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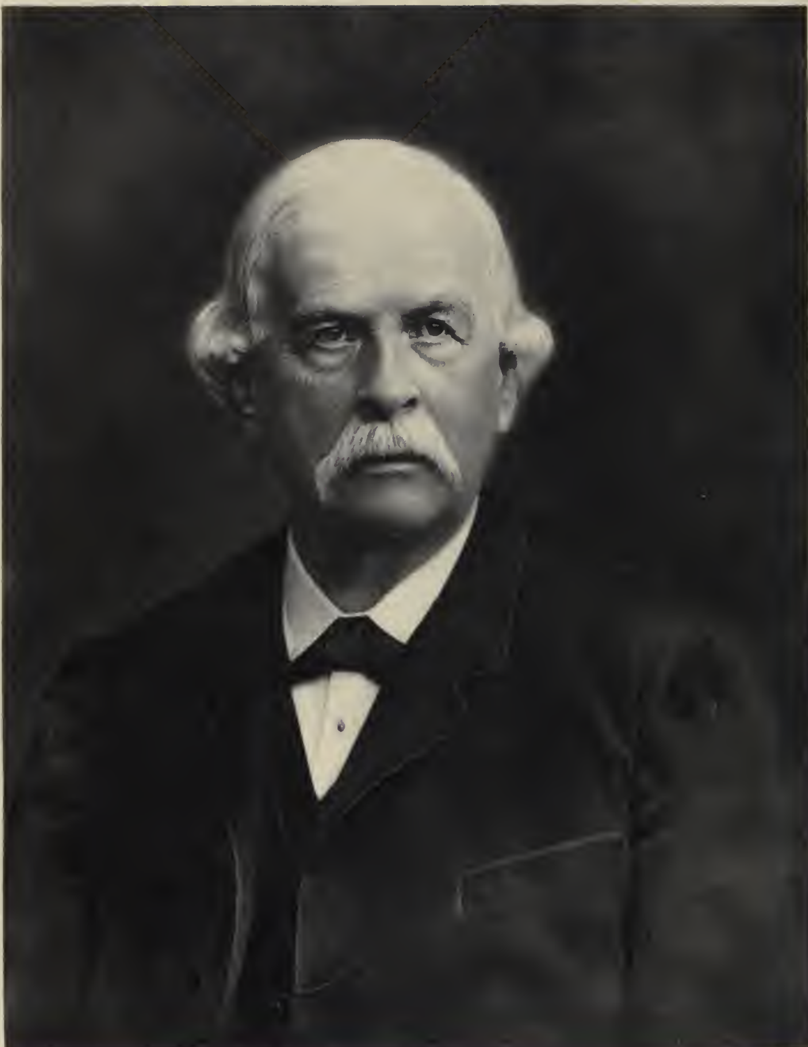
Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE



Alfred Naumann, Photo Walker & [illegible] Ph.Sc.

A. Koelliker

[Supplement to Nature, December 8, 1898]

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"To the solid ground
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, MAY 5, 1898.

SCIENTIFIC WORTHIES.

XXXI.—ALBERT VON KÖLLIKER.

ALBERT VON KÖLLIKER was born at Zürich on July 6, 1817; he therefore is the eldest of the illustrious teachers who have brought down to the present day the tradition of that active spirit of biological inquiry which had its most complete expression, during the first part of the century, in the life and work of Johannes Müller.

After visiting several universities, and so hearing the lectures of many eminent biologists (among whom Johannes Müller himself may be specially mentioned), Kölliker took the degree of M.D. in Heidelberg in 1842; and in 1843 he commenced his teaching career as Prosector to Henle in Zürich. In 1846 he became Professor extraordinarius in Zürich, and in the autumn of 1847 he was called to Würzburg as Professor of Human Anatomy. This chair he has continuously occupied ever since. The remarkable Festschrift, recently published in his honour, contains a long list of names of men who are proud to call themselves his pupils; and the scientific position which so many of these men have won is evidence of the way in which he has fulfilled the highest function of a teacher, imparting to his hearers not only a great store of knowledge, but a just perception of the point where knowledge ends, and something of his own determination and energy in the acquisition of new scientific truth.

It is impossible to give anything like a detailed account of Prof. von Kölliker's scientific work, the results of which are embodied in some couple of hundred memoirs (written with apparently equal facility in any one of four languages) and in a series of text-books. All that can be attempted is an outline of its most important features.

The publication, in 1838, of Schwann's great work drew attention to a number of problems; and Kölliker was one of the first to realise that the complete justification of the cell-theory must be accomplished by a study of the whole history of animal tissues, from the fertilised egg onwards. The first results of this conviction are seen in his monograph of the development of Cephalopods (1844), and in a series of papers on the development of Amphibia (1846-1847). These memoirs are of great importance in the history of embryology, because they definitely bring the phenomena of the segmentation of fertilised ova into the category of normal cell divisions, and lay the foundation of the modern doctrine that an ovum is to be regarded as a single cell. Speaking in 1860 of his work on the Cephalopoda, Prof. von Kölliker points out, with justifiable pride, that he had already in 1844 asserted

"Dass in der ganze Reihe der Entwicklung der thierischen Gewebe, ebensowie bei den Pflanzen, keine Zellenbildung ausserhalb der schon vorhandenen sich finde, vielmehr alle Erscheinungen als die ununterbrochene Folge von Veränderungen ursprünglich gleichbedeutender und alle von Einem ersten abstammender Elementarorgane aufzufassen seien"—

the process of derivation being always a cell-division comparable with the division of cells in a later embryo, or in the adult body (cf. *Entwicklungsgeschichte*, ed. 1861). But besides this important general proposition, the memoir contains a detailed account of Cephalopod development, so far as it could be studied by the methods available at the time, which is of great and permanent value to students of molluscan embryology. The papers on the development of Amphibia describe in outline the process by which the cells of cartilage and blood, the walls of blood-vessels and the elements of embryonic muscle are derived from blastomeres, and therefore have an important bearing on the fundamental problems of histogenesis.

A second series of early papers (1841-1847) was of great assistance, although in a different way, to the study of animal development. The acceptance of Caspar Wolff's doctrine of epigenesis, while it led to a right understanding of the structure of the ovum, was accompanied for a time by a curious belief concerning spermatozoa. After the discovery of these bodies in Leeuwenhoek's laboratory (1677) they were held by many supporters of the hypothesis of "evolution" to contain the whole preformed germ of the future animal, which unfolded and grew after entering the egg. This view never obtained universal acceptance, and it was abandoned by every one at the close of the eighteenth century, as Wolff's view of development became fashionable; but the belief which then grew up was further from the truth than that previously held, for it was maintained that spermatozoa were parasites of extraneous origin, which played no part whatever in the process of fertilisation. This belief was finally destroyed by the researches of Kölliker, who showed conclusively that spermatozoa arise from the tissues of the male gonad, and said in 1847: "Ich betrachte sie als befruchtende Princip und glaube, dass sie durch Berührung der Eier in denselben ein neues Leben erwecken"—thus leading the way directly to modern views. These papers again, besides establishing an important general proposition, contain statements of value on many points of detail, among which the descriptions of the large non-motile male elements of the higher Crustacea may be mentioned.

The two series of memoirs referred to contain perhaps the most fundamental results achieved before going to Würzburg in 1847; but they give no idea of the amount of work actually done before that date. In the field of pure histology must be mentioned the memoir on the Pacinian bodies, written in cojunction with Henle (1844); the important demonstration of the whole course of the connection between a medullated nerve fibre and a nerve cell (1845); a memoir on the spleen, and another on the synovial membranes (1847); also a preliminary account of the researches on the structure of smooth muscle, which were fully described later. Of more purely zoological interest are the papers on the hectocotylus of Cephalopods, in which the trematode hypothesis is shown to be untenable; the paper on the marginal bodies of Medusæ (1843), which contains the earliest recognition of the nature of the otocysts in these animals; the description of the remarkable *Rhodope Varanii* (1847), discovered by v. Kölliker; and two papers, written in conjunction with Löwe, on the presence of cellulose in the test of Tunicata (1846).

On going to Würzburg, Prof. v. Kölliker's activity was if anything increased. He almost immediately joined von Siebold in founding the *Zeitschrift für wissenschaftliche Zoologie*; and it is not the least of his claims to the gratitude of biologists that he has continued for half a century to edit this valuable journal. The first numbers contain a series of papers written by himself, of which the following are the most important.

The essay on *Actinophrys* recognises the rhizopod nature of this animal, and contains a remarkable discussion of the manner in which rhizopods generally ingest their food. The suggestion is clearly made that the contractile substance of *Actinophrys* and *Amœba* is identical in nature with that of *Hydra* and of the higher animals; so that this paper, and Ecker's paper on the contractile substance of *Hydra* which is printed immediately after it, mark an important step in the general conception of what is now called protoplasm.

The monograph of the *Gregarinidæ*, also in the first volume, clearly recognises the unicellular nature of an adult *Gregarina*, and in it the *pseudonavicellæ* are stated to represent stages in the life-history of the *Gregarina*. Many species of Gregarines are described.

[The description of *Dicyema* (1849) may be most conveniently referred to here, although it was not published in the *Zeitschr. f. w. Zoologie.*]

Of papers relating to vertebrate histology, published in the early numbers of the *Zeitschrift*, the most important are the memoirs on smooth muscle, and on the skin. In the first the result of the work already referred to is more fully described. This memoir contains a description of the cellular elements of smooth muscular tissue, and a detailed account of its occurrence in the vertebrate body, including a final demonstration of its presence in the walls of the blood-vessels, which was doubted by several anatomists at the time. In the second memoir, the development of the epidermis is described, and a full account of the development of sweat-glands, hairs, and sebaceous glands is also given.

A paper on nerve-cells, and a note upon the distinction between the two classes of cranial bones, according to their method of ossification, must also be mentioned.

The first published volume of the "Mikroskopische Anatomie," the first of the series of text-books which Prof. von Kölliker has produced, appeared in 1850. This volume was the second of the projected work, and contained a systematic account of the various organs, illustrated by a large series of original figures, many of which have been copied by subsequent writers continuously until the present day. Within two years this was followed by the celebrated "Handbuch der Gewebelehre des Menschen," translated into English, soon after its appearance, by Busk and Huxley, and again (from a subsequent edition) by Bowman.

These masterly works are remarkable not only for their complete treatment of adult histology, but for the way in which the development of each tissue is described, whenever such description is possible, as a means of elucidating its adult structure. The necessity for such a study of the whole history of a tissue, from the egg upwards, is emphatically dwelt upon in the introduction to the "Gewebelehre." Among points of interest in special sections must be mentioned the whole treatment of the derivatives of the ectoderm (other than the central nervous system), including the development of the sweat-glands, the sebaceous and the mammary glands, and a description of the structure, development and succession of hair, which seems, if an English reader may presume to judge, clearer in some respects than the description given in the *Zeitschr. f. w. Zoologie.* The relation between striped muscles and their tendons is described so as to confirm, by independent evidence, many of the statements of Bowman; and a special point of interest in the account of muscular tissues is the description of the branched muscle-plates of the heart and certain other organs, which had been described by Leeuwenhoek, although the description seems to have been forgotten until the rediscovery of the structures by Prof. Kölliker. The chapters on the bones and on the process of ossification describe the mode of addition to bone beneath the periosteum, and include a detailed description of the growth of bone, together with the ossification of membrane bones. These chapters, in which the results of Prof. von Kölliker's researches were shown to be in complete agreement with those conducted in this country by Sharpey, had an important influence upon scientific opinion. The formation of "membrane bones" had been asserted by Nesbitt in 1736, and since his time by Rathke, Jacobson, and others; but the researches of Sharpey in this country, and von Kölliker in Germany, gave the first intelligible account of the process from a histological point of view. The chapters dealing with the spleen, and with the organs of reproduction, must be mentioned; and the account of the ear is especially interesting, from the remarks upon the work of Corti, which had recently been carried out in Würzburg itself, and described in the third volume of the *Zeitschr. f. w. Zoologie*. It is characteristic of Prof. von Kölliker's scrupulous care that, although this work had been done so lately in his own University, he investigated the whole matter again for himself before writing the chapters dealing with it.

During the next ten years many important papers were published. In 1853 Kölliker paid a visit to Messina in the company of H. Müller; and after their arrival the two naturalists were joined by Gegenbaur. The visit has become celebrated among zoologists because of the investigations which were then begun. An account of the work done by each of the three naturalists is given in a joint paper (*Zeitschr. f. w. Zoologie*, Bd. iv.). Prof. Kölliker occupied himself chiefly with observations on the structure and development of hydrozoa; a sketch of his observations is given in the paper referred to, and his fuller quarto work on the Siphonophora was published in the following year, while a paper on the development of Pneumodermon, by Profs. Gegenbaur and Kölliker together, appeared in the *Zeitschr. f. w. Zoologie* for 1853.

Between this time and 1861 appeared a series of papers on the vertebrate notochord, in its relation to the adult vertebral column and to the skull. The investigations recorded in these papers constitute an important step in the detailed knowledge of the cranial notochord of the lower Fishes; while the description of the post-cephalic notochord leads to a classification of vertebral columns generally, based upon the degree to which the chordal sheath persists, and the share taken by this structure and by the "skeletogenous layer" of tissue outside it, in the formation of vertebral centra. The classification suggested was not accepted for many years; but it has lately been justified, and has formed the starting-point for important recent work. Of great value are the papers on the minute structure of the bony skeleton of adult fishes, published during the same period.

In 1861 the first edition of the "Entwicklungsgeschichte des Menschen u. d. höheren Thieren" was published. This edition is of interest not only from its scientific value, but because of its form. It is printed, after some revision, from the shorthand notes of a course of lectures delivered in Würzburg in 1860; and one can, therefore, gather from it some faint idea of the author's method and style of exposition. As usual, the book contains the result of several original investigations. Especially interesting are the lectures on the nature of meroblastic ova, and on segmentation of ova generally, and those relating to the development of the nervous system and the organs of special sense.

In the meantime the "Handbuch der Gewebelehre" had passed through three editions, and had been again translated into English. In 1863 the fourth edition appeared.

