern (Tunisian) Atlas Mountains, their main structural and morphological features, a paper embodying the results of a journey made by Mr. Allorge and a companion in Tunis last spring.

It may be mentioned, in conclusion, that a somewhat dramatic incident marked the close of the meeting of this section. The last paper had been read, the audience had withdrawn, and the two secretaries, after winding up the work of the meeting, were just about to leave also, when they were summoned to the telephone to be informed of the reported reaching of the North Pole by Dr. Cook.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE president's address on "The Physiological Basis of Success," as distinguished from simple survival, has already appeared in NATURE (September 23, p. 384).

The report of the committee on Anæsthetics formed the basis of an interesting discussion. Presented by Dr. Waller, the chairman, the report gave, in the first instance, a summary of the work done during the year by the members of the committee, each of whom added appendices on the particular branch of the subject they had investigated. Appendix i. gave the results in clinical practice of Drs. Hewitt and Blumfeld, who employed a mixture of two parts of chloroform and three parts of ether; this they consider to be safer than chloroform alone when given by the open method.

Appendix ii. described Dr. Waller's chloroform balance, which shows at a glance the percentage of chloroform given to the patient. Appendices iii. and iv. summarise Dr. Waller's results on the comparative anæsthetising power of chloroform, ether, and alcohol, and Appendix vi., by Drs. Waller and Symes, gave a method of intravenous anæsthesia which can be used for the basis of a similar calculation. The very important results are reached that 1 gram of chloroform is equivalent to 8 grams of ether and 32–40 grams of alcohol, according to the method used for the calculation. Further, the effect of mixtures of anæsthetics is that of the sum of the constituents. As the anæsthetic action of ether (and still more of alcohol) is so much less than that of chloroform, a mixture of ether and chloroform will behave in practice like dilute chloroform, so far as the experiments have gone.

In the discussion that followed all the speakers expressed their appreciation of the scientific value of the determinations that had been made. Dr. N. H. Alcock referred to the excellent results that had been obtained by the administration of known percentages of chloroform vapour, and summarised the work that had been done on the individual variations in susceptibility to the drug. He regretted that the case of sudden death under a mixture of chloroform and ether (*Times*, August 5) had supplied such an inauspicious comment on Appendix i. of the report.

Prof. A. R. Cushny considered that the results obtained by Messrs. Buckmaster and Gardiner were of great importance to the general theory of pharmacological action. He considered that as the concentration of chloroform in the blood of patients who had succumbed during anæsthesia had not yet been ascertained, it was possible that the concentration was not unduly high.

Prof. W. T. Porter suggested that the unhappy result in some of these cases could not at present be averted by the most skilful anæsthetists, and that the cause might be sought in the hyper-irritability of the heart and vaso-motor apparatus.

Dr. Webster contributed a paper on the use of atropine and allied drugs in conjunction with anæsthetics, giving the results of numerous experiments. The conclusion reached was not favourable to the use of drugs of this class in conjunction with a general anæsthetic.

Prof. A. B. Macallum read two papers on the inorganic constituents in the blood of fishes, the first dealing with the osmotic pressure and the second with the relations of the inorganic salts to one another. He also read a third paper, on the inorganic composition of the blood in puerperal eclampsia, in which he pointed out the greater preponderance of magnesium, and especially potassium, in comparison with sodium.

A group of papers on the tracts in the spinal cord was furnished by Dr. Page May and Prof. Sutherland Simpson. Dr. Page May, who exhibited microscopical specimens and lantern-slides, gave a further description of a descending tract discovered by him, and which he names the "postero-septal tract." The origin and course, as determined by Wallerian degeneration and by retrograde chromatolysis, is from a joint region of the optic thalamus and corpora quadrigemina along chiefly the mesial fillet into the posterior column of the spinal cord, where it lies symmetrically on either side in close contact with the posterior septum, terminating in the tenth and eleventh thoracic segments. Its function is still undetermined, a series of detailed experiments showing only that it is not concerned with the pyramidal or voluntary motor path, or with any obvious vasomotor process of the spleen, kidney, and other organs, as examined with the plethysmograph.

Dr. Page May also demonstrated, by the method of retrograde chromatolysis, the delimitation of the motor area in the cerebral cortex. The method is free from the fallacies that attend stimulation and ablation, and has enabled the author and Dr. Gordon Holmes to map out the cerebral motor area with great precision. This area in man and the higher mammals is definitely precentral, as Sherrington and Grünbaum have found by other methods.

Dr. Sutherland Simpson and his pupils described the pyramidal tract in the sheep and guinea-pig. The fibres were traced by the degeneration method after removal of the motor cortex of one side, the staining being carried out with Marchi's method. In the sheep it was found that no pyramid fibres could be found in the posterior columns, the proportion of direct fibres was large as compared with the crossed fibres, and the fibres could not be traced at all below the first cervical segment.

Prof. Simpson also communicated a paper by Mr. E. C. Peterson on the ascending tracts in the spinal cord of the cat.

The report of the committee on the ductless glands, drawn up by Prof. Swale Vincent, furnished an interesting group of papers by Mrs. W. H. Thompson (of Winnipeg), Drs. Halpenny and Brandson, and Dr. Young.

Mrs. Thompson (who illustrated her paper with a series of excellent diagrams), as a result of the study of the thyroids and parathyroids throughout a wide range of the animal kingdom, supported the views of Vincent and Jolly, and Forsyth, that these bodies are not separate and independent, but are very intimately related. Although distinct in the lower Vertebrata, and of somewhat different embryological origin, in the Mammalia they form, in fact, one apparatus.

Dr. Halpenny discussed the operation of parathyroidectomy, and also the effect on the parathyroids after excision of the thyroids.

Dr. Young investigated the effect of excluding the blood passing through the adrenals from the circulation; he found no fall of blood pressure even after several hours; there was, however, a distinct rise when the ligature was removed.

In presenting the report of the committee on Arum spadices, Dr. Waller referred to the result obtained by him of the effect of local heat on vegetable and animal tissues. "Thermic shocks," short of actual injury to the tissues, produce no excitation, in contradiction to the usual text-book statement, but give an electrical effect of opposite sign to that given by excitation.

Prof. E. J. McWeeney read a paper on the bacilli connected with food poisoning, for the details of which the report must be consulted.

The joint discussion with Section B, to which Dr. E. Frankland Armstrong, Dr. E. J. Russell, and Prof. J. Wilson communicated papers, proved one of the most successful features of the meeting, and it is to be hoped that the precedent thus set will be followed on future occasions. Dr. E. Frankland Armstrong directed attention to the difference in composition of different proteins, and pointed out that not only should the total nitrogen be taken into account in comparing the different foods, but due regard should also be paid to the composition and nature of the constituent units. Dr. E. J. Russell referred to the very great difference in food value between different samples of hay and roots, which showed but small variation with the usual methods of analysis. Prof. J. Wilson gave a most interesting historical account of the practice of farmers in feeding live-stock, particularly bullocks. He pointed out the great economic importance of the knowledge of the proper amount of the different proportions of the more expensive protein to the less expensive fat and carbohydrate, and showed how the practice of farmers had changed in this matter. Prof. H. E. Armstrong, Prof. Cushny, Dr. Alcock, and Dr. Hardy also joined in the discussion.

On the last day of the meeting Dr. Alcock gave a demonstration of his chloroform apparatus in the theatre of the Winnipeg General Hospital, and subsequently there was a discussion on the structure and function of the nucleus, in which Prof. A. B. Macallum and Dr. W. A. Hardy took part.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—At a meeting of the master and fellows of St. Catharine's College, held on October 19, Prof. R. H. Biffen, of Emmanuel College, was elected to the vacant professorial fellowship. Prof. Biffen, who was a scholar of Emmanuel College, was placed in the first class in part i. of the natural sciences tripos in 1895, and in the first class in part ii. of the same tripos in the following year. Shortly after taking his degree he was elected to the Frank Smart studentship at Gonville and Caius College, and soon afterwards he undertook a research which greatly modified the process of the manufacture of india-rubber. Later, as professor of agricultural botany, he has done much to produce new wheats, some of them rust-resisting, others combining a high yield with the "strength" which bakers desire. This autumn, for the first time, the seeds of these wheats are being distributed to agriculturists. Prof. Biffen is also a well-known authority on fungoid diseases of plants.

Mr. V. H. Mottram, of Trinity College, has been appointed additional demonstrator of physiology until Michaelmas, 1912.

Mr. W. McD. Scott has been elected to a John Lucas Walker studentship, and Dr. C. W. Ponder, of Emmanuel College, has been elected to a second studentship.

The Arnold Gerstenberg studentship has been awarded to Mr. C. D. Broad, scholar of Trinity College.

MANCHESTER.—In response to the appeal made by Prof. Perkin at the opening of the new extension of the chemical laboratories on October 4, the following donations have been received towards the cost of the necessary apparatus, material, and equipment:—Dr. Hugo Müller, 300*l.*; anonymous, 250*l.*; Mr. Vernon K. Armitage, 250*l.*; Mr. M. J. Fernandez Ferreira, 50*l.*; Mr. Noah Kolp, 50*l.* The sum of 1100*l.* is still required.

Dr. C. P. Lopage has been appointed lecturer in observation of children and school hygiene.

OXFORD.—The geographical scholarship for 1909–10 has been awarded to Mr. H. Wallis, scholar of Hertford College.

MR. A. P. I. COTTERELL has been appointed lecturer on sanitary engineering in the faculty of engineering of the University of Bristol. The faculty is provided and maintained in the Merchant Venturers' Technical College.

DR. A. CAMPBELL GEDDES has been appointed successor to the late Prof. A. Fraser in the chair of anatomy at the Royal College of Surgeons in Ireland. Prof. Geddes was formerly assistant to the late Prof. D. J. Cunningham, F.R.S., Edinburgh.

To show his personal interest in the new Hong Kong University, the King has directed that holders of Government scholarships shall be styled "King Edward VII. scholars." Lord Crewe, the Secretary of State for the Colonies, suggests that the scholarships should be confined to Hong Kong Chinese and Chinese born in the Straits Settlements.

THE corporation of Yale University has received from Messrs. W. D. and H. T. Sloane, of New York, a gift of 425,000 dollars for the erection and equipment of a physics laboratory. Among other recent gifts are 25,000 dollars from Mr. A. G. Vanderbilt toward the general endowment, and 15,000 dollars for the school of forestry from Mr. G. H. Myers, a graduate of that school.

THE Joint Matriculation Board of the Universities of Manchester, Liverpool, Leeds, and Sheffield has appointed Mr. J. Murray Crofts, of Emmanuel College, Cambridge, as their organising secretary for the inspection and examination of schools. Mr. Crofts was for two years assistant master at Giggleswick, for two years junior inspector of the Board of Education, secondary branch, and for five years headmaster of the Johannesburg College, Transvaal, a post which he recently resigned.

WE learn from the *Scotsman* that during the recent recess many alterations and additions to the buildings in connection with the physiological department of the University of Edinburgh have been carried out, and that the additional accommodation will be available in the course of the present month. By utilising what was formerly the lecture-room, a new physiological chemical laboratory has been obtained, and the former chemistry room has been re-fitted as a laboratory for special research in chemical physiology. In addition to the foregoing, a new lecture-room has been erected on a piece of vacant ground at the south-west corner of the new buildings of the University. It is a one-storey building, designed to harmonise in appearance with the older adjacent buildings, and accommodates about 350 students.

THE *Electrician* for October 1 reprints in slightly abridged form from the *Electric Journal* an article by Mr. F. W. Taylor, an employer and past president of the American Society of Mechanical Engineers, on the reasons why manufacturers dislike college graduates. The difficulty in America appears to be that the graduate, on first entering works, becomes dissatisfied with the simplicity of the jobs allotted to him, and only after a year or two of shop experience develops character enough to do monotonous, unpleasant, or disagreeable work. Mr. Taylor suggests as remedy a year of hard work in the shops to follow immediately the first year of college life of all students, whether they are intended ultimately for the engineering profession or the Church. He believes they will in this way get a sounder knowledge of man and his duty in this world than can be gained by any other means. The *Electrician*, in a leading article devoted to the question raised by Mr. Taylor, cordially endorses many of the opinions he expresses.

PROF. W. OSLER, F.R.S., formally opened on October 15 three new laboratories for physiology, chemistry, and physics, respectively, at the London Hospital Medical College. The laboratories have been constructed and equipped at a cost of about 8000*l*., and afford accommodation for some 120 students. In declaring the laboratories open, Prof. Osler said that, after all, laboratories are the foundation-stones on which the work of a hospital rests. Medical students cannot spend too long a time in them. Medical students ought to get their laboratory methods so thoroughly ingrained into their constitution that they carry them with them to their dying day. If they are to be good practitioners they have to carry their laboratory work with them into their practice. Prof. Osler said he would like every medical student in one or other of the laboratories to undertake during some portion of his career a small piece of research work. It is difficult, but it altogether depends upon the individual will of the individual man. All can do it if they only make up their minds to it, and in view of their large research endowment fund there is no reason why some of the money should not go to helping the research work of some of the younger men.

THE new University College of South Wales and Monmouthshire at Cardiff was opened on October 14 by Lord Plymouth, president of the college. The King, as Protector of the University of Wales, sent wishes for the success and prosperity of the future work of the college. The Prince of Wales, as Chancellor of the University, sent a letter to Lord Plymouth to be read at the ceremony. In the letter the Prince said:—"The steady growth of the college and the record of work accomplished during the first twenty-five years of its life are evidence that it has adapted itself to the needs of the community. This development is particularly noticeable in the technological and medical schools, and, thanks to the generous support of the coalowners of South Wales to the former and the assistance specially given by the Treasury to the latter, still further vigour and usefulness may be looked for from these departments. To Principal Griffiths and the students past and present I offer my hearty congratulations upon the good results achieved by the college. Meanwhile, we must look ahead and endeavour to be ready to meet all the requirements of scientific and intellectual progress. The imperative necessity for higher education and research is becoming more and more recognised, and I feel sure it is not lost sight of by those who direct the great commercial industries of the district. The University College of South Wales is destined to provide the want, and I confidently believe that the people of South Wales, through whose patriotic generosity so much has already been accomplished, will by their continued sympathy and material support not only extinguish the debt upon the new buildings, but secure the funds necessary for still further developments."

THE trustees of the Oxford University Endowment Fund have completed the first year of their administration of the fund. The total sum received by the trustees was 86,570*l*., the greater part of which was forwarded to them as the result of Lord Curzon's appeal for donations for the further endowment of Oxford University. Among grants made by the trustees the following may be mentioned. A grant of 500*l*. a year has been promised for eight years to the curators of the Bodleian Library. The trustees have also provided the funds required to convert the North Gallery into a new reading-room, and have undertaken to meet the cost of constructing an underground chamber for the storage of books belonging to the Bodleian Library. It is estimated that this chamber will cost 10,000*l*. Five hundred pounds have been offered to meet the cost of equipment for further accommodation if space can be found by the University for the expansion of the school of geography. The trustees have agreed to pay for three years the salary of the newly appointed lecturer in Japanese, so that the school of Japanese—the first to be established in any English university—may be initiated without more than nominal calls upon the funds of the University. A school of engineering has been provided, largely by gifts allocated by donors and passing through the hands of the trustees. From the sum thus provided the trustees have promised a payment of 600*l*. a year for five years as a contribution to the cost of the engineering school, and have paid 300*l*. for equipment. Out of the general income of the trust fund a further sum not exceeding 150*l*. per annum has been promised for three years to furnish accommodation for the professor, for whom at present there is no adequate laboratory available. The sum of 61,553*l*. has been invested. The income will enable the trustees to make annual grants in aid of studies at present endowed inadequately, or in the establishment and initiation of new studies.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, October 5.—Mr. Francis Jones, president, in the chair.—A new binary progression of the planetary distances, and on the mutability of the solar system: Dr. H. **Wilde.** In his table of planetary orbits the author has adopted the radius vector of Mercury as the unit to which the other planetary distances should be referred, the terrestrial unit being a survival of the geocentric system of the universe. The change in the unit of distance has revealed a new binary progression of the planetary distances nearer the observations than that of Bode's law.

PARIS.

Academy of Sciences, October 11.—M. Bouchard in the chair.—The total sugar of the plasma and globules of the blood: R. **Lépine** and M. **Boulud**. The sugar estimated in the blood by the ordinary methods is called by the authors the immediate sugar of the blood; after heating with hydrofluoric acid the maximum amount of sugar found is called the total sugar. An investigation is described on the estimation of the immediate and total sugar in the blood from dogs both in a normal healthy condition and after deprivation of food.—Observations on the surface of the planet Mars from June 4 to October, 1909: R. **Jarry-Desloges**. The work was done at two observatories, both at a high altitude, at Revard (1550 metres above the sea) and near Massegros (900 metres). The paper is illustrated by two diagrams.—The effects of mechanical shocks on the residue of condensers: Paul L. **Mercanton**. A glass condenser was charged to about 400 volts, and the effects of mechanical shocks and also vibrations on the amount of the residual discharge studied. The results are summarised in tabular form.—The reduction of weighings to vacuum applied to the determination of atomic weights: Ph. A. **Guye** and N. **Zachariades**. The substances studied in this work, twenty-six in all, were chosen from material actually used in atomic-weight determinations. The reduction to vacuum weights was first applied in the usual way from the known densities of the substances, and the results compared with direct weighings in a vacuum. The differences on 100 grams of material varied between 1 and 32 milligrams, and the conclusion is drawn that it is completely illusory to weigh bodies closer than 1 part in 10,000, or to calculate atomic weights with a greater precision, whenever the weights of powdered substances, determined in air, are reduced to vacuum by calculation.—The probable influence of the motion of the moon on atmospheric radio-activity. Some meteorological consequences: Paul **Besson**. The radio-activity of the principal spring of Uriage-les-Bains has been found to vary with the barometric pressure and also with the movements of the moon. If this latter effect is confirmed, it would result that the moon, by increasing or reducing the number of condensation nuclei, would have an effect on weather.—The asymmetry created by a continuous current in liquid chains, initially symmetrical, formed by aqueous couples of identical viscosity: M. **Chanoz**.—The revision of the density of gaseous hydrochloric acid; the atomic weight of chlorine: Otto **Scheuer**. Twenty-eight determinations, made in seven series, of the density of hydrochloric acid gas give 1·6394 grams as the normal weight of a litre ($t=0°$ C., $H=760$ mm., $h=0$, $\gamma=45°$). This leads to the figure 35·45 as the atomic weight of chlorine.—The spectrographic analysis of blendes: G. **Urbain**. The spectra were taken from the arc, iron being taken as the comparison spectrum. Out of sixty-four blendes, thirty-eight gave clear evidence of the presence of germanium, and amongst these five contained the element in such a proportion that all the germanium lines were observed. Indium was found in forty-one blendes, three being remarkably rich. Nearly all the blendes contained gallium, there being only five in which gallium could not be detected. The other elements noted included iron, copper, silver, tin, antimony, cobalt, bismuth, arsenic, and molybdenum.—Some derivatives of hexahydro-oxybenzoic acid: P. J. **Tarbouriech**. This acid was first obtained by Bucherer from cyclohexanone. This latter substance can now be readily obtained in quantity by the Sabatier and Senderens reaction, and Bucherer's work is repeated and extended.—A new series of leucobases and colouring matters derived from diphenylethene: P. **Lemoult**.—The liquid crystals of the combinations of cholesterol and ergosterol with urea: Paul **Gaubert**.—The Dioscorea cultivated in tropical Africa, and on a case of natural selection relating to a species spontaneous in the virgin forest: Aug. **Chevalier**.—The stratigraphical position of the *Heterodiceras Lucii* layers at Salève: E. **Joukowsky** and J. **Favre**.—The distribution of granites in the French Congo: H. **Arsandaux**.—The earthquake of October 8, 1909: Alfred **Angot**. The earthquake felt in Croatia was registered in the observatories of Parc Saint-Maur and Grenoble.—Some remarks on the great magnetic disturbance of September 25, 1909, and the accompanying solar phenomena: Émile **Marchand**.

CAPE TOWN.

Royal Society of South Africa, September 15.—Borchard's form of the eliminant of two equations of the nth degree: Dr. T. **Muir**.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 21.

INSTITUTION OF MINING AND METALLURGY, at 8.—The Influence of the Railroads of the United States and Canada on the Mineral Industry: Dr. J. Douglas.—The Development of Heavy Gravitation Stamps: W. A. Caldecott.

OPTICAL SOCIETY, at 8.—The Theory of Vision and Colour Perception: Dr. F. W. Edridge Green.

FRIDAY, OCTOBER 22.

PHYSICAL SOCIETY, at 5.—On Cadmium Amalgams and the Normal Weston Cell: F. E. Smith.—The Production of Helium from Uranium and Thorium: Frederick Soddy.—The Production of Radium from Uranium: Frederick Soddy.—Note on a Gravitational Problem: Dr. C. V. Burton.

TUESDAY, OCTOBER 26.

QUEKETT MICROSCOPICAL CLUB, at 8.—Notes on the Life-history of the Tachnid Fly, *Phorocera serriventris*, Rondani: W. Wesché.—Note on a Quick Method of Preparing and Staining Pollen: W. Wesché.—Low-power Photomicrography, with Especial Reference to Stereoscopic Work: A. C. Banfield.

WEDNESDAY, OCTOBER 27.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.—Annual Meeting: Address by the President.

FRIDAY, OCTOBER 29.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Prof. W. E. Dalby's Report on Heat Transmission (*Resumed Discussion*).

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THURSDAY, OCTOBER 28, 1909.

THE CLEAVAGE OF THE OVUM.

Lehrbuch der vergleichenden Entwicklungsgeschichte der wirbellosen Thiere. Allgemeiner Theil, Dritte Lieferung. By Prof. E. Korschelt and Prof. K. Heider. Pp. 166. (Jena: Gustav Fischer, 1909.) Price 4.50 marks.

IN the development of the individual organism there are involved growth, cell-division, and differentiation. It is with the second of these that the present instalment of a splendid text-book deals.

Apart from certain alterations of egg-structure which are consequent upon fertilisation, the subdivision of its material is the first sign the fertilised ovum gives of its activity, and this "segmentation" proceeds with great regularity until other events—germ-layer formation—supervene. The problems that at once arise are therefore: (1) What is it which sets a term, not, indeed, to cell-division, for that continues, but to the period of segmentation? (2) To what causes must the definite pattern of division—spiral, radial, or bilateral, and so on—be attributed? and (3) Is there any necessary relation between the manner in which the ovum is thus cut up and the ultimate processes of differentiation?

In this volume—a very admirably written and beautifully illustrated description of the various types of cleavage—these problems are to some extent touched upon, and we are glad to see that the view is taken that it is the attainment of a definite size-relation between nucleus and cytoplasm which defines the end of this, the first phase of development (p. 7), though Boveri's important experiments are not noticed here.

In respect of the other two problems—which, indeed, largely overlap—the position which the authors appear to have adopted—that cleavage is necessarily a process of differentiation, that in some, *e.g.* in the spiral type, it is a "Mosaikarbeit" in Roux's sense, and that the blastomeres in this case are not interchangeable (pp. 15, 115)—is not, we believe, wholly justified by the results of experiment, though in dealing with the amphibian egg they admit (p. 38) that the relation between cell-division and differentiation is "wenig fixirt."

The truth is that Roux's attempt to demonstrate an absolute coincidence of the first furrow and the sagittal plane in the frog's egg, and the consequent formulation of the "Mosaik-theorie," with its imaginary qualitative division of the nucleus, still casts its shadow upon this discussion. That hypothesis, however, so far as the nucleus is concerned, has now been abandoned, while recent work has shown that the factors which determine the pattern of cleavage are distinct from the causes of differentiation, even in those cases in which cell-division does look like a "mosaic." Thus there is in the frog's egg a far closer relation between the plane of symmetry and the sagittal plane than between the latter and the first furrow. The type of segmentation may be altered, by pressure or other means, without prejudice to normal development. In the Ctenophora abstraction of the vegetative egg-substance involves absence of costæ in the embryo, but division is still normal, while the isolated *D. blastomere* of a Dentalium ovum will produce a normal larva, in spite of the fact that its cleavage is partial, because it contains the polar lobe. Moreover, cells occupying identical positions in similar cleavage systems have *not* always the same fate.

The two sets of factors may coincide, but they do not necessarily do so. The causes of cell-division will be found in the relations between nucleus and cytoplasm, surface tensions, and so on, of differentiation in the various substances present in the cytoplasm (and the nucleus), but the way in which this heterogeneous material is cut up in cleavage is a matter of indifference; what is essential is that it should be diminished by division until the necessary ratio between cytoplasm and nucleus has been reached.

A CANADIAN MINING AND METALLURGICAL DIRECTORY.

Report on the Mining and Metallurgical Industries of Canada, 1907–8. Pp. xvi+972. Canada, Dept. of Mines, Mines Branch. (Ottawa: Government Printing Bureau, 1908.) Price 1 dollar.

THE Dominion of Canada, having the area and varied geological and geographical structure of half a continent, has naturally a great diversity in its mineral wealth. The mining fields are widely scattered, and most of them are imperfectly known. Hence, in accordance with a wise provision of the Canadian Mining Act of 1907, a detailed guide to the mining and metallurgical industries of Canada has been prepared by the Department of Mines. The work has been prepared under the superintendence of the director, Dr. Haanel, and edited by Mr. S. Groves. In order to secure the most trustworthy and recent information, a series of special investigators have visited all the mining districts of the Dominion, and numerous short reports on the geology and on mining and metallurgical methods are included from members of the Geological Survey and from mining engineers. The work includes 936 pages of text, and is illustrated by numerous maps and plates, showing the distribution of the mining fields and views of the surface operations at the mines and metallurgical works.