In 1864 Prof. v. Kölliker made his first statement of opinion upon questions raised by the publication of the "Origin of Species." While he accepted a doctrine of descent with modification as a statement of the way in which species had appeared upon the earth, he refused to admit that Natural Selection had been the agency by which the modification had been produced, and he argued against the assumption that "utility" in the Darwinian sense had determined the survival of varieties. He also urged the possibility that variations of considerable magnitude might suddenly appear and survive. In his subsequent writings he has maintained essentially the same position, postulating an *allgemeine Entwicklungsgesetz*, working independently of any utilitarian effect, which determines the evolution of living things. His conception of the process of evolution is, therefore, allied to that of Nägeli and his school rather than to that of Darwin himself.

From 1865–1875 appeared a series of papers dealing with the anatomy of Cœlenterates, and including the celebrated memoirs on the Alcyonaria (on *Renilla*, 1871; on the *Pennatulida*, 1872; on *Umbellula*, 1875). These papers, with their account of the remarkable dimorphism of the pennatulid zooids, and the mass of anatomical information they contain, are of fundamental importance to the student of the Alcyonaria. In 1879 the report on the *Pennatulida* collected during the voyage of H.M.S. *Challenger* was written.

A fifth edition of the "Gewebelehre" appeared in 1867.

Other work during these years deals with the development and resorption of bone, and with various points in the development of Vertebrates, especially of Mammals.

In 1876 the second edition of the "Entwicklungsgeschichte des Menschen u. d. höheren Thiere" was published. This edition is much larger than the first, and contains what Balfour, in his notice of the book calls "the most complete description which has yet beer given of the early development of the Bird and Mammal" (*Journ. Anat. Physiol.*, 1876). Especially interesting are the account of the development of the Fowl during the first three days of incubation; the statements concerning the origin of the heart and the Wolffian bodies; and the whole account of the early development of the Rabbit. The great number of original figures shows how largely the whole work is based on personal observation.

The considerable series of embryological and other papers published since that time cannot here be noticed. The little space remaining must be given to a mention of the last edition of the "Handbuch der Gewebelehre," of which the first volume was published in 1889. This is, as the author declares in the preface, rather an altogether new treatise than a new edition of an old one; and as usual every page shows how largely it is based on Prof. von Kölliker's own observations, whether original or in confirmation of results obtained by others. The first volume deals with the simple tissues, with the skin and its derivatives, with bone and with muscle. The second volume, which deals with the nervous system, appeared in parts from 1893 onwards.

The advance in knowledge since the fifth edition of the "Gewebelehre" is nowhere so striking as in the case of the central nervous system. The extended study of degeneration following upon injury, and the histological methods introduced by Erlich, Golgi, and others, have led to a rapid increase in knowledge concerning the distribution of nerve fibres both within the central nervous system and outside its limits; while an altogether new conception of the anatomical relations of ganglion cells has been established. Prof. von Kölliker was one of the first to recognise the importance of Golgi's work; and after visiting him in Padua in 1887, he adopted the new method in a series of investigations, some of which are described in seven papers published between 1889 and 1891 (cf. especially *Zeitschr. f. w. Zoologie*, vols. xlix. and li.), while the results of others appear for the first time in the second volume of the "Gewebelehre." This volume, of nearly 900 closely-printed pages, illustrated by 840 figures, most of which are as usual original, attempts nothing less than an outline of the comparative histology of the central nervous system in Vertebrata generally. The value of this enormous work arises not only from the new statements of fact which it contains, but from the systematic treatment of the mass of detail, constituting almost a new science, by a man who knows every fact referred to from his own observation.

This is not the place in which to speak of the numerous and well-merited honours conferred upon Prof. von Kölliker by the Government of his own country and by scientific societies and academies in almost every land. It is hoped that the foregoing imperfect outline of his work may give some idea of his position as one of the founders of modern systematic histology, and of his valuable services to embryology and comparative anatomy. Those who are best able to judge the imperfections of this sketch will be best able to understand the magnitude of the attempted task.

W. F. R. WELDON.

NITRO-EXPLOSIVES.

Explosifs Nitrés. By J. Daniel. Pp. viii + 235. (Paris: Gauthier-Villars et Fils.)

BY far the greater portion of this book is a fairly literal translation of Mr. Sanford's work on nitro-explosives, published in 1894. It suffers therefore, in many respects, from the same defects, though in others it is a decided improvement. Like the original it gives, for example, a description of all the gelatinised nitroglycerine preparations before giving the manufacture of the various nitro-cottons used in gelatinising them, which is, in several respects, an inconvenient arrangement. Like Sanford's work, it describes the manufacture of nitroglycerine and nitrocellulose in greater detail than is necessary for the use of a general chemist, and yet insufficiently so to serve as a complete guide to the manufacturer. The description of nitroglycerine is, however, a marked improvement on the original, and does not, for example, leave the reader in doubt as to whether nitroglycerine should be regarded as a nitric ether or not. It is, therefore, all the more surprising to find that M. Daniel, like Mr. Sanford, has apparently failed to grasp the great importance, from a theoretical as well as a practical point of view, of the fundamental difference between a nitric ether, on the one hand, and a true nitro-compound on the other. The former, although, when pure, perfectly stable at ordinary temperatures, decompose readily at, comparatively speaking, low temperature, and are one and all unstable at ordinary temperature in the presence of even minute traces of strong mineral acids as well as in the presence of many organic acids. Hence, in order to ensure the stability of a powder containing a nitric ether, it is absolutely essential not only to exclude all free acids, but also all compounds likely to become acid. Hence ammonium salts, like nitrate of ammonium, for example, may be used with perfect safety in admixture with a nitro-compound, such as dinitrobenzole in the manufacture of bellite, roburite, securite, &c., whereas the presence of this salt would be fatal in an explosive containing a nitric ether such as guncotton or nitroglycerine.

The preparation of the various nitro-celluloses, soluble and insoluble, is given very fully—too fully for the general chemist; but the author, in following too closely his original, fails to point out that the question of solubility or non-solubility of nitro-cotton is, in great measure, at least, one of method of manufacture and not one of degree of nitration, and also depends, in a measure, on the temperature of the ether alcohol mixture. This is very remarkable, seeing that the Cordite trial, during the progress of which this question of soluble and insoluble guncotton was very fully discussed, is several times alluded to in the work. The statement, found in both works, that the sulphuric acid in the manufacture of guncotton does not take part in the reaction, is, at least, open to doubt. The manufacture of celluloid, to which eight pages are devoted, however interesting in itself, should scarcely occupy so much space in a work of only 271 pages devoted to nitro-explosives.

A very useful addition of M. Daniel consists in a description of the physiological effects of nitroglycerine and dinitrobenzole. The baneful effects of this latter compound on the health of the workpeople employed in the manufacture of explosives containing it, was first clearly established by a small Departmental Committee of the Home Office, and it is curious to find it taken up by a Frenchman and omitted from the work of an Englishman.

Most of the more commonly used explosives are shortly, but sufficiently described; but the mistakes found in the original unfortunately reappear in the translation. Thus roburite never was a mixture of ammonium nitrate and chlorodinitrobenzole, but one of the former salt with chlorinated dinitrobenzole containing, at most, 2 per cent. of chlorine, a very different thing. This original roburite is no longer manufactured in England. M. Daniel also, like Mr. Sanford, gives what may be called the ideal composition of dynamite (25 per cent. kieselguhr and 75 per cent. nitroglycerine) as the ordinary one, whereas, as a matter of fact, commercial dynamite practically never contains 75 per cent. nitroglycerine, and almost always contains mineral matters besides kieselguhr.

As a further interesting addition by the translator may be mentioned the statement regarding the curious difference in the behaviour of frozen gelatine dynamite and blasting gelatine respectively, to shock or percussion, gelatine dynamite, when frozen, being, if anything, rather more sensitive to percussion than when unfrozen, while with blasting gelatine the reverse is the case. This is a point of some importance when these two explosives have to be dealt with in winter, and it is curious to note that this fact, like the baneful effects of dinitrobenzole, although first established in England, is not found in the English work, but appears in the French translation.

We must also raise our protest against the statement, repeated in the translation, that blasting gelatine, when ignited in the open, burns but does not explode; this is true only when the blasting gelatine is in relatively small quantities, or in an unfrozen condition. The burning of large quantities of blasting gelatine frequently ends in a violent explosion, and the burning of even a pound or two of the frozen material nearly always leads to explosion. This is one of those careless statements which, unfortunately, frequently lead to accidents.

As regards this portion of the work we should have been grateful to the author if he had given us a little more information as to the various explosives, propulsive as well as disruptive, used in the French army. We in England, foolishly perhaps, have few or no secrets in such matters; it is, in fact, one of the most difficult things imaginable to keep anything secret. In France they manage these things better, or at least differently, and we are still, many years after their introduction, ignorant of the exact nature of the powder and other explosives used by the French army. Any information on these points from M. Daniel would have met with our warmest appreciation.

The chapters on the analysis of explosives are practically a simple translation of Mr. Sanford on the same subject, and suffer from the same defects, and have the same excellencies as the original. Here we can only point out one more instance of want of care in the translator. M. Daniel, like Mr. Sanford, dries moist guncotton at 100° C. to estimate the proportion of water, a proceeding which every one who has tried it must know to be impossible.

One of the greatest, if not the greatest, advances made in the production of smokeless powder, consisting in their complete gelatinisation, whereby they are converted into hard non-porous masses which burn only on the surface, is scarcely hinted at in this work.

Lastly, the list of explosives given at the end of the work suffers from the same defect as did the similar list in Mr. Sanford's book, and several explosives are given, which from the nature of their constituents must be unstable, and therefore dangerous to keep, without a word of warning being added; such as, for example, ammonia dynamite (amidogene) and poudre au nitrate d'ammoniac, which latter contains two salts incompatible with each other, viz. nitrate of ammonium and chlorate of potassium.

In conclusion we welcome this book as a useful addition to our library, but cannot refrain from expressing a hope that Mr. Sanford may soon have an opportunity of giving us a second edition of his work, free from the mistakes and shortcomings of his own first edition as well as those in the French translation of the same.

A. D.

PSYCHICAL RESEARCH.

Studies in Psychical Research. By Frank Podmore, M.A., author of "Apparitions and Thought-Transference." Pp. xi + 458. (London: Kegan Paul, Trench, Trübner, and Co., 1897.)

MR. FRANK PODMORE'S "Studies in Psychical Research" is at once a critically sifted account of facts and the story of a movement. The facts, or alleged facts, concern spiritualism, poltergeists, thought-transference, telepathic hallucinations, ghosts, haunted houses, premonitions, previsions, secondary consciousness, impersonation, obsession, clairvoyance. The movement is the persistent transfer of the facts from the region of myth to the region of verified science. This movement is typified by the work of the Psychical Research Society, which, as Mr. Podmore in his opening chapter shows, was founded by competent persons for the special purpose of ascertaining whether the popular belief in certain phenomena had any basis in scientific evidence. Some ten years ago "Phantasms of the Living" set men thinking on these topics. The theories, as much as the facts there adduced, have stimulated reflection at every hand. Mr. Podmore now aims at placing in a simple form the critical result of twenty years' labour. He is lucid, exact and critical. He pushes no hypothesis except so far as the evidence seems to justify it. Even his favourite "telepathy" is offered as a "working hypothesis" chiefly because it is the smallest "draught upon the unknown."

In Chapter ii., Mr. Podmore gives an account of "spiritualism as a popular movement." The testimony is, he finds, more "copious than cogent." The high-water mark in the scientific observation of spiritualism was Mr. Crookes' experiments with Home and others. The facts narrated in this chapter are subjected to a thorough criticism in Chapter iii. The two chapters are in admirable contrast—the facts of the one melting away under the scrutiny of the other. "Perhaps they heard Dr. Hodgson and the new generation knocking at the door" (p. 81). As the scientific search-light grows stronger, the marvels grow smaller and less numerous. Yet, negative conclusions notwithstanding, the year 1894 witnessed the performances of Eusapia Palladino. In regard to Mr. Crookes and his experiments, Mr. Podmore is becomingly respectful; but the best critical faculty may be taken in by trickery (*e.g.*, p. 111, "Miss Cook, Miss Fay, and other mediums with whom Mr. Crookes experimented"). Mr. Podmore concludes: "Unless and until some feat is performed which fraud cannot explain, the presumption that fraud is the all-sufficient cause remains unshaken" (p. 124). The "unless" and "until" rest with spiritualism, and were it for this result alone, the S.P.R. has not worked in vain. The poltergeists (Chapter v.) are, in brief, demonstrated trickery. In Chapter vi., Madame Blavatsky and her theosophy are, after a narrative that leaves no doubt, dismissed with a *decipiantur*. The grosser theosophy, like the grosser spiritualism, now receives its "unless" and "until." In Chapter vii. ("experimental thought-transference"), however, we are on more solid ground. Much of the material reminds one of Mr. Podmore's former book. He states the cases, and lets the reader "judge for himself" (p. 199). But this assumes that all the necessary data are supplied—a large assumption. Fraud, at least conscious fraud, may be held as excluded by the conditions, which have all the seeming of true scientific methods. Agent and percipient are strictly watched and guarded. The most obvious sources of error are forestalled. Silent choosing of cards, and the like, obviate any risk of suggestion by normal channels—the purpose being to isolate the fact of the actuality of transference. How difficult it is so to isolate the fact may be guessed from the somewhat extraordinary results of Hansen and Lehman with "involuntary whispering." Their results, as even Parish (" Hallucinations and Illusions," p. 320) allows, are not necessarily conclusive against any experiments recorded by the Society, but they show how extremely difficult it is to establish, in this kind, the ordinary conditions of strict physiological experiment. But apart from these possible errors, the accounts seem somewhat wanting everywhere in psychological "context." This is specially true of the telepathic hallucinations (Chapter viii.), where, once more, the "method of agreement" predominates. A detached mental fact, when once it is subjectively assigned to so simple a cause as telepathic agency, is apt to escape from its mental current. The immediate association may be forgotten instantaneously, or pass utterly unrecognised. It is a more distingushed and impressive thing to have thoughts inspired by an outside source than following in the orthodox way of contiguous or similar association, This defect is very obvious in many of the cases (*e.g.*, p. 245). Several of the recorders of hallucinations state that this is their only experience of the kind. This seems to be a fairly complete proof of bad self-observation. It is true that a well-defined hallucination is, in the ordinary acceptation, a relatively uncommon experience; but Mr. Podmore admits (p. 244) that dreams and waking hallucinations differ, not in essence, but in the accident of sleeping or waking. Obviously, the recorders of those isolated experiences do not take hallucinations in this wide sense. Consequently, a doubt arises as to their competence to record the psychological context. Further, if dream and hallucination are thus to play into each other, the long arm of coincidence is made yet longer, and telepathy, while the marvel of it is none the less, becomes all the more difficult to establish. Mr. Podmore's exposition is so persuasive, and he obviously holds in reserve so much more information, that one hesitates to express doubts crudely. Yet he seems to allow too little for the "submerged dream," for the coincidences that (in excess of chance) must result from the general similarity of mental venue of friends or relatives or acquaintances. He seems to accept too easily the "veridicality" (Parish) of the alleged coincidence, for in some of his instances the precise nature of the fact is just what escapes. Thus the "come to me" of case iv., p. 245, and of her telepathic correlate, may have been, in each case, the end of a normal associational sequence. But the data are not enough to settle the point. The same difficulty in fixing evanescent processes of association has been pointed out by Prof. W. James (*Psych.*, ii. 83), and by Miss Helen Dendy (*Mind*, N.S., 7, 370), in connection with subconscious processes. Many disputes might be raised on the time that hallucinations take to emerge after the alleged telepathic message has been sent, and the suggestions to meet the difficulty are sometimes more "copious than cogent."