The book is divided into two main sections, the first dealing with the metalliferous ores and fuels, and the second with building materials, cements, clays, ochre, &c. Each part is subdivided geographically; the history of mining in each province is recorded, and there is a brief, often, perhaps, too brief, statement of the structure of the mining field. The bulk of the work consists of an account of the present condition, including capital, staff, area, equipment, and operations, of every important mine and metallurgical establishment in the Dominion. This valuable directory of Canadian mining gives a clear idea of its growing importance and variety.

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In the far west, both in Yukon and in British Columbia, gold was the first attraction. The history of Yukon mining is summarised since the first report of gold there by Whymper in 1869. There is reference to the Klondyke boom in 1897–8, and the subsequent decline of the field. Lode mining there is still unimportant. Five dredges are at present mining the alluvial deposits, but they cannot work economically in frozen ground, which has to be thawed by the play of steam upon it.

In British Columbia gold mining began with the Fraser river rush of 1858, followed by twenty years of placer mining. Since 1887 lode mining has made steady progress; the gold is generally associated with copper, silver, or silver lead, and these ores have usually to be smelted. The most famous mining centre is Rossland, which includes some large copper deposits in which the unoxidised ore rises to the surface, and, according to Mr. Brock's account, some of these ores have been deposited parallel to the present land surface. The ores at Rossland occur in fissure veins in sheared and shattered belts, and as irregular impregnations of the country rock. The veins, such as that at Le Roi, the chief Rossland mine, are usually well defined. The ores are low-grade and their concentration is difficult, as the chalcopyrite which contains so much of the gold readily flows away in water.

Of the mines worked primarily for copper, the gold being obtained as a by-product, the most important in British Columbia is the Britannia Mine on Howe Sound, which consists of a mineralised belt of country up to 600 feet wide and two miles in length. Most of this rock contains only 0·5 per cent. of copper, and the ore of commercial value, containing an average of $1\frac{3}{4}$ per cent. of copper, occurs in large patches scattered through the mineralised belt.

The iron ores of British Columbia have hitherto been little used, but the Puget Sound Mine on Texada Island, a contact deposit between granite and limestone, and replacing both rocks along their junction, has been smelted with bog iron ores in San Francisco. The Glen Iron Mine, situated on the Canadian Pacific Railway, is worked to supply flux to the British Columbian smelters.

The most sensational story in recent Canadian mining history is that of cobalt, which was discovered by accident in 1903, and is famous for its narrow, rich veins of silver. They are found traversing ancient quartzites and conglomerates that have been intruded by diabase.

The Sudbury field is of great commercial, historical, and theoretical interest; it gives Canada the control of the world's nickel market, and has been the subject of a long controversy as to the origin of its ores. They are claimed by some authorities such as Prof. Coleman to be due to direct segregation from a molten rock, a norite gabbro; whereas other authors, relying on the microscopic structure and sequence of the minerals, claim that the ores were deposited long after the consolidation of the adjacent igneous rocks.

The volume contains a short account of Dr. Haanel's fruitful experiments at Sault Sainte Marie on the electric smelting of iron, and its maps give impressive evidence of the vast extent of the coalfields of western Canada, as well as of the widespread and varied mineral wealth of the Dominion.

A MONUMENT TO LATIMER CLARK.

Catalogue of the Wheeler Gift of Books, Pamphlets, and Periodicals in the Library of the American Institute of Electrical Engineers. Edited by W. D. Weaver. With Introduction, Descriptive and Critical Notes by Dr. Potomian. Vol. i., pp. viii + 504; vol. ii., pp. 475. (New York: American Institute of Electrical Engineers, 1909.)

ALL who knew Mr. Latimer Clark will feel the most lively satisfaction that his cherished and invaluable library of books ancient and modern relating to electricity should have found the resting-place and custodian which kind fate and American generosity have provided. The position is best expressed by the following three quotations from the book under review:—

"It was Mr. Clark's wish that this valuable collection of his should eventually be transferred to the United States, inasmuch as London was already in permanent possession of the Library of Sir Francis Ronalds. Failing an American purchaser, it was to go to Japan, 'a rising country which would greatly value such a unique collection.' Thus wrote Mr. Clark to Mr. P. Fleury Mottelay, of New York, on February 21, 1898, eight months before his death."

"My object in securing the collection was to present the books to our Institute and make it the custodian of the most complete electrical library in the world, as well as to stimulate such interest that the Institute may in time own a permanent home in New York."

"This work is due to the generosity of Mr. Andrew Carnegie, who donated a fund to house, catalogue, and complete the celebrated Latimer Clark collection of books, pamphlets, and periodicals presented to the library of the American Institute of Electrical Engineers by Dr. Schuyler Skaats Wheeler."

Given an unrivalled collection and a free hand, it is not every librarian or every professor of physics who could, in preparing what is called a catalogue, have produced what is in reality also a delightful book, which will afford the book-lover some of the inspiration and charm which the library itself alone can provide in full. The books are numbered in chronological order, the earliest being Vincentius (1190–1264). The system is to give a copy of the material on the title-page, with some account of the nature of the contents of the book. Where this is of exceptional importance, a facsimile of the frontispiece, title-page, or of some page or pages from the text, and of some illustrations is given also. On turning over the pages, the reader not altogether devoid of historical interest cannot fail to be attracted by these glimpses of the work of long ago, and to be driven to seek in the library itself the continuation of accounts of investigations to which the end of a page sets a disappointing limit. Among the facsimiles is the historic letter, a typical example of the official *non possumus* attitude not even unknown at the present day, dated August 5, 1816, from the secretary of the Admiralty to Mr. (afterwards Sir) Francis Ronalds, F.R.S., relative to the electric telegraph.

"Mr. Barrow presents his compliments to Mr. Ronalds, and acquaints him with reference to his note of the 3rd inst. that telegraphs of any kind are now wholly unnecessary; and that no other than the one now in use will be adopted."

This was a semaphore!

The two volumes contain 5966 entries, and they are completed by a name-index.

The American Institute of Electrical Engineers is to be congratulated upon its possession of so valuable a library, the contents of which have been brought home to them in so pleasing and sympathetic a manner.

C. V. Boys.

COMPARATIVE ANATOMY OF ANIMALS.

An Introduction to the Study of the Comparative Anatomy of Animals. By Prof. Gilbert C. Bourne. Vol. i. Second edition, revised. Pp. xvi+299. (London: George Bell and Sons, 1909.) Price 6*s*.

PROF. BOURNE says rightly that there is a considerable difference of opinion as to the limits of elementary teaching in comparative anatomy, which he defines as "the science which treats of the architecture of animals." The second edition of his well-known and interesting text-book will be welcomed by all serious students of animal biology, for it is with animal biology rather than pure anatomy that it deals. This is necessarily the case, for anatomy and physiology must ever go hand in hand.

The position of biology in the University curriculum is at the present time a very critical one, especially in the case of medical students, for whom this work is expressly intended. The enormous increase in our knowledge of the detailed structure of all the commoner forms of animal life which has taken place during the last few years makes it more and more difficult to select the materials for a first year's course. The introduction of too large a number of types necessitates superficial treatment, while, on the other hand, the too detailed study of only a few types leaves the student without time to follow even the main steps in the evolution of the animal kingdom. He cannot see the wood for the trees. The chief value of the study of comparative anatomy and physiology for the medical student lies in the fact that they help him in the end to understand the structure and functions of the human body, but there is very much in the minute structure of the lower animals which is not necessary for this purpose, and we fear that the insistence upon what many regard as superfluous detail has done much in late years to discourage the study of zoology, not only amongst medical students, but also amongst others who doubt their ability to digest and assimilate (especially for examination purposes) the immense mass of intellectual food set before them. Fortunately so much detail, however interesting in itself, is not really necessary for the comprehension of the great principles of the subject.

Prof. Bourne's view is, as he tells us in his preface, that the more elementary the teaching the fuller it should be, and this view finds full expression in the volume before us, which, we venture to think, is likely to appeal to the advanced perhaps even more than to the elementary student. Protozoa are fashionable at the present day, but it is, perhaps, a pity that Prof. Bourne did not follow what he tells us was his original intention, and omit some of the types with which he deals so fully. Actinosphærium, at any rate, has very slight claims to inclusion in an elementary text-book. On the other hand, a cordial welcome may be extended to Copromonas, a very valuable new type, of which an admirable account is given, based upon the work of Mr. Dobell.

A few inaccuracies in phraseology might with advantage be attended to in future editions, *e.g.* "smell and taste are localised patches of end organs" (p. 9), but these are minor blemishes which detract but little from the thoroughness with which the author has carried out his extremely useful work.

MODERN MIRACLES.

The Faith and Works of Christian Science. By the writer of "Confessio Medici." Pp. xi+242. (London: Macmillan and Co., Ltd., 1909.) Price 3*s*. 6*d*. net.

THE cult, if it may be so termed, of Christian science has taken considerable hold on a section of the community here and elsewhere, and we welcome this book by the author of "Confessio Medici" exposing its fallacies, inconsistencies, and dangers. No one, perhaps, could do this in a more genial manner, but the whole forms a scathing indictment indeed.

In the introductory pages the author tries with more or less success to put into plain words the contrast between philosophy and Christian science. He then arranges in the form of articles some of the tenets of Christian science taken from Mrs. Eddy's writings, discusses life and Christian science, the reality of disease and the reality of pain, and gives a brief survey of Mrs. Eddy's remarkable career. Next, and most important, the record of the testimonies of healing by Christian science is critically examined. Two hundred recent cases (April–August, 1908) are analysed; the author has taken the trouble to write to many of the patients for additional information, and a more inadequate and unconvincing series could hardly be imagined. This one is healed of "kidney and liver trouble," that one of "stomach trouble," a third of "fever," a fourth of "colds and eruptive fever," and so on. The details are of the scantiest, and, in most instances, the diagnosis is the patient's own. The author concludes from these evidences

"that Christian science accepts all testimonials, even the most fantastic and illiterate. That she embellishes what she publishes. That she evades investigation. That her claim to cure organic disease breaks down under the most elementary rules of criticism. That she does cure 'functional' diseases. That she has never cured, nor ever will, any disease, except those which have been cured, a hundred thousand times, by 'mental therapeutics.'"

Two further lines of criticism are pursued by the author. First, he pictures a large hospital given over to the care of Christian "scientists," with its cases of appendix abscess rupturing into the peritoneum, strangulated hernia going on to gangrene, advanced heart disease getting out of bed and taking violent exercise, and spinal disease hanging on gymnastic bars! Secondly, he has obtained information from various medical practitioners of cases of organic disease going from bad to worse under the "treatment" of Christian "scientists."

The author is no dogmatist; he freely admits the influence of mind over body, that Christian science may cure hysteria and the liquor habit, that as regards the revival of "spiritual healing" it is for the patient and the family to have what ordinance or ritual they wish to have. No doctor would find fault with that sort of work provided it is kept in its proper place. This aspect of mind renders the book all the more convincing, and we feel sure that it may fill a useful place in refuting the pretensions of Christian "scientists." R. T. H.

SEMITIC MAGIC.

Semitic Magic, its Origins and Development. By R. Campbell Thompson. Pp. lxviii+286. (London: Luzac and Co., 1908.) Price 10s. 6d. net.

MESSRS. LUZAC have produced a useful as well as well-looking volume as the third contribution to their "Oriental Religious Series" in Mr. R. Campbell Thompson's "Semitic Magic." Mr. Thompson's book is an attempt to bring our knowledge of Arab, Hebrew, and Babylonian (Assyrian) magic into line with the scientific treatment of the demonology and witchcraft of other peoples which the labours of many devoted workers have given us during the past half-century.

It is not too much to say that the field of Semitic magic has hitherto been somewhat unduly neglected by writers on the subject. Probably shyness of dealing with a subject which must owe so much to a correct interpretation of the cuneiform texts has had much to do with this fact. A knowledge of the necromantic ideas of the Jews and the Arabs, especially of those of the former people, we have always possessed in abundance, but Semitic magic without Babylonian and Assyrian magic would indeed be Hamlet without the Prince of Denmark, and up to the present time general anthropologists have rightly been diffident of their power to collate adequately material of which they have no first-hand knowledge with the results of their study of the necromancy of the Jews and Arabs. It was first necessary that a cuneiform scholar should be found with an active interest in the general subject, and a competent knowledge of the other anthropological material, not only from the rest of the Semitic nations, but from the whole of the primitive world.

Mr. Thompson, who is an Assyriologist with a general knowledge of anthropology and a special interest in the subject of magic, has essayed to fill the gap; and we think that as a first essay he has done so very successfully. His book is not an exhaustive treatise; it can be regarded simply as an introduction to the subject, based from the Semitic side ultimately on Robertson Smith's epoch-making book, "The Religion of the Semites," and from the general side largely on the work of Frazer. But at the same time, Mr. Thompson is an original thinker who does not hesitate to criticise the work of his models when he thinks they are wrong, and to draw new conclusions from the large amount of new material which he now places in our hands, derived from his own Assyriological knowledge. Later on Mr. Thompson may perhaps produce a larger work on the subject, to which his present volume will serve as a preface. As it stands, his book is an authoritative contribution to anthropology, which will be found of very great use by all students of the beliefs of primitive mankind.

Mr. Thompson lays great stress upon the subject of tabu, of the existence of which he finds constant evidence among the Semites, while demoniac possession, sympathetic magic, and the specially Semitic ideas of the Atonement, Sacrifice, and the Redemption of the Firstborn, all have chapters specially devoted to them. The long quotations which he gives from the cuneiform texts are of great interest, and enable us to form an adequate idea of the great part which magic played in the daily life of the oldest civilised peoples of the ancient world.

OUR BOOK SHELF.

British Rainfall, 1908. On the Distribution of Rain in Space and Time over the British Isles during the Year 1908 as recorded by more than 4500 Observers in Great Britain and Ireland, and discussed with Articles upon Various Branches of Rainfall Work. By Dr. Hugh Robert Mill. Pp. 100+304; with maps and illustrations. (London: Edward Stanford, 1909.) Price 10s.

The author has stated elsewhere that the perfect rainfall map is a thing of the future, many preliminary studies being necessary before it can be drawn. The irregularity of rainfall and its dependence upon orographical features require a very large number of stations, and observations made during the same period for at least thirty or thirty-five years for determining its average annual distribution and variation. By the energy of the late Mr. G. J. Symons, the founder of the British Rainfall Organisation, and his successors, the British Isles can boast of a system of rainfall observations quite unique and unrivalled by that of any other country; the data published yearly in "British Rainfall" supply invaluable materials for general discussions, and, in fact, have been frequently utilised by various authorities. Part i. of the present volume, the forty-eighth of the series, contains articles by Dr. Mill on new recording rain-gauges, by Mr. A. Lockwood on rainfall observations in Snowdonia, and others; also records of evaporation and percolation, duration of rainfall at various stations, and other matter. Part ii. includes, *inter alia*, observers' weather notes for days, months, and the year, heavy rains for short periods and for days, monthly and seasonal rainfall, and a general table of the annual rainfall at all stations. There is also a coloured frontispiece map showing the relation of the rainfall of 1908 to the average of 1870–99. The rainfall of Scotland and Ireland, generally, was practically normal, that of England and Wales rather more than one-tenth less than the average. Only a small part of England and Wales, but a large part of Scotland and Ireland, had more than the average; parts of the south of Ireland, south-west and east of England and east of Scotland were very dry. The greatest annual amount recorded was 237·3 inches, at Llyn Llydaw (Snowdon); the least, 15·6 inches, at Bourne (Lincolnshire). Among the changes introduced in this volume may be mentioned (1) that, in discussing monthly rainfall, maps of the actual fall are given side by side with those showing the percentage difference from the normal; (2) much fuller treatment of the sections relating to heavy falls on rainfall days and in short periods. Although efforts have been made to economise space, and no part is a repetition of any previous issue, the present volume is larger than any of its predecessors, and, we think, compares favourably with them.

La Mesure rapide des Bases géodésiques. By J. René Benoit and Ch. Ed. Guillaume. Quatrième édition. Pp. 228. (Paris: Gauthier-Villars, 1908.)

The invention of invar, the nickel-steel alloy with a small or zero coefficient of expansion, in 1897 imported new conditions into determinations of length. The great value of this invention for the measurement on the ground of the base-lines of a survey was at once apparent, and during the next year the new method was tried by the joint Russo-Swedish expedition in Spitsbergen. The results obtained equalled the most sanguine expectations. Not only was a high limit of precision attained, but the rapidity of the work, as compared with the old methods, was enormously enhanced. It was obvious that the geodesist had in his hands a new tool which greatly accelerated the most laborious portion of his operations, and at the same time gave him a degree of accuracy at least equal to that hitherto achieved with far more cumbrous apparatus.

These results came into prominent notice at the International Geodetic Conference held at Paris in 1900, and a further and more minute investigation of the whole problem was undertaken by the Comité international des Poids et Mesures.

At the meeting in 1905 a report was furnished by the present authors, to be expanded into a more complete form for presentation to the Geodetic Conference of 1906. The large demand for copies of this report, and the fact that the new method has now been adopted by almost all surveys having any pretensions to execute work of the first order, have induced the authors to put the record of their investigations into a permanent and convenient shape. Of the present little volume we can only say that it is one that must be in the hands of every geodesist. It contains, in a succinct form, the general theory of measurements by wires hung freely between supports, a short discussion of the physical properties of invar, an account of the testing and standardisation of the wires and of their possible distortions under different conditions of tension, temperature, repeated windings and unwindings, and, in general, their stability under the practical conditions of their employment in the field. This is followed by a description of the auxiliary apparatus used for base measurement, all of a very simple character, and a full account of the routine of the field work and of the calculations for the reduction of the measures to the horizontal, including the necessary tables.

A summary of the actual results attained in practice shows that a rate of measurement of about 5 kilometres per day can be kept up with a limiting error of between $\frac{1}{500000}$ and $\frac{1}{1000000}$. With special precautions a still higher degree of apparent accuracy can be reached, but such appearance is largely delusive, and in geodetic work would soon disappear in the angular measures.

We congratulate the authors, not only on their most valuable investigations, but also upon the excellent form in which their conclusions are presented.

E. H. H.

Bibliotheca Geographica. Jahresbibliographie der gesamten geographischen Literatur. Herausgegeben von der Gesellschaft für Erdkunde zu Berlin. Bearbeitet von O. Baschin. Band xiv. Jahrgang, 1905. Pp. xvi+545. (Berlin: W. H. Kühl, 1909.)

This is one of those publications (and there are not a few) for which British geographers may well be grateful to German. We do not produce many works of this kind—works which can hardly bring profit sufficient to reward the labour of their compilation. The "Bibliotheca Geographica" is a wonderfully full bibliography of geographical books and papers published, in all parts of the world, during the year 1905—it is not to be wondered that the volume bears a date of issue four years later, when the magnitude of the task of tracing such a vast number of publications is considered. General treatises on the various scientific branches of geography are given first; after these there follows what occupies the bulk of the volume—a bibliography according to topographical divisions. Each topographical division is minutely subdivided according to special subjects, an arrangement which partially disarms the criticism that the entry of a publication under its own title or the name of its author seems somewhat arbitrary.

It is doubtful, however, whether any large bibliography would entirely escape this criticism. Some difficulty, again, is evidently felt with regard to the entry of individual papers out of collected volumes. Thus, when the report of a research committee of the British Association is entered only under the name of the secretary of the committee, it may be doubted whether this method gives the reader the best chance of finding the reference. On the other hand, cross-references are provided from one subject subdivision to others of a kindred nature, and at the end there is an authors' index, so that one cannot but recognise that the system of the whole work is well-nigh perfect. Moreover, the entries, so far as can be judged, appear to be admirably accurate.

The Invicta Number Scheme. By J. W. Ladner. (London: George Philip and Son, Ltd., n.d.) Handbook, price 8*d.* net; Number Board, price, with plain edges, 6*s.* 6*d.* per dozen; with edges, cloth-mounted, 8*s.* 6*d.* per dozen.

This device is a method found useful by a practical schoolmaster of experience in teaching the fundamental principles of arithmetic by constant reference to the decimal system of notation. The plan utilises not only the ears, but the hands and eyes of the children. Though many original teachers will have developed equally good expedients for rendering their lessons in arithmetic practical, interesting, and intelligible, the scheme may be recommended to the attention of teachers who have not as yet adopted concrete aids in their instruction. It is now very generally agreed that children learn best by doing, and Mr. Ladner's method of teaching will certainly assist the children to arrive at the rules they have to learn from the results of their own experiments.

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.*]

Magnetic Storms.

In his article upon the recent magnetic storm (Nature, September 30) Dr. Chree writes:—"Another difficulty in regarding the phenomena of magnetic storms as entirely and directly due to the action of electrical currents associated with aurora is that it is a frequent occurrence—as on the present occasion—for the horizontal force to be considerably depressed below the normal value when the storm has apparently ceased and for some considerable time thereafter. It is possible, of course, that the external currents have partly demagnetised the earth, or at least modified its distribution of magnetism, and that there are recuperative tendencies tending to cause reversion of what is for the time being a more stable distribution, but if this be the true explanation the demagnetising action and the recuperative tendencies are presumably in action during the course of the storm, and profoundly modify the magnetic phenomena."

I wish to add to Dr. Chree's words the remark that this phenomenon of decrease in horizontal intensity is nothing but part of the phenomena I described a long time ago,[1] and about which I exchanged opinions with Dr. Chree in *Terrestrial Magnetism*.

Later on I found occasion in several publications again to deal with those phenomena of "Post-turbation"; also recently, at the meeting of the Helvetic Association of Natural Science at Lausanne.

In a short statement I directed attention to the fact that the results of my investigations on magnetic perturbation are in accordance with the splendid results and theories of Birkeland and Størmer.

My results were shortly as follows:—

A force of disturbance is always present; it strongly increases when a storm appears, decreasing afterwards. The horizontal component of this force is chiefly directed to the magnetic south, *i.e.* along the meridian of the regular magnetism of the globe, thus lying in the plane through the magnetic axis and the station.

The vertical component, on the contrary, mostly has the same direction as that of permanent magnetism, *i.e.* downward in the northern hemisphere. Its character and sign are much less constant than those of the horizontal component.

The regular post-turbation is most frequent at lower latitudes.

An extensive study of all the storms recorded at Batavia has taught me that the post-turbation often emerges in a negative sense (northerly), but shortly after turns and reaches its maximum positive value. Afterwards it decreases at a slower rate, and this decrease continues until a new storm (it may be a very small one) appears. I found that successive quiet days show that same decrease. This is the same that Dr. Chree also detected, and called non-cyclic variation.

At Lausanne I pointed to the fact that this kind of disturbance corresponds to Birkeland's class of positive equatorial disturbances. He also found negative disturbances, but from my statistics it is evident that they are much less frequent than the positive.

As to the cause of these positive equatorial disturbances, Birkeland, according to his experiments with his terella and the theoretical calculations of Størmer, accepts currents of electrons flying around the magnetic equator of the earth. As for the negative ones, he accepts electrons which move also in that plane, but through a loop in their orbit, thus having a contrary direction.

If we accept the cause of the post-turbation to be the presence of an electric current, this current must be extra-terrestrial, because the vertical component generally increases when the horizontal one decreases.

The less regular character of the vertical component may be explained by the currents of induction raised inside the globe. Accordingly, an effect of demagnetisation of the earth seems to be improbable.

From the inspection of thousands of magnetic curves recorded at Utrecht, Batavia, and other non-Arctic stations, I received the impression that the increase and decrease of the post-turbation are fairly regular, the rapid oscillations being superposed on this variation.

No doubt these rapid oscillations are caused by currents of electrons nearly approaching the earth, and this will happen more frequently in the polar regions than in the equatorial ones. Thus the action of the ring current will show itself more distinctly at stations at lower latitudes, the ring being nearer to them than to stations at higher latitudes, and it will be less disturbed by other currents coming very near to the earth.

Dr. Chree concludes his article with wise words, saying:—"To many minds subscription to some theory may be a necessity for intellectual comfort, but in the case of magnetic storms reservation of judgment appears at present the more scientific attitude."

I fully agree with him in this respect, but I think he, who himself has contributed so much to the science of terrestrial magnetism, will agree with the call for more activity. The work of Birkeland and Størmer is splendid indeed, but it is only in the power of international cooperation, such as in the year 1882–3, to unravel all the problems of magnetic disturbance.

We should repeat that work, considering that at present we are able to do so much better and more completely than our predecessors were in those days.

Concentration of our efforts on special problems, I think, would be more effective than the unsystematic accumulation of material nowadays.

The crowding of permanent magnetic observatories in Europe may be favourable to the solution of minor problems; it is a hindrance to that of the fundamental ones, because it absorbs too great a part of the powers at our disposal.

W. van Bemmelen.

The Hague, October 13.

[1] "Die magnetische Nachstörung," *Meteorologische Zeitschrift*, 1895.

Homogeneous Corpuscular Radiation.

When a metal plate is subjected to a beam of Röntgen rays, a corpuscular radiation is in general emitted, in addition to the secondary radiation of the Röntgen type.

This corpuscular radiation has been investigated by various experimenters. They have shown that the intensity and the absorbability of this radiation vary when different metals are used, and that they are also dependent upon the degree of "hardness" of the exciting radiation. In particular, Cooksey has recently shown that the corpuscular radiation excited by a "hard" primary beam is homogeneous, while that excited by a "soft" primary is heterogeneous.

But the primary beams used in these investigations were necessarily heterogeneous, and it is therefore impossible to decide with certainty which components were chiefly concerned in producing the phenomena under investigation.

It has been shown in various papers by Prof. Barkla and myself that a series of secondary Röntgen radiations can be obtained from the group of metals the atomic weights of which lie between those of chromium and silver, each radiation being homogeneous and having a perfectly definite coefficient of absorption by a given metal, *e.g.* aluminium. The absorption coefficients of the beams from the different members of the series vary greatly in value; thus for the secondary radiation from iron the absorption coefficient by aluminium is 240, while for that from silver it is only 6·7.

I wish to place on record a summary of the results of some investigations I have made upon the corpuscular radiations excited in various metals when these homogeneous secondary beams are employed as primaries instead of the heterogeneous primary beams used by previous investigators.

(1) It had been shown by Prof. Barkla and myself that the penetrating power of the incident primary radiation must exceed that of the homogeneous secondary Röntgen radiation characteristic of a metal before the latter is excited. Using homogeneous beams, I have shown that when the primary beam is only just more penetrating than the secondary Röntgen radiation characteristic of the metal, the intensity of both the secondary Röntgen radiation and

the corpuscular radiation is small. For a slightly more penetrating primary beam a rapid increase in the intensity of both the secondary Röntgen radiation and the corpuscular radiation takes place. This seems to suggest that the production of corpuscular radiation is in some way intimately associated with the emission of the Röntgen type of radiation.

(2) I had recently shown that when homogeneous radiation falls upon a thin layer of a substance which may act as a secondary radiator, a portion is transmitted unchanged, and that the fraction of the remaining energy which is transformed into secondary Röntgen radiation *decreases* as the primary beam becomes more penetrating. In the present experiments it is found that the corresponding fraction of the remaining energy which is transformed into corpuscular radiation *increases* as the primary beam becomes more penetrating.

(3) The corpuscular radiation emitted by these metals when subjected to homogeneous beams is itself surprisingly homogeneous, whether the exciting beams are "soft" or very "hard."

(4) The absorption coefficients of the corpuscular radiation from a given metal excited by homogeneous secondary Röntgen radiation vary with the nature of the exciting radiation. These absorption coefficients are a decreasing linear function of the atomic weight of the secondary radiator.

I hope to publish further details of these experiments shortly. CHARLES A. SADLER.

George Holt Physics Laboratory,
Liverpool University.

Drought in South-west Ireland.

THE deficiency of rainfall in the south of Ireland, to which Mr. Armstrong refers in NATURE of October 21 (p. 487), has been apparent in the annual total rainfall for the last three years, the deficiency also affecting the south-west of England. At the same time, there has been a marked excess of rainfall in the north of Ireland, deficiency and excess being taken as synonymous with quantities below and above the average of many years. It is frequently found that parts of the country, often quite narrow strips, show a marked deficiency of rainfall for several successive years, and afterwards revert to an average condition or show an excess. The most probable explanation seems to me to be a change, perhaps a slight one, in the prevailing tracks of the centres of barometric minima, but I have not found data in a form suitable for testing the truth of the suggestion.

The extreme dryness of August was experienced over a large area of the south of Ireland, less than half an inch of rain having fallen over about 2800 square miles. In September less than half an inch fell over not more than 500 square miles.

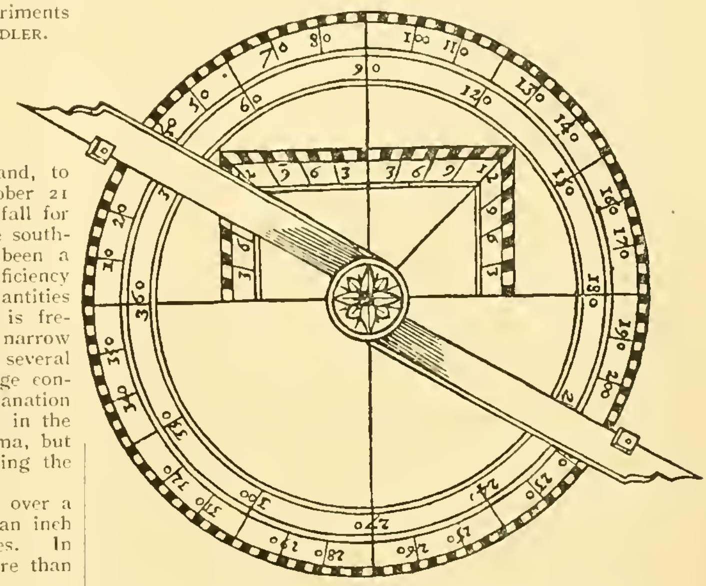
I may perhaps be excused for pointing out that while Mr. Armstrong uses "absolute drought" to describe a period of twenty-four hours without rain, it has been usual for many years to reserve the words "absolute drought" for a period of more than fourteen *consecutive* days without recorded rainfall. HUGH ROBERT MILL.

62 Camden Square, London, N.W., October 25.

Derivation of the Word "Theodolite."

ALTHOUGH the etymology of the word theodolite has been discussed from time to time,[1] no satisfactory solution has hitherto been established. It was first used in England, and the earliest reference to it is contained in a book by Leonard Digges (completed and published by his son, Thomas) called "Geometrical practical treatize, named Pantometria, diuided into three bookes, longimetria, planimetria, and stereometria, &c.," first published in 1571, with a second edition in 1591, wherein the "composition of the instrument called Theodelitus" is represented as a "circle diuided in 360 grades or degrees, or a semi-circle parted in 180 portions"; or again, "the composition also of the Square and Planisphere or Circle named Theodelitus for measuring lengthes, breadths, and distances." It had a "*double scale*," an "index," "the sightes," and the circle was 2 feet in diameter, and "fastened in the top of some staffe." He does not state how the name was derived, and spells it "theodelitus" and "theodolitus" alternately. William Bourne ("Treasure for Travailers," 1578) named the same instrument "horizontall or flatte sphere," and not theodelitus; but when he speaks of the alidade he calls it only once *alideday*, but otherwise always *athelida*. After this de Morgan, who first discussed the derivation in the *Philosophical Magazine*, concluded that the "theodelited circle" of Digges, who, however, does not use that adjective, and "athelidated circle" of Bourne, were various corruptions of the Arabic word *al-idhâda* (a sort of rule), from which the word *alidade*, which carries the sights or telescope of a theodolite, is derived.

It has been suggested by various writers that theodolite is derived from the Greek roots θέα (sight), ὁδός (the way), and λίθος (a stone), for the latter root λιτός (smooth) being



Reproduction of Digges' illustration of his "Theodelitus." From the *Zeitschrift für Vermessungswesen.*

substituted by others; also from θεάω (I see) and δολιχός (long). Another suggested derivation is the English article "*the*" combined with the Arabic "*alidhada*."

In searching for a more satisfactory solution, the idea occurred to the writer that the word would naturally be compounded to represent the principal parts of the instrument, and when reading Prof. E. Hammer's latest and most interesting discussion in the *Zeitschrift für Vermessungswesen*, vol. xxxvii. (1908), pp. 81–91 and 113–25, he was impressed by one of the illustrations reproduced of Digges' "theodolitus" and description of it, with special mention of the words "sightes," "index," and "double scale." He would submit, therefore, that the true etymology is from the Greek words θέα = a sight; ὀδελός = any pointed instrument; ἴτυς = a circle or a felloe of a wheel. These Greek words appear to be those which would actually denote the three essential parts of the instrument, viz. the *sight*, the *index arm*, or alidade (Digges uses the word index, never alidade), which is represented as a pointed instrument, and the limb of graduated *circle*. The spaces on the circle appear like the

[1] *Philosophical Magazine*, vol. xxviii. (1846), note by de Morgan, pp. 287–9. *Poggendorff's Annalen*, vol. cxxxiii. (1868), pp 192, 349. *Zeitschrift für Vermessungswesen* (1880), p. 55; (1883), p. 321; (1908), pp. 81–91 and 113–25. Vogler's *Praktische Geometrie* (1885), p. 361. *Proc. Inst. C.E.*, vol. clxxiii. (1907–8), p. 330. *Preussische Jahrbücher*, note by Prof. Didolff, vol. cxvi. (1904), pp. 362–4.

felloes of a wheel. This derivation corresponds with Digges' description of the instrument.

E. H. V. MELVILL.

203 and 204 New Stock Exchange Buildings, Johannesburg, Transvaal, September 27.

A Supposed New Mineral.

A SPECIMEN of a mineral, forming portion of a mass stated to have been found in the basalt of Co. Antrim, was recently sent for identification to the office of the Geological Survey of Ireland by Mr. S. B. Wilkinson, the senior geologist, to whom it was handed by the finder. As it presents some peculiar features, and appears to be new to science, we take this opportunity of recording its occurrence. The complete examination of the mineral will necessarily occupy some time.

The mineral strongly resembles cobaltite in appearance. Its lustre is metallic, hardness about six. It breaks with a surface which under the microscope shows a finely conchoidal structure. When etched with an acid a crystalline structure becomes apparent; it is fusible with difficulty, but in the oxyhydrogen flame it melts without apparent alteration. Heated in a closed tube it does not yield any sublimate.

When the mineral is powdered, or even its surface scratched, it emits an odour like that of acetylene prepared from commercial calcium carbide. Hydrofluoric acid dissolves the mineral, the other acids have little effect upon it, while it is readily decomposed by fusion with the alkaline hydroxides.

A preliminary chemical analysis shows that the mineral is essentially a compound of iron, silicon, and carbon.

RICHARD J. MOSS.
HENRY J. SEYMOUR.

Laboratory, Royal Dublin Society, October 20.

The Pitcairn Islanders.

WHEN reading Mr. M. J. Nicoll's "Three Voyages of a Naturalist" a short time ago, I came across the following passage on p. 211 in the chapter on Pitcairn Island:—

"The older people, as well as the younger children of Pitcairn, have fair complexions, but the people of from thirty to fifty years of age are quite as dark as the average Polynesian. It appears from this that the Pitcairners resemble their ancestors, the 'Bounty' mutineers, every alternate generation."

It may be remembered that in 1790 nine mutineers, six native men, and twelve native women sailed from Tahiti to Pitcairn; the native women killed the native men, and by 1800 only one British sailor was left, from whom the present inhabitants are descended.

Just before the above extract Mr. Nicoll tells us that "Lord Crawford paid a visit to the two oldest inhabitants . . . both of whom are grandchildren of the original mutineers." So we see that the grandchildren and the great-great-grandchildren were fair, resembling the British men, while the great-grandchildren were dark, resembling the native women. That is to say, that F_2 and F_4 generations resembled the ♂ P_1, while F_3 generation resembled the ♀ P_1.

These facts struck me as being particularly interesting, as experiments of this nature in human heredity are difficult to obtain. Perhaps some "Mendelist" may be able to use or explain them.

C. B. WILLIAMS.

Clare College, Cambridge, October 14.

The Auroral Display of October 18.

I WAS very much interested in Mr. Harcourt-Bath's letter describing an auroral display which he saw from the Cotteswold Hills.

From West Kirby Hill, on the Wirral, I noticed a luminous band low down on the horizon, with upward streamers and "a detached, red, cloud-like portion" rather north of west.

What struck my attention, however, was that behind this red patch there were dark clouds, at no great altitude, faintly illuminated on the underside by the aurora.

As the red colour outlasted the streamers by several minutes, I was brought to the conclusion that it was independent of the auroral display.

However, in view of Mr. Harcourt-Bath's letter, I am led to ask you if observers have ever thought that an aurora could be comparatively close to the earth, and not of necessity in the "highly rarefied layers of the air"?

ERNEST J. BATY.

"Nunclose," West Kirby, Cheshire.

IT may interest Mr. Harcourt-Bath to know that the auroral display of October 18 was strikingly visible at Dudley. At 9.15 p.m. there were six or more broad beams of white light of unequal lengths and widths. These sprang normally from a broad circular arc resembling a "Milky Way" in luminosity and a broad rainbow in shape and size.

The central vertical beam was the brightest, widest, and longest, extending vertically about 45°, but not terminating definitely; it was about 10° W. of N.

The broad arched base appeared to cross through Ursa Major, the vertex being about 20° above the horizon, and was not uniformly bright. About 9.30 p.m. the left-hand (W. of N.) half of the base became a soft violet light; the right-hand portion remained white, but grew fainter.

W. AUSTIN MORLEY.

14 Park Road, Dudley, October 26.

The Occurrence in India of the Pappataci Fly (*Phlebotomus papatasii*).

THE *rôle* nowadays assigned to *Phlebotomus papatasii* in the transmission of a certain type of fever (see "Das Pappatacifieber," 1909, by Drs. Doerr, Franz and Taussig) makes the geographical distribution of this little fly a matter of practical importance. It is therefore interesting to note that this species is common in certain parts of northern India. Some time ago Mr. F. M. Howlett, second imperial entomologist, sent me specimens from Rawalpindi, in the Punjab, and Pusa, in Bihar, which I identified as belonging to a species allied to *P. papatasii*. Through the kindness of Dr. J. H. Ashworth I have now been able to compare some of these specimens with European examples of *P. papatasii* in the zoological laboratory of the University of Edinburgh. I can find no difference except that the Indian specimens are perhaps slightly smaller than the European ones. The former agree as regards venation, genitalia, &c., with Grassi's beautiful figures (" Ricerche sui Flebotomi," 1907).

In addition to *P. papatasii*, six Indian species of Phlebotomus are now represented in the collection of the Indian Museum. They will be fully described shortly.

N. ANNANDALE.

The Mansfield Automatic Water-finder.

WITH reference to Mr. A. A. Campbell Swinton's letter in regard to Mansfield's water-finder, which appears in NATURE of October 14, it may be of interest to state that I made inquiries from Messrs. Mansfield and Co. in May, 1908, asking for the names of the "leading scientists and engineers" who, as they stated, "vouched for the successful application of the invention"; they did not send me any names, but allowed a friend of mine in Liverpool to call to see the documents. One was from an architect in Liverpool, another from a firm of well-borers, and there were some foreign ones, but none were produced that were signed by persons whom I should describe as "leading scientists and engineers."

I may add that I expressed my willingness to test their instrument, but one was not placed at my disposal.

J. WERTHEIMER.

Merchant Venturers' Technical College, Bristol, October 20.

TO DETERMINE THE REFRACTIVITY OF GASES AVAILABLE ONLY IN MINUTE QUANTITIES.

ON a former occasion [1] I described a refractometer capable of dealing with rather small quantities (12 c.c.) of gas. The optical tubes, one of which would contain the material under investigation and the other air, were of brass, 20 cm. in length and 6 mm. in bore, and were traversed by two pencils of light from the same origin, subsequently brought to interference in the observing telescope. For this purpose the object-glass of the telescope was provided with two parallel slits opposite the axes of the tubes. The image of the original slit, formed in the focal plane, was examined through a high-power cylindrical lens, constituting the eye-piece of the telescope, and exhibited the familiar pattern of interference bands the position of which shifts with changes in the densities of the gases occupying the tubes. With this apparatus, and using pressures not exceeding one atmosphere, it was possible to compare refractivities $(\mu - 1)$ with a relative accuracy of about one-thousandth part.

In recent conversation my son, the Hon. R. J. Strutt, raised the question as to the minimum quantity of gas upon which a determination of refractivity could be made, having in mind such rare gases as the radium emanation. Towards answering it I have made a few experiments dealing merely with the optical side of the question.

A reduction of volume in the gas tube implies a reduction of length below the 20 cm. of the apparatus just referred to, and this carries with it a loss of accuracy. A reduction to 2 cm. should leave possible an accuracy of at least 1 per cent., and this was the length chosen. As the inquiry was limited to the optical conditions, it was unnecessary to close the ends, and thus the tubes reduced themselves to two parallel tunnels through a block of paraffin 2 cm. thick. They were prepared by casting wax (from a candle) round two similar sewing needles of suitable diameter previously secured in a parallel position. The rest of the apparatus was merely an ordinary spectroscope arrangement (without prism). Sunlight admitted through a slit, and rendered parallel by the collimating lens, traversed the double tunnel, and was received by the observing telescope focussed, as usual, upon the slit. It is necessary, of course, that the length of the slit be perpendicular to the plane containing the axes of the tunnels.

The appearance of the bands as seen with a given telescope depends upon the size of the apertures and upon their distance apart. The width of the bands is inversely as the distance between the centres of the apertures (tunnels), and the horizontal diameter of the luminous field upon which the bands are seen is inversely as the diameter of the apertures themselves. Since a large number of bands is not required, small and rather close apertures are indicated. The only question is as to the amount of light. If we suppose the apertures and their distance apart to be proportional, we may inquire as to the effect of linear scale L. Here a good deal may depend upon the relative values of length of slit, focal length of collimator, length as well as diameter of tunnels. In my apparatus the slit was short, and the height, as well as the width of the field of view, was determined mainly by diffraction. If we suppose the slit very short, the calculation is simplified, though this cannot be the most favourable arrangement. With a given width of slit the whole light in the field of view is then proportional to L^2. Since the angular area of the field practically varies as L^{-2}, it would seem that the brightness varies as L^4. This would impose an early limit upon the reduction of L; but there are other factors to be regarded. In order to secure an angular field of given size, we must use an eye-piece the magnifying power of which is proportional to L. This consideration changes L^4 back to L^2. Nor is this all. With a given eye-piece the admissible width of primary slit varies inversely as L, and thus, finally, the brightness of a field of given angular width, and containing a given number of bands, varies as L simply.

In the earlier experiments the tunnels were of $\frac{3}{4}$ mm. bore, and were too widely separated. In order to see the bands well, a very powerful eye-piece was needed. An attempt to gain light by substituting a cylindrical lens (very successful in the former apparatus, where the beams are limited by *slits*) for the spherical lenses of the eye-piece showed little advantage. Subsequently smaller tunnels were prepared $\frac{1}{2}$ mm. in bore, and so close that the distance of the nearest parts was rather less than the diameter of either. These gave splendid bands with the ordinary eye-piece of the spectroscope, and I estimated that there should be no difficulty in setting a web correctly to one-twentieth of a band.

The capacity of one of these passages is about 4 cubic millimetres, and I have no doubt a further reduction might be effected, so far as the optics is concerned; but the further such reduction is carried the greater, probably, would become the difficulties of manipulation. The mere closing of the ends of such small tubes with plates of glass would not be an easy matter. In order to prevent encroachment upon the course of the light, it might be necessary to enlarge the ends so as to allow a little more room for overflow of cement. For the present I content myself with showing that it is possible to obtain well-formed black bands on a sufficient angular scale with light which has traversed tubes 2 cm. long and $\frac{1}{2}$ mm. in bore. RAYLEIGH.

[1] Proc. Roy. Soc., vol. lxiv., p. 95, 1898; Scientific Papers, iv., p. 364.

GAY-LUSSAC'S LAW—ITS CENTENARY.

GAY-LUSSAC'S law regarding the composition of gases by volume was made known about a hundred years ago. The paper in which he elaborated it, having been read to the Société philomatique on December 31, 1808, was published in the Mémoires de la Société d'Arceuil in the following year. Since then the law has come to have a history of its own. Chemists were at a loss and made many efforts to get it and the atomic theory to suit one another, and the place of the law in science, though not now likely to change, was for long unsettled and dubious.

Ostwald puts the law in the following way:—"If several gases appear or disappear in a chemical change, they do so always in simple ratios by volume." For example, one volume of hydrogen and one of chlorine yield two volumes of hydrochloric acid, and, again, one volume of oxygen and two volumes of hydrogen give two of steam.

The composition of nitrous and nitric oxides and numerous other gases was discovered for the first time by Gay-Lussac. But no one who has paid much attention to the history of science can be surprised that observations had been made earlier in the same field. William Higgins knew that hydrogen and oxygen combine, yielding water, in the proportion 2 : 1, and this was probably only a version of Cavendish's result. He knew also Austin's experiment proving that sulphuretted hydrogen contains its own volume of hydrogen, and he had himself observed that sulphur dioxide contains its own volume of oxyyen. It must be admitted that Higgins, who stated these facts and reasoned very justly upon them in his "Comparative View of the Phlogistic and Anti-phlogistic Hypotheses" (1789), did not give any sign, by collating them, that he felt himself on the threshold of a great discovery. Again, Gay-Lussac and Humboldt, taking up the study, for purposes of eudiometry, of the combination of hydrogen and oxygen, found the ratio between these gases to be 2 : 1 as nearly as they could measure. This was in 1804. The observation arrested Gay-Lussac's attention. Curious to find if other suchlike cases exist, he began work which resulted in the discovery of his law, one of the most important in science.

Gay-Lussac, like Newton, did not form hypotheses. The memoir in which he set forth his work is remarkably free from speculative matter. His conviction was that "in natural science, and above all in chemistry, generalisation should come after and not before a minute knowledge of each fact." And assuredly the history of Gay-Lussac's law in science does show that a "law of nature" may prove a dangerous weapon to the man who puts it to theoretical and practical uses, before its range and bearings in nature have been accurately fixed.

The law when published aroused the widest interest. The world of science was just then pondering the atomic theory in the form impressed on it by Dalton, and it was obvious that theory and law must stand in the most intimate relation to one another. Strangely enough, the law was objected to by Dalton of all people, and by him alone. In the second part of his "New System of Chemical Philosophy," published in 1810, he made strictures on it, and concluded :—"The truth is, I believe, that gases do not unite in equal or exact measures in any one instance; when they appear to do so, it is owing to the inaccuracy of our experiments. In no case, perhaps, is there a nearer approach to mathematical exactness, than in that of one measure of oxygen to two of hydrogen; but here the most exact experiments I have ever made gave 1·97 hydrogen to 1 oxygen." Berzelius wrote to Dalton protesting in the most courteous way against the part of the atomic theory "which obliges you to declare as inaccurate the experiments of Gay-Lussac, on the volumes in which gases combine. I should have thought rather that these experiments were the finest proof of the probability of the theory; and I confess to you, that I will not so readily think Gay-Lussac at fault, especially where the point is one of good or of bad measurement." Nothing, however, could ever remove the distrust Dalton felt in the law.

The chemists who accepted both Dalton's theory and Gay-Lussac's law had themselves to solve the problem of defining the relation between the two. No more than Dalton would Gay-Lussac do anything to help them. Even so late as the year 1814, in his memoir on iodine, and in the one on prussic acid of the following year, he ignores the atomic theory. He uses the word "molecule" for the sake of convenience, and that is all. Yet there must be a connection between the specific gravities, that is, the weights of equal volumes, of different gases and their atomic weights. This connection is the primary subject of a paper by Prout, published in 1815. Here he advanced his famous hypothesis that the atomic weights of the elements are multiples of the atomic weight of hydrogen, but there is good reason to think that the hypothesis was conceived after the data had been rounded off.

Berzelius had already, in 1813, if not earlier, given his solution of the problem. This was his "volume-theory," that equal volumes of different gases contain the same number of atoms. This hypothesis affords a basis of a purely physical kind for the determination of atomic weights, for it means that the atomic weights of different gases stand in the same ratio to one another as the weights of equal volumes of the gases.

The "volume-theory," plausible as it seems, involved its author in difficulties one after another, which finally became overwhelming. One arises as soon as the theory is formulated. Each atom of hydrogen, on combining with chlorine, could, as Berzelius and Dalton understood the atom, yield only one compound atom of hydrochloric acid. But the volume of the hydrogen is half that of the hydrochloric acid which it produces, so that the atom of the element occupies only half the volume of the compound atom. Hence the theory must either be limited to elements, or given up altogether. Years before Dalton had to face the same difficulty in the case of nitric oxide. What he did at first was to abandon outright the hypothesis that atoms of different gases have the same volume, and then to object even to Gay-Lussac's law. Dalton was "for thorough." What Berzelius did was to make the "volume-theory" apply only to the elements.

In course of time another difficulty appeared. The atoms of many important elements seemed to enter into combination only by pairs. This strange result arose in the following way. Berzelius began in the year 1826 to ascribe the general formula RO to all strong bases. Now, by the chemical equation for the formation of a chloride from a base—$RO + H_2Cl_2 = RCl_2 + H_2O$—it is plain that the amount of acid needed to form a chloride with one molecule of a base contains two atoms of hydrogen and two of chlorine. That is, as Berzelius saw, the hydrogen enters into chemical combination in pairs, and so does the chlorine atom.

This, be it noted, involves a conception of the element which is precisely the reverse of the modern one. Hydrogen is now supposed to consist of physical atoms, each of which can be halved when it enters into chemical combination. The physical atom of hydrogen is composed of two chemical ones. Berzelius had formed the conception of a chemical atom composed of two physical ones. It applied to quite a large number of elements in addition to hydrogen, namely, to chlorine, fluorine, bromine, iodine, nitrogen, phosphorus, antimony, and arsenic.

The very natural comment on this was made by Gmelin, that the "existence of the physical atom was improbable and its adoption superfluous and troublesome." One could arrive at Gmelin's system of chemical formulæ by suppressing every pair of physical atoms in Berzelius's formulæ, and putting in a chemical atom instead. Thus H_2O became HO. Nobody could help seeing that Berzelius's system simply led the way to Gmelin's. This was a great blow to the "volume-theory," for Gmelin's system differs from Berzelius's only by leaving out the "volume-theory" and all its consequences.

The above as an objection to the theory was perceived and felt to be overwhelming only in course of time. As already explained, from the first the theory could include in its scope only the elements. But before long Berzelius had to limit the theory still further. So long as it is applied to elements the molecules of which are of the same degree of complexity, hydrogen and oxygen, for instance, the physical method of finding atomic weights is in agreement with the chemical. The ratio H_2/O_2, which the former method gives, is the same as the ratio H/O given by the latter. But this is a matter of accident. About the year 1826 Dumas succeeded in finding the vapour-density of elements such as mercury and phosphorus, and was therefore enabled to calculate their respective atomic weights by the physical method. For mercury the ratios are Hg/O_2 (physical) and Hg/O (chemical), and for phosphorus P_4/O_2 (physical) and P/O (chemical).

These discrepancies forced Berzelius to limit the "volume-theory" to gaseous elements, and to such as are easily converted into gas. Finally, when discrepancies, no less serious, arose in the case of sulphur and of arsenic, he decided to abandon the theory. This was in 1833, after he had held to it for twenty years.