Ghosts (Chapter ix.) and haunted houses (Chapter x.) are investigated only to be discredited, and Mr. Podmore then concentrates himself on a very important subject, "secondary consciousness," which, in its turn, is found not proven as a coherent system of ideas. That is, he does not regard as sufficient the argument that contends for separate subconscious personality acting in a hidden way alongside of the normal supraliminal consciousness. The ordinary doctrine of subconscious storage of memories in the nerve centres is considered enough. These subconscious personalities are "manufactured articles," and indicate rather the possible education of special centres for special ends than any fresh revelation of "transcending" consciousness. Once or twice in this book we seem to catch a tendency to meet popular explanations half-way (*e.g.*, p. 378), but there is proof enough that Mr. Podmore has a firm hold of positive psychology, and his fair-minded restatements of somewhat inflated doctrines are excellent instances of an investigator's patience. Although he seems to give too little to "veridicality" of coincidence, too little to mental venue, the submerged dream, the psychological context, dissociation of consciousness, the state of health and the "pathologic" element generally, yet he presents a residuum that will compel explanation, and that is at once the final justification of the Society he represents and of his elegantly narrated studies.

W. LESLIE MACKENZIE.

BRITISH EAST AFRICA.

Travels in the Coastlands of British East Africa and the Islands of Zanzibar and Pemba. By W. W. A. FitzGerald. Pp. xxiv + 774. Maps and illustrations. (London: Chapman and Hall, 1898.)

THIS handsome volume deals with a part of East Africa which, in spite of its apparent accessibility, has down to the present day remained surprisingly little known to the world at large. In the general rush to explore the more remote recesses of the African continent, many of the immediate coastlands have been left comparatively unheeded, and nowhere, perhaps, has this been more the case than in the northern districts of the British sphere along the East African coast. The present book, therefore, fills a decided blank in the literature of the continent.

Commissioned in 1891 by the late British East Africa Company to study the agricultural capabilities of the coastal zone falling within its sphere of operations, Mr. FitzGerald during the space of two years traversed that region in all directions, from Mombasa in the south to Port Durnford in the north, besides extending his inquiries to the two largest islands lying off the coast. He was thus able to gain an intimate acquaintance with the country, and the record of his experiences possesses a solid value, which fully atones for the slight delay noticeable in its presentation to the public. With the aid of the numerous illustrations, all of them reproductions of photographs, we gain a vivid idea of the characteristic features of the East African coastlands—their labyrinth of creeks and backwaters, their miles of waterless scrub, or groves of *Hyphæne* palms, perhaps the most typical tree of a large part of their area. In the more northern districts traversed, on the borders of the Galla territories south of the Jub River, Mr. FitzGerald was actually breaking new ground, and the result of his journeys has been to modify considerably our ideas of the general character of the country, by showing that the vegetation is in parts of the interior much more luxuriant than has been generally supposed. Throughout his residence in the country he was in close touch with the native inhabitants, for whom he shows a genuine liking, and of whose life and customs many interesting details are given.

It is, however, in the treatment of the agricultural capabilities of the country that the chief value of the book will be found to exist. During the whole of his travels, the author devoted his constant attention to this subject, so that the information collected was unusually varied and complete, and the picture presented of the various aspects of life in the African "shambas" (plantations) is full of interest. The general reader may, perhaps, find the mass of details on agricultural subjects hardly to his taste; but to all who require a trustworthy guide to the capabilities of British East Africa in such matters, the book will prove of sterling value. A special weight attaches to Mr. FitzGerald's views from his wide experience of agriculture as carried out in Southern India, and he has done good service in calling attention to what he considers the great possibilities which lie before British enterprise in this direction in the East African coastlands. Much of the country is, in his opinion, eminently adapted for the growth of cotton and coco-nuts, while other products, such as fibre-plants and india-rubber, would also repay attention. Much apposite information regarding all these, drawn from sources not widely accessible, is printed in the form of appendices.

In the second part of the book, Mr. FitzGerald enlarges upon his report, made to the Directors of the East Africa Company in 1892, on the agricultural capabilities of Zanzibar and Pemba Islands. He treats exhaustively of the clove cultivation there carried on, describing minutely the requirements of the clove tree, the present methods employed in its culture, and various improvements which should be introduced. He also treats of other products to which attention should be paid, in order that the prosperity of the islands may not depend, as it does at present, on one crop alone. In the case of Zanzibar the ground has, it is true, been already covered to some extent by Dr. Baumann's useful monograph, but it is valuable to have also a professed agriculturist's views on the subject, which the German traveller approached rather from the standpoint of a scientific geographer. A point of special interest at the present time, when the slavery question seems to await its final solution, is the discussion of the sources of labour supply, into which Mr. FitzGerald enters fully. He holds that the introduction of Indian coolies will afford the best hope of a satisfactory solution of the problem.

A useful feature in the book is the lavish supply of maps (compiled by Mr. Reeves, of the Royal Geographical Society), in which the whole of the author's routes can be followed, and which contain material not hitherto published. The index—also a point of special importance in a work intended, like the present, to be used for reference—is particularly full and well arranged.

OUR BOOK SHELF.

Notes on Observations. By Sydney Lupton, M.A. Pp. ix + 124. (London: Macmillan and Co., 1898.)

THE sub-title of this book describes the contents as "an outline of the methods used for determining the meaning and value of quantitative observations and experiments in physics and chemistry, and for reducing the results obtained." It is very important that students of science should be logical in their arguments and sound in their conclusions; and Mr. Lupton's concise description of the methods which must be followed before a scientific law or any general proposition can be established conduce to this end. The opening chapters of the book remind us of Huxley's inspiring little "Introductory" Science Primer. After these more or less metaphysical, but distinctly serviceable, statements as to ideas, premisses, and laws, come short chapters on units, averages, interpolation, the law of error, the method of least squares, the expression of results by graphical and by empirical methods, and many other subjects of interest to all who are engaged in quantitative physical and chemical experimentation. The treatment is but brief in most cases, and questions involving higher mathematics are not introduced. Sufficient is said, however, to show students how to apply to his own results the methods described; and for those who desire to go into the subjects more thoroughly, a list of references to standard works is appended to each chapter.

The book should find a place in the library of every physical and chemical laboratory, and all students of the laws and phenomena of nature should make themselves familiar with the principles described; for they will thereby learn the methods of sound reasoning, and be instructed in the art of computation for the purposes of science.

Prospecting for Minerals: a Practical Handbook for Prospectors, Explorers, Settlers, and all interested in the Opening-up and Development of New Lands. By S. Herbert Cox. Pp. xi + 239. With illustrations. (London: Charles Griffin and Co., Ltd., 1898.)

THIS little work forms the first volume of a new series of handbooks to be edited by Prof. Grenville Cole, and issued under the title of "The New Land Series." Although it can hardly be said that the title of the series is very happily chosen, it will be immediately admitted that the object of the series is distinctly good. The explorer or the settler in any new country needs, in most cases, some instruction as to the best means of discovering and developing its resources. Of all pioneers of civilisation, the mineral prospector is the most likely nowadays to lead the way; and the first volume of the series is, therefore, appropriately devoted to the subject of prospecting. The preparation of the work has been entrusted to Mr. Herbert Cox, a well-known mining engineer in London, who has in his day travelled widely and seen much of mines and minerals. Those who know the character of his professional work will feel no doubt as to his ability to lead the prospector in the way he should go; and an examination of the volume shows that its value is beyond dispute. Mr. Cox has furnished the prospector with a portable guide, which, while essentially practical, contains sufficient geology and mineralogy to explain the scientific principles on which the search for minerals should be based. The rough-and-ready prospector may probably think that the science is too much in evidence, and may grow impatient as he turns over pages about such things as "anhydrous silicates of lime and alumina and their crystallographic allies." But the explorer should clearly understand that, notwithstanding occasional accidents, the most trustworthy results in the search for minerals will, in the long run, be reached by that man who brings to bear upon his work the widest range of scientific knowledge.

The Process of Creation Discovered; or, the Self-evolution of the Earth and Universe by Natural Causes. By James Dunbar. Pp. viii + 290. (London: Watts and Co., 1898.)

To review this book would be to give prominence to a volume every page of which exemplifies the dangerous character of a little knowledge. We will merely remark that the author finds himself at variance with very many physical facts and theories, disbelieves the results of spectroscopic analysis applied to celestial bodies, and regards the solar photosphere as a deep ocean of water. According to his theory of inorganic evolution, "the only elements employed or necessary in the formation of the sun, solar system, and universe are those composing atmospheric air and water." Students of science may be left to form their own opinion upon a book containing an assertion of this kind.

Domestic Science Readers. Book vii. By Vincent T. Murché. Pp. 298. (London: Macmillan and Co., 1898.)

The subject of domestic economy is taught in the various standards of our elementary schools; and this book is adapted to supply girls in the highest standards with the information which the Education Department expects them to possess. The laws of health, infant management, common ailments and their remedies, common accidents, infectious diseases, and management of the sick-room are the subjects dealt with in the six parts of the book, and they are treated in a very clear and instructive manner. Mr. Murché knows how to interest the young readers for whom he writes, and this little school book will doubtless be as successful as the others of which he is the author. Moreover, the pupils who read the book will receive a large amount of sensible advice which will give them a sound understanding of the laws of health, and thus be of service to them and to future generations.

A Course in Mechanical Drawing. By John S. Reid. Pp. 128. (New York: John Wiley and Sons. London: Chapman and Hall, 1898.)

Teachers of the elements of mechanical drawing to students in marine, electrical, railway, and mechanical engineering will find that this book contains a concise statement of the essential principles of the subject. In the five chapters, the author deals with drawing instruments, geometrical drawing, or the use of the instruments, conventional methods of drawing used by draughtsmen, lettering and figuring, and orthographic projection. The author is instructor in mechanical drawing and designing in Sibley College, Cornell University, and his experience has enabled him to produce a useful work.

Flower Favourites, their Legends, Symbolism and Significance. By Lizzie Deas. Pp. viii + 229. (London: George Allen, 1898.)

Many pretty stories concerning common flowers have been collected from folk-lore and classic myths by the author, and are presented here in an attractive setting. The nursery traditions and love legends referring to flowers and flower-names are numerous and interesting enough, but very little attention is devoted to the subject of "plants and flowers in their widest relationships" referred to in the preface.

LETTER TO THE EDITOR.

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

Röntgen Rays and Ordinary Light.

I quite agree with the physical principles in Lord Rayleigh's article on "Röntgen Rays and Ordinary Light" in Nature of April 28, and think that the difference between us is one of terminology. I am accustomed to restrict the word wave to disturbances in which the harmonic character is well developed, and not to use it in physics in the sense in which it is used in the phrase "a wave of enthusiasm." It would never have occurred to me to speak of a disturbance localised in a thin shell as a wave of short wave-length. I should speak of it as a pulse, and though such pulses can of course be resolved by Fourier's theorem into trains of waves, yet it seems to me that when a simple pulse is so resolved (except for some special purpose), there is a loss of clearness both in expression and conception analogous to that which would occur if we regarded a straight line as an aggregate of harmonic curves.

The term pulse has the advantage that it suggests the fundamental property of the Röntgen rays, that their action on matter in their path is an *impulsive* action, *i.e.* that the time constant of the disturbance (the time taken by the pulse to pass over a point) is small compared with the time constant of the system in their path (the time of vibration of the molecules).

I am not aware that I have ever regarded these pulses as possessing any physical property which would be inconsistent with the physical properties of the constituents into which they can be resolved by Fourier's theorem. Personally I should expect that if a train of waves of wave-length λ were refracted, a pulse of thickness λ would be refracted too, and if the thickness of these pulses were of the order of the wave-length of ordinary light, that the Röntgen rays would be like ordinary light.

I believe the Röntgen rays to be pulses rather than waves of small wave-length, not because I think the properties of the latter would be different from those of Röntgen rays as far as we know them, but because electromagnetic theory shows that pulses, and not short waves, are produced by the impact of kathode rays. J. J. Thomson.

Cambridge, April 30.

SLEEP, AND THE THEORIES OF ITS CAUSE.

The theory of the origin of sleep which has gained the widest credence is the one that attributes it to anæmia of the brain. It has been shown by Mosso, and many others, that in men with defects of the cranial wall the volume of the brain decreases during sleep. At the same time, the volume of any limb increases as the peripheral parts of the body become turgid with blood. In dogs, the brain has been exposed, and the cortex of that organ has been observed to become anæmic during sleep. It is a matter of ordinary observation that in infants, during sleep, the volume of the brain becomes less, since the fontanelle is found to sink in. It has been supposed, but without sufficient evidence to justify the supposition, that this anæmia of the brain is the cause and not the sequence of sleep. The idea behind this supposition has been that, as the day draws to an end, the circulatory mechanism becomes fatigued, the vasomotor centre exhausted, the tone of the blood vessels deficient, and the energy of the heart diminished, and thus is the circulation to the cerebral arteries lessened. By means of a simple and accurate instrument (the Hill-Barnard sphygmometer), with which the pressure in the arteries of man can be easily reckoned, it has been recently determined that the arterial pressure falls just as greatly during bodily rest as during sleep. The ordinary pressure of the blood in the arteries of young and healthy men averages 110–120 mm. of mercury. In sleep, the pressure may sink to 95–100 mm.; but if the pressure be taken of the same subject lying in bed, and quietly engaged on mental work, it will be found to be no higher. By mental strain or muscular effort, the pressure is, however, immediately raised, and may then reach 130-140 mm. of mercury. It can be seen from considering these facts that the fall of pressure is concomitant with rest, rather than with sleep. As, moreover, it has been determined on strong evidence that the cerebral vessels are not supplied with vasomotor nerves, and that the cerebral circulation passively follows every change in the arterial pressure, it becomes evident that sleep cannot be occasioned by any active change in the cerebral vessels. This conclusion is borne out by the fact that to produce in the dog a condition of coma like to sleep, it is necessary to reduce, by a very great amount, the cerebral circulation. Thus, both carotids and both vertebral arteries can be frequently tied at one and the same time without either producing coma or any very marked symptoms. The circulation is, in such a case, maintained through other channels, such as branches from the superior intercostal arteries which enter the anterior spinal artery. While total anæmia of the brain instantaneously abolishes consciousness, partial anæmia is found to raise the excitability of the cortex cerebri By estimation of the exchange of gases in the blood which enters and leaves the brain, it has been shown that the consumption of oxygen and the production of carbonic acid in that organ is not large. Further, it may be noted that the condition of anæsthesia is not in all cases associated with cerebral anæmia. Thus, while during chloroform anæsthesia the arterial pressure markedly falls. Such is not the case during anæsthesia produced by ether or a mixture of nitrous oxide and oxygen.

The arterial pressure of man is not lowered by the ordinary fatigue of daily life. It is only in extreme states of exhaustion that the pressure may be found decreased when the subject is in the standing position. The fall of pressure which does occur during rest or sleep is mainly occasioned by the diminished rate of the heart. The increase in the volume of the limbs is to be ascribed to the cessation of muscular movement, and to the diminution in the amplitude of respiration. The duty of the heart is to deliver the blood to the capilliaries. From the veins the blood is, for the most part, returned to the heart by the compressive action of the muscles, the constant change of posture and by the respiration acting both as a force and suction pump. All of these factors are at their maximum during bodily activity, and at their minimum during rest. On exciting a sleeper by calling his name, or in any way disturbing him, the limbs, it has been recorded, decrease in volume while the brain expands. This is so because the respiration changes in depth, the heart quickens, the muscles alter in tone, as the subject stirs in his sleep in reflex response to external stimuli. Considering all these facts, we must regard the fall of arterial pressure, the depression of the fontanelle, and the turgescence of the vessels of the limbs as phenomena concomitant with bodily rest and warmth, and we have no more right to assign the causation of sleep to cerebral anæmia than to any other alteration in the functions of the body, such as occur during sleep.

We may well here summarise these other changes in function.

(1) The respiratory movement becomes shallow and thoracic in type.

(2) The volume of the air inspired per minute is lessened by one-half to two-thirds.

(3) The output of carbonic acid is diminished by the same amount.

(4) The bodily temperature falls.

(5) The acidity of the cortex of the brain disappears.

(6) Reflex action persists; the knee jerk is diminished, pointing to relaxation in tone of the muscles; consciousness is suspended.

Analysing more closely the conditions of the central nervous system, it becomes evident that, in sleep, consciousness alone is in abeyance. The nerves and the special senses continue to transmit impulses, and to produce reflex movements. If a blanket, sufficiently heavy to impede respiration, be placed upon the face of a sleeping person, we know that it will be immediately pushed away. More than this, complicated movements can be carried out: the postillion can sleep on horseback; the punkah-wallah may work his punkah, and at the same time enjoy a slumber; a weary mother may sleep, and yet automatically rock her infant's cradle. Turning to the histories of sleep-walkers, we find it recorded that, during sleep, they perform such feats as climbing slanting roofs, or walking across dangerous narrow ledges and bridges. The writer knew of the case of a lad, who, when locked into his room at night to prevent his wandering in his sleep, climbed a partition eight to ten feet in height which separated his sleeping compartment from the next, and this without waking.

The brain can carry out not only such complicated acts as these, but it has been found to maintain during sleep its normal inhibitory control over the lower reflex centres in the spinal cord.

Thus, in sleeping dogs, after the spinal cord has been divided in the dorsal region, reflexes can be more easily evoked from the lumbar than from the cervical cord, because the former is freed from the inhibitory control of the brain.

The strength of stimulus necessary to pass the threshold of consciousness, and to produce an awakening, has been measured in various ways. It has been determined that it takes a louder and louder sound, or a stronger and stronger electric shock to arouse a sleeper during the first two or three hours of slumber; after that period, the sleep becomes lighter, and the required stimulus need be much less.

The alternative theories, which have been suggested to account for the onset of sleep, may be classed as chemical and histological.

In relation to the first, it has been suggested that if consciousness be regarded as dependent upon a certain rate of atomic vibration, it is possible that this rate depends on a store of intramolecular oxygen, which, owing to fatigue, may become exhausted; or it may be supposed that alkaloidal substances may collect as fatigue products within the brain, and choke the activity of that organ. Against this theory may be submitted the facts that monotony of stimulus will produce sleep in an unfatigued person, that over-fatigue, either mental or bodily, will hinder the onset of sleep, that the cessation of external stimuli by itself produces sleep. As an example of this last, may be quoted the case recorded by Strumpel of a patient who was completely anæsthetic save for one eye and one ear, and who fell asleep when these were closed. Moreover, many men possess the power, by an effort of will, of withdrawing from objective or subjective stimuli, and of thus inducing sleep.

The histological theories of sleep are founded on recent extraordinary advances in the knowledge of the minute anatomy of the central nervous system, a knowledge founded on the Golgi and methylene-blue methods of staining. It is held possible that the dendrites or branching processes of nerve cells are contractile, and that they, by pulling themselves apart, break the association pathways which are formed by the interlacing or synapses of the dendrites in the brain. Ramon y Cajal, on the other hand, believes that the neuroglia cells are contractile, and may expand so as to interpose their branches as insulating material between the synapses formed by the dendrites of the nerve cells. The difficulty of accepting these theories is that nobody can locate consciousness to any particular group of nerve-cells. Moreover, the anatomical evidence of such changes taking place is at present of the flimsiest character.

If these theories be true, what, it may be asked, is the agency that causes the dendrites to contract or the neuroglia cells to expand? Is there really a soul sitting aloof in the pineal gland, as Descartes held? When a man like Lord Brougham can at any moment shut himself away from the outer world and fall asleep, does his soul break the dendritic contacts between cell and cell; and when he awakes, does it make contacts and switch the impulses evoked by sense stimuli on to one or other tract of the axons, or axis cylinder processes, which form the association pathways? Such an hypothesis is no explanation: it simply puts back the whole question a step further, and leaves it wrapped in mystery. It cannot be fatigue that produces the hypothetical interruptions of the dendritic synapses and then induces sleep, for sleep can follow after fatigue of a very limited kind. A man may sleep equally well after a day spent in scientific research, as after one spent in mountain-climbing, or after another passed in idling by the sea-shore. He may spend a whole day engaged in mathematical calculation, or in painting a landscape. He fatigues—if we admit the localisation of function to definite parts of the brain—but one set of association tracts, but one group of cells, and yet, when he falls asleep, consciousness is not partially, but totally suspended.

We must admit that the withdrawal of stimuli, or their monotonous repetition, are factors which do undoubtedly stand out as primary causes of sleep. We may suppose, if we like, that consciousness depends upon a certain rate of vibration which takes place in the brain structure. This vibration is maintained by the stimuli of the present, which awaken memories of former stimuli, and are themselves at the same time modified by these. By each impulse streaming into the brain from the sense organs, we can imagine the structure of the cerebral cortex to be more or less permanently altered. The impulses of the present, as they sweep through the association pathways, arouse memories of the past; but in what way this is brought about is outside the range of explanation. Perhaps an impulse vibrating at a certain rate may arouse cells or fibrils tuned by past stimuli to respond to this particular rate of vibration. Thus may be evoked a chain of memories, while by an impulse of a different rate, quite another set of memories may be started. Tracts of association are probably formed in definite lines through the nervous system, as during the life of a child repeated waves of sense-impulses beat against and overcome resistances, and make smooth pathways here and there through the brain structure. Thus may be produced growth of axons in certain directions, and synapses of this cell with that. If the same stimulus be often repeated, the synapses between groups of cells may become permanent. A memory, a definite line of action which is manifested by a certain muscular response, may thus become structurally fixed. If the stimulus be not repeated, the synapses may be but temporary, and the memory fade as the group of cells is occupied by a new memory of some more potent sense stimulus. Many association tracts and synapses are laid down in the central nervous system when the child is born. These are the fruits of inheritance, and by their means, we may suppose, instinctive reflex actions are carried out.

So long as the present stimuli are controlled by past memories and are active in recalling them, so long does consciousness exist, and the higher will be the consciousness the greater the number and the more intense the character of the memories aroused. We may suppose that when all external stimuli are withdrawn, or the brain soothed by monotony of gentle repetition, and when the body is placed at rest, and the viscera are normal and give rise to no disturbing sensations, consciousness is then suspended, and natural sleep ensues. Either local fatigue of the muscles, or of the heart, or ennui, or exhaustion of some brain centre usually leads us to seek those conditions in which sleep comes. The whole organism may sleep for the sake of the part. To avoid sleeplessness, we seek monotony of stimulus either objective or subjective. In the latter case, we dwell on some monotonous memory picture, such as sheep passing one by one through a gap in the hedge. To obtain our object, we dismiss painful or exciting thoughts, keep the viscera in health, so that they may not force themselves upon our attention, and render the sense-organs quiet by seeking darkness, silence and warmth. L. H.

A PROPOSED REVOLUTION IN NAUTICAL ASTRONOMY.

DURING the last two years a movement has been set on foot, which seems likely to be attended by somewhat important results in the simplification of the formulæ of astronomical navigation for every-day use. Any one who has looked even cursorily into a text-book of navigation of the Raper type, can hardly fail to have been impressed by the multiplicity and variety of the precepts, and can easily understand how complicated the various rules must appear to the unlearned men, upon whom, for the most part, the daily routine of practical navigation at sea must devolve.

And the difficulty of comprehending and putting into practice the various rules, is undoubtedly increased by the fact that at one time or another all the trigonometrical functions of an angle are brought into play. Sines, cosines, tangents, cotangents, secants and cosecants, versed sines and half-versed sines, all make their appearance, adding to the bewilderment of the unskilled computer, and introducing the liability to take a required function from a wrong column as a very frequent source of error.

Nautical astronomy, for the most part, may be regarded as simply a practical application of the formulæ employed in the solution of spherical triangles, so that the object to be attained by those who would simplify the various problems, is to devise a system of formulæ in logarithmic shape, which, without materially adding to the amount of arithmetic employed, should introduce but one function of an angle throughout, such as the sine, the cosine, or the tangent. In the verbal precepts, into which, for the benefit of those possessing no knowledge of mathematics, the formulæ have to be translated, the simple word "logarithm" would then take the place of "log sine," "log cosine," &c., and a single table of a few thousand logarithms would do the work formerly effected by the aid of a large collection of different tables.

To M. E. Guyou, an officer of the French navy, belongs the credit of having first devised such a system. As far back as the year 1885 he published in a small pamphlet entitled "Tables de Poche," methods of finding hour angle and azimuth of a heavenly body by means of a single table of logarithms. During the next ten years he employed himself in further researches, and early in 1896 there appeared in connection with the "Annales Hydrographiques," published periodically by the Hydrographic Department of the French navy, a more exhaustive account of his methods, with a special arrangement of the required table, intended to enable his processes to be more easily and effectively carried out.[1]

The particular table employed by M. Guyou does not give logarithms for one of the ordinary functions of the

[1] "Les problèmes de Navigation et la Carte Marine. Types de calcul et tables complètes." Par M. le capitaine de frégate E. Guyou, Membre de l'Académie des Sciences. (Paris: Imprimerie Nationale, 1895.)

angle, but is a table which is made use of daily in the calculations which belong to Mercator sailing, and which is consequently to be found in every collection of nautical tables. It is known as the table of "meridional parts," or, as the French call it, "*latitudes croissantes*." The meridional parts for a given latitude are defined by some writers as "the value in minutes of a great circle of the line on the Mercator's chart, into which the true difference of latitude is expanded."

For a given latitude l the meridional parts represent the sum of the series

$$\sec 0' + \sec 1' + \sec 2' + \sec 3' + \ldots + \sec (l^{\circ} - 1')$$

which is found by the integral calculus to be

$$r \log_e \tan \left(45^{\circ} + \frac{l}{2}\right)$$

or

$$\frac{10800}{\pi} \log_e \tan \left(45^{\circ} + \frac{l}{2}\right)$$

when r is expressed in minutes.

In the table of meridional parts we have then a series of logarithms to the base $e^{\frac{\pi}{10800}}$, which has been found to lend itself in a remarkable manner to the purpose which we have in view.

It should be mentioned here that M. Guyou's general method is to deduce his formulæ from a study of the properties of the curves of equal altitude on a Mercator's chart. To other writers, especially in Italy, where considerable attention has been bestowed upon the new formulæ, it has appeared more satisfactory, while accepting the expressions, to deduce them directly from fundamental trigonometrical formulæ.

Shortly before the issue of M. Guyou's second work there was published, in the numbers of the *Nautical Magazine* for November and December 1895, a system of formulæ, for the solution of all the ordinary problems of nautical astronomy, by the aid of this table of meridional parts alone, the general principle adopted being to break up the spherical triangle, or "triangle of position," as it is generally called in nautical astronomy, into two right-angled triangles, and thus obtain expressions which, containing three terms only, would be more manageable than the general formulæ involving four terms.