The only sound application of the law to theoretical chemistry was made by Avogadro in 1811. In considering his teaching, it is best to set aside the word atom and its associations, at least in the first place, and to use the word "molecule" instead. Avogadro's hypothesis is that equal volumes of different gases contain the same number of molecules. In that case the weights of equal volumes of gases are proportional to their molecular weights.

The hypothesis has a special and important consequence regarding the constitution of the molecule. For instance, each molecule of hydrogen, with the necessary chlorine, yields two molecules of hydrochloric acid. But each molecule of the acid contains hydrogen, and therefore the hydrogen molecule has certainly been halved. This conception of the molecule of an element as a thing which may consist of parts is an inevitable consequence of Avogadro's hypothesis, and it was boldly accepted by him. The mere possibility of such a thing was scouted by Thomson, and Berzelius, and Graham as utterly subversive of the atomic theory. Yet it forced itself forward again and again upon Ampère, Dumas, Prout, Waterston, Krönig, Gerhardt, Laurent, Clausius. Finally, in 1860, Cannizzaro was able to convert chemists to Avogadro's hypothesis and all its consequences. Since then the hypothesis, based as it is upon Gay-Lussac's law, has been the fundamental doctrine of chemistry.

One thing about the definition of the law is worth noting. Nothing is said in it, but much is implied, regarding the conditions under which the gases are measured. The teacher would do well to direct attention to this. There is the obvious assumption that the different gases concerned in a particular experiment are measured under the same temperature and pressure. But the definition implies another assumption, namely, that different gases behave in the same way under the same conditions. Otherwise the combining ratio, say, of hydrogen and chlorine, could not remain constant over a range of temperature and pressure.

Of course, we know that the combining ratio of two gases does not remain strictly constant when the conditions alter. The fact that a gas such as carbon dioxide deviates considerably from Boyle's law and Charles's law leads to the expectation that Gay-Lussac's law is itself only an imperfect description of the facts. The expectation is verified, for even the combining ratio of hydrogen and oxygen is not strictly 2 : 1, but has been ascertained to be 2·00285 (Scott), 2·0037 (Leduc), and 2·0027 (Morley). This is an important consideration, for molecular and atomic weight data obtained on the assumption that Gay-Lussac's law is strictly accurate must be defective. The physical method cannot lead to the same result as the chemical until a correction is introduced, and then the discrepancy is found to disappear. One systematic way of making this correction has been devised and used by M. Daniel Berthelot, and another by M. Guye.

Berzelius was led into a grave numerical error by his unqualified acceptance of Gay-Lussac's law. In the year 1819, in conjunction with Dulong, he determined the atomic weight of carbon by the physical method. The process adopted was to weigh a certain bulk of carbon dioxide and subtract the weight of the same bulk of oxygen. The difference is the weight of the carbon, on the incorrect assumption that carbon dioxide contains exactly its own bulk of oxygen. The atomic weight was found to be 76·44 (O = 100) or 12·23 (O = 16). This datum, which as a matter of fact is much too high, was long used in chemistry. Berzelius should not have fallen into this error, for he had received a warning two years before against the danger of the physical method. He had determined the atomic weight of sulphur by an experiment, similar to the carbon dioxide one, with sulphur dioxide, and he set aside the result, which was 103·35 (O = 100), because it differed so much from the figure, 100·7, which he had obtained by a chemical method.

Dumas and Stas found it necessary, in the year 1839, to embark on a re-investigation of the atomic weight of carbon. Dumas had been analysing the hydrocarbon naphthalene, and had obtained the anomalous result, again and again, that the percentages of carbon and hydrogen added up to much more than 100. As a result, the atomic weight of carbon was found to be 75·00, instead of 76·44, as Berzelius had said.

This was a severe blow to Berzelius. He had endured many reverses. One cherished conviction of his had gone after another. Chlorine and nitrogen had proved to be elements and not compounds of oxygen, the "volume-theory" had become untenable, his electrochemical theory was undermined, and his system of chemistry was threatened by Gmelin. Berzelius was yet the great master of atomic-weight determination. Even that satisfaction was now denied him; none of his atomic weights was to be above suspicion any longer, all because he had made an unjustified use of Gay-Lussac's law, twenty years before. There is a strange irony in the difficulties in which Berzelius involved himself time and again by his use of this law, in view of the protest he had made against Dalton's refusal to accept it.

A. N. MELDRUM.

ANEMOGRAPHIC OBSERVATIONS IN INDIA.[1]

MOST of these memoirs are by the late Sir John Eliot, whose loss, while he was still capable of much useful work, all meteorologists deplore. They deal with the changes in wind direction and force at the stations, showing both the diurnal and the seasonal variations, and form a store-house of information for anyone who wishes to study the Indian monsoons.

Saugor Island is situated in the north-west of the Bay of Bengal on the coast, about sixty-five miles in a direct line from Calcutta, and ninety if the bends of the river are followed. The land around it is perfectly flat, and only a few feet above the sea, so that the exposure is an excellent one.

The land at Alipore is also flat, but there are many trees in the district the tops of which are level with or above the anemometer. As might be expected, the winds are far stronger at the coast station.

Saugor Island lies in the track of the circular storms (cyclones) of the Bay of Bengal, and it is of interest to compare the maximum hourly velocity in these

[1] A Discussion of the Anemographic Observations recorded at Saugor Island from March, 1880, to February, 1904. Also at Alipore, Calcutta, from March, 1877, to February, 1904. Vol. xviii., part ii. Also at Pachmark from September, 1883, to April, 1887. Also at Nagpur from January, 1882, to December, 1902. Vol. xix., part i. At Roorkee from September, 1879, to August, 1904. At Lahore from January, 1889, to May, 1905. At Mussoorie from May to October, 1877 to 1888. (London: Harrison and Sons.)

storms with that which occurs in other places. Unfortunately, the factor that has been used is not given, but it is probably the old erroneous factor 3. It is in few years that this velocity exceeds 50 miles per hour—37 on the present scale of the Meteorological Office—and there are few stations on the British coast at which this is not often exceeded. One instance of 90 (66 corrected) is given.

It does not seem unlikely that the violence of the tropical hurricanes is somewhat overestimated owing to the contrast with the usual calm of the tropics, and also, perhaps, because the proximity of violent winds from different directions produces a very irregular and dangerous sea.

The memoirs also contain curves showing the direction and magnitude of the daily variation. The results for St. Helena have lately been treated in a similar manner with very interesting results. The daily oscillation of the barometer, more particularly the second term in the harmonic series with the twelve-hour period, must be associated with the transfer of a considerable mass of air from place to place, and it is of interest to try and trace this transfer in the anemometric records from various parts of the globe. These variations, as they are shown at the mouth of the Ganges and in Northern India, are very fully discussed. The conditions are naturally very different at the different stations, both in space and with the changing seasons, and the causes that produce local winds are so complex that it is almost hopeless to try and correlate cause and effect. At all the stations the change from hour to hour seems to be large by day and small by night, from which one may perhaps conclude that local heating by the sun plays an important part in the phenomena.

Although the observations at Mussoorie were only taken during the summer, they are of especial interest, since the station stands on the summit of one of the outer ridges of the Himalayas at an elevation of some 6500 feet above the sea. The hourly and monthly values, as at the other inland stations, are very complex; but there is, as might be expected, a distinct tendency for the air to run up the slope of the mountains during the day and down during the night. Naturally, also, the winds are stronger than at the stations in the plains.

ROCK PAINTINGS OF THE LOWER EBRO.

A VERY interesting article on this subject by MM. l'Abbé Breuil and Juan Cabré appeared in the January–February number of *l'Anthropologie*. The first part of the paper deals with the painted rocks on the Calapatà at Cretas (Teruel) first observed by M. Cabré in 1903, although it was not until 1906 that he communicated his discovery, having then realised its significance in relation to Quaternary art. The pictures, which are painted under a shallow shelter, represent animals in various attitudes, and show considerable vigour of execution. Close by, flint flakes are to be found which exhibit no Neolithic characters, but rather Magdalenian. The paintings comprise three deer, a bull, and a small subject difficult to determine. All are done in dark red, and are outlined by a very lightly engraved line; certain details, such as eyes and nostrils, are added in the same way, as they would not otherwise appear in a monochrome without shading. The first deer, measuring 30 cm. by 25 cm., is represented in a graceful attitude in the act of rising to its feet; the second (33 cm. by 27 cm.) is walking rapidly towards the first, the movement being admirably depicted. It is interesting to note that in all the stags drawn in profile the antlers are conventional, as if seen partly from the front, partly from the side. This curious disposition of the branching is met with, not only at Cretas, but also at Cogul (Lerida), and in France in the reindeer drawings of the Portel grotto. This points to a closer connection in late Quaternary times of the tribes of Aragon and Catalonia with those of the Ariège than with any others.

The second part of the article describes a series of rock paintings at Cogul, in Lerida (Catalonia), which was brought to the public notice in 1907. The surface painted measures about 2 m. across, and lies beneath a ledge of rock. Altogether there are five distinct pictures. Two are hunting scenes, of which the figures are drawn schematically. M. C. Rocafort regards this as a hieroglyphic inscription, possibly of the Iberian period, but the authors consider that it cannot be thus separated as regards date from the accompanying paintings. The third picture (measuring 75 cm. across) represents a stag surrounded by hinds. The animals of this group are less realistic than those of Cretas, but none the less the execution is delicate, and the attitudes graceful and lifelike.

The right-hand lower scene apparently represents nine women dancing round a man, four being to the right of the man, and five to the left. The man is much smaller than the women, and has no clothing beyond an ornament at the knees; the women are all wearing petticoats reaching to the knees, while the upper part of the body is bare. The figures are painted in black, red, or black and red; the man is dark brown rather than black. The outlines of the four right-hand figures are emphasised by engraving. The whole group measures 68 cm. across.

The dress of the women presents a superficial analogy with the Cretan series, but the lifelike character of the Minoan figures and many details are in strong contrast with the stiffness of the Cogul "ladies." Much more definite evidence would be necessary in order to establish any connection between the two series.

The style of the animal frescoes at Cogul, as of those of the Calapatà (Cretas), is that of our Quaternary drawings, not of later art. This indication is corroborated by the presence, not far from the painted rock at Cogul, of small Magdalenian stations with numerous flint flakes (in some cases retouched) of the type usual in France. Thus it is certain that in the immediate neighbourhood of the painted rocks there existed stations of the late Palæolithic age, contemporary with our civilisation of the Reindeer age; it is also highly probable that the whole of these open-air frescoes are to be attributed to the peoples living there; those of single animals afford further beautiful specimens of Quaternary art in animal-drawing. The hunting pictures at Cogul introduce a historic scenic episode as yet unknown in mural art. The dancing scene described raises a small corner of the veil drawn over the social life of those remote ages, and the style of dress tells us something of the use to which the Magdalenian seamstresses put those fine eye-needles which the caves of the Cantabrian Mountains, the Pyrenees, and Dordogne have so long yielded to the astonished eyes of investigators.

PROF. HUGH BLACKBURN.

THE unexpected decease of Prof. Hugh Blackburn, who occupied the chair of mathematics in the University of Glasgow from 1849 to 1879, was announced by Principal Sir Donald MacAlister to the great audience of students and friends assembled to hear the inaugural address of Prof. Gibson. The news came as a great shock to such former students as were present, among them his then retiring successor, Prof. Jack, and Prof. Gibson himself, and Prof. Blackburn's old student, colleague and life-long friend, Prof. Ferguson. It was well known that Prof. Blackburn's health had broken down seriously in the spring, and that there had been no sensible improvement, but the actual news was unexpected.

Prof. Blackburn's family have been connected with Glasgow for at least three centuries. An ancestor of his, Peter Blackburn, was one of the "regents" of the slowly growing University, from 1574. He was appointed when the Town Council handed over to the University grants made to themselves of lands and buildings by Queen Mary in 1567. From that time until Peter Blackburn was appointed a regent in 1874 the University had been all but moribund. Blackburn was brought from St. Andrews, where he had graduated, and he acted as regent shortly before the arrival of the great reformer Andrew Melville. During Melville's epoch-making six years as principal, and for two years after it, Mr. Blackburn acted as third or principal "regent." The regents used each to take the students committed to them through all their subjects, and for their whole university course. Melville revolutionised this system, setting each regent to teach some special branch of the graduation course to all the students. Mr. Blackburn was, in fact, "professor" of physics and astronomy in the modern sense until he left for Aberdeen, two years after Melville had left for St. Andrews.

It is curious to find the name Peter surviving after three centuries in the family of which Prof. Blackburn was a member. His eldest brother was Peter Blackburn, long M.P. for Stirlingshire and chairman of the Edinburgh and Glasgow Railway before it was merged into the North British. His second brother, Colin Blackburn, afterwards the famous Lord Blackburn of the High Court of Appeal, was eighth wrangler in 1835, and Hugh Blackburn, the youngest brother, was fifth wrangler in 1845. It was a memorable year at Cambridge. William Thomson, afterwards Lord Kelvin, then a boy of eight, came across from Belfast to Glasgow, where, in 1832, his father had been appointed professor of mathematics. At the age of twenty-one he was second wrangler and first Smith's prizeman, and founder and editor of the famous *Cambridge and Dublin Mathematical Journal*. To its first volume Prof. Blackburn contributed a paper on the variation of elements in the planetary system. Nothing quite like that first volume had previously appeared in the British mathematical world. Side by side with Prof. Blackburn's paper were one by Cayley (senior wrangler in 1842); a note on induced magnetism on a plate, by William Thomson; a paper by Sir William Rowan Hamilton, Irish Astronomer Royal; and another on quadrature of surfaces of the second order, by Mr. John H. Jellett, fellow and tutor, and afterwards provost, of Trinity College, Dublin. In the same volume there were papers by Leslie Ellis, senior wrangler in 1840; by Boole, afterwards the famous professor at Cork; by Augustus de Morgan, London; by Stokes, senior wrangler in 1841; by D. F. Gregory, fifth wrangler in 1837; by Townsend, of Dublin, and Liouville, of Paris, with four other papers by the young editor himself. In that splendid galaxy of men of mathematical genius Prof. Blackburn took a distinguished place, and he had deeply impressed his friends, and Thomson, no doubt, in particular, by inventing and exhibiting in his rooms his well-known pendulum with double suspension. A little later the two young Scotchmen, Thomson and Blackburn, went to Paris together on a mathematical and physical pilgrimage, and all their lives they remained attached and devoted friends. In 1871 they published together the full text of Newton's "Principia." Later, Prof. Blackburn published a revised and extended edition of Sir George Airy's treatise on trigonometry from the "Encyclopædia Metropolitana," which appeared in a separate cabinet form in 1855.

William Thomson entered in 1846 on his splendid tenure of the chair in natural philosophy in Glasgow, which he filled for fifty-three years. Two years later his father, the professor of mathematics there, died unexpectedly, and it was probably largely due to Thomson's entire conviction of the exceptional mathematical ability of his friend that Prof. Blackburn was appointed in 1849 to succeed Prof. James Thomson.

His students always felt for him the greatest affection and respect. Every teacher's qualities are appraised by the world very much as Mr. Lowe used to judge primary teachers under the famous revised code—by results. Prof. Blackburn had many distinguished pupils who took high places in the mathematical world. I may name Dr. Thomas Muir, who was an admirable assistant to the professor, and who has never, in spite of his engrossing duties as director of education in Cape Colony, intermitted his work on determinants. There was Sir Charles Abercrombie Smith, formerly Auditor-General in Cape Colony and now Vice-Chancellor of the Cape University; Mr. Dickson and Mr. Dodds, formerly tutors of Peterhouse; Prof. Pinkerton, of Cardiff, and Mr. Nixon, of Belfast. But Prof. Blackburn was much more than a mere mathematician. His University speedily discovered his administrative and financial strength, and made him successively convener of its library and its finance committees. Mr. Blackburn was, perhaps, more trusted and more responsible than any of his colleagues in the removal of the old college from the site it had occupied for four centuries, after it had become unsuitable and perhaps insanitary, to the present splendid buildings. Among his colleagues his authority was always great, and he owed this to the strength and simplicity of his character, and to the clearness of his practical and judicial mind. Students and colleagues alike, who knew him better than others could, honoured him and believed in him. Of a sensitive and artistic nature, he did not, however, care, after thirty years, to continue services which increasing deafness made irksome and difficult.

For years, Prof. Blackburn, in declining strength and health, never left the estate, beyond the Mull of Ardnamurchan, where he had found a home in 1879, and where he died.

W. J.

NOTES.

SIR RAY LANKESTER writes to inform us that he has heard from the representatives of the late Prof. Anton Dohrn to the effect that the Zoological Station at Naples remains the property of the heirs of its founder. Neither the German Government nor any German society have acquired any rights in its future disposition. Dr. Reinhardt Dohrn, who has for two years been the acting director of the Zoological Station of Naples, is now director, and has inherited from his father (by agreement with his brothers) the actual property and the leases granted by the Naples municipality as to the site. We wish Dr. Reinhardt Dohrn success and happiness in carrying on the work of his eminent father.

THE Meteorological Office has received reports of observations of an aurora on the nights of October 17, 18, and 19, at several places in England, Scotland, and Ireland. An aurora is also reported in the French *Bulletin International* as having occurred at Haparanda on the night of October 18, and vessels engaged in the Transatlantic trade report an unusually brilliant display of aurora on the same night—October 18–19—over practically the whole route between Europe and the United States of America. In connection with these reports, it is of interest to note that considerable magnetic disturbance was recorded at Kew on October 18–19, though nothing at all approaching that recorded on the late occasion. The whole afternoon of October 18 was slightly disturbed magnetically, but there was a marked sudden development about 8.30 p.m., and a considerable disturbance prevailed thereafter until 6 a.m. on October 19. During this time there was a range of $37\frac{1}{2}'$ in the declination, of 130γ in the horizontal force, and of 170γ in the vertical force. The most noteworthy features were that the declination needle remained to the east of its normal position continuously from 8.30 p.m. on October 18 until 3.30 a.m. on October 19, while the vertical force was depressed below its normal value from the commencement of the storm until 7 a.m. next morning. There was further disturbance, but of a minor character, later on October 19.

MR. W. E. COOKE, Government astronomer, Western Australia, informs us that the most magnificent aurora visible in Australia for half a century occurred on September 25. From reports in the *West Australian*, it appears that the aurora was observed throughout Australia, as well as at Cocos Island, Batavia, Singapore, Rodriquez, Durban, and elsewhere. Magnetic disturbances appear to have been recorded generally, interfering considerably with the telegraph and cable services. The electrical engineer in the Western Australia railway department (Mr. Dowson) informed Mr. Cooke that for the space of half an hour on the evening of Saturday, September 25, the lines between Perth and Kalgoorlie (350 miles), and between Perth and Albany, worked well with all the batteries cut out. The current was at least double that which is usually employed, and the needle of the ammeter went hard over at 35 milliamperes. The pressure must have been at least 150 volts. As the auroral light waxed and waned the current followed suit. By a curious coincidence, the last great display in Australia occurred almost exactly fifty years ago.

THE Bakerian lecture for the session 1908–9 will be delivered at the Royal Society on Thursday, November 18, by Sir J. Larmor, Sec.R.S., on "The Statistical and Thermodynamical Relations of Radiant Energy."

THE annual Huxley memorial lecture will be delivered by Prof. Gustaf Retzius on Friday, November 5, at the Royal Anthropological Institute. The subject will be "The North-European Race."

RECENT American obituary includes the name of Dr. Hermann Endemann, a German by birth, who was for several years one of the editors of the publications of the American Chemical Society, and frequently appeared as an expert chemist in the courts and before legislative committees at Washington and Albany.

MR. HORACE G. KNOWLES, recently U.S. Minister at Bucharest, has been so impressed by the value of the sturgeon fisheries of the Danube that he is making an attempt to re-introduce the sturgeon into the rivers of the Atlantic coast, where for many years it has been almost unknown. He has obtained the consent of the Rumanian Government to the shipment to America of a car-load of the fry of the Black Sea sturgeon, said to be the best in the world. His efforts are warmly approved by the U.S. Fish Commissioner, who believes the experiment will be successful.

THE Secretary of State for the Colonies has appointed an advisory committee on medical and sanitary questions connected with the British Colonies and Protectorates in Tropical Africa. The members of the committee are:—Mr. H. J. Read, C.M.G. (chairman); Sir Patrick Manson, K.C.M.G., F.R.S.; Sir Rubert Boyce, F.R.S.; Mr. C. Strachey; Mr. W. T. Prout, C.M.G.; Dr. T. Thomson, C.M.G.; Prof. W. J. Simpson, C.M.G.; and Dr. J. K. Fowler. Mr. A. Fiddian, of the Colonial Office, will act as secretary to the committee.

AT the general meeting of the Royal Society of Edinburgh, held on October 25, the following office bearers and members of council were elected:—*President*, Sir William Turner, K.C.B., F.R.S.; *vice-presidents*, Dr. R. H. Traquair, F.R.S., Prof. Crum Brown, F.R.S., Prof. J. C. Ewart, F.R.S., Dr. J. Horne, F.R.S., Dr. J. Burgess, Prof. T. Hudson Beare; *general secretary*, Prof. G. Chrystal; *secretaries to ordinary meetings*, Dr. C. G. Knott, Dr. R. Kidston, F.R.S.; *treasurer*, J. Currie; *curator of library and museum*, Dr. J. S. Black; *councillors*, Prof. F. W. Dyson, F.R.S., Prof. D'Arcy W. Thompson, C.B., Dr. O. Charnock Bradley, C. Tweedie, Prof. J. W. Gregory, F.R.S., Dr. A. P. Laurie, Prof. Wm. Peddie, Prof. H. M. Macdonald, F.R.S., Prof. D. Noël Paton, Dr. W. S. Bruce, Prof. F. A. Baily, J. G. Bartholomew.

THE council of the Institution of Civil Engineers has made the following awards for the year 1908–9:—Telford gold medals, Prof. B. Hopkinson and G. R. G. Conway; Watt gold medals, D. A. Matheson and W. C. Popplewell; George Stephenson gold medals, E. H. Tabor and A. J. Knowles; the "Indian" premium and a Telford premium, T. R. Nolan; Telford premiums, S. J. Reed, C. T. Purdy, L. A. B. Wade, G. Hobbs, W. Cleaver, J. D. W. Ball, Prof. A. H. Gibson, and R. D. Gwyther; the "James Forrest" medal and a Miller prize, J. A. Wotherspoon; the Miller scholarship, J. A. Orrell; the "James Prescott Joule" medal and Miller prizes, W. E. Fisher and E. B. Wood; Miller Prizes, W. E. R. Gurney, E. G. L. Lovegrove, J. Purser, G. C. Minnitt, S. F. Deacon, C. H. Bradley, and A. E. Marshall.

NEWS of large disturbances of seismographs by distant earthquake shocks was recorded in the *Daily Mail* of Friday, October 22, by Prof. Milne (Shide, Isle of Wight), Prof. Belar (Laibach, Austria), and Prof. Michie Smith (Kodaikanal, southern India). The earthquake occurred at 11.47 p.m. Greenwich time, and the duration of the motion was more than three hours. Prof. Milne's records indicated that "its origin was about 80° distant, which is about the distance of Japan, San Francisco, and Mexico. The probability is that it occurred in the east." Prof. Belar reported that "the place of origin was distant about 3750 miles to the east." On the following day telegraphic messages from Calcutta and Simla announced that there had been a great earthquake in Baluchistan. Belput, about two hundred miles from Quetta, is said to have suffered severely from the earthquake.

ON Thursday last, October 21, the King performed the ceremony of opening the new Royal Edward Tuberculosis Institute at Montreal by means of an electric current sent from West Dean Park, Chichester. A special telegraph line was laid from West Dean Park to Chichester, and from there the General Post Office lines were used to the Royal Exchange office of the Commercial Cable Company. The line used by the Commercial Cable Company was their shortest route *via* Waterville (Ireland) to Canso (Nova Scotia), from where it was transmitted by land lines to

Montreal. The arrangements made by the cable company were such that by means of relays and repeaters at the intermediate points the signal sent by the King travelled the whole distance without manual help. The current transmitted from West Dean Park released a current at Montreal which opened the doors of the new institute, hoisted a Union Jack, and turned on the electric light. This is, we think, the first time that a ceremony of this kind has been performed at such a distance, namely, 3000 miles, without any outside assistance, and shows the great advance that has been made in telegraphic transmission of late years. Within one minute of the key being pressed at West Dean Park a return signal was received from Montreal intimating that the ceremony had been performed satisfactorily, and a message of congratulation was sent by the King to the manager of the Commercial Cable Company within four minutes of the first signal. All these facts prove that modern telegraphic instruments are becoming more and more efficient, and the latest accomplishment will doubtless advance the closer relationship between the Mother Country and the colonies.

The United States Government, says *Science*, is now carrying on work at regular forest experiment stations similar to the agricultural experiment stations in the different States. The first forest experiment station created was the Coconino Experiment Station at Flagstaff, Arizona, established in 1908. Investigations covering many phases of forestry in the south-west have already been undertaken at this station. The second forest experiment station has been established this year on Pike's Peak, Colorado. The need for such stations becomes apparent when the long time necessary for handling forest experiments is considered; in forestry, because of the long time required for trees to develop, scores of years are often required to complete a single experiment. All experimental work is conducted under the direction of men who have had training in technical and practical forestry. The greatest technical problem which now confronts the forester in handling the great pine forests of Arizona and New Mexico is that of establishing a new stand of trees to replace the old timber which is cut off. This was the first problem undertaken by the Coconino Experiment Station. Much information regarding the factors influencing natural reproduction has been secured already, but many years of systematic study will be required to solve the problem. The feasibility of artificial regeneration by planting and sowing is also being tested. The plans for the near future provide for a detailed study of the problems concerning the natural and artificial regeneration of other commercial trees, such as Douglas fir, Engelmann spruce, and the junipers.