This treatment of the subject was based upon certain easily established lemmas, the most important of which may be thus stated. (The abbreviation MP will be adopted for meridional parts throughout.)

$$\mathrm{MP}(180^{\circ} - \theta) = \mathrm{MP}(\theta) \quad \ldots\ldots \quad (1)$$

$$\mathrm{MP}(-\theta) = -\mathrm{MP}(\theta) \quad \ldots\ldots\ldots \quad (2)$$

If

$$\tan x = \sin \theta,$$

then will

$$\mathrm{MP}(2x) = 2\mathrm{MP}(\theta) \quad \ldots\ldots\ldots \quad (3)$$

If

$$\tan a = \tan b \tan c \ldots$$

then will

$$\mathrm{MP}(2a - 90^{\circ}) = \mathrm{MP}(2b - 90^{\circ}) + \mathrm{MP}(2c - 90^{\circ}) \quad . \quad (4)$$

With regard to (1) it may be stated that from the form of the expression

$$\mathrm{MP \ for \ lat} \ l^{\circ} = r \log e \tan \left(45^{\circ} + \frac{l^{\circ}}{2}\right),$$

the meridional parts in the first instance have reference to angles in the first quadrant only. The lemma enables us to pass to angles in the second quadrant.

Similarly by lemma (2) we can introduce negative angles also.

The result involved in (3) is exceedingly important, for it follows from this that if we have a logarithmic formula connecting the sines and cosines of parts of a spherical triangle, we may pass by means of auxiliary angles to other logarithmic formulæ, involving only the meridional parts of the angles employed, and that not only for right-angled and quadrantal triangles, as in the *Nautical Magazine*, but for any spherical triangle whatever.

As an example we may take one of the family of formulæ which express a function of an angle of a spherical triangle in terms of functions of the sides, supposed known. These expressions are perhaps, from a navigator's point of view, the most important which spherical trigonometry presents; for in the problem of finding the hour angle of a body, and thence the longitude of the place, such a formula may have to be brought into requisition on board a fast steam-ship as many as four or five times in the course of twenty-four hours. And while many of the problems of navigation may be, to some extent, "dodged" or evaded by the use of some of the many tables which ingenious persons have devised, there is no getting away from the hour-angle problem, because in that case the necessary degree of accuracy is more minute than any table of reasonable size could be expected to afford, unless we are content to spend more time and trouble in interpolating for variations in the values of the elements from the arguments given in the tables, than would suffice for the actual calculation by logarithms.

Let us assume that in the spherical triangle A B C we have to deal with the expression

$$\tan \frac{A}{2} = \sqrt{\frac{\sin (s - b) \sin (s - c)}{\sin s \sin (s - a)}}.$$

Assume that

$$\sin (s - b) = \tan x \qquad \sin s = \tan w,$$
$$\sin (s - c) = \tan y \qquad \sin (s - a) = \tan z.$$

So that

$$\tan \frac{A}{2} = \sqrt{\frac{\tan x \tan y}{\tan w \tan z}}.$$

By lemma (3) we have

$$\mathrm{MP}(2x) = 2\mathrm{MP}(s\text{-}b),$$

and so on for y, w, z; a system of equations which will determine $2x$, $2y$, $2w$, $2z$.

Then by lemma (4)

$$\mathrm{MP}(A - 90^{\circ}) = \tfrac{1}{2}\{\mathrm{MP}(2x - 90^{\circ}) + \mathrm{MP}(2y - 90^{\circ}) - \mathrm{MP}(2w - 90^{\circ}) - \mathrm{MP}(2z - 90^{\circ})\},$$

whence A is readily determined.

The formula here established is only given as an illustration of the ease with which by the aid of lemma (3) we may pass from a sine or cosine formula to one involving meridional parts only by the simplest possible transformations.

The processes deduced by M. Guyou from the curves of altitude upon the Mercator's chart are probably somewhat shorter, and more likely, therefore, to be adopted for general use. His methods of procedure however, although, as has been well said of them by an Italian critic, "of high scientific interest for their originality and rigorous analysis," may be found somewhat subtle and difficult to follow by any but expert mathematicians. At all events, although, as has been said, the Guyou formulæ were received in Italy with much favour, mathematicians in that country lost no time in setting to work to establish them upon a basis purely trigonometrical.

An interesting article in the *Rivista Marittima* (Rome) for January 1897, by Signor P. L. Cattolica, "Capitano di corvetta," gives a summary of the work done in 1896 by Signor Molfino and other writers, whence it appears that the principal Guyou formulæ may be deduced with little difficulty from the well-known Napier's analogies as follows.

Let us suppose, as before, that in a spherical triangle the three sides a, b, c being given, it is required to determine the angles A, B.

We have

$$\tan\frac{a+b}{2} = \frac{\cos\frac{A-B}{2}\tan\frac{c}{2}}{\cos\frac{A+B}{2}}$$

$$= \frac{\cos\frac{A}{2}\cos\frac{B}{2} + \sin\frac{A}{2}\sin\frac{B}{2}}{\cos\frac{A}{2}\cos\frac{B}{2} - \sin\frac{A}{2}\sin\frac{B}{2}}\tan\frac{c}{2}$$

$$= \frac{1 + \tan\frac{A}{2}\tan\frac{B}{2}}{1 - \tan\frac{A}{2}\tan\frac{B}{2}}\tan\frac{c}{2}.$$

Let

$$\tan\frac{A}{2}\tan\frac{B}{2} = \tan\frac{x}{2} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

Then

$$\tan\frac{a+b}{2} = \frac{1+\tan\frac{x}{2}}{1-\tan\frac{x}{2}}\tan\frac{c}{2} = \tan\left(45^\circ + \frac{x}{2}\right)\tan\frac{c}{2}.$$

Whence

$$\text{MP}(x) = \text{MP}(90^\circ - c) - \text{MP}(90^\circ - \overline{a+b}) \quad . \; . \quad (2)$$

An equation which determines x.

While from equation (1) it may be deduced that

$$\text{MP}(90^\circ - \text{A}) + \text{MP}(90^\circ - \text{B}) = \text{MP}(90^\circ - x) \quad . \quad (3)$$

Proceeding in the same manner to expand

$$\sin\frac{A+B}{2},\ \sin\frac{A-B}{2}$$

in the expression

$$\tan\frac{a-b}{2} = \frac{\sin\frac{A-B}{2}}{\sin\frac{A+B}{2}}\tan\frac{c}{2},$$

and assuming that

$$\tan\frac{B}{2}\cot\frac{A}{2} = \tan\frac{y}{2} \quad . \; . \; . \; . \; . \; . \; . \quad (4)$$

we arrive at the equations

$$\text{MP}(y) = \text{MP}(90^\circ - \overline{a-b}) - \text{MP}(90^\circ - c) \quad . \; . \quad (5)$$

$$\text{MP}(90^\circ - \text{B}) - \text{MP}(90^\circ - \text{A}) = \text{MP}(90^\circ - y) \quad . \quad (6)$$

By adding and subtracting each side of the two equations (3) and (6), we obtain equations which will enable us to determine the values of A and B respectively.

In place of the notation "MP," M. Guyou adopts the Greek letter λ (lambda). Thus, meridional parts for an angle $\theta = \lambda(\theta)$.

He also indicates the meridional parts of the complement of an angle by the symbol Co-λ, so that meridional parts for the angle $(90^\circ - \theta) = \text{Co-}\lambda(\theta)$.

And in his excellent collection of tables the values of λ and Co-λ are given for each angle side by side, an arrangement which much facilitates the work of computation.

The ordinary employment of Napier's analogies in practical work is limited to finding the remaining two sides when two angles and the included side are given, or to finding the remaining angles when two sides and the included angle are known. It is a somewhat remarkable extension of their functions to find that they suffice also to furnish satisfactory logarithmic formulæ for solving a triangle where the three sides are the given parts. In a similar manner formulæ may be found which will determine the sides when the three angles are given, so that formulæ of the type which gives $\tan\frac{A}{2}$ in terms of functions of the sides, or $\tan\frac{a}{2}$ in terms of functions of the angles may be dispensed with altogether.

It would be premature at present to hazard a conjecture as to whether the new processes will come into general use in England. In these matters we move slowly. The British mariner does not easily surrender the methods upon which he has been brought up, the practice of which becomes almost automatic with him, and he looks with feelings of doubt, tempered with suspicion, upon any novelties that may be brought to his notice. But some advantages, at least, of a system of rules involving the use of only one table of logarithms must be obvious to all. In the first place, as has been already mentioned, we have that of the greater simplicity in the statement of rules, and the diminished risk of error through the taking out of a logarithm from a wrong column. But even more important than these is the saving of time lost at present in turning over the leaves of tables in hunting for sines and cosines in different parts of a somewhat bulky book. In the table of meridional parts we have but 5400 logarithms, occupying some nine pages of Inman's collection, not more than might be printed on a sheet of cardboard of moderate size, so as to save the turning over of leaves altogether.

These logarithms furnish results correct to the nearest minute of arc, which is the usual limit of accuracy aimed at by the practical navigator.

As the case stands at present, the new system is well thought of in France; it has excited considerable attention in Italy, and has won the approbation of at least one distinguished authority in Spain; so that, perhaps, M. Guyou is not over-sanguine in his expectation that "the table of meridional parts is destined to become sooner or later the universal instrument of computation amongst mariners."

H. B. G.

THE NEW PHYSICAL RESEARCH LABORATORY AT THE SORBONNE.

AN interesting account of the new physical laboratory at the Sorbonne recently appeared in *La Nature.*

This laboratory, originally situated in the old Sorbonne, was founded in 1868 by M. Jamin, who was its director until his death in 1886. In 1894 it was transferred to the new Faculty of Sciences, and was reconstructed by the architect M. Nénot. At the present time M. Lippmann, member of the Institute, is the director. Although this change took place in 1894, the work has only recently been carried on in the usual manner.

The new buildings are surrounded by other buildings connected with the Sorbonne, and are therefore away from any disturbances caused by passing vehicles. On the ground floor, after passing an entrance hall with a cloak-room, there is a large room (Fig. 1) two stories high, and measuring 16 metres (about 52 feet) long by 12 metres broad (about 39 feet). Six physicists can work here, provided their work does not require any special conditions with regard to light and isolation. In the middle of the room, and at the corners there are solid stone pillars isolated from the floor; a "comparateur" is attached to the one in the middle. Each of the six places has four jets of gas, two incandescent lamps, one arc lamp, and a water-tap. About two yards above each table there is a joist, thus making it possible to suspend apparatus if necessary; the tables themselves are of slate.

Next to this large room is the sub-director's room and laboratory; then we come to a small chemical laboratory, and finally the machine-room. The latter is built over a vault, and contains two Lenoir gas machines of 16 horse-power each, three dynamos, and a large switch-board, which makes it possible to distribute the current for various uses in the laboratory, such as illumination, experiments and accumulators. Above this room, and accessible by a staircase from it, is the mechanical workshop, well equipped with apparatus and under the direction of two mechanics and an electrician. All the machines are worked by electricity. On the same floor there is an open terrace for the accumulators, which include a battery of the Tudor system used for illuminating purposes (60 elements), and another battery, of the Peyrusson system (80 elements), for experiments. Facing the workshop is a large hall, used as a laboratory by the assistants. This is connected with the workshop by a gallery, which is at present given up to experiments on electric waves. Next to this laboratory there is a terrace and a photographic room, and in the large entrance hall on the first floor are M. Lippmann's private room and laboratory. The latter is divided into three parts, a light and a dark room, and another room for optical researches, with optical benches of slate. The ore-dresser occupies the last room on this floor.

A tower 40 metres (nearly 131 feet) high contains the general staircase, and also leads to the extensions of the upper stories. This tower extends 18 metres (59 feet) in the ground, by which means a long vertical range is procured, and experiments in height can be made. The extensions of the upper floors referred to consist of a large hall, two stories high, comprising the library and laboratory of the sub-director, M. G. Maneuvrier, whose room adjoins it; the next floor has a dark room for optical researches. Lastly, on the third floor are three small rooms for private students. It may also be added that this tower connects the different parts of the laboratory with the physical amphitheatre, and with the collections of apparatus for the various courses. Under the large hall on the ground floor there are three cellars completely fitted up as laboratories, and a Gauss magnetometer mounted on solid stone pillars. On the ground floor there is a dark room isolated by three stone pillars, and used for electrical measurements and measurements of precision.

It will thus be seen that the laboratory is very complete in itself; but the money allowed for its maintenance (12,000 francs) is quite insufficient, when the general expenses, experiments, and course of lectures are taken into consideration. Nevertheless, the work of the students who have been through the laboratory is a proof of the thoroughness of the instruction. MM. Bouty, Pellat, Foussereau and Leduc (professors of physics at the Sorbonne) all studied at this laboratory, and qualified for their doctor's degrees in it. Several well-known Roumanians and Russians studied there also, and M. Benoît, director of the Bureau of Weights and Measures of Sèvres, wrote his thesis under Jamin. The laboratory has, indeed, become celebrated by M. Lippmann's own work, for it has all been done there, from the investigations on the electro-capillary phenomena to the wonderful discovery of colour photography. It is, therefore, to be hoped that the additional funds required will be forthcoming, and that the enlarged Institute may be even more successful than the old one.

We are indebted to the editor of *La Nature* for the accompanying illustration of the laboratory

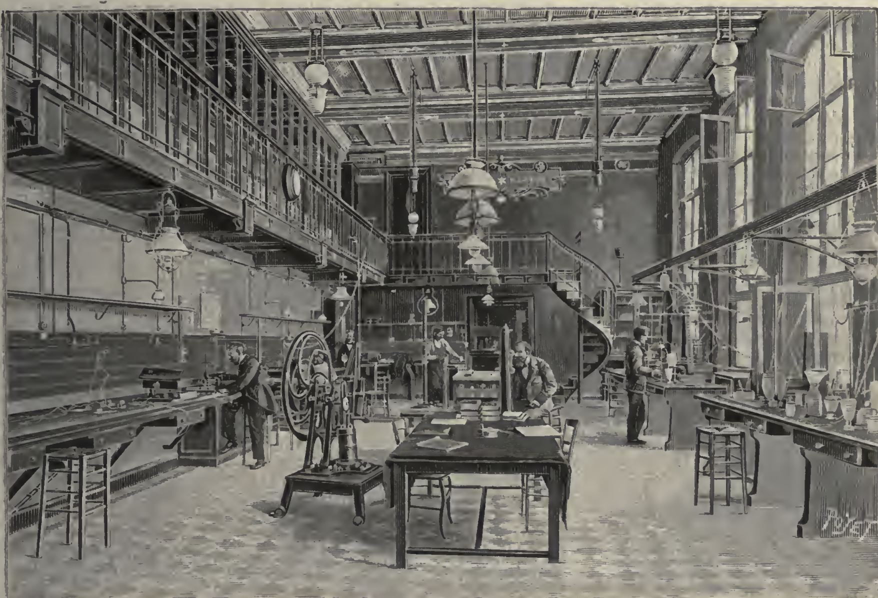

FIG. 1.—New Physical Research Laboratory at the Sorbonne.