We learn from the *Pioneer Mail* that a committee has been appointed for establishing a Pasteur institute in Burma, and is actively engaged in forwarding the scheme. Recently the Secretary of State intimated, in view of the straitened condition of the provincial finances of Burma and of the fact that there was no guarantee that the initial capital outlay on the institute would be met from private subscriptions, sufficient cause to resort to public money had hardly been made out, and consequently regretted his inability to sanction the project as outlined in the first instance. A subcommittee, appointed to formulate a working scheme for the building and equipment of the institute, has reported, and is of opinion that it is possible to provide for bare requirements for one-half of the available capital. The institute, it is hoped, will in course of time find itself in proximity to a general bacteriological institute, and it is considered desirable that the buildings of the institute shall be permanent and substantial, so that they will be a creditable feature of the entire group of buildings to be constructed ultimately for scientific research. The subcommittee recommends, also, that the institute should be under the direction of an officer specially selected in the United Kingdom for his success in bacteriological research. Such an officer, it is suggested, should be appointed on a special agreement, and should not expect transfer, war service, pension, private practice, or any other of the special privileges open to members of the Indian Medical Service.

The third part of vol. vi. of the Annals of the South African Museum is devoted to the continuation of Messrs. Gilchrist's and Wardlaw's description of a collection of fishes from the coast of Natal, among which several are new.

In a paper on the remains of Carboniferous air-breathing vertebrates in the U.S. National Museum, published in No. 1696 of the Proceedings of that institution, Mr. R. S. Moody directs special attention to the reptile *Isodectes punctulatus*, on account of its bearing on the origin of the reptilian class. The type and only known specimen, which lacks the skull and nearly the whole of the fore-limbs, and measures less than 6 inches, is re-described in detail. It displays indications of affinity with the Microsauria, but its ordinal position among reptiles cannot be determined. Several new amphibians are described in the paper.

To the October number of the *Popular Science Monthly* Prof. W. A. Locy contributes a thoughtful article on the service of zoology to intellectual progress. The study of this science has been a great factor in the cultivation of straight thinking; "its influence has been great in clearing the atmosphere of thought, in dispelling clouds, and in freeing the mind from the bonds of inherited prejudice and traditional superstition." Another result was the conception of the constancy of nature, and, in particular, the idea that all animal life is the result of one continuous and orderly progress. As regards the practical applications of zoology—often in connection with botany—these have been exemplified during the last decade by the wonderful discoveries as to the modes in which diseases are introduced into the human systems by the intervention of insect and other animal carriers, while scarcely less important are the benefits which a knowledge of heredity has conferred upon breeders. Finally, there is the crowning service which zoology has conferred upon mankind in enabling us to realise the existence of evolution, which is so comprehensive in its extent that it enters into all realms of thought, and largely aids in teaching man to comprehend himself, and in some dim degree to understand his own future destiny.

In a pamphlet entitled "Breeding Horses for Use, or Equine Eugenics," published by Messrs. Swan Sonnenschein and Co., Ltd., Mr. Francis Ram seems well pleased to play the part of Cassandra, for he tells us that, six-and-twenty years ago, he issued under the same title an unanswerable pamphlet, and that if the advice contained therein had been followed a sum of at least 100,000,000*l.* would have been saved to the nation, while the breed of horses would have been vastly improved. The main feature of the scheme seems to be the substitution of stallions for geldings in cavalry and omnibus horses, and the selection from among these, after severe tests of stamina and endurance, of a small percentage for breeding purposes. Perhaps the author might have had a better chance of getting his scheme more carefully considered had he not run a tilt at judges at horse-shows and other experts, whom he pronounces utterly unfit for their duties. He also seems to possess better vision than most persons, as he asserts that he can see the true position of the limbs of a galloping horse without the aid of photography, while he also accuses Sir Ray Lankester of being in error regarding the position of the legs and feet in a running dog.

In a paper published in the "Annals and Magazine of Natural History" for 1903, Mr. J. L. Bonhote strongly urged the inadvisability of regarding the numerous island forms of chevrotains as distinct species, and pointed out that there are really only four types entitled to specific rank. This view is entirely ignored by Mr. G. S. Miller in a paper on the mouse-deer (chevrotains) of the Rhio-Linga Archipelago, published as No. 1695 of the Proceedings of the U.S. National Museum, in which a large number of island forms related to the napu are treated as distinct species. Apart from this, Mr. Miller draws some interesting conclusions regarding the development of melanism and other colour-phases in this group. "The only conclusion that seems justified," he writes, "is that the *Tragulus napu* group consists of a series of local species whose colour-pattern, probably for some physiological reason, is varying along two main lines of divergence, both of which are independent of external conditions as ordinarily understood. Each series is equally incapable of explanation by the hypotheses of Lamarck, Darwin, or De Vries. On the larger land-masses such changes as may be taking place are uniform over wide areas and relatively slow, while in the regions which, by submergence, have become divided into small land-areas separated by water the changes are irregular and rapid, though progressing on different islands at a very unequal rate."

Messrs. Williams and Norgate have forwarded to us the third and fourth parts of the thirty-ninth volume of Gegenbaur's *Morphologisches Jahrbuch*, containing papers on the development of the vertebral column in Echidna and in man, by G. P. Frets; the prothorax of birds and mammals, by T. Funccius; the saccus endolymphaticus, by Giuseppe Sterzi; the segmental theory of the vertebrate head, by B. Hatschek; the swim-bladder of Malacopterygii, by L. F. de Beaufort; and the brain-pattern of the anterior cranial fossa, by E. Landau.

We have received from the publishers an essay, by Prof. O. Grosser, on the methods of fœtal nourishment amongst mammals (including man), forming part iii. of the collection of anatomical and physiological lectures and essays edited by Profs. Gaupp and Nagel (*Sammlung anatomischer und physiologischer Vorträge und Aufsätze*, Heft iii.; Jena: Gustav Fischer, 1909, price 60 pf.).

The investigations of the *Challenger* and other deep-sea exploring expeditions have long since made us familiar with the fact that many deep-sea fishes possess luminous organs of various kinds, but one would hardly expect to find such organs in species which live habitually in shallow water. It appears, however, from the observations of Dr. Otto Steche, published in a recent number of the *Zeitschrift für wissenschaftliche Zoologie* (Band 93, Heft iii.), that we must modify our ideas on this subject. *Anomalops katoptron* and *Photoblepheron palpebratus* are two fishes which inhabit the shallow waters of a coral reef in the Malay Archipelago. In each case the luminous organ is a large oval body lying beneath the eye. The author was able to keep the fish in captivity, and gives some interesting particulars of the behaviour of the organ in the living animal, as well as a detailed account of its microscopical structure. It appears that the fishes are well known to the native Malays, who actually make use of the luminous organs for catching other fish, cutting them out and attaching them to the hook above the proper bait, under which conditions they will remain luminous for some hours, a fact which throws an interesting sidelight on the function of such organs. The fishes themselves are, as one would suppose, predaceous, feeding on all the small inhabitants of the coral reef, especially crustacea.

A note on tamarisk manna is contributed by Mr. D. Hooper to the Journal and Proceedings, Asiatic Society of Bengal (vol. v., No. 2). The substance is obtained from the halophytic shrub *Tamarix gallica* and from *Tamarix articulata*, while the species *Pallasii* yields an inferior sweet gum. It has not been ascertained whether the manna is produced by insect agency or is a natural secretion of the plant. The ordinary method of extraction consists in pounding the branches or leaves; the saccharine ingredient of the manna was found to be cane-sugar. A curious occurrence of manna was observed on certain land in Seistan which was subject to inundation; the manna shed by the tamarisk bushes had apparently dissolved in the water and dried out in lumps as the water evaporated.

On the subject of nomenclature in connection with plant formations, an article by Dr. R. Gradmann, published in Engler's *Botanische Jahrbücher* (vol. xliii., part iii.), deserves careful attention. It is pointed out that three methods of classification have been advanced, the physiognomic, adopted by Grisebach, the pioneer in this branch of botany; the ecological, exemplified by Warming's "Plant Formations"; and the purely floristic. As regards the last-named, it is observed that while the designation of formations according to dominant and subdominant or typical plants has its practical uses, the only comprehensive system is furnished by a complete list of all the plants for each individual formation. Three points arise out of this paper:—first, the basis for a system of classification; secondly, a convenient designation for each formation; and, thirdly, the means of differentiation between similar formations.

The *National Geographic Magazine* (p. 822) contains an interesting paper, by Mr. G. R. Putnam, of the United States Coast and Geodetic Survey, on modern nautical charts. The article contains a popular account of the methods of hydrographical surveying and chart construction, and charts of different periods are compared.

The first number of a new volume of the *Abhandlungen* of the Vienna Geographical Society is devoted to a memoir, by Dr. H. Leiter, on the question of changes of climate in northern Africa during historic times. An exhaustive examination from different points of view shows that there is no evidence that any progressive change of climate has taken place.

We have received Publications Nos. 3 and 4 of the Finland Commission for Hydrographic and Biological Investigations in the Gulf of Finland. In the first of these Dr. Johan Gehrke discusses at length the variations in the mean values of temperature and salinity in the waters of the gulf, from observations made at three stations during the years 1902–7. The second memoir consists of a table giving hourly values of water-level at Hangö from 1897 to 1903.

Captain P. K. Kozloff contributes an account of the Mongolia-Sze-Chuan expedition, carried out under his charge on behalf of the Imperial Russian Geographical

Society during 1908, to the October number of the *Geographical Journal*. The work of the expedition was to explore certain unvisited parts of Mongolia, to examine Lake Koko-nor, and to investigate the region of the upper course of the Hwang-ho. Amongst the most important results already obtained from the first part of the journey is the identification of the dead city, Khara-khoto, with Hsi-hsia, the capital of a Tangut kingdom which flourished from the eleventh to the fourteenth century.

An important list of the strong earthquakes felt in the Philippine Islands during the last half-century has recently been issued by the Rev. Miguel Saderro Masô, assistant director of the Weather Bureau. The earthquakes, fifty-five in number, vary in intensity between the degrees 7 and 10 of the Rossi-Forel scale of seismic intensity, five of them attaining the highest degree. The year of maximum activity, when eight strong earthquakes were felt, was 1897, which was also that of the great Assam earthquake; and, during the decade 1890–1900, sixteen strong shocks occurred in the Philippines, while in the same interval no fewer than nine were felt in Japan. The most unstable district in the archipelago is Mindanao, and especially the eastern part of the island, which lies in the neighbourhood of the great geosynclinal of the Pacific Ocean.

An analysis of the underground temperature at Osaka, western Japan, by Mr. T. Okada and Mr. T. Takeda, is contained in the Bulletin of the Central Meteorological Observatory of Japan, No. 2, 1909. The tables show the hourly mean temperature at depths varying from 0·0–0·6 metre for the years 1901–6, and the monthly mean temperature between 0·0 and 5·0 metres for the years 1895–1904. Below the surface the soil consisted of granite sand. At the depth of 60 cm. the diurnal variation is almost insignificant; the minimum occurs between 2h. and 3h. p.m., and the maximum between midnight and 3h. a.m. The mean annual temperature increases up to a depth of 300 cm. and then decreases; at the depth of 500 cm. the minimum occurs in May and the maximum in November. The total annual heat exchange is computed to be about one-thousandth part of the total quantity of solar radiation received by the surface of the soil.

Storms of wind and rain have occurred very generally over the British Islands during the past week, and the weather throughout the period was under the influence of cyclonic disturbances, which arrived with considerable frequency from off the Atlantic. On Saturday, October 23, a south-westerly gale blew in most parts of the country, and at Scilly the wind during the evening blew in squalls with a velocity of ninety miles per hour from the westward. In London the aggregate rainfall to the morning of October 27 is 2·65 inches, whilst the average for the whole month is 2·73 inches, and as yet rain has fallen on twenty days this month.

A preliminary note, by Mr. J. R. Sutton, on the results of observations made during three years upon the diurnal variation of level at Kimberley, is published in the Transactions of the Royal Society of South Africa for July last. It appears from the tables that the movements on the seismograph are very great; the maximum westerly elongation of the pendulum occurs at $5\frac{1}{2}$h. a.m., the maximum easterly about $4\frac{1}{4}$h. p.m., the median positions a little before 11h. a.m. and $9\frac{1}{2}$h. p.m., the mean daily range for the period being 5·5 mm. Not much connection with the weather can be traced; cloud and variations of barometric pressure are thought to be the most potent disturbers in a small way of the regular diurnal march of the pendulum. There was a strong tendency for the pendulum to deviate more and more to the west of its mean position during winter, and to the east during summer.

The *Philippine Journal of Science* for June (iv., No. 3) contains several papers of importance on protozoology and parasitology, and a study of the diet and nutrition of the Filipino people by Mr. Hans Aron.

We have received the first part of a volume of memoirs of the Oswaldo Cruz Bacteriological Institute, Rio de Janeiro ("Memorias do Instituto Oswaldo Cruz," Tomo i., Faciculo 1, 1909). The text is in Portuguese, but in parallel column a translation in German, French, or English is given of each article. It contains three excellent coloured plates and other illustrations. Among the contents are a description of a new species of Tabanus, and a contribution on native Tabanidæ, by Dr. Adolpho Lutz and Dr. Arthur Neiva; observations on Brazilian Anophelinæ, by Dr. Neiva; descriptions of two new species of Plasmodia, by Drs. Aragão and Neiva; a study of a new species of Amœba, by Dr. Aragão; studies on tuberculosis, by Dr. Fontes; concentration of diphtheria anti-toxin, by Messrs. Giemsa and Godoy; and the preparation of anti-plague serum, by Dr. Vasconcellos.

A novel type of gas-driven water pump, designed by Mr. H. A. Humphrey, seems likely to find numerous applications owing to its simplicity and high economy. The pump consists of a vertical U tube, having legs of unequal length. The longer leg enters at the bottom of the delivery tank, and the shorter leg is partly immersed in the tank from which the water to be pumped is drawn. The water enters the shorter leg through a number of admission valves, and the upper portion of this leg forms the combustion chamber, and is fitted with admission, exhaust, and scavenging valves, and also an electric ignition device. The gaseous pressure acts direct on the surface of the water in the shorter leg. By taking advantage of the oscillations set up in the water contained in the U tube, and the consequent alterations in gaseous pressure in the combustion chamber, Mr. Humphrey has succeeded in producing a four-stroke cycle, having a long expansion stroke, a long return exhaust stroke, a short suction stroke, and a short compression stroke, at the end of which the charge is ignited. Prof. Unwin has tested this pump, and finds the equivalent coal consumption to be only 1·06 lb. per pump-horse-power hour, a result doubtless owing to the utilisation of the "toe" of the diagram, which is generally wasted in an ordinary gas-engine cylinder.

In continuation of a previous paper, Prof. James Barnes, of Bryn Mawr College, publishes a note on the new lines in the calcium spectrum in No. 1, vol. xxx., of the *Astrophysical Journal*. The spectra measured were produced by an arc between poles of metallic calcium, enclosed in an exhausted chamber. The first table gives the wave-lengths of two series of triplets previously measured by Kayser and Runge, and three series given by Saunders. The frequencies can be represented by a formula of the Rydberg type, the following giving the first line of each triplet:— $\frac{\lambda}{1}=28911-\frac{109675}{(m+0{\cdot}927)^2}$; for λ 4586·10, the first line of the least refrangible series, $m=3$. There are no lines near λ 6208, which is the approximate wave-length for $m=2$; it therefore appears that the series is a subordinate one, as suggested by Ritz. Prof. Barnes also gives the wave-lengths of the two groups at λ 6382 and λ 6389, observed by Fowler in sun-spots and obtained by Olmsted in the calcium arc in hydrogen, but doubts whether they are due to a compound of these two elements. Between these two groups other bands were observed, and the wave-lengths are given. It is interesting to note that when the arc-gap was lengthened the line at λ 4227 reversed at the positive pole only, while H and K were much stronger near the negative pole than the positive.

The concluding part of the first volume of the Memoirs of the College of Science and Engineering, Kyoto Imperial University, contains a second paper by Mr. Y. Osaka on the mutarotation of glucose. It is shown that the velocity of the change of rotatory power which takes place in freshly prepared solutions of this sugar increases between 15° and 25° in the ratio 1/2·7. Sodium chloride has no catalytic action at dilutions below N/15, but at N/10 and N/5 a distinct retardation could be detected, as already noted by Levy and by Trey; in presence of hydrogen chloride, however, it was found to stimulate the catalytic action of the acid. In accordance with the author's theoretical conceptions, the addition of a trace of a weak acid (N/300 succinic or acetic acid) was found to produce a slight retardation, although larger quantities of the acid accelerated the change. The same issue contains a paper by Kuhara and Komatsu on a series of isomeric phenyl-phthalimides. Two compounds previously described could not be prepared again, but, in addition to the ordinary stable, colourless phthalimide, the authors obtained a colourless isomeride melting at 83–84°, which readily passed over into the stable form, and a yellow compound melting at 125–126°, which could not be transformed. The isomerism of the derivatives of phthalic acid is undoubtedly one of the most important of the cases awaiting investigation, and further work in this direction is much to be desired.

The October issue of *Pearson's Magazine* contains a further instalment of Lieut. Shackleton's narrative entitled "Nearest the South Pole." In the same number is also to be found an illustrated article dealing with oak galls.

MM. A. Hermann et Fils, of Paris, have published a second French edition of the third part of Mr. W. Rouse Ball's "Mathematical Recreations and Essays." The volume includes the chapters on astrology, hyper-space, and time and its measurement, together with additions by MM. Margossian, Reinhart, FitzPatrick, and Aubry. The translation is from the fourth English edition, and its price is 5 francs.

In the Proceedings of the American Academy of Arts and Sciences (xliv., 25) Messrs. Gilbert W. Lewis and Richard C. Tolman discuss the principle of relativity, and the system of non-Newtonian mechanics required to maintain such fundamental conservation laws as that of energy and to reconcile them with the experimental results of Michelson and Morley and of Bucherer.

A series of volumes on the history of science has been arranged by the Rationalist Press Association, and will be published by Messrs. Watts and Co. The first two volumes are "The History of Astronomy," by Prof. George Forbes, and "The History of Chemistry" (vol. i., from earliest times to 1850 a.d.), by Sir T. E. Thorpe. Among the authors who will contribute to the series are Dr. J. Scott Keltie (geography), Mr. Horace B. Woodward (geology), Prof. L. C. Miall (biology), and Dr. A. C. Haddon (anthropology).

The Railway Department of the Cape Government has issued a second edition of its official guide-book under the title "Cape Colony To-day." The book runs to 280 pages, is profusely illustrated, and provides an admirable account of the distinguishing characteristics of the districts described. For the convenience of tourists who wish to explore Cape Colony thoroughly nine tours have been mapped out, and particulars are given of the chief towns and other interesting places *en route*. The principal industries dealt with are fruit and grain growing and ostrich farming in the western province; sheep, goat, and ostrich farming and fruit growing in the midland districts; and the cultivation of maize. Every sort of information likely to be of service to the traveller is to be found in the book.

A copy of the report for 1908–9 of the council of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne has been received. The society is to be congratulated upon receiving, by the will of the late Mr. George E. Crawhall, a legacy of 6000*l.* to be invested for the benefit of its funds. The legacy was most opportune in view of the many financial needs of the society, and it is to be hoped that the council's appeal for donations to enable the cost of maintenance of the Hancock Museum at Newcastle-upon-Tyne and of printing the society's Transactions to be met will be responded to generously. The curator's report on the museum shows that a complete overhauling and re-installation of the fishes in the zoology department has been effected, and that numerous valuable specimens have been presented to different sections of the museum.

A sixth edition of Mr. Herbert M. Wilson's "Irrigation Engineering" has been published by Messrs. Chapman and Hall, Ltd., in this country, and by Messrs. John Wiley and Sons in America. The fourth edition of the work was reviewed at length in these columns on January 28, 1904 (vol. lxix., p. 291), and it will suffice to mention some of the distinguishing characteristics of the present edition. The book has been re-written almost entirely, and brings up to date the remarkable progress made in construction by the Reclamation Service of the United States. Much old matter has been eliminated, and a large amount of new text and eighty new illustrations, representative of more modern designs for irrigation works, have been introduced.

We have received the third part of the first volume of the Journal of the Municipal School of Technology, Manchester. An explanatory note points out that the journal was established to record the original scientific work done in the school by members of the teaching staff or by students. Such work has accumulated so rapidly, however, that it has been decided to print in abstract only, or in some cases the titles only, of all the work published previous to 1908 which has not appeared in the journal already. The papers for 1908 are to be printed in full. The present issue contains the paper by Mr. J. Prescott on the figure of the earth which appeared in the *Philosophical Magazine* of October, 1907, and abstracts of papers from the mechanical engineering, the physics, the electrical engineering, and the chemistry departments. It is noteworthy that the excellently produced periodical was printed in the photography and printing crafts department of the school.

OUR ASTRONOMICAL COLUMN.

Halley's Comet.—In a communication to No. 4263 of the *Astronomische Nachrichten* (p. 319, October 13), Prof. Millosevich states that the photographic observations of Halley's comet made on September 14 show that the elements already published need very small corrections, and that, according to his calculations, perihelion passage should occur at 1910 April 19·2d. (Berlin M.T.) ±0·5d.

Father Searle, director of the Brooklands Catholic University Observatory (U.S.A.), finds, from the Mount

Hamilton observations of September 12, 13, and 14, that perihelion should occur at 1910 April 18·63 G.M.T., and that the nearest approach to the earth should take place on 1910 May 19 at a distance of about 0·14, *i.e.* about 13,000,000 miles. Further, he points out that on May 18·14d. (G.M.T.) the earth and comet will be in heliocentric conjunction in longitude, the longitude being 236° 48′; the heliocentric latitude of the comet will then be −7′, so that, according to the present elements, no actual transit of the comet over the sun's disc will occur, but a slight change in the elements might produce one. "At any rate," he says, "it seems highly probable that we shall on May 18 be inside the tail."

In a communication to the *Times* (October 25), Prof. Newall announces that he observed the comet, visually, with the 25-inch refractor, power 214, on October 21. The magnitude was about 14·0 or 14·5, and the faint nebulous patch had neither stellar nucleus nor definite borders; the diameter was estimated as 10 or 12 seconds of arc.

At the previous apparations, in 1759 and 1835, the comet was first seen 77 and 102 days, respectively, before perihelion; Prof. Newall's observation was made about 180 days before the calculated perihelion passage of 1910, but he points out that this does not necessarily mean that the comet is so much brighter at the present apparition, for he would probably not have detected it had he not known its exact position as indicated by the previous photographic observations.

QUANTITATIVE MEASURES OF THE OXYGEN BANDS IN THE SPECTRUM OF MARS.—In Bulletin No. 41 of the Lowell Observatory Prof. Very describes the methods by which he measured the relative strength of the B, oxygen, band in the spectrum of Mars, and discusses the results in their relation to the presence of, and quantity of, oxygen in the planet's atmosphere.

As Prof. Very points out, the B band is normally so intense, by the absorption in the earth's atmosphere, that only by a method capable of the minutest accuracy could it be expected that any slight extra intensification, due to the Martian atmosphere, would become measurable. He claims that, over a long series of measures, his improved spectral-band comparator is capable of measuring this added intensification. Briefly, although a visual examination shows no increase of intensity of B in passing from the spectrum of the moon to that of Mars, the comparator measures are surprisingly concordant in showing a positive value, in favour of Mars, several times greater than the probable error; B, in the spectrum of the planet, is 15 per cent. stronger than in the lunar spectrum, and the probable error is 1·8 per cent. There is, as would be expected, a considerable variation among the individual measures, but no contradictory results.

STARS HAVING PECULIAR SPECTRA: NEW VARIABLE STARS.—Harvard College Observatory Circular, No. 143, contains a list of seven stars exhibiting peculiar spectra, and twenty-eight stars shown to be variable. For each star the position, for 1900·0, is given, and the class of spectrum indicated, whilst a series of notes summarises the observations. Some of the variables show a long range of magnitude, in one case amounting to 5·0.

Circular No. 151 is a similar publication announcing the discovery of twenty new variable stars in the Harvard map No. 49. It also describes a star in Taurus, at

R.A. = 5h. 43m. 12s., dec. = +19° 2·0′,

which varies more than five magnitudes, and exhibits a light-curve of the rare R Coronæ Borealis type. Long periods of normal brightness are followed by sudden diminutions over a wide range, the normal brightness being 10·2 and the minimum fainter than 15·5.

THE NATAL GOVERNMENT OBSERVATORY.—Mr. Nevill's report for the year 1908 deals chiefly with the meteorological observations, which, with the time service, form the chief work of the observatory, but it is noted that the large equatorial telescope was overhauled and repaired, and some observations were made with it by Mr. Hodgson. Among these was a new series of lunar photographs, for the determination of the real libration, and some sketches of the surface configurations of Mars, Jupiter, and Saturn.

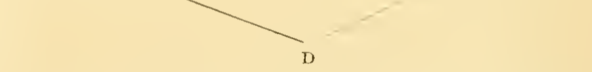
FIRST MAGNETIC RESULTS OBTAINED ON THE "CARNEGIE" IN THE NORTH ATLANTIC.

THE non-magnetic yacht the *Carnegie*, engaged in a magnetic survey of the oceans under the direction of the Department of Research in Terrestrial Magnetism of the Carnegie Institution of Washington, left Brooklyn, New York, on her first cruise, August 21, and proceeded direct to Gardiner's Bay, Long Island. Here several complete swings of the vessel were made with both helms in order to test the instruments, train the observers, and, above all, to determine whether actual non-magnetic conditions had been secured at the various positions of the instruments. These tests resulted most satisfactorily, not only proving the absence of deviations in the three magnetic elements (declination, dip, and intensity), within the errors of observation, at all observation positions, but also showing that with the instruments installed and the methods of observation employed a high degree of accuracy can be obtained.

Summary of Swings at Gardiner's Bay, Long Island, New York, August 31 to September 2, 1909.

Ship's head	West declination		Dip	Horizontal intensity in C.G.S. units	
	M.C.	Deflector	North	L.C.D.C.	Deflector
	Position A	Position C	Position B	Position B	Position C
N.	11°·41	11°·41	72°·02	0·1823	0·1830
N.E.	11·39	11·52	72·12	0·1823	0·1824
E.	11·45	11·48	72·11	0·1823	0·1830
S.E.	11·39	11·29	72·11	0·1826	0·1824
S.	11·34	11·41	72·09	0·1825	0·1831
S.W.	11·33	11·28	72·04	0·1824	0·1827
W.	11·32	11·40	72·08	0·1822	0·1823
N.W.	11·46	11·42	72·18	0·1823	0·1822
Mean ...	11·39	11·40	72·09	0·1824	0·1826

Only one who has had experience both in the observations and reductions of magnetic elements determined at sea can appreciate the full significance of these results and can realise the advance made.



The above diagram will assist in the interpretation of the figures given in the above table, and at the same time make clear the general arrangements of the various instruments and the methods used. Consider the plane ABCD to be a vertical section through the four instrument positions and the fore and aft line of the vessel. Position A is on the bridge above the deck or chart-house, B is in the forward observatory, C in the after observatory, and D at the middle point of the chart-house, vertically below A. The sides of the parallelogram are about $13\frac{1}{2}$ feet.

At A is mounted the standard compass, one of a new type invented and constructed by the Department of Terrestrial Magnetism, and called the "marine collimating compass"; it will be found described in the March (1909) issue of the journal *Terrestrial Magnetism*. The basis of the instrument is a Ritchie 8-inch liquid compass with the card, however, removed, and an optical collimating system with scale introduced, enabling the observer to note the arc of motion of the magnet system *while sighting on the sun or star*, hence knowing precisely to what part of the arc the stellar azimuth applies. In all forms of compass azimuth circles hitherto used, the magnetic azimuth of the celestial body must be taken from whatever point the card in its oscillations to and fro has momentarily reached. In brief, practically the same method of observations can now be used at sea as on land, where the magnetometer circle would be set to some convenient point on the magnet scale and then scale readings taken of the positions of the magnet during the interval of observations. The angle is next determined between the circle setting and some mark, or the true meridian, and the declination is finally deduced. Similarly with the marine collimator compass. The angle (say, middle of scale) between the magnet and some celestial body, as the sun, is read with a pocket sextant to the nearest minute of arc at a given time, and then scale readings of magnet and of watch are taken. With the aid of the time readings, the motion of the sun during the interval of observation is taken into account, and the true azimuths determined, whereas the scale readings give the varying positions of the magnet system.

With this instrument, therefore, one is almost entirely independent of the yawing and rolling of the ship, making it possible still to get satisfactory results when with all other azimuth circle devices hitherto used at sea observations would be wholly impossible, or at least very uncertain.

In five to ten minutes a value of the magnetic declination is now obtained possessing an accuracy attainable with previous instruments only by most careful observation and by laborious repetitions extending over a half-hour or more to eliminate the motion of the card. Thus not only has the accuracy of declinations at sea been increased, but, what is equally important, the time has been reduced and the possibility of getting useful results in all kinds of seas greatly extended.

Furthermore, sufficient attention has not always been paid in previous ocean magnetic work to a proper control of constants. Thus, *e.g.*, with the compass azimuth circles, as usually constructed, there are movable parts subject to wear, such as the axes of mirrors or of prisms and of the azimuth circle on the bowl. The wearing of these parts may easily bring about the same effect as though the compass were not mounted in the fore and aft line, *i.e.* introduce a quantity A not due necessarily to the ship's magnetism, but to instrumental error, which is likely to vary with extent of use of azimuth device. To control such errors, all instruments were invariably dismounted in the case of the vessel (the *Galilee*) employed in the Pacific Ocean work, whenever a port was reached, and corresponding observations made between land and ship instruments. With the present instrument, there being no such wearing parts, there will not be the source of error described.

It may also be pointed out that the *effect of drag of magnet* system moving in the liquid during changes of the ship's head is overcome in the present instrument, as well as in the one mounted at C, for the method of observation involves turning the compass bowl *opposite* to the ship's motion.

At B is the gimbal stand for mounting an L.C. dip circle, as modified for the *Galilee* work, with which the dip is determined absolutely (*i.e.* in all positions of circle and needle, inclusive of reversal of polarity by an electric coil) with two regular dip needles and again by the method of deflections, and total intensity is obtained using two deflecting distances.

At C is a Ritchie liquid compass provided with an improved azimuth circle and a deflecting attachment, both designed and made by the Department of Terrestrial Magnetism. With this instrument declinations are obtained, and also the horizontal intensity of the earth's magnetic force, by the method of deflections independently with two deflecting magnets, the magnetic moments of which are controlled from time to time by shore observations whenever the vessel is in port, and using two deflecting distances. In these deflection observations the yawing of the ship, or the changes in the lubber-line from which the deflection angles are counted, is controlled by the recorder stationed at D, who reads the ship's head by a spare Thomson dry compass. The same kind of deflecting device by which the deflecting magnet is brought at right angles to the axis of the deflected card, thus admitting of the simple sine-computation formula, is likewise attached to the marine collimating compass at A. In the latter case the angle between deflected magnetic system and the sun (or true meridian) is read with a pocket sextant, thus making one entirely independent of the yawing of the ship.

The declinations obtained at C are intended chiefly as some control against any gross blunders which may be made at A; for a fairly smooth sea they compare favourably with those got at A, but in rough seas the great superiority of the A results is very evident.

In brief, then, the scheme of observations, whenever fully carried out, will yield the following determinations in about one hour's time by independent observers, with different instruments, and at different positions on the vessel:—

At A.—Declinations (also horizontal intensity when a celestial body is long enough visible to permit of full sets of deflection observations).

At B.—Two values of dip by the regular absolute method, and two values of total intensity and of dip, using two deflecting distances.

The horizontal intensity is determined by computation from the dip and the total intensity.

At C.—Two values of horizontal intensity independently with two magnets, and using each time two deflecting distances; also, whenever possible, magnetic declinations. D, as above described, is simply accessory to C, and does not furnish any direct result.

It is thus seen that an effective control is obtained for each magnetic element, and it is for this purpose a great gain indeed that it is now possible to compare *at once* the values of horizontal intensity, for example, got at B and C without first waiting until the deviations are well determined, as has hitherto been the case in all previous vessels engaged in magnetic work—even on the *Galilee*, which, before the *Carnegie*, had the smallest deviations of any ship.

Besides the great improvement resulting from having a non-magnetic vessel, and from the perfection of the instruments themselves, the conditions and opportunities for observing have also been materially bettered on the *Carnegie*. Thus the instruments at B and C are under shelter, being mounted in observatories with revolving domes and movable slides, permitting of both magnetic and astronomical observations, with full protection to the observer and instrument from wind and weather.

Outstanding Difficulties.—These are chiefly due to meteorological conditions and the state of the sea. Thus in the absence of sun or star no magnetic declinations can be obtained, though dip and intensities may be got even in a pouring rain, because of the introduction of the sheltering observatories. It is hoped that some instrument based on the gyroscope compass may be soon perfected having the desired accuracy, with the aid of which the direction of the magnetic needle may be referred to an invariable plane to be controlled whenever a celestial body becomes visible.

Were one to wait for a calm or a fairly smooth sea it would occur quite frequently that no magnetic results would be forthcoming. In fact, on the entire recent October passage of the *Carnegie* from St. John's, Newfoundland, to Falmouth, England, there was not a single day which would fall in the usual category of favourable days of observation, but, instead, on nearly every day there was a gale, the sea was rough, the vessel yawed through an angle of 10° or more, and rolled through an arc of 20° to 30° and more, and yet observations were secured on every day except one. That utilisable magnetic results have still resulted under such very adverse conditions is due to the perfection of the instruments, the cutting down of time required for observations to get a desired degree of accuracy, thus reducing to a minimum the condition of steadiness of ship, and, of course, to the skill of the observers. Still further improvements are being striven for with regard to independence of steadiness of ship.

It is thus seen that while the endeavour is steadfastly held in mind to measure the magnetic elements at sea with every possible precision, the improvements made, and yet to be made, are along the line of reduction in time required to achieve the desired result—in other words, towards simplicity. With proper instrumental means and methods it need not require any more time to make accurate observations than to get indifferent results with instruments not adapted to the conditions to be met.

As a proof of this is given below the table of results of the work on board the *Carnegie* from September 1 to October 18, or in about six weeks' time. After the tests in Gardiner's Bay referred to above, the vessel proceeded, under the command of Wm. J. Peters, to New London, Connecticut, to have some slight alterations made. She left this port on September 11 bound for St. John's, arriving there September 25. Here the director rejoined her, having left the vessel in Long Island Sound to attend the meeting of the British Association at Winnipeg, Canada.

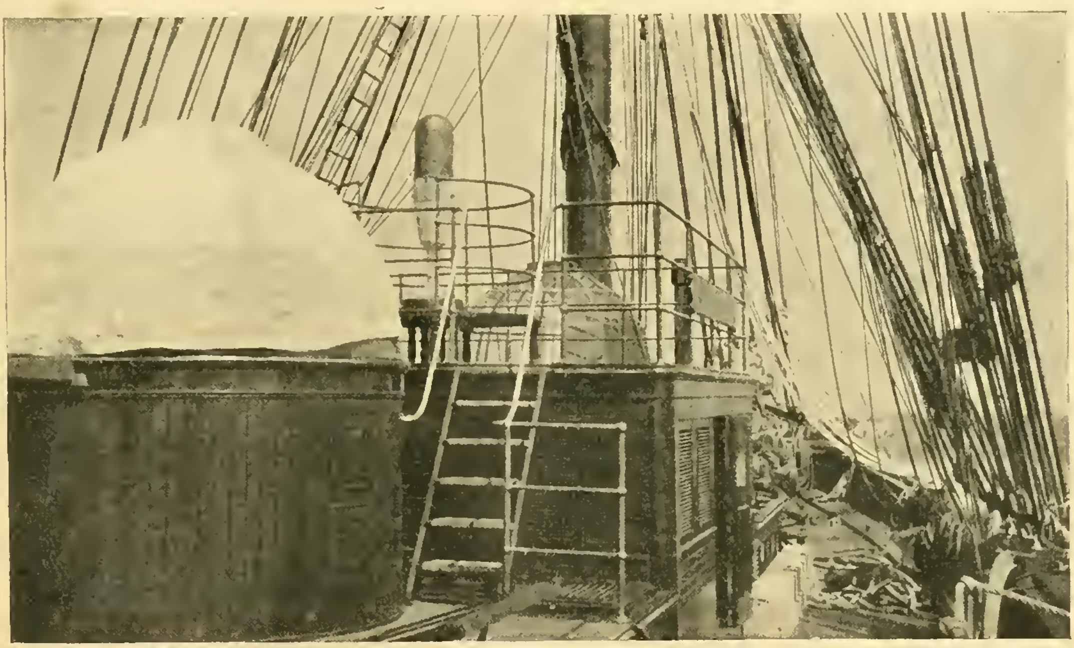
After the necessary shore observations, the *Carnegie* set sail from St. John's on October 2 direct for Falmouth, England, arriving there on October 14, having had favourable winds. Owing to the lateness of the season the Hudson Bay cruise for this year had to be abandoned. After the completion of the harbour and shore observations at Falmouth, the *Carnegie*, continuing under the command of Mr. Peters, will proceed to Madeira, and will return early next year to New York *via* Bermuda, the director returning to Washington.

Personnel.—Besides the director of the department and the commander of the vessel, the scientific and navigation staff is composed as follows:—C. E. Littlefield, sailing master; J. P. Ault, E. Kidson, R. R. Tafel, observers; Dr. C. C. Craft, surgeon and observer; and D. F. Smith, chief engineer. The ship's *personnel* includes, furthermore, two watch officers, two cooks, eight seamen, and one mechanic.

Auxiliary Propulsion.—Of considerable interest in marine circles, aside from the magnetic work on board this vessel, are the experiments being made in the perfecting of a producer-gas engine for marine propulsion. Such a plant—and an almost entirely non-magnetic one—is aboard the *Carnegie*, of 150 horse-power, sufficient to drive her at six knots' speed in calm weather. This engine has already proved a useful adjunct to the vessel's equipment, facilitating the entering and leaving of ports, and such tests as were made at Gardiner's Bay requiring swinging of the vessel. The installation is in the charge of the chief engineer, Mr. D. F. Smith, who has had both theoretical and practical experience with gas engines. Mr. Carl Smith, an acknowledged gas-engine expert of the technological branch of the United States Geological Survey, is consulting expert in connection with this work. Should this type of engine be made a practical success for marine purposes, even though it be but for auxiliary uses, it will be a valuable achievement, being the most economical form of motor now employed.

The Magnetic Results.—In submitting now the magnetic results obtained to date, it should be stated that the computation and revision of results goes on apace on board with the observational work, not only that possible errors may quickly be detected, but also that the results may be made known promptly. It is the intention, hereafter, to publish the results at intervals of about three months.

Accuracy of Magnetic Results.—In general, the declinations given may be taken as correct within 0·1°, and only in but a few instances, when the conditions of sea were unusually bad, will the error be 0·2°; under favourable conditions the observation error in declination with the marine collimating compass for the mean result will be about $\pm 0·05°$ (see the Gardiner's Bay results). About the same statement as made for the declination applies to the dip. The horizontal intensities, as at present given, may be assumed correct within 1 unit in the third decimal for the severe conditions encountered on the greater part of the cruise thus far; for fairly good conditions of the sea the error need not be more than 5 in the fourth decimal, and may be made less, as shown by the Gardiner's Bay work.



Deck view of the *Carnegie*, showing the chart house with Marine Collimator (A in diagram) in the middle and the two observatories. The forward one is uncovered, and inside it position B of the diagram, where the L.C. Dip Circle is mounted; inside the after observatory (the covered one) is mounted the Deflector and Compass (Position C).

In making these preliminary statements, it should be remarked that every possible source of error is considered—in other words, *absolute* accuracy, not relative accuracy, is meant. For example, when it is declared that, given fairly good conditions, it is possible to get the dip on board the Carnegie within 0·05°, *i.e.* within three minutes *absolutely*, this means more than may at first appear. Thus dip circles—especially ship dip circles—have instrumental corrections exceeding frequently the relative error of observation. Accordingly, the dip circle on the *Carnegie* has been compared, not only with various observatory dip circles, but also with an earth inductor at Washington, for the range of dip from $+88°$ to $-60°$. Further control will be had at the various ports of call during the progress of the work. This serves as an illustration of the care required and being taken, not only with this form of magnetic instrument, but with every instrument used aboard.

We have preferred to underestimate our absolute accuracy rather than to overestimate it. In any case, it may be said that the magnetic elements are now being obtained on the *Carnegie* with sufficient accuracy, not only for practical demands, but also for purely scientific ones.

Were we able to choose the time to observe and wait for fairly smooth sea, the magnetic elements could be determined at sea with an accuracy practically the same as in the determinations for land magnetic surveys.

Diurnal Variation Corrections.—No corrections for diurnal variation need, in general, be applied. The attempt is being made to get the magnetic elements at such times of the day when these corrections are small or are of the order of the error of observations. Thus, for example, the most favourable condition for the declination work is when the sun is low, *i.e.* early in the morning or late in the afternoon, and at these times the diurnal variation corrections are small and frequently of opposite sign. Should there be evidence of magnetic disturbance during the observations, or as may appear later from observatory records, the observations, if necessary, will be rejected.[1]

Geographic Positions.—Equal care is bestowed upon the determination of the geographic positions of the points where the magnetic observations are made. The astronomical observations and computations are made in duplicate, and at times in triplicate, by the observers, and thus the positions are effectively checked. Six well-tested chronometers are carried aboard. With the methods followed, it would appear that the errors in the final positions assigned will, in general, be less than three minutes of arc in latitude and in longitude.

Magnetic Results obtained on the "Carnegie," September 1 to October 18, 1909, in the North Atlantic Ocean.

No.	Lat. N.	Long. W. of Greenwich	Date, 1909	Declination W.	Dip N.	Hor. Int. C.G.S.	Corrections of Variation Charts		
							British	U.S.	Ger.
	°	°		°	°		°	°	°
1	41·1	72·2	Sept. 1	11·4	72·1	0·183	+0·4	+0·5	+0·2
2	41·0	71·1	13	12·3	72·0	0·182	+0·6	+0·3	+0·6
3	40·0	70·4	14	12·0	—	—	+0·8	+0·9	+0·7
4	40·7	69·4	14	12·8	71·7	0·185	+0·22	+0·4	+0·4
5	40·9	68·9	15	13·9	71·9	0·182	+0·8	+0·4	+0·7
6	40·9	68·4	16	14·4	—	—	+0·8	+0·3	+0·6
7	41·3	66·4	17	16·2	71·9	0·181	+0·8	+0·3	+0·9
8	42·0	61·1	20	20·2	—	0·177	+1·1	+0·7	+0·8
9	42·5	61·2	21	20·8	—	0·176	+1·3	+0·6	+0·6
10	42·8	60·8	21	21·4	72·5	0·173	+1·4	+0·9	+0·4
11	43·8	58·9	22	23·7	72·7	0·171	+1·5	+0·7	+1·3
12	45·5	55·7	23	—	72·7	0·169	—	—	—
13	47·3	52·6	25	—	73·5	0·158	—	—	—
14	47·6	52·7	28	29·75	73·5	0·159	0·0	0·0	0·0
15	47·8	51·4	Oct. 3	30·4	—	—	+0·2	−0·2	+0·9
16	48·2	50·4	3	—	73·5	0·157	—	—	—
17	48·4	48·0	4	31·8	—	—	+0·4	+0·3	+1·2
18	48·5	47·7	4	31·8	73·0	0·161	+0·2	+0·1	+1·1
19	48·7	46·5	5	31·8	—	—	−0·1	−0·2	+1·1
20	48·9	45·5	5	32·1	72·5	0·161	−0·1	−0·3	+1·5
21	49·6	37·5	7	—	71·2	0·168	—	—	—
22	50·3	32·1	8	30·2	70·7	0·171	−0·4	−0·4	−0·4
23	50·6	28·8	9	29·0	—	—	−0·7	−0·8	−0·7
24	50·6	24·0	10	26·6	—	—	−0·6	−0·9	−0·8
25	50·6	22·2	10	—	69·2	0·174	—	—	—
26	50·5	19·2	11	24·5	—	—	−0·2	−0·3	−0·3
27	50·3	17·2	11	22·9	68·3	0·180	−0·9	−0·8	−0·9
28	49·9	11·9	12	20·3	67·4	0·185	−0·7	−0·6	−0·5
29	49·6	9·3	13	19·7	—	—	+0·2	+0·1	+0·2
30	49·5	7·5	13	18·6	66·3	0·190	0·0	−0·1	−0·1
31	50·0	5·0	14	17·5	—	—	+0·1	−0·1	−0·2
32	50·1	5·0	18	17·8	66·5	0·187	+0·2	+0·2	+0·1

No. 1 in Gardiner's Bay; No. 14 at St. John's, Newfoundland; No. 32 in Falmouth Bay.

[1] *Magnetic Storms and Northern Lights.*—It so happened on board the *Carnegie* that no magnetic observations were in progress during the severe portions of the magnetic storms of September 25 and October 18–19. No Greenwich time signals could be obtained at St. John's from Heart's Content on the morning of September 25 on account of heavy earth currents. Northern lights were seen between 8 and 10.30, local apparent time, of the evening of September 21 in latitude 43° N. and longitude 60½° W. of Greenwich. A glow of white light with occasional streamers extended upward about 10° above the horizon from a low bank of cumulo-stratus clouds. The display was in the magnetic north. The evenings of September 22, 23, 24, and 25 were cloudy or foggy.

Corrections of the Present Magnetic Charts.—The table requires no explanation other than is already given in the headings, with the exception of the last three columns, which exhibit the quantities to be added to or subtracted from the declinations scaled from the lines of equal magnetic declination ("variation of the compass"), first, as given by the British Admiralty chart, 1907; next, by the United States Hydrographic Office for 1910; and, lastly, by the Deutsche Seewarte for 1905.[1] In all cases the values scaled from the charts have been referred to the present time with the aid of the secular variation corrections as given on the respective charts. It will be seen that, in the case of each chart, the corrections are usually less than 1°, and, considering the miscellaneous data at the disposal of the makers of the charts and the uncertainty of the secular variation reductions, the general correctness of the charts is most gratifying.

However, one fact, revealed by the prevalence in sign of the quantities appears to be of sufficient practical importance to require attention. The data given in the table apply pretty closely to the tracks followed by the Transatlantic steamers between New York and England.

Along the portion from New York to a point somewhat beyond Sable Island the corrections for each chart are positive, amounting in the maximum to 1½°; they then change sign, with eastwardly progression, reaching a negative value of nearly 1°. In other words, for the track pursued by the Atlantic liners from England to a point off Sable Island, the present magnetic charts, in general, show too large westerly declination, whereas on the remainder of the route to New York the charts give too small westerly declination.

It can readily be seen what the effect of these systematic errors of the charts would be on the course of a vessel sailing from England to New York if, during the entire passage, no sun or stars were visible, as sometimes occurs, so that the course of the vessel would have to be shaped entirely by the compass and the log. At the end of the 2000 miles of the great circle route the vessel, off Sable Island, would be about thirty miles too far *north* of her regular track, and if the set of the current were in the same direction the vessel would easily be exposed to shipwreck. From Sable Island to New York the effect of the chart errors, being reversed in sign to what they were before, would be in the opposite direction, *i.e.* the vessel would be put out of her true course in a southerly direction.

For a vessel going eastward the effects are just reversed; hence on the course from New York to Sable Island the tendency of the chart error would be to set the vessel to the northward, hence again towards the source of danger; thereafter the vessel would be set to the southward of her outlined course. So that, if proper allowance were not made, a captain would have his vessel turned off towards Sable Island or Cape Race, whether he came from the east or from the west.

It appears to be known to some captains, at least, that there is some such systematic change which, judging from conversations had with them by one of the present writers (Bauer), during various Atlantic voyages, is ascribed by them to a systematic change in their ship deviations. Two captains have told him, independently of each other, that after their compasses had been carefully adjusted they have noticed by repeated observation a systematic change in the deviations, which *reversed* in sign when Sable Island was passed. The effects would be opposite for the eastward and the westward cruises. The deviations referred to by these captains are the differences between chart values and those observed with their adjusted standard compasses; hence they are not pure deviations, but are the sums of ship deviation and chart error. The work of the *Carnegie* has now proved that the cause of the systematic change and reversal of ship deviations encountered by these painstaking captains was due, in part at least, to systematic errors in the variation charts.

The corrections for the chart of the lines of equal magnetic dip (British Admiralty Chart of 1907 and the Deutsche Seewarte of 1905) are generally less than ½′, being sometimes plus and sometimes negative.

The lines of equal horizontal magnetic intensity as laid

[1] The latest chart of the Deutsche Seewarte is not at present to hand.

down on the British Admiralty Chart for 1907 are in error by amounts reaching 16 units in the third decimal C.G.S., and those of the Deutsche Seewarte for 1902 (the most recent chart not being available to us just now) require corrections running up to 12 units in the third decimal on the values obtained by the *Carnegie*. A part of this error is, of course, due to secular variation, but the major portion appears to be due to defective data. For both charts there are five negative corrections, amounting in the maximum to 4 units in the third decimal, four zero values and thirteen positive ones for the "B.A." chart, and two zero and fifteen positive corrections for the "Seewarte" chart. On the average for the Atlantic, from Long Island to Falmouth, the chart values are too low by about 1/45th part of the value of the force, even at times amounting to 10 per cent. to 20 per cent. In the Pacific Ocean the intensity charts gave, in general, too high values by about 1/25th part.

Since the above was written the *Carnegie* has been swung in Falmouth Bay, observations of the three magnetic elements (declination, dip, and horizontal intensity) being made on eight equidistant headings. The mean results of the entire swing are in excellent agreement with what would be deduced from Rücker and Thorpe's magnetic charts of the British Isles applying secular variation corrections as deduced from the records of the Falmouth Magnetic Observatory. The declinations and dips agree within two or three minutes, and the horizontal intensity within 1/2000th part. This again proves that there are no deviation corrections of whatever nature to be applied to the *Carnegie* results; also that the instrumental constants have been well determined. We have here also a satisfactory proof that if the distribution of magnetism is uniform, as appears to be the case here, the sea values, upon careful measurement, will be found in agreement with the shore values.

L. A. BAUER.
W. J. PETERS.

THE ANALYSIS OF SOUNDS USED IN SPEECH.

THE characteristics of the simpler sounds which form the elements of speech have been studied by many physicists. At first, attempts were made to reproduce the vowel sounds synthetically; Helmholtz achieved noticeable successes in this endeavour, but by themselves synthetical methods can never be quite satisfactory, since it is necessary to prove that the ear does not possess properties similar to those possessed by the eye; it is well known that two mixtures of light may produce identical effects on the eye, although the component waves may be quite different in the two cases.

Many attempts have been made to analyse complex sounds, but the results obtained up to the present have not been quite conclusive. Dr. Erskine-Murray used a thin membrane stretched slackly over the small end of a conical tube; a light mirror was adjusted so that it was rocked to and fro by the motion of the membrane, and a beam of light was reflected from this on to a revolving mirror and thence on to a screen. Such an arrangement is very sensitive for sounds of low pitch, but it is mechanically unsuitable for analysing sounds of high frequency. Hermann, McKendrick, and Bevier have attacked the same problems by analysing phonograph records, and have obtained much useful information; but there is small reason to suppose that a phonograph record, however good it may be, affords an exact equivalent to human speech.