PHOTOGRAPHY AT THE CRYSTAL PALACE.

PHOTOGRAPHY as a practical art of interest to others than a few investigators dates from 1839, when the Daguerreotype was introduced. Its development and applications were well illustrated at the Great Exhibition of 1851, but since that time there have been very few attempts, and none altogether successful, to show its further progress. The Royal Photographic Society has held more than forty annual exhibitions, but as each of these has dealt with its current year only, the Council of the Society considered it desirable to arrange an exhibition that should demonstrate, not only the last year's advances, but the present position of photography and its applications as well as the history of its development.

The exhibition that was opened last week by the Prince of Wales is the result of the Society's endeavours. It must be regarded as eminently satisfactory, for it is not possible to call to mind many individuals or firms intimately connected with photography that have not contributed characteristic and interesting exhibits. The large areas of the north and south naves of the Crystal Palace, and of many of the courts, are well filled. The catalogue, which is published by the Society, will form an important historical work of reference, because of the numerous descriptive notes, references to original literature, dates, and examples of work that it contains. It is particularly fortunate that such an exhibition as this should have been inaugurated now rather than ten or twenty years later, as those of the older generation who are best able to speak of some of the older processes that are obsolete, and the introduction of the methods of to-day, are fast disappearing from our midst. There are, for example, but few left who are skilled enough in the Daguerreotype process to work it with a fair average of certainty, but Messrs. Negretti and Zambra have arranged a studio for taking Daguerreotypes of any who may desire it while the exhibition remains open. This is an opportunity that in all probability will never occur again.

The exhibition is divided into seven sections, namely: (1) the historical collection, (2) pictorial photography, (3) apparatus and material, (4) scientific and industrial applications, (5) photography in colours, (6) photography as a science, and (7) general technical photography. The Society's collection of portraits of eminent workers in connection with photography has been largely reinforced by loans from private individuals, and the series includes the elder and the younger Niepce, Fox Talbot, five of Daguerre, Andrew Ross, Sir David Brewster, Baron Pollock, Sir John Herschell, Mungo Ponton, W. B. Woodbury, F. von Vöigtlander, Dr. Draper, and many others; and in the catalogue there is a short biographical notice of each. Among the works of the elder Niepce there are exhibited the first camera photograph, taken in 1824, and some of the specimens that he submitted to the Royal Society in 1827. The Daguerreotype process is well represented. Daguerre's history and description of the process, dated 1839, and a translation of it into English published in the same year, are on view. The collection of Daguerreotypes and apparatus for producing them dates from 1842. Fox Talbot's callotype process, which was also made public in 1839, is even better represented; but space forbids further reference to these, and the various collodion and gelatine processes. The first methods and the developments of carbon printing are fully illustrated, including the gum-bichromate process, which, after being nearly forgotten, has lately been reintroduced and extolled.

After the examples of early work in the production of photo-etched plates and photo-typographic blocks, there follows the optical section. This is certainly the most complete collection of lenses ever got together. Examples of nearly ninety different kinds are shown, ranging from the early form of single lens by Chevalier and the first lens made in England for portraiture (in 1841, by Andrew Ross) to the stigmatics of Dallmeyer and Zeiss' planars. Sectional drawings of nearly fifty different kinds of lenses are given in the catalogue, and also a print from a photograph taken for the purpose with Sutton's panoramic water lens and his camera carrying curved plates.

Passing a very fine loan collection of photographs, which includes many examples by deceased workers, particularly Mrs. Cameron, D. O. Hill, O. G. Rejlander, B. B. Turner, and Colonel Stuart Wortley, and also the whole section of present-day apparatus and materials for photographic and photo-mechanical processes, there follows the section of the scientific and industrial applications of photography. The importance of photographic methods of observation was never more fully realised than it is at present. From almost the earliest days of photography the "recording science" has been applied in scientific investigations with the result not only of greater accuracy, but of the discovery of many facts that could never have been known by the use of the eye alone. Astronomy was one of the first of the sciences to derive benefit from photography; and in the delineation of the forms and features of celestial bodies, as well as in the spectroscopic analysis of their constitution, photographic processes have now almost entirely replaced the old method of drawing by hand what it was thought the eye could see. In many other domains of science photography is daily becoming more important, and it must continue to do so, especially as the scientific investigation of photography itself progresses. This important and universal method of work does not yet receive the attention and encouragement that it deserves in our teaching colleges; but this is due doubtless to the fact that, although it has done so much, it is still in its infancy so far as years are concerned. At the next exhibition of this kind there will without doubt be a far richer harvest of results to show, though this section, as it is here represented, well indicates not merely the directions in which future work is possible, but the very fine results that have already been accomplished, some of which it is difficult to believe can ever be surpassed. The Royal Observatory, Greenwich, contributes many exhibits, including some 12 × 10 prints of photographs of the recent solar eclipse, taken with the Thompson coronograph. Numerous other astronomical photographs are shown by the Royal Astronomical Society, Colonel Waterhouse, Dr. Common and Dr. Gill. Messrs. R. and J. Beck show twelve of De La Rue's original negatives of the moon. Photography as applied to spectroscopy, geology (including forty-one specimens from the B.A. Geological Photographs Committee), meteorology, zoology, botany, and Röntgen-ray work is well illustrated. In connection with the last, six large stereoscopic "skiagrams," by Dr. Mackenzie Davidson, mounted in reflecting stereoscopes, are strikingly good. The Kew Observatory Committee of the Royal Society sends photographs of various photographic recording apparatus, lens-testing apparatus, and other examples.

The section illustrating military photographs is of especial interest just now. The examples date from the Crimean war, and include balloon apparatus and photographs, the pigeon-post film used in the siege of Paris in 1871, and various examples from the School of Military Engineering at Chatham. But probably what will strike photographers as the most wonderful exhibits in this section is the telephotographic work contributed by the Italian Minister of War. The magnifications are far greater than we have been accustomed to, ranging up to one hundred diameters. Photo-micrography forms a large section, and includes a "complete photo-micrographic apparatus" by Zeiss, an apparatus that would probably be regarded as an extreme luxury by most microscopists.

Photography in colours, by all the current methods, is well illustrated, many examples being of historic interest. G. Lippmann, A. Lumière, L. Vidal and H. W. Vogel and several English exhibitors contribute to this section.

"Photography as a science" refers apparently to what might be called *pure* photography to distinguish it from *applied*. But the distinction is neither clear nor precise. This section includes apparatus for measuring the densities of photographs, including opacities and blacknesses, by Captain Abney, Hurter and Driffield, and Chapman Jones; besides sensitometers, actinometers, and similar apparatus. Many results of the various treatments of photographic plates are shown, such as the sensitising for various colours, and the getting of an image free from stain, &c., that it may be of definite opacity. E. Sanger Shepherd shows an ingenious form of slit for spectroscopes, that is stated to be specially suitable for photographic use.

The National Photographic Record Association, that has recently become established through the energy of Sir Benjamin Stone, is well represented. Sir Benjamin himself contributes twenty-one photographs relating to the Houses of Parliament, every one of which is of general interest. There are numerous other examples of technical work to which we cannot refer in even the most general terms, except to a case exhibited by the Bolt Court Technical School of the London County Council Technical Educational Board, which illustrates the working of some of the most important photomechanical processes arranged for educational purposes.

While there are some exhibits that claim attention because of their novelty, these are the exception; the chief interest centres round the old rather than the new, and the complete presentation of the capabilities of photography in its numerous applications at the present day. But those whose knowledge of photography is of the general kind, and those who have not followed up its developments during the last few years, will find more that is new, of both examples and processes, than they will be able to appreciate in a single visit. Such an exhibition has never before been organised, and it must obviously be impossible to arrange another of similar extent until after the lapse of several years. The exhibition will close on May 14.

MICRO-BIOLOGY AS APPLIED TO HYGIENE.

AT the Congress of Hygiene and Demography recently held at Madrid, many matters of scientific interest and importance were introduced and discussed. Unfortunately the papers were not printed and distributed among the members, and as the majority were read in Spanish, the discussions were curtailed. The Section of Micro-biology as applied to Hygiene attracted the largest share of attention. Among the more important contributions was that of Dr. Behring, who announced that, as the result of experimental work with the toxin and antitoxin of tuberculosis, he had isolated a substance from the tubercle bacillus a hundred times more powerful than Koch's tuberculin, and had obtained, by passing the virus through the horse, an antitoxin which he believed to be an efficient cure for the disease. Experiments on a large scale are to be carried out at the Berlin Veterinary University. Dr. A. Calmette, of the Pasteur Institute of Lille, demonstrated in a highly successful manner the prophylactic effect on snake-bitten patients of serum of the blood of horses subjected to small doses of the venom. For this purpose a rabbit was injected with a large dose of a mixture of venom of the cobra, naja, and bothrops; this proved fatal in twenty minutes. Two rabbits were then injected with the protective serum, and in ten minutes each received a dose of the mixture equal in amount to that which killed the first rabbit. These rabbits appeared to suffer no ill-effects. Further experiments gave unquestionable evidence as to the prophylactic property of the serum, which is easily prepared and retains its protective power for an indefinite period. Great interest was evinced in the paper read by M. Nocard, of the Alfort Veterinary School, and delegate of the French Academy of Medicine, describing a method of cultivating the microbe of pleuro-pneumonia of cattle, the demonstration of which had baffled the efforts of bacteriologists for nearly half a century. This destructive disease of cattle is communicable only by cohabitation, and heretofore has not been communicated to animals of other than the bovine species. As long ago as 1850, Willems had established the fact that the virus existed in the liquid exuding from affected lungs, and laid down rules for a protective inoculation which has been regarded to a great extent efficacious. His method was to introduce into the subcutaneous connective tissue of the animal to be protected a drop of the serosity from an affected lung. The necessity for having an absolutely fresh lung from which to obtain the inoculating material renders Willem's method very inconvenient and often impracticable. It is hoped that the discovery of the specific microbe and the power of cultivating it for indefinite periods, independent of animals suffering from the disease, will afford the means of providing an effectual, protective vaccine at all times available when necessity for preventive inoculation may occur. Heretofore, failure to cultivate the virus has followed sowing in all ordinary media in air or *in vacuo*, and no method of staining has been successful in demonstrating the virus. Nocard and Roux have, however, applied with success the plan adopted by Metchnikoff on the toxin and antitoxin of cholera. Very thin-walled capsules of collodion, rendered sterile by heat, are filled with sterile bouillon, sown with a very small quantity of virulent matter from a fresh pleuropneumonia lung and hermetically sealed. The capsules are then inserted into the peritoneal cavity of a rabbit. The collodion wall proves an absolute barrier to the egress of the microbe and to the ingress of the cells of the animal, which ordinarily have a destructive effect on each other. The wall, however, is permeable to liquids and dissolved matters. Products of the microbe pass out, and sometimes prove fatal to the animal; while it is usually found that products of the animal body, favouring the growth of the microbe, pass inside the capsule, so that after a longer or shorter period, according to the nature of the microbe and the animal, a rich culture is found inside the capsule. The microbe of pleuropneumonia thus cultivated is exceedingly minute. When examined under a very high power (2000 diameters magnification) the culture shows innumerable refractile, motile specks, so fine that, even after staining, their form cannot be exactly determined. Experiments with cows indicate that subcutaneous inoculation of small quantities of these cultures afford protection from the disease. Another interesting fact in connection with these experiments, is the discovery that if collodion capsules filled with sterile bouillon be inserted into the peritoneal cavity of the rabbit or the cow, and remain there for fifteen to twenty days, they are found to contain a medium suitable for cultivation of the microbe *in vitro*. Beyond the definite results in relation to the special disease under consideration, facts elicited concerning the method of providing favourable culture media would appear to have a broad significance.

Among the most novel suggestions for the application of bacteriological science were those of Dr. E. Vallin, of the French Academy of Medicine, who drew attention to the existence of saltpetre on the walls of dwelling-houses, and its ill-effects on the health of the dwellers therein. Dr. Vallin states that the salt is produced by nitrifying bacilli, and indicates that the prevention and cure are to be effected by removal of conditions favourable to their life and development. Mortar should be mixed with germicides, as coal-tar, sulphate of copper, &c., and where disease of the walls exist, the cure should be effected by inoculation of the walls with anti-nitrifying bacilli.

NOTES.

THE Council of the Institution of Civil Engineers have made the following awards for papers read and discussed before the Institution during the past session:—Watt medals and premiums to Prof. H. L. Callendar, F.R.S., and Mr. J. T. Nicolson; a Telford medal and premium to Mr. A. H. Preece; George Stephenson medals and premiums to Messrs. Whately Eliot and W. O. E. Meade-King; a Crampton prize to Mr. E. W. Anderson; Telford premiums to Messrs. L. B. Atkinson, Henry Fowler, and W. L. Strange. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of the next session.

THE Reception Committee of the Fourth International Congress of Zoology have issued a circular containing particulars with regard to lodgings and other accommodation at Cambridge during the meeting in August next, and giving information as to the railway fares from various parts of the Continent, and other arrangements for the Congress. The circular is accompanied by a reply-form, to be filled up and returned to the Secretaries by any member of the Congress who wishes rooms to be taken for him. These circulars have been sent to all who have already informed the Reception Committee that they hope to be present at the meeting, and will be sent to other zoologists on application to the Secretaries of the Reception Committee, The Museums, Cambridge.