For some time past Mr. G. Bowron, of 57 Edgware Road, has devoted attention to the construction of an oscillograph which projects on a screen a curve representing the sounds produced by a gramophone; a brief notice of this oscillograph was given in NATURE of May 21, 1908 (vol. lxxviii., p. 69). The curves obtained are very instructive, and they appear to possess as much detail as those obtained by the elaborate method of Prof. McKendrick; but the problem of the analysis of the sounds used in speech can scarcely be solved in this way.

The best curves representing vowel sounds have been obtained by Mr. Duddell; some of these are published in the Journal of the Institution of Electrical Engineers (vol. xxxix., No. 186, 1907, pp. 545–6). They were obtained by speaking into a "solid-back" telephone transmitter, and transmitting the periodic current obtained thereby through the high-frequency electrical oscillograph invented by Mr. Duddell. The regularity of these curves is very striking; a perfectly definite curve corresponds to each vowel sound, and with some practice it would be possible to decipher a telephone message by inspecting the curve which corresponds to the telephone current. It may be mentioned, in passing, that the analysis of the sounds which constitute speech is now acquiring commercial importance in connection with the problem of telephone transmission.

Mr. Bowron has constructed an acoustic oscillograph intended to show the vibrations comprised in ordinary speech; but although this gives some interesting information, the curves obtained are not nearly so good as those obtained by Mr. Duddell. The arrangement used is somewhat like that due to Dr. Erskine-Murray, but the slack membrane is replaced by a ferrotype telephone diaphragm. In practice it is found that Mr. Bowron's oscillograph does not give good curves for sounds of low pitch; this is due to the fairly high frequency of the natural vibrations of the diaphragm. It has been pointed out by Mr. A. Campbell (Jour. Inst. Elec. Engineers, vol. xxxix., No. 186, p. 533) that even a microphone transmitter has certain definite free periods, and that sounds of the corresponding pitches are greatly reinforced. Mr. Campbell's experiments in proof of this are worthy of mention here. A solid-back microphone is put in circuit with a battery of 6 volts or 8 volts and the primary circuit of a fair-sized spark coil. The secondary of this coil is connected to a reflecting electrostatic voltmeter reading up to 10 volts. The deflections of the voltmeter afford a sensitive indication of sounds received by the microphone. If the nearly pure note of a stopped organ-pipe be sounded, a deflection of the voltmeter is produced, and if the pitch of the note be gradually raised the spot of light rushes off the scale when the note attains certain definite frequencies. This arrangement might be used with advantage in cases where measurements of the intensities of sounds are required.

There can be little doubt that much remains to be done in connection with the analysis of the sounds used in speech. Thus the curve obtained by Mr. Duddell for the *oo* sound in "coo" scarcely differs from a sine-wave curve; a slight alteration of the mouth introduced the octave of the fundamental vibration. According to the accepted theory of vowel sounds, each vowel is distinguished by the reinforcement of those partials which lie near to certain definite pitches. The question could be answered definitely if we possessed a diaphragn which would vibrate indifferently for all pitches; and since the drum of the ear does this, it may be hoped that we may be able to realise the conditions necessary to the solution of the problem.

EDWIN EDSER.

HEAT TRANSMISSION.

A PAPER on heat transmission was read by Prof. W. E. Dalby before the Institution of Mechanical Engineers on Friday, October 15. The object of the research was to place before the members a general view of the work which has been done relating to the transmission of heat across boiler-heating surfaces, and in carrying this out more than 500 papers have been read and abstracts of the more important prepared.

In a furnace heat is transmitted by three methods simultaneously, viz. radiation, convection, and conduction. It is extremely difficult to analyse the results of experiments, so that the heat transmitted by each of these methods may be stated separately. Formulæ of simple type have been devised to express the results of definite sets of experiments; the application of such formulæ should be strictly limited to cases in which similar conditions prevail and fall within the range of the original experiments.

In discussing radiation, the author gives Stefan's law expressed in British thermal units radiated per square foot per hour as $16\times10^{-10}(T_1^4-T_2^4)$, where T_1 and T_2 are the temperatures of the incandescent gases and of the boundary respectively in degrees Fahrenheit absolute. This formula may be applied in order to find a theoretical upper limit to the quantity of heat radiated to the fire-box boundary on the assumption that the flame is actually composed of solid masses of incandescent carbon, and so follows Stefan's law. Thus, with flame and boundary temperatures respectively of 3000° and 800° F. absolute, the heat radiation is 129,600 British thermal units per square foot per hour. With temperatures respectively of 4000° and 800° the radiation amounts to 410,000 British thermal units, showing the rapidity of increase of radiation as the flame temperature rises. Stefan's law does not apply to cases where the gases are not incandescent.

In transmission by conduction and convection the heat-flow path from the interior of the mass of gas in the fire-box to a point in the interior of the mass of water is made up of the following parts:—the gaseous part from the starting point to the gas film clinging to the plate; the gas film itself; the surface of contact between the plate and the gas; the metallic plate; the surface of contact between the plate and the water; the water film; the water from the film to the point in the mass of water. To these must be added, for dirty plates, a layer of sooty deposit on the gas side and a layer of scale on the water side, on which there may also be a deposit of oily matter. There is evidence that 98 per cent. of the total "temperature" head is required in order to force the heat from the gas into the plate, the remaining 2 per cent. alone being required to transfer the heat from the plate to the water in the boiler. The presence of oily matter may raise the temperature difference between the hot side of the plate and the water from 68° F. to 550° F., depending on the nature and thickness of the greasy deposit. The thickness of the film of gas clinging to the plate is probably of the order of 1/40-inch, and accounts for the greater part of the resistance offered to heat transmission by the total path of flow. The water film clinging to the plate also contributes to the resistance, as convection currents cannot exist in it, and heat must be transferred across it by the conductivity of the water forming the film, which is known to be exceedingly small.

If these films be completely or partially destroyed, the head required to effect the heat transmission from the gas to the water across the plate will be considerably reduced. One of the most potent factors in disturbing the gas film is the velocity possessed by the moving gases. Most of the work in connection with heat transmission since the time of Rankine shows attempts to introduce a velocity factor variable into the expressions. Again, owing to the temperature gradient from the centre of the flue gases to the boundary, the efficiency must increase with a decrease in the size of the flue within limits. Hence the hydraulic mean depth of the flue must form a factor. The importance of good water circulation lies in the fact that forcing water across the heating surface with a high velocity has the effect of breaking up the water film.

Notwithstanding the large number of researches bearing on the subject of heat transmission, there is a general absence of complete data regarding the actual phenomena occurring in a steam boiler when working under ordinary conditions of practice. For instance, no data exist which gives the temperature gradients at different parts of a boiler flue with accuracy. Researches have had little effect in modifying the general design of steam boilers, although the costly nature of these may be understood from a set recently made by the United States Geological Survey, costing 100,000 dollars. The author suggests that the institution might undertake a research in which steam boilers of different types under practical conditions may have all the elements of their working measured, together with temperature measurements for the purpose of establishing the temperature gradients at different parts of the heating surface. Such a research would be costly, but would be well worthy of the institution.

The paper contains elaborate indexes giving reference to all known work bearing on the subject; these will be extremely valuable to all interested in heat transmission.

THE ANTIQUITY OF MAN IN SOUTH AMERICA.

THE views held by Dr. Florentino Ameghino as to the antiquity of man in South America are based on the occurrence of split bones, and bones showing signs of having been cut, side by side with certain scoriaceous products, the "tierras cocidas" of Argentina. We are not as yet in possession of figures of the bones, and it may be presumed that they are regarded as of less importance than the baked and reddened earths. A lively controversy has arisen round the latter, and the question appears to be one that must be decided by the geologist rather than by the anthropologist.

Several series of deposits of Cainozoic age are recognised along the curving coast-line south of the mouth of the Rio de la Plata, past Mar del Plata, and away towards Bahia Blanca. The orientation of one of Dr. Ameghino's maps is unsatisfactory; but much topographical and descriptive matter will be found in his paper on "Las formaciones sedimentarias de la región litoral de Mar del Plata y Chapalmalán" (*Anales del Museo nacional de Buenos Aires*, tomo xvii., p. 343; published November 28, 1908). This, so far as the baked earths are concerned, is overshadowed by a memoir by Señor Outes, Dr. Ducloux, and Dr. H. Bücking, of Strassburg, issued on September 15 of the same year ("Estudio de las supuestas escorias y tierras cocidas de la serie pampeana de la República Argentina," *Revista del Museo de la Plata*, tomo xv., p. 138).

The two authors who have called in Dr. Bücking to their assistance review the question historically. The Araucanian formation, with the Monte Hermoso beds, which Florentino Ameghino prefers to regard as Miocene, is very generally placed by other authors in the Pliocene; but this does not affect the arguments of Outes and Ducloux. They point out that in 1865 Heusser and Claraz, in a paper published in French at Zürich, recognised cellular, and apparently volcanic, material in the lower part of the Pampas beds near Mar del Plata. More than twenty years later, in 1887, Florentino Ameghino gathered similar "escorias" at Monte Hermoso, 60 km. north-east of Bahia Blanca, and in 1889 described others from the neighbourhood of La Plata. These places are, of course, all remote from any volcanic vents that have so far been discovered.

Meanwhile, from 1874 onwards, the more obscure materials known as "tierras cocidas" were collected by Señores Juan, Carlos, and Florentino Ameghino from various places in the province of Buenos Aires, and the last-named writer claimed them as traces of ancient hearths, and as indicating man's antiquity in South America. The field was widened by other observers, and the typical specimens, with new ones personally collected, have now been investigated by Outes and Ducloux.

These authors make no claim to originality in rejecting the opinion of Florentino Ameghino. They quote the views of Steinmann in 1906 (p. 160 of their memoir) as to the andesitic nature of the scoriæ and baked earths, and they go back (p. 191) to Charles Darwin, who recorded, in 1851, the occurrence of pebbles of pumice on the surface of the raised terrace at Monte Hermoso. Darwin attributed these pebbles to the transporting action of ancient rivers, and pointed out how the rivers Negro and Chupat bring down volcanic pumice and scoriæ at the present day. Outes shows that such materials need not have been carried directly from the Andes, but may have been washed out of the detrital volcanic beds of the Araucanian formation, which is much older than the Pampas beds, and possibly than those of Monte Hermoso. The inclusion of vegetable remains in the scoriæ is held not to militate against their volcanic origin. Doering has urged the importance of laterisation in determining the characters of the red beds in the Lower Pampas series, and Outes (p. 194) quotes his views with approval as explaining many of the "baked earths." The elaborate chemical work of Ducloux (pp. 162–184) goes to show that the loess of the Pampas beds and the included scoriæ and "baked earths" have a similar chemical composition, and masses like volcanic scoriæ have been made artificially by heating the loess at 1300° C. to 1350° C. The loess appears to contain abundant minerals that characterise volcanic lavas. The analyses given show a silica percentage of about 66 for the debatable scoriæ and "baked earths," and of only some 57 for the specimens of loess; but the latter loses some 13 per cent. of water, against 4 or 5 per cent. from the former materials. Ducloux opposes the suggestion of Ameghino that alkalies from the associated vegetation, burnt up with the loess, have entered into the composition of the scoriaceous matter.

H. Bücking's petrographic contribution (p. 185) should certainly have been illustrated. The writer, after microscopic examination, has no hesitation in classing the scoriæ as ordinary andesites. He traces volcanic lapilli in a "baked earth" from "Chapadmalal," and describes features in this material and in others sent to him which suggest a laterisation of volcanic dust.

Dr. Ameghino's paper, published in November, 1908, is largely stratigraphical. The beds of Monte Hermoso (p. 344) are here held to be much older than the Pampas formation, on account of their absolutely distinct fauna. If, then, man "or his precursor" is responsible for the "baked earths" found among them, the human race in South America may be traced back further than even Ameghino had previously supposed. We gather that this paper was well advanced before the issue of that by Outes and Ducloux, for Ameghino has since found it necessary to emphasise still further his views on the "baked earths" in a specially written memoir, in both French and Spanish, entitled "Productos piricos de origen antrópico en las formaciones neogenas de la República Argentina" (*Anales del Museo nac. de Buenos Aires*, tomo xix., p. 1; published February 17). He points out that the analyses of Ducloux merely show that the alleged volcanic cinders might have been formed from the fusion of the earth in which they lie, which is precisely the point that Ameghino wishes to establish. But it is not clear that the fused products (p. 17), prepared by Ameghino himself at 950° to 1000° C., have been submitted to microscopic examination, or that they exhibit the felspars and other associated minerals found by Bücking in the scoriæ.

Ameghino (p. 19) states that certain burrows formed as nests by the bee *Ancyloscelis analis* occur in the "baked earth," which must therefore have been burnt after the formation of the nests. Presumably this bee must also be transferred to the Miocene period if this argument is to be sustained. The paper concludes with a statement of how Outes and Ducloux failed to bring forward at Santiago, in Chile, a promised refutation of Ameghino's reiterated views. We may be happy, perhaps, if they consider that enough has now been said. While Florentino Ameghino does not seem to appreciate sufficiently the changes induced in rocks by laterisation, his critics have certainly not utilised to the full the resources of modern petrology. Probably some independent worker will ultimately arrive upon the scene, and we venture to think that he will confirm the views of Steinmann, Outes, and Ducloux. The widely distributed materials which have aroused so much discussion are hardly likely to add to our knowledge of the antiquity of man in South America.

G. A. J. C.

AGRICULTURE AT THE BRITISH ASSOCIATION.

IN view of the outstanding importance of agriculture in Manitoba, it was decided to concentrate attention on a few of the fundamental problems of the North-west and to discuss them as fully as possible both in the subsection itself and in joint meetings with other sections. Such joint discussions are particularly valuable, because the problems in agricultural science are highly complex, and have generally to be dealt with by men working away from large university centres and only occasionally coming into contact with pure men of science. Only those who have had to work under such conditions know what it means to attempt research work in small laboratories in the country without the stimulus of the research atmosphere, often, indeed, with the drag of a considerable amount of routine work and little opportunity of discussing the problem with the chemist or botanist who could throw much light upon it. Under present conditions almost the only opportunity the agriculturist has of meeting his fellow-workers in the region of pure science is at the British Association meeting. For this reason agriculturists are awaiting with no small interest the outcome of the proposal made last year, and carried forward another stage this year, that agricultural science shall form a definite and permanent part of the British Association programme.

In his presidential address Major Craigie dealt with the future wheat supply of the world, and showed that there was no reason for the gloomy apprehensions that have at times been raised, and particularly by Sir W. Crookes at Bristol in 1898, as to whether or not population would outstrip wheat production. The address is printed *in extenso* in NATURE (September 30).

Dr. W. Saunders gave an account of the experimental farm system in Canada. The central farm is at Ottawa, where the scientific staff reside. There are eight subsidiary stations situated at various points between the Atlantic and Pacific coasts, viz. at Prince Edward Island, Nova Scotia, Branden (Man.), Indian Head and Rosthern (Sask.), Lacombe and Lethbridge (Alta.), Agassiz (B.C.). At each of these a scheme of experiments drawn up at Ottawa is carried out under the supervision of an experienced superintendent; different varieties of crops suited to the district and different methods of management are all investigated, and the results published as widely as possible. Any abnormalities or matters of general interest that may require further elucidation are examined in greater detail at Ottawa.

The possibility of extending the food production of Canada was discussed at a joint meeting with the Economics Section, papers by Prof. Brigham, secretary of the Association of American Geographers, and Prof. Mavor, of the Toronto University, forming the text. The possible wheat area of the three provinces Manitoba, Alberta, and Saskatchewan has been put at $17\frac{1}{2}$ million acres, and the possible output at $317\frac{1}{2}$ million bushels, which estimates are not at all accepted by the optimistic westerners. Prof. Mavor, however, points out that wheat cultivation cannot continue to be the mainstay of husbandry, but that mixed farming must become more common. Already, indeed, the wheat area is going down in Ontario, and in certain other districts it is not increasing so rapidly as the area under oats. Dry farming, which alone could be practised over large areas, is as yet on its trial. The difficulty of forming satisfactory estimates is complicated by the fact that two sets of mutually inconsistent statistics are officially issued, one compiled by the Dominion Statistical Department, the other by the provincial authorities.

A joint meeting with the botanical and chemical sections was held for the discussion of wheat problems. An important contribution to the history of the various wheats was made by Dr. Stapf, whose paper was read in his absence by Colonel Prain. Hitherto this question has been very obscure, and has formed the subject of much speculation. Dr. Stapf has succeeded in applying more precise methods, and in replacing the vague ideas hitherto held by definitely ascertained facts. The factors determining the yield of wheat formed the subject of a paper by Messrs. A. D. Hall and E. J. Russell. Wheat is very dependent on a supply of nitrogenous food-stuff; indeed, for small increments of nitrogen a more than proportional crop return is obtained. At a later stage the returns diminish, and after a time cease to yield any profit. Phosphates are of less direct importance, but have considerable indirect effect; in particular, they often enable the crop to be harvested at a somewhat earlier date, and thus they tend to extend further northwards the region of profitable production. It was also shown that wheat is capable of withstanding drought conditions, and is therefore a crop adapted to dry regions. Mr. F. T. Shutt discussed the influence of environment on the composition of the grain. Whilst not prepared to maintain that the percentage of nitrogen, phosphoric acid, or potash in the soil would appreciably affect the percentage of these substances in the grain, he nevertheless showed that the composition of the grain was influenced by its surroundings. Soil moisture affects the quantity of nitrogen present; on adjacent pieces of ground with varying amounts of organic matter, and therefore of moisture, the nitrogen was found to decrease with increasing water content. Thus a strong wheat containing 12·5 per cent. of nitrogen yielded on newly broken prairie land a grain containing only 9·9 per cent. of nitrogen, but on adjacent older and drier land the grain contained 12·4 per cent. of nitrogen. Mr. Shutt's view is that the character of the gluten is a matter of heredity, whilst its amount depends on environment.

Two papers then followed on the strength of wheat, one, by Mr. A. E. Humphries, in which strength was described from the miller's point of view, and one by Dr. E. F. Armstrong, in which the present position of the chemistry of wheat strength was set out. Good quality is the sum of excellence in several directions. The capacity for making large, shapely, and therefore well-aërated loaves; the facility with which large masses of dough can be handled in the bakehouse; the percentage of water required to make a dough of standard consistency, are all taken into account by the miller in valuing his flour. This paper of Mr. Humphries is of great value to the chemist in that it sets forth with clearness the problem that has to be solved; correlations are now wanted between the chemical composition of the flour and these various characters. Dr. Armstrong, in a critical review which was much appreciated, showed what had been done up to the present in tracing such connections, and set forth the methods by which it is possible in particular cases to judge the value of flour. No one chemical characteristic is sufficient; account must be taken of various factors, such as the percentage of nitrogen, the size of the starch grains, and others. Prof. Harcourt then described experiments he had conducted on the baking qualities of certain flours from the western provinces. When Alberta red flour was mixed with soft Ontario winter wheat, a distinctly better result was obtained than when either flour was baked alone. The value of these flours for blending purposes was thus demonstrated. Mr. W. B. Hardy then described the experiments he had made with Prof. Wood to emphasise the importance of mineral constituents of the flour on the plasticity of the gluten.

Dr. C. Saunders approached the subject from quite a different point of view, and described his experiments in breeding wheats. It is fortunately recognised in Canada that wheat may have to be bred to suit local requirements, and indeed has to be bred if the area of the crop is to be pushed northwards. Early ripening is essential in districts where the harvest may be spoiled by frost, and early ripening varieties are being produced by Dr. Saunders at Ottawa. A note on selection was then read by Prof. L. S. Klinck, of the Macdonald College. Finally, Prof. Zavitz discussed the influence of good seed as a factor in wheat production, and described also the work done at Guelph on selection and breeding. Altogether, the wheat papers formed a valuable summary of our knowledge of the various phases of the wheat problem, and general satisfaction was felt at the decision to print them *in extenso* and to issue them in the form of a pamphlet.

Another session was devoted to the discussion of forestry problems. Prof. Somerville opened by a paper on the outlook for timber supplies, pointing out that the consumption of timber is rising faster than the supply, the growing scarcity of timber being clearly reflected in its rising prices. During the past twenty-two years, nine out of thirty-two varieties examined had risen more than 100 per cent. in price, and only two had risen less than 25 per cent. It is to the interest of every country to take energetic steps to prevent waste of timber and to plant up such lands as are not otherwise wanted. The Canadian chief forester, Mr. R. H. Campbell, followed with a paper from which it appeared that perhaps Canada is not yet fully alive to the importance of the problem. The area of forest land is probably not more than 500–600 million acres, only half of which appears to be of actual value. Suggestions were made for conserving the supply, and various administrative, educational, and legislative reforms were urged. The entomological problem was next discussed by Messrs. Lockhead and Swaine, of the Macdonald Agricultural College, who showed that much remains to be done by way of survey to ascertain the damage caused by forest insects.

A morning was devoted to live-stock problems. Mr. P. A. Mørkeberg, the Danish State expert on the breeding of dairy cattle, described the remarkable cooperative system obtaining in Denmark and its effect in increasing both the output and also the value of the output from the farms. Mr. Mørkeberg came over as the foreign representative of the subsection, and his paper was of great value by reason of its suggestiveness to the Canadian authorities who were present, and who are faced by a not dissimilar problem. Mr. Rutherford, the veterinary inspector at Ottawa, sketched out the general character of the western cattle trade, and Prof. Somerville described his experiments at Cockle Park, in which a clay pasture has been improved by basic slag. Prof. Wilson, of Dublin, gave the results of his investigations into the history of the Aberdeen-Angus breed of cattle. The idea underlying the method is that an invading race would bring their cattle with them; thus the original cattle were black; the Romans brought white cattle; the Anglo-Saxons brought red; the Norsemen brought a hornless race; while a large flecked race was imported from Holland in the seventeenth and eighteenth centuries. Prof. Wilson examines the history of each district, and shows how the local cattle have been derived.

The last meeting of the session was devoted to soil problems. Mr. F. T. Shutt described the prairie soils as characterised by a high percentage of organic matter, intimately mingled with clay and sand. The percentage of organic matter is of the greatest importance in determining their fertility, because it so often happens that water is the factor limiting their productiveness. It is hoped that this paper, which summarises a considerable amount of work on the subject, may soon be available for the agricultural chemist. Prof. Alway followed by studies on semi-arid and arid soils, where the problem is quite different in type from that on humid soils. It was found, for instance, that a crop of clover did not increase the succeeding wheat crop, because the clover had taken too much water from the soil. A mere determination of soil moisture is not sufficient to give useful data; the hygroscopic coefficient is wanted before the result can be interpreted. Prof. King, of Wisconsin, sent an admirable summary of his work on soil moisture, which will be much appreciated by English students. The phenomena connected with the water relationships of soils were dealt with in some detail, and a very useful warning was given with regard to "dry farming." By applying certain methods of cultivation that produce a firm subsoil and a loose surface soil it is possible to economise the water supply, and therefore to raise crops in arid or semi-arid regions normally almost desert land; but Prof. King points out that the rainfall goes more or less in cycles, and that the favourable results so often quoted have in some cases, at least, been obtained in seasons when there was quite a considerable amount of rain. Whilst fully admitting the close relationship between cultivation and soil moisture, of which, indeed, his own work forms the best illustration we have, he laid stress on the fact that the large-scale methods are in no sense fully developed.

The last paper, by Messrs. A. D. Hall and E. J. Russell, dealt with the general problem of the conservation of soil fertility, especially with regard to the nitrogen of the soil. At least five factors affect the amount of nitrogen present. Two tend to increase it, viz. (*a*) bacteria fixing atmospheric nitrogen, and (*b*) the combined nitrogen brought down by the rain; and three to decrease it, viz. (*c*) drainage water, (*d*) bacterial action in decomposing organic matter, with liberation of free nitrogen, and (*e*) the growth of plants with its concomitant assimilation of nitrogen compounds. Three sets of cases were discussed. It was shown that the nitrogen content of land under arable cultivation declines when the produce is entirely removed and no organic matter is added as manure. When land rich in organic compounds is subjected to arable cultivation the destructive agents become very active, and the land loses nitrogen rapidly. On the other hand, when land is carrying natural vegetation which is not removed, there is a gain of nitrogen.

BOTANY AT THE BRITISH ASSOCIATION.

So far as Section K is concerned, the Winnipeg meeting must be pronounced to have been a distinct success. Though less than a dozen British botanists and only one Canadian were present, the numbers attending the section were about up to the average. This was largely due to the presence of a number of American botanists, many of whom communicated papers and in other ways contributed to the success of the meeting.

The opening address of the president, Lieut.-Colonel Prain, was delivered on Thursday, August 26. It dealt chiefly with the position of modern systematic botany, and its relations to palæobotany, phytogeography, and other branches of botanical study. The address was published in full in Nature of September 30.

The papers read during the meeting may be roughly classified according to subjects.

Cytological and Fungal Papers.

Prof. J. B. Overton (of Wisconsin) contributed a paper on the organisation and reconstruction of the nuclei in the root-tips of *Podophyllum peltatum.* After summarising the work of Grégoire and others, the author described his own observations, which, in his opinion, strongly support the view of the individuality of the chromosomes. During the passage of the chromosomes from the equatorial plate to the poles, they exhibit progressive vacuolisation. Dr. Overton believes that each individual chromosome increases in size, and ultimately forms an independent elementary reticulum. Thus the reticulum of the resting nucleus is composed of a number of these smaller reticula. Conversely, during the earlier prophases of division, the chromosomes become more condensed and distinct, and, joining end to end, give rise to the well-known spireme.

Mr. Harold Wager communicated a paper by Miss A. Peniston and himself on the nucleus of the yeast plant. The authors contend that the so-called vacuole of the yeast cell is in reality part of the nuclear apparatus. This vacuole is surrounded by a peripheral chromatin network, which in its turn is connected with a stainable nucleolus. The paper was illustrated by a number of convincing drawings.

Miss H. C. I. Fraser discussed the nuclear phenomena of Ascomycetes in relation to heredity. Fertilisation in the Ascomycetes may be either normal or degenerate. The latter, which consists of the fusion in pairs of either ascogonial or even vegetative nuclei, is found in cases where one or both sexual organs are absent. Fertilisation of either type is followed by a second nuclear fusion in the ascus. The sexual fusion is compensated by a true meiotic reduction, while the fusion in the ascus is followed by a simpler brachymeiotic division. It thus appears possible to differentiate between sexual and asexual fusion by a study of the subsequent reduction phenomena.

Prof. A. H. R. Buller (of Winnipeg) gave an account of the production and dispersion of spores in the Hymenomycetes. A number of experiments were made on the rate of spore discharge, the path of the falling spores, &c. During the paper Prof. Buller gave a pretty demonstration of the discharge of spores from the fruit-body of a species of Polyporus. By suspending the fungus in a closed glass chamber, through which a concentrated beam of light was passed, the clouds of falling spores were rendered clearly visible. A full account of this work is contained in the book on fungal researches just published by the author.

Another paper by Prof. Buller, in collaboration with Mr. C. W. Lowe, dealt with the number of bacteria in the air of Winnipeg. Observations were made on the University campus every week for a year. Both the volumetric and the plate methods were employed. During the winter half of the year the average number of micro-organisms in ten litres of air was 0.9, while in the corresponding summer half the average number rose to 10·33.

Papers on Pteridophyta.

Prof. D. H. Campbell (Leland Stanford University) read a paper on the prothallium and embryo sporophyte of Danæa, a fine series of which (belonging to several species) had been procured in Jamaica. Of the points described by the author, two may be mentioned. First, as compared with other Marattiaceæ, the ventral canal cell of the archegonium is very imperfectly developed. Secondly, no trace of a root can be found until the embryo has reached a considerable size. The first root then arises endogenously.

Prof. D. T. Gwynne-Vaughan communicated a paper by Dr. Kidston and himself on the ancestry of the Osmundaceæ. Lalesskya and Thamnopteris are two genera of primitive Osmundaceæ from the Permian deposits of Russia. The stem in these forms contains a protostele with a solid mass of xylem. The latter, however, is not homogeneous, as it consists of a central mass of short tracheids surrounded by a peripheral zone of normal scalariform tracheids. This central mass of short tracheids is held by the authors to be homologous with the parenchymatous pith of the modern Osmundaceæ. They also believe that the Osmundaceæ and Zygopterideæ have been derived from a common ancestor.

A paper was also presented by Mr. W. T. Gordon on the structure of a new Zygopteris. This species (*Z. Pettycurensis*) exhibits a protostele, a type of vascular system which had hitherto not been found in the group. This form thus occupies the same position in the Zygopterideæ as *Thamnopteris schlechtendahlii* does in the Osmundaceæ.

Ecological Papers.

Friday morning was largely devoted to the consideration of papers on ecology. The first was by Prof. H. C. Cowles, of Chicago, on the fundamental causes of succession among plant-associations. In dealing with the fact of succession, Prof. Cowles stated that plant-associations only exhibit this phenomenon when changes occur in the external conditions; but complete stability of conditions is rarely met with, so succession constitutes the normal course of events. The earlier stages may be termed the proximate, and the later ones the ultimate stages. Except in those cases where the proximate and ultimate formations are the same, as, for instance, in deserts, it is only in the ultimate stages that a plant-association becomes relatively stable. The author then discussed a number of the causes of succession. Apart from such obvious ones as topographic and climatic changes, the most important are those which are more or less associated with the plants themselves. Of these, Dr. Cowles laid especial stress on two factors: the accumulation of humus, which involves changes in the temperature, and the moisture and air content of the soil; and the increase of shade, due to the increasing luxuriance of the vegetation. The ultimate formation of any upland will be composed of plants that can germinate in the densest shade that exists there. Other factors discussed were the invasion of an area by alien species, and the influence of man. The latter makes itself felt chiefly by reason of man's destructive activity. Speaking broadly, the effect of interference by man is to keep plant-associations more xerophytic than they would otherwise be.

Prof. F. Ramaley (Colorado) discussed the Rocky Mountain flora in relation to climate. He stated that the flora of the Rockies is remarkably uniform from Canada to Colorado; but any given species must be looked for at higher and higher altitudes as one travels southwards from Canada. The author is of opinion that the chief factor which determines this altitudinal distribution is temperature. This he regards as more important in this instance than either topography, soil, or rainfall.

Prof. B. E. Livingston (Baltimore) then gave an account of the porous cup atmometer as an instrument for ecological research. The author first emphasised the importance of evaporation determinations in ecological investigations, and then described the form of instrument he has himself used. Finally, he gave some useful hints with respect to precautions to be observed when using this instrument.

Prof. R. H. Yapp gave the result of some observations and experiments on the ecology of *Spiraea Ulmaria.* This plant exhibits curious seasonal changes in respect to the formation of glabrous and hairy leaves. It was shown that the production of these two types of leaves in nature varies with the annual march of evaporation and light intensity.

Papers of Economic Interest.

On Monday, August 30, there was a joint discussion on "wheat" by the chemical, botanical, and agricultural sections. Most of the papers read at this discussion have already been noticed in NATURE (see the article on "Chemistry at the British Association," October 14, p. 475, and that on "Agriculture at the British Association" in the present number). The only one that need be further dealt with here is an important botanical contribution by Dr. O. Stapf (communicated by Lieut.-Colonel Prain), on the history of the wheats.

The wheats are generally divided into (*a*) the wheats proper, with tough spindles to the spikes, loose grains, and thick pericarps (N.B.—the first two of these characters are of economic importance, as they greatly facilitate threshing); (*b*) the spelt wheats, with brittle spindles, grains tightly enclosed in the husks, and thin pericarps. The former comprise the soft, hard, and English wheats, together with the dwarf and Polish wheats. The latter include the spelt wheats proper, the emmer and the einkorn wheats, and also the wild *Triticum aegilopioides* and *T. dicoccoides*.

After careful investigation, and in the light of recent discoveries, Dr. Stapf concludes that all the varieties of modern wheat may be traced to some four distinct primitive wild types:—(1) the einkorn to *Triticum aegilopioides*, with its original home in Asia Minor and the Balkans; (2) the emmer and the hard wheats, as also the English and Polish, to *Triticum dicoccoides*, recently re-discovered by Mr. Aaronsohn in northern Palestine; (3) the spelt proper to *Triticum cylindricum*, in an area extending from Rumania to southern Russia; (4) the common or soft, and probably also the dwarf, wheats, to a still unknown species, which probably occurred either in Syria or Mesopotamia.

Dr. Stapf concluded his paper with an appeal for the systematic collection of all the wheats at present cultivated in the Old World, which must, he said, still include many of the more primitive races; also for a further exploration of the Orient, which might well result in the discovery of new wild forms.

Other papers of agricultural interest were read by Prof. H. Bolley (North Dakota), on the destruction of weeds in field crops by means of chemical sprays; and by Prof. Pammel (Iowa), on the delayed germination of seeds. The latter author experimented with the seeds of a number of species of weeds. He found that if the seeds were kept during the winter in paper packages, the percentage germination was lower, and the dormant period longer, than if the seeds were placed in sand and exposed to the climatic conditions of an ordinary winter.

On Thursday afternoon Mr. J. Parkin gave an interesting account of the industry of rubber cultivation. He referred to the various rubber-yielding trees, and more particularly to *Hevea brasiliensis*, the Para rubber tree. After describing the introduction of the latter into the eastern tropics, Mr. Parkin dealt with the methods employed in tapping the rubber trees. He fully discussed the relation between the yield of rubber and the phenomenon known as "wound response," and also the nature of latex coagulation. The paper was fully illustrated with specimens of the plants, commercial rubber, the instruments used, &c. Mr. Parkin also demonstrated the actual coagulation of rubber latex.

Other Papers.

In contrast to the Dublin meeting, there was a noticeable dearth of physiological papers. One, however, was contributed by Prof. R. Willstätter, on the chemistry of chlorophyll. One of the points emphasised by this author was the essential difference between chlorophyll and hæmoglobin in respect to the metals bound up in their respective molecules. Iron occurs in that of hæmoglobin, while in the case of chlorophyll the iron is replaced by magnesium. The action of acids and alkalis on chlorophyll was also discussed.

Mr. J. Parkin put forward some rather novel views as to the evolution of the inflorescence. He is of opinion that racemose inflorescences have been in all cases derived from cymose. According to his view, solitary terminal flowers were primitive; these were succeeded by simple dichasia, and these by compound dichasia. From the latter, racemose inflorescences may have been derived by an increase in the number of lateral flowers, with suppression of tertiary branching, and, finally, of the original terminal flower itself.

Miss E. J. Welsford described the life-history of *Trichodiscus elegans*, an alga belonging to the Chætophoraceæ. It was found in this species that various forms of reproduction may occur under identical external conditions. These results are somewhat at variance with the well-known experiments of Klebs.

Dr. R. R. Gates (Chicago) discussed the effects of tropical conditions on the development of certain English Œnotheras. Two species were grown from seed in a tropical greenhouse. The resulting plants were usually found to continue indefinitely in the rosette stage. Even when ordinary stems were produced they exhibited marked fasciation.

The Semi-popular Lecture.

This was given on the Friday afternoon by Mr. Harold Wager. He chose for his subject the perception of light in plants. The lecturer dealt with the problem as it affects both the lower, free-swimming organisms, such as Euglena, Chlamydomonas, &c., and also the various orthotropic and diatropic organs of the higher plants. With respect to the latter, Mr. Wager criticised Haberlandt's view of the ocellar function of the epidermal cells of leaves. While agreeing that the optical behaviour of those cells may in general be as Haberlandt suggests, the lecturer inclined to the view that the chlorophyll grains, rather than the cytoplasmic lining of the epidermal cells, constitute the actual percipient organs. The lecture, which was thoroughly appreciated, was well illustrated by a number of beautiful photographs.

Several botanical excursions were arranged during the meeting by the local secretary, Prof. Buller. One of these was to Hedingly, where a fine bit of uncultivated prairie was examined. Another was to Winnipeg Beach, on the shores of Lake Winnipeg. On a third occasion Elm Park, on the Red River, was visited. Some of the members of Section K also took part in the western excursion, and so had a further opportunity of witnessing some of the remarkable types of vegetation to be found in travelling from east to west across the North American continent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—It is proposed that, in accordance with the recommendation contained in a report of the council of the Senate on the endowment of a professorship of German, the generous offer of Messrs. J. Henry Schröder and Company of the sum of 20,000*l.* for the endowment in the University of a professorship of German, to be known as the Schröder professorship of German, be gratefully accepted, and that the thanks of the University be conveyed to the donors.

The superintendent of the museum of zoology has appointed Mr. C. L. Boulenger to the office of assistant to the superintendent of the museum of zoology for one year from October 1, 1909. Mr. H. H. Thomas has been appointed curator of the botanical museum for a period of three years from Michaelmas, 1909, and Mr. Gordon Merriman has been appointed to the studentship in medical entomology lately held by Mr. F. P. Jepson.

The Vice-Chancellor, Mr. R. F. Scott, Mr. Fitzpatrick, Prof. Kenny, Dr. Anderson, Prof. Sorley, Sir J. J. Thomson, Mr. R. T. Wright, Mr. C. E. Grant, and Mr. H. McL. Innes have been nominated a syndicate to consider the question of providing pensions for professors and others in the service of the University.

LONDON.—At the meeting of the Senate held on October 20, the degree of D.Sc. was granted to Mr. L. L. Fermor, an external student, for a thesis entitled "The Manganese Ore Deposits of India," and other contributions; and to Mr. S. Russ, an internal student, of University College, for a thesis on "The Active Deposits of Radio-active Substances."

Many old students of the Royal College of Science and Royal School of Mines having expressed the opinion that there should be a reunion in the Midlands, in addition to the annual dinner of the Old Students' Association in London, arrangements have been made for a dinner at the Imperial Hotel, Birmingham, on Saturday, November 6. Tickets or particulars can be obtained from Mr. Philip C. Coultas, Municipal Technical School, Birmingham.

The commissioners under the Irish Universities Act, 1908, have appointed the following professors, among others, in University College, Dublin:—mathematics, H. C. M'Weeney; chemistry, Dr. Hugh Ryan; experimental physics, Dr. J. A. M'Clelland; mathematical physics, Dr. Arthur W. Conway; zoology, Dr. George Sigerson; anatomy, Dr. E. P. M'Loughlin; surgery, J. S. M'Ardle; geology, H. J. Seymour; physiology and histology, Dr. B. J. Collingwood; pathology and bacteriology, Dr. E. J. M'Weeney; medicine, Sir Christopher Nixon; civil engineering, P. F. Purcell.

The following candidates were successful in this year's competition for the Whitworth scholarships and exhibitions:—*Scholarships* (tenable for three years), 125*l.* a year each. A. W. Judge, Plymouth; J. Airey, Shipley; H. S. Rowell, Newcastle-on-Tyne; H. Mawson, Leeds. *Exhibitions* (tenable for one year), 50*l.* each. F. Duncanson, Sunderland; A. Ryan, Oldham; A. H. Campbell, Portsmouth; J. J. Clark, Liverpool; W. H. Shinkfield, Portsmouth; A. W. Stevenson, Melrose; G. W. E. Hayward, Southsea; J. Morgan, Sheerness; A. F. Grieveson, Chatham; A. E. Gladwyn, Plumstead; W. H. T. Harvey, Swindon; T. H. Webster, Newcastle-on-Tyne; W. J. Davis, Plymouth; O. R. Randall, Birmingham; G. F. Haddock, Sunderland; F. H. Reid, Plymouth; G. B. Kellagher, Gillingham (Kent); T. Norcross, Hollinwood, Oldham; L. P. Parker, Leytonstone; A. Morris, Portsmouth; J. Smith, Crewe; W. Shaw, Woolwich; H. E. Pinch, Sheerness; D. H. Emby, Plumstead; W. Fox, Plumstead; R. H. May, Leytonstone; E. D. Brodie, Swindon; H. J. Goudie, Leith; H. Collins, Gillingham (Kent); C. Williams, Plumstead.

On October 20 the University of Birmingham held the first special degree congregation since its inauguration. In commemoration of the Royal opening of the University in July last, a number of distinguished persons received honorary degrees. Among the representatives of pure and applied science upon whom was conferred the honorary degree of Doctor of Laws were Mr. W. N. Atkinson, H.M. Inspector of Mines for South Wales; Mr. H. T. Butlin, president of the College of Surgeons of England; Sir William Crookes, F.R.S.; Mr. Maurice Fitzmaurice, C.M.G., engineer-in-chief to the London County Council; Sir Archibald Geikie, K.C.B., president of the Royal Society; Dr. John S. Haldane, F.R.S., reader in physiology to the University of Oxford; Sir Alexander Kennedy, F.R.S.; Sir Joseph Larmor, Sec.R.S., Lucasian professor of mathematics in the University of Cambridge; Sir Richard D. Powell, K.C.V.O., president of the Royal College of Physicians; Sir William Ramsay, K.C.B., F.R.S.; Lord Rayleigh, O.M., F.R.S.; Prof. E. Rutherford, F.R.S., professor of physics in the University of Manchester; Prof. S. P. Thompson, F.R.S.; Prof. W. A. Tilden, F.R.S.; Sir Joseph Thomson, F.R.S.; Mr. C. S. Tomes, F.R.S., past-president of the Odontological Society of Great Britain; and Dr. B. C. A. Windle, F.R.S., president of University College, Cork.

The issue of *Science* for October 15 announces the following gifts to higher education in the United States. Yale University has received from Mr. W. D. Sloane and Mr. H. T. Sloane the sum of 95,000*l.* to build, equip, and endow a physical laboratory. This laboratory, it is understood, will replace the present Sloane Physical Laboratory. Yale University has also received 5000*l.* from Mr. A. G. Vanderbilt for general endowment, and 3000*l.* from Mr. G. H. Meyers for the endowment of the Forest School. Columbia University has received gifts amounting to about 47,200*l.*, of which 22,500*l.* is from Mr. W. H. Charpentier, to be added to the J. S. Charpentier fund, and 20,000*l.* is given anonymously. The Pratt Institute of Brooklyn has received the sum of 350,000*l.* from Mr. Charles M. Pratt, son of the founder and now its president, and from his five brothers and his sister, Mrs. E. B. Dane. Dr. D. K. Pearsons has offered to give 20,000*l.* to Berea College, provided that the sum of 80,000*l.* is otherwise subscribed, and Mr. N. B. Duke has made a further gift of 10,000*l.* to Trinity College at Durham, N.C.

The first part of "Statistics of Public Education in England and Wales," 1907–8, has been published (Cd. 4885) by the Board of Education, and deals wholly with educational statistics. We notice that during the year thirty-five technical institutions were recognised by the Board, these being defined as institutions giving an organised course of instruction in day classes, including advanced instruction in science, or in science and in art, and provided with a staff and equipment adequate for the purpose. Provision must be made in such institutions for at least a two years' systematic course in science, or in science and art, either alone or in conjunction with subjects of general commercial, manual, or technological instruction. With a few exceptions, no student may be admitted to the course unless he has passed through a three years' course in a recognised secondary school, or is more than sixteen years of age and is qualified from his general education to profit by a course of advanced instruction. There were in these thirty-five institutions 644 teachers, while 2768 students attended at some time during the year, though 1630 only attended a full course of instruction. It is noteworthy that twenty-one of the teachers were women, and 198 of the students were girls or women. Of the 2570 boys and men in attendance, 7 were fourteen years of age; 492 were fifteen and under seventeen years of age; 465, seventeen and under eighteen years of age; 439, eighteen and under nineteen; 343, nineteen and under twenty; 232 were twenty and under twenty-one; and 592 were twenty-one years of age or more. It must be remembered that, in addition to these students, there were many others attending day technical classes. The Board recognised day technical classes in ninety-six institutions during the year, and upwards of 9000 students attended these classes at some time or other during the year.

SOCIETIES AND ACADEMIES.

London.

Institution of Mining and Metallurgy, October 21.—Mr. Edgar Taylor, president, in the chair.—The influence of the railroads of the United States and Canada on the mineral industry: Dr. J. **Douglas**. After a brief historical summary of the development of the railroad systems of the North American continent, the author gave statistics of the mileage and traffic of the various railroads, showing the proportion of mineral traffic conveyed and its nature. He also showed the part taken by improved railroad communication in developing the mineral resources of the continent, and sought to prove that as the vast regions so far untouched by railroads, especially in Canada, are opened up, it is reasonable to conclude that greater stores of mineral wealth will be discovered and developed.—The development of heavy gravitation stamps: W. A. **Caldecott**. The author opened his subject with the statement that the history of ore crushing by means of gravitation stamps shows a progressive increase in their weight and in corresponding efficiency, and by means of figures he proceeded to prove how closely the factors of weight and efficiency are related. The first stamp-mill erected in the United States, in 1835, was equipped with 50 lb. stamps, this weight being increased to 380 lb. ten years later. Nowadays, on the Rand and elsewhere, stamps are in operation weighing as much as 1750 lb. In the meantime, however, the introduction of secondary grinding by means of tube mills, &c., has modified the original requirements of a stamp-battery, and tended to render the heavier stamps more efficient for their present purpose than were the older and lighter stamps under then existing conditions. The author concludes that the future limit of weight is difficult to foretell, and may be determined by mechanical considerations rather than by any decrease of relative efficiency as a device for pulverising ore. The data given as the result of exhaustive experiments with different weights and duties of stamps add considerably to the practical value of the paper.

Manchester.

Institute of Metals, October 14.—Sir William White, K.C.B., F.R.S., president, in the chair.—The constitution and properties of the ternary alloys aluminium-copper-tin: J. H. **Andrew** and C. A. **Edwards.** The authors recorded an interesting series of conclusions of both a practical and theoretical character, based on a prolonged research which had necessitated the preparation and testing of many hundreds of alloys.—The surface appearance of solders: C. O. **Bannister** and H. J. **Tabor.** Results were given of experiments carried out with a view to obtain exact information as to the effect of small quantities of impurities on the surface appearance of solders, the impurities added to ordinary tinman's solder (50 per cent. tin and 50 per cent. lead) being antimony, copper, silver, and zinc.—Some causes of the corrosion of copper and brass: E. L. **Rhead.** The author dealt particularly with the corrosion of condenser tubes. Samples of hard copper and brass were submitted to corrosion in various saline solutions, some of which were saturated with CO_2. Strips of hard brass were softened at one end and bent into U-shape. It was found that there was a much greater tendency for the hard material to corrode, the corrosion occurring in lines parallel to the direction of rolling. The surface of the hard metal was made very rough and irregular, whilst that of the soft metal remained quite smooth, when both were immersed in saline solutions.

October 15.—Sir William White, K.C.B., F.R.S., president, in the chair.—The copper-zinc alloys: a study of volume changes during solidification: Prof. T. **Turner** and M. T. **Murray.** The authors held that their experiments were likely to have an important theoretical as well as practical bearing, and it was believed that expansometer tests would be largely used in future as an aid to the determination of the constitution of alloys.—The elastic breakdown of non-ferrous metals: Prof. C. A. **Smith.** The author gave the result of researches conducted by means of his instrument, the sphingometer, which showed that, so far as the elastic properties of the material were concerned, mild steel was very much more trustworthy than any non-ferrous metal. The sphingometer was described, and shown to be capable of measuring extensions of length of the astonishingly small amount of a quarter of a millionth part of an inch.—Notes of the production of pure spelter: J. S. **Primrose.** A review of the commercial position of zinc and the existing methods of refining the metal, the author also discussing the theory of the new process of fume filtration purification during distillation.—The technical assay of zinc: H. W. **Greenwood** and Dr. E. J. **Erislee.** The paper described work undertaken with a view to determine the relative value and accuracy of the various analytical methods for the determination of zinc, and also the gathering together of the more important references to the analytical chemistry of zinc in both British and foreign literature. The authors reviewed briefly the more important processes, volumetric, gravimetric, and electrolytic, for the estimation of zinc.

DIARY OF SOCIETIES.

THURSDAY, October 28.

Society of Dyers and Colourists, at 8.—Some Unsolved Dyeing Problems: Dr. E. Feilmann.

FRIDAY, October 29.

Institution of Mechanical Engineers, at 8.—Prof. W. E. Dalby's Report on Heat Transmission (*Resumed Discussion*).

MONDAY, November 1.

Society of Chemical Industry, at 8.—Technical Gas Calorimetry: J. H. Coste.—On Naphthalene Picrate and the Quantitative Determination of Naphthalene: W. P. Jorissen and J. Rutten.—Some Notes upon the Manufacture of Large Blocks of Artificial Stone from Sand and Lime: J. C. Stead.

Aristotelian Society, at 8.—Presidential Address: Sensations and Images: Dr. S. Alexander.

TUESDAY, November 2.

Institution of Civil Engineers, at 8.—Address by the President, J. C. Inglis.

WEDNESDAY, November 3.

Society of Public Analysts, at 8.—Note on the Detection and Estimation of Small Quantities of Antimony: Dr. P. Schidrowitz and H. A. Goldsbrough.—The Phosphates in Certain Vinegars, and in the Materials used in their Manufacture: T. Fairley.—On the Determination of Essential Oils in Spices and Aromatic Drugs: R. A. Cripps and J. A. Brown.—Note on Holde's Test, and the Detection of Paraffin Wax in Lard and other Fats: H. Dunlop.

Geological Society, at 8.—(1) Certain Jurassic (Lias Oolite) Strata of South Dorset, and their Correlation; (2) Certain Jurassic (Inferior Oolite) Species of Ammonites and Brachiopoda: S. S. Buckman.—(1) The Cretaceous and Eocene Strata of Egypt; (2) The Granite Ridges of Kharga Oasis: Intrusive or Tectonic? Dr. W. F. Hume.

Entomological Society, at 8.

THURSDAY, November 4.

Royal Society, at 4.30.—*Probable Papers*: (1) The Development of *Trypanosoma Gambiense* in *Glossina palpalis*; (2) A Note on the Occurrence of a Trypanosome in the African Elephant: Colonel Sir David Bruce, C.B., F.R.S., Captains A. E. Hamerton and H. R. Bateman, R.A.M.C., and Captain F. P. Mackie, I.M.S.—On the Perception of the Direction of Sound: The Lord Rayleigh, O.M., F.R.S.—The Diffraction of Electric Waves: Prof. H. M. Macdonald, F.R.S.—On the Mechanism of the Absorption Spectra of Solutions: Robert Houstoun.—(1) Note on the Spontaneous Luminosity of a Uranium Mineral. (2) The Accumulation of Helium in Geological Time: Hon R. J. Strutt, F.R.S.—On the Physical Properties of Gold Leaf at High Temperatures: J. C. Chapman and H. L. Porter.—The Dimensions and Function of the Martian Canals: Dr. H. C. Pocklington, F.R.S.

Linnean Society, at 8.—Some Account of the Field-botany of Namaqualand, Damaraland, and South Angola: Prof. H. H. W. Pearson.

Röntgen Society, at 8.15.—Presidential Address: C. E. S. Phillips.

FRIDAY, November 5.

Royal Anthropological Institute, at 8.30.—Huxley Memorial Lecture. The North European Race: Prof. G. Retzius.

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