THE Select Committee appointed to inquire into and report upon the administration and cost of the Museums of the Science and Art Department have agreed to the following preliminary report:—Since the issue of the report of the Museums of the Science and Art Department Committee in July 1897, your Committee have continued the inquiry, but reserve for a further report the publication of additional evidence with their final review and recommendations. They feel, however, bound to report without delay certain conclusions at which they have arrived, on consideration of the evidence, as regards the South Kensington Museum and the Geological Museum in Jermyn Street. They are unanimously of opinion that with a view to present efficient management, to economy of administration, to future development of the collections, and to their full use for the purpose of exhibition and of instruction, it is necessary—(1) That the whole area on the east side of Exhibition Road (except that occupied by the Royal College of Science, which cannot be sacrificed except at great cost) be exclusively devoted to the Art Museum and the Art Library, with provision for the conduct of the business connected with Loans of Art Objects, and the Art Schools. They are satisfied that the whole of this space is required for the Art Schools, the due exhibition of the Art Collections, and the administration connected with such a museum. (2) That provision for the whole of the Science Collection, the Science Library, for Loans of Scientific Objects, and for the Science Schools be made on the west side of the Exhibition Road. They are convinced that this concentration of Art on one side of the road and of Science on the other is essential to good administration, to satisfactory results from the money expended, and efficiency both in the museum and in the schools. This arrangement would allow space for the future development both of the Art and of the Science branches. They also unanimously recommend that the Geological Museum in Jermyn Street be no longer occupied for the same purposes as now; and that the collections there exhibited be removed to the west side of Exhibition Road, and made part of the Science collections.

THE address of the British Institute of Preventive Medicine is now Grosvenor Road, London, S.W., instead of Great Russell Street, London, W.C.

THE death is announced of M. Demontzey, Correspondant of the Section of Rural Economy of the Paris Academy of Sciences.

WE regret to notice the announcement of the death of Dr. Samuel Gordon, president of the Royal Academy of Medicine in Ireland, and successor to the late Dr. Haughton as president of the Royal Zoological Society, Dublin.

AT the Royal Institution on Thursday, May 12, Lord Rayleigh will deliver the first of a course of three lectures on "Heat," and on Saturday, May 21, Mr. J. Arthur Thomson will begin a course of two lectures on "The Biology of Spring." The Friday evening discourse to-morrow is by Mr. E. A. Minchin, whose subject is "Living Crystals."

THE death is announced of Dr. Karl Ludwig Fridolin von Sandberger, who until recently was Professor of Mineralogy and Geology in the University of Würzburg, and Director of the Mineralogisches Institut. Although known for his many important contributions to mineralogical science, to the study of ore deposits and to the microscopic structure of eruptive rocks, he was likewise distinguished for his researches on the fossil Mollusca of various formations in the Rhenish provinces and other parts of Germany. His published works date back to 1847. During the years 1850–56 he issued, in conjunction with his brother Dr. Guido Sandberger, "Die Versteinerungen des rheinischen Schichten-systems in Nassau"—a work remarkable for the beauty of its illustrations and the fidelity of its descriptions, and one which was honoured by the award of the Wollaston Fund, which was given to the authors by the Council of the Geological Society in 1855. In 1863 Dr. Fridolin Sandberger published "Die Conchylien des Mainzer Tertiärbeckens"; in 1870–75 he issued, in two volumes, "Die Land-und Süsswasser-Conchylien der Vorwelt"; and in 1882–5, "Untersuchungen über Erzgänge," an authoritative work on the subject of mineral veins. In the course of his long labours he turned his attention to the Mollusca of many different formations, from those of Devonian age to those of Pliocene and Pleistocene deposits. In later years his work became more concentrated on mineralogical science. In 1875 he was elected a Foreign Member of the Geological Society of London. He was born in 1826, and died at Würzburg on April 11.

MR. W. J. LEWIS ABBOTT sends us the following particulars concerning the career of Mr. Henry Lewis, who died on April 10, at the age of sixty-four:—Though apprenticed to a bootmaker, throughout his early life Lewis spent much of his time in the pursuit of natural history subjects, and thirty years ago was led to the subject of flint implements, and forthwith became one of the most ardent collectors. For many years weekly visits were made to pits in the Thames Valley, in each of which he set workmen hunting. He also successfully worked the Botany Bay section, securing much more material than Skertchley, consisting of worked flakes as well as finished implements. His next work was upon the plateau, where he secured valuable spoil. For the last ten years he visited the glacial and pre-glacial deposits in search of worked flints and implements, glacially striated and otherwise, and accumulated a mass of material at present undescribed. His late Celtic discoveries at

Aylesford were of singular interest and importance, and were described by Mr. Arthur Evans before the Society of Antiquaries. A large amount of material obtained by him still waits description. But, after all, it is this collection of material which is so indispensable and important; and hence great credit is due to Henry Lewis for the part he played in unravelling the secrets of prehistoric anthropology.

THE sixty-ninth anniversary meeting of the Zoological Society of London was held on Friday last, the chair being taken by Sir William H. Flower, K.C.B., F.R.S., President of the Society. Mr. P. L. Sclater, F.R.S., read the report of the Council, from which it appeared that the occurrence of the Queen's Diamond Jubilee in 1897, together with the very favourable weather experienced during the summer and autumn of that year, resulted in a large number of visitors to the Society's gardens, and the total income of the Society consequently reached the large amount of 28,713*l.*, being 1631*l.* more than in 1896, and greater than that of any year since the year 1884. The principal new building opened in the Society's gardens in 1897 was the new ostrich and crane-house, which was commenced in the autumn of 1896. During the past summer, also, a new glass-house for the reception of the Society's collection of tortoises was built, adjoining the reptile-house. The Council referred to the loss sustained by the death of Mr. A. D. Bartlett, for thirty-eight years superintendent of the Society's gardens, and recorded their deep sense of the services rendered by him during the long period he held his post. The vacancy thus caused has been filled up by the appointment, as superintendent, of Mr. Bartlett's second son, Mr. Clarence Bartlett. The number of visitors to the gardens in 1897 was 717,755, being 52,751 more than the corresponding number in 1896. The number of animals in the collection on December 31 last was 2585, of which 792 were mammals, 1362 birds, 431 reptiles and batrachians.

WE learn from the thirty-first annual report of the Peabody Museum of American Archæology and Ethnology, that Miss Maria Whitney has made a gift of great scientific interest from the estate of her brother, the late Prof. J. D. Whitney. This consists of the world-famous "Calaveras skull" and all the original documents relating to its discovery and history; with the gravel, small human bones, and other objects found in the cemented débris in which the skull was enclosed at the time of its discovery, as shown by the photograph taken before the cemented material was removed. With these are also a rude stone mortar, stone pestle and steatite dish, found under similar geological conditions in California. The full history of the discovery of the skull by Mr. Mattison, in 1866, under four beds of lava in a shaft he had sunk to the depth of 127 feet, is given in Prof. Whitney's volume on the "Auriferous Gravels of California," published in 1879 as vol. vi. of the *Memoirs* of the Museum of Comparative Zoology. When taken in connection with other discoveries under similar geological conditions in California, there seems to be no reason to doubt that these human remains were found in the gravel under the lava, as stated by Mr. Mattison. The principal question still in doubt is the exact age of the lava beds and gravels. The skull itself, so far as can be judged by a comparative study of the portion preserved, is of the type which there are reasons for regarding as the oldest on the Pacific coast. The objects, fashioned by the hand of man, found in the gravel, have been considered by some authors to be of a character too advanced in the development of the arts of man on the American continent to have come from so old a deposit. It is pointed out, however, that one cannot apply to American archæology the old classification of the culture epochs which, during the growth of science, has been used to distinguish several periods of prehistoric culture in Europe. In addition to Miss Whitney's valuable gift, the Museum received during the past year a number of other objects of scientific importance, including gifts from friends and collections made by expeditions to Yucatan and Honduras. A description of some of the results of archæological explorations in Central America and Yucatan recently appeared in these columns (p. 568).

THE Deutsche Seewarte has rendered a valuable contribution to meteorology by the publication of means for the ten years 1886–1895, based upon the observations made three times daily at nine stations connected with that institution. Dr. Neumayer has always carefully adhered to the regulations made by the various meteorological conferences, and the present work, which continues the means previously published for the years 1876–1885, contains monthly, seasonal, and annual values and extremes made with trustworthy instruments and trained observers.

SINCE 1882, the Royal Meteorological Institute of Utrecht has published a yearly volume relating to the thunderstorms and optical phenomena observed in the Netherlands. The number of stations at which thunderstorms are observed is 254; the days on which storms were recorded amounted to 119 during the year 1897. With the exception of the months of January and February, during which no thunderstorms were observed, they were regularly distributed throughout the year. The report contains a discussion of the storms in each month, and is accompanied by various charts.

A VERY useful feature which is being introduced into Russian schools is the sending out of the pupils in summer for small natural science and ethnographic excursions, during which they explore some region and make all sorts of collections and observations. The Caucasus School administration is especially active in that direction. One such excursion will be made to the foot of the Elbrus this summer by fifty pupils of the Ekaterinodar Gymnasium. The party intends to visit the Great Karachai region, to ascend the Elbrus up to the snow-line, and to cross the Main Ridge. The excursion will last fifty days, during which the pupils will collect natural history specimens and ethnographical data, take photographs, sketch landscapes, and live amidst the beautiful pine forests of the Main Caucasus ridge. Some of the boys will take musical instruments with them to enliven the party.

A JOINT expedition of the West Siberian branch of the Geographical Society and the Moscow Society of Amateurs of Natural Sciences will this summer explore the hydrography and the fauna of the lakes in the South of Omsk. The collections will be divided between the two Societies.

PROF. J. TROWBRIDGE, Rumford professor of the application of science to the useful arts, Harvard University, describes in the *Century Magazine* some experiments he made with a view to determining the nature of Röntgen rays. He concludes as follows:—"I believe that the experiments which I have described support the theory that there are really two classes of phenomena—one an electrical disturbance in a medium, another the conversion of this electrical disturbance into fluorescent and phosphorescent light at the surfaces of suitable screens or in the body of suitable crystals. My experiments certainly show that there are anode rays as well as kathode rays, and that both are subject to the well-known laws of electrical induction. One should not expect, therefore, that the electrical rays or lines of force should be reflected and refracted like waves of light."

SOME interesting properties of Röntgen rays were recently described by Prof. Röntgen in a communication to the Berlin Academy of Sciences, and are summarised in the *Electrical*

World. If a fluorescent screen is protected from the direct action of rays emitted by a tube, by means of an opaque plate, a slight fluorescence is nevertheless seen when the tube is in action. Röntgen has now shown that this is due to the fact that the air around the tube gives forth X-rays. The brightness of a screen illuminated with rapidly intermittent rays depends on a number of properties which he enumerates. The X-rays from a platinum focus plate which are most active for showing mages are those which leave the plate at the greatest angle, but not much greater than 80°; thick plates have a relatively arger transparency than thin ones, that is, the specific transparency of a body is greater the thicker the body; the same body has different transparencies with different tubes, "soft tubes" being those requiring a small potential, and "hard tubes" those requiring a high one. The quality of the rays from the same tube depends on: the way in which the interrupter works, the insertion of a Tesla transformer, the vacuum, other processes in the tube which are not yet fully investigated. The smallest pressure at which X-rays are produced is very likely below 0·0002 mm. of mercury. The composition of the rays from a platinum anode depends largely on the element in the current; the quality of the rays does not change with changes of the primary current, or at least very little, but the intensity is proportional to the strength of the primary current between certain limits. The following conclusions are stated: the radiation consists of a mixture of rays of different intensity and absorbability; the composition depends greatly on the time element in the current; the rays produced by the absorption of bodies are different for different bodies; as X-rays are produced by kathode rays, and as both have common properties, it is probable that both processes are of the same nature. If two screens are illuminated with two tubes of different hardness, the illumination being made equal, and if then replaced by photographic plates, the one illuminated by the harder tube will be blackened much less than the other; rays which produce equal fluorescence can be photographically quite different; the usual photographic plates are very transparent for X-rays (in a pile of ninety-six filaments exposed for five minutes the last one showed photographic action); the eye is not entirely passive to X-rays.

Prof. Louis Boutan, lecturer on zoology at the Sorbonne, contributes to the *Century Magazine* (May) an account of his experiments in submarine photography. To procure photographs under water, Prof. Boutan uses a camera enclosed in a water-tight case, a blue glass being arranged in front of the lens to suit the conditions of submarine illumination, and so give a picture having pleasing contrasts. He descends under water in a diver's costume, and the camera is sent down to him from an anchored boat. The spot to be photographed is then selected, and the exposure is made in precisely the same way as on land. When no artificial light is used, submarine photographs require a rather long exposure, the time often extending to twenty-five minutes, and depending upon the depth of the water. Four reproductions of photographs obtained at depths from six and a half feet to sixteen and a half feet, accompany Prof. Boutan's article, and they are sufficient to show that submarine photography can produce useful results. It is estimated that not more than one hundred square metres of area can be photographed under water, but even with this limitation the pictures obtained will contain more valuable information than divers can furnish. The problem to be solved is to construct an apparatus which will take photographs in artificial light in any depth of water without needing a submarine photographer to manipulate it.

The immunity of bee-keepers from the effects of bee-poison, forms the subject of a paper, by Dr. Langer, read before the sixty-ninth Congress of German Naturalists and Physicians in Brunswick. The author sent circulars to all parts of the country addressed to bee-keepers, and from the answers he received he has compiled some interesting statistics. One hundred and forty-four bee-keepers stated that they were immune to the sting of bees, nine mentioning that they were naturally immune to the poison, whilst twenty-six replied that they could not acquire immunity. The number of bee-stings necessary to produce the much-desired immunity appears to vary considerably, sometimes thirty being sufficient, but in other cases as many as 100 being necessary to accustom the system to the poison. The remedies applied range over a large variety of substances, and include tobacco juice, French brandy, rum, water, spirits of ammonia, seltzer water, acetate of alumina, loam, saliva, cognac, besides massage and heat. The most favourite means of dealing with bee-stings appears to be spirits of ammonia. Dr. Langer states that a 5 per cent. solution of permanganate of potash will counteract the poison, and he recommends an injection of a 2–5 per cent. solution of this substance. Bee-poison is extraordinarily resistant to both dessication and heat, whilst it is quite unaffected by additions of alcohol. It used to be commonly supposed that the irritating nature of bee-poison was due to the presence of formic acid; but inasmuch as it can withstand heat and retain its poisonous activity, which would effectually volatilise the formic acid were it present, this idea must be abandoned. The opinion now appears to be that the toxic substance present partakes of the nature of an alkaloid.

A copy of the Act of Incorporation, bye-laws, and list of officers of the recently-established Washington Academy of Sciences has been sent to us. The particular business and objects of the Academy are stated to be the promotion of science, with power to acquire, hold, and convey real estate and other property, and to establish general and special funds; to hold meetings; to publish and distribute documents; to conduct lectures; to conduct, endow, or assist investigation in any department of science; to acquire and maintain a library; and, in general, to transact any business pertinent to an Academy of Sciences. The Academy will act as a federal head of the affiliated scientific societies of Washington, with power to conduct joint meetings, publish a joint directory and joint notices of meetings, and take action in any matter of common interest to the affiliated societies. The term "affiliated societies" at present covers the Anthropological, Biological, Chemical, Entomological, National Geographic, Geological, Medical, and Philosophical Societies, each society nominating a vice-president. The President of the Academy is Mr. J. R. Eastman, and the Secretary Prof. G. K. Gilbert.

Curators of museums know that the papers read at the annual meetings of the Museums Association, and the discussions which take place upon them, are serviceable in indicating the best systems of classification and arrangement of specimens, and in evoking expert opinions upon museum technique. The Report of the proceedings of the Oxford meeting of the Association, edited by Mr. James Paton, has just been published by Messrs. Dulau and Co., and from it much valuable information can be gained by the officers of local museums. Among the contents is an address by the president, Prof. E. Ray Lankester, F.R.S., and papers on the methods of setting and labelling Lepidoptera for Museums, by Prof. E. B. Poulton, F.R.S.; the arrangement of the mineral collection in the University Museum, Oxford, by Prof. H. A. Miers, F.R.S.; the arrangement of ethnographical collections, by Mr. F. W. Rudler; popular museum exhibits, the relation of museums to elementary education, and a description of the Colombo Museum. Opinions and conclusions based upon successful experience are always valuable, therefore this report of the Museums Association will be of service not only to the organised provincial museum officer, but will also educate the curators and managers of local institutions of the "curiosity shop" type to a sense of their responsibilities and opportunities.

IN March 1848, Louis Agassiz began his instruction at Harvard College, and with it a new era in zoological science commenced in America. To commemorate the jubilee of his appearance as a teacher in America, the March number of the *American Naturalist*, which has only just reached us, contains a sketch of the life of Agassiz and reviews of some aspects of his work. It is peculiarly appropriate that the *American Naturalist* should take advantage of the opportunity which this fiftieth anniversary presents to pay a tribute to Agassiz's work, seeing that the periodical was founded by four pupils of that distinguished investigator—Alpheus Hyatt, Edward Sylvester Morse, Alpheus Spring Packard, and Frederick Ward Putnam. The anniversary thus commemorated is also the anniversary of a change in the character of zoological science in America, and of a change in the academic position of zoology in the educational institutions in the New World. To these changes must be ascribed the advances which American students have made in morphological science, and have gained for their country a foremost position among the nations of the earth.

FRIENDLY intercourse between men working in various fields of natural knowledge tends to broaden views and sympathies. With this aphorism in mind, and also the fact that the number of persons in the University of Durham interested in the progress of science is increasing, some members of the University met towards the end of 1896 and formed themselves into a Philosophical Society having for its principal objects the promotion of research and the communication of facts and ideas bearing upon scientific questions. The first number of the *Proceedings* of this Society has just been issued, and it is a creditable production which may, we trust, be taken as an earnest of greater things to come. Among the subjects of papers printed in the *Proceedings* are: education and instruction in England and abroad; the effect of alternating currents upon the frog's heart; native methods of fire-making; and the Great Ice-Age.

THE popular science lectures delivered on Tuesday evenings at the Royal Victoria Hall, Waterloo Bridge Road, provide a valuable means for instructing a large section of the general public in the methods and results of scientific work. The lecturers give their services, and only a few pence is charged for admission, the object being not to make the lectures commercially profitable, but to encourage interest in the pursuit of natural knowledge. After the lecture a short variety entertainment is provided, and it says much for the character of the audience that more people leave at the end of the lecture than are admitted to the entertainment. During May several distinguished men of science will lecture at the Hall. On Tuesday, Prof. Tilden delivered a discourse in which he described "What a Chemist can get out of a Brick"; on May 10, Prof. McLeod will lecture on "A Simple Experiment, and its Explanation"; Prof. Sollas will take as his subject "Funafuti, or three months on a Coral Island," on May 17; and Prof. Marshall Ward will say "Something about Wood," on May 24. The Hon. Secretary of the Hall should feel gratified at being able to offer such an attractive programme as this.

THE many subjects covered by the articles which have appeared in *Science Progress* since its commencement, and the satisfactory way in which they have usually been treated, make the volumes which have been published almost an encyclopædia of science. There are few scientific subjects of prime importance in which advances have been made in recent years but what have been dealt with by our solid contemporary, and surveyed in sufficient detail to make the volumes very serviceable to students of science. The April number of this "quarterly review of current scientific information" contains an article on Julius Sachs by Prof. K. Goebel, and one on the germination of seeds by Mr. F. Escombe. Prof. H. Crompton describes association and dissociation; Dr. T. Gregor Brodie, the phosphorus-containing substances of the cell; Dr. F. A. Dixey, recent experiments in the production of insect hybrids; Mr. A. Harker, the forms and habits of igneous rocks; Dr. J. S. Haldane, F.R.S., the secretion and absorption of gas in the swimming-bladder and lungs; and Prof. J. Reynolds Green, F.R.S., oxidases or oxidising enzymes.

THE additions to the Zoological Society's Gardens during the past week include a Mona Monkey (*Cercopithecus mona*, ♂) from West Africa, presented by Mrs. Christiana G. R. Potter; a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mrs. Burrell; a Ring-tailed Coati (*Nasua rufa*) from South America, a Mantled Buzzard (*Leucopternis palliata*) from Brazil, presented by Mr. Basil T. Freeland; a Daubenton's Curassow (*Crax daubentoni*) from Venezuela, presented by Mr. Emil A. Goeldi; two Silver-bills (*Munia malabarica*) from India, presented by Lady Charlotte Amherst; two Moorish Toads (*Bufo mauritanica*) from North-west Africa, presented by Mr. D. P. Turner; a Humboldt's Lagothrix (*Lagothrix humboldti*, ♀) from the Upper Amazons, two Beautiful Grass Finches (*Poëphila mirabilis*) from Australia, two Yellow-legged Herring Gulls (*Larus cacchinnans*) from Egypt, twelve Midwife Toads (*Alytes obstetricans*), European, purchased; a Californian Sea Lion (*Otaria californiana*) from California, received in exchange; four Barbary Wild Sheep (*Ovis tragelaphus*), a Grey Ichneumon (*Herpestes griseus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET PERRINE (MARCH 19).—The ephemeris of this comet for the ensuing week is as follows:—

12h. Berlin Mean Time.

1898.	R.A. h. m. s.	Decl. ° ′	Br.
May 5	0 58 43	+52 18·3	0·46
6	1 4 9	52 38	
7	9 35	52 56·9	
8	15 0	53 14·7	0·42
9	20 24	53 31·5	
10	25 46	53 47·4	
11	31 6	52 2·4	
12	1 36 25	+54 16·3	0·38

TEMPEL'S COMET (1867 II.).—M. Gautier publishes (*Astr. Nach.*, No. 3490, Beilage) an ephemeris of this periodic comet, which was discovered by Tempel at Marseilles in 1867. The comet has a period of about 6·5 years, and it was observed at its returns in 1873 and 1879, but since that time has not been seen, although two returns have been due. M. Gautier, who has interested himself in this comet, calculated that the last return ought to have occurred in 1892, owing to the perturbating action of Jupiter on its orbit. If this be so, then probably we should expect its return during the present year. The region of the sky which should be swept for picking up this object is, according to M. Gautier, for the present week between R.A. 11h. 20m. and 11h. 43m., and between Declinations +16° 46′ and +18° 7′.

KIRCHHOFF'S SPECTROSCOPE.—The Potsdam Astrophysical Observatory has just become possessed of the celebrated spectroscope which Kirchhoff used in his well-known investigations on the solar spectrum. Although this instrument has been previously described, detailed information on several points connected with it was lacking. To remedy this Prof. H. C. Vogel brings together (*Sitzungsberichte der Königlich Preussischen Akademie der Wis., Berlin*, February 1898) such information as is supplementary to that already known, obtaining his facts from a minute examination of the instrument itself. As regards the optical parts, Prof. Vogel says: "The objectives are very beautiful and colourless; the prisms are masterpieces of workmanship; the glass of which they are composed is pure, colourless and free from streaks, and only in two prisms do a few air bubbles appear." The spectra given by the prisms are said by Prof. Vogel to be very excellent, and the working of the whole set of prisms exceeds even to-day any other instrument of the same dispersion. The refractive angles of the prisms, as measured by Dr. Hartmann, are 44° 57′·1, 45° 6′·9, 45° 26′·9 and 59° 50′ 8, and the relative refractive indices at a temperature of 18° C. was found by the same observer to be for the lines—

B 1·6093	D 1·6158	F 1·6275
C 1·6110	E 1·6220	Hγ 1·6375
a 1·6129	b_1 1·6230	g 1·6403

JUPITER'S RED SPOT.—Jupiter is now in a good position for observation, and his surface markings have become of late of great interest in consequence of the numerous spots which many observers have seen on his disc. Dr. A. A. Nijland draws attention to two very curious spots (*Astr. Nachr.*, No. 3488) which are situated on the northern hemisphere, their coordinates in longitude and latitude (according to "Marth's System," ii., *Monthly Notices*, lviii. p. 107) being $\lambda = 272°$ $\beta + 31°$, $\lambda = 289°$ $\beta = + 38°$. Dr. Fauth, from the private observatory at Landstuhl, gives us a continuation of the list of longitudes of several prominent spots observed by him. Another short communication of interest is that which appears in the *Astr. Nach.*, No. 3490. In this Dr. Lohse discusses the movement of the great red spot from observations extending over a period of twenty years. The proper motion of the spot is, according to him, distinct and regular, and this will be clearly seen from the short table given below.

The method of reducing this proper motion was to obtain for each opposition a normal position for the centre of the spot on the surface of Jupiter, on the assumption of a fixed meridian and a regular velocity of rotation of the planet. In plotting the positions of these deduced normal positions on paper with the time as abscissæ and the Jovian longitudes as ordinates, a regular and symmetrical curve was brought to light. The following figures give the Jovian normal longitudes of this spot as shown in this manner, together with the name of the observer:—

Epoch.	Normal longitude	Obs.
1878·65	° 249·5	L.
1878·86	237·1	Tr.
1879 73	182·7	L.
1880 71	128 5	L.
1881·70	89·2	L.
1882 14	78·0	L.
1883·14	50·4	L.
1884·15	32 6	L.
1885·27	15·8	L.
1886·27	8·3	L.
1887·27	2·9	St. D.
1888·27	358·9	L.
1890 15	353·6	T. P.
1891·74	352·0	L.
1892·76	356·2	L.
1894·03	358·8	L.
1895·18	5·2	L.
1896·13	10·1	L.
1897·27	20·4	L

The observers mentioned above were Lohse, Trouvelot, Stanley Williams, Denning, Terby, and Pritchett. From the curve it can be seen at a glance that the spot in the year 1891 rotated in the same time as that assumed for the rotation of the planet. The curve at this period has reached a turning point, and the longitudes of the spot commence now to increase instead of decrease. The observations show that for thirteen years (1878–1891) this spot has moved through nearly three-quarters of the whole circumference of the planet, and since that interval has begun to retrace its path. The fact of such a distinct acceleration and retardation of the motion of this large spot will, if the observations be continued, help us probably to gain some knowledge of the system of circulation involved in the Jovian atmosphere. It would be interesting to know whether any other comparatively large marking on the planet's surface follows the same or a similar law.

PETROLIFEROUS SANDS AND MUD VOLCANOES IN BURMA.

THE occurrence of petroleum in Burma, and its technical exploitation have, in a recently published volume, been very fully treated by Dr. Fritz Noetling, palæontologist to the Geological Survey of India (*Mem. Geol. Survey India*, vol. xxvii. part 2). The Yenangyaung oil-fields occupy an area of about 350 acres on the borders of the left bank of the Irawadi, a few miles distant from the river. They have been known from time immemorial, while the methods of obtaining the oil at the present day differ but little from those of a hundred years ago. In 1855 there were about 130 productive wells; there are now about 600, together with six or seven bore-holes. The oil-field is situated in a low but rugged table-land which is intersected by numerous ravines, and the strata which yield the oil have been bent into a gentle dome-like anticline. The strata consist of sands or soft sandstones, and shales of Tertiary ages overlaid by drift. The oil is held in the sandy beds, the thickest of which (though not the richest in oil) is a little over 130 feet. As many as ten bands yielding oil may occur in vertical succession; but water and petroleum occur independently in different beds, or in the same layer, and in the latter case the petroleum generally rests on the water.

Oil has been found by boring in a bed of sandstone 900 to 1000 feet deep, but the main oil-sand is from 200 to 350 feet from the surface. The sands are somewhat inconstant in character, and the strata generally exhibit false-bedding. They have yielded numerous remains of land mammalia and reptiles, as well as some marine fossils, so that Dr. Noetling believes the strata were accumulated in shallow water not far from land, and that carcases of animals brought down by a river were entombed in the estuarine sediment. He regards the petroleum as indigenous in these sandy estuarine or deltaic deposits. The clays contain no trace of it. Moreover, he considers that the strata were laid down on a plane gently inclined towards the sea, and that this inclination facilitated a sliding of the sediments seawards, whereby certain minor folds and irregularities, otherwise difficult to explain, were produced. These folds were intersected by cracks, which became filled with mud—like veins of eruptive material.

Turning his attention to the mud volcanoes of Minbu, Dr. Noetling points out that they are connected with subterranean petroliferous strata: both volcanoes and mud-wells produce a

The Mud Volcanoes of Minbu, in Burma (Dr. F. Noetling).

greyish-blue mud more or less saturated with petroleum. The low temperature of the ejected mud, seldom so much as 85°, indicates that its source is not deep-seated. Some of these mud volcanoes are figured (the accompanying illustration is reduced from a Plate in the *Memoir*.) The largest had, in 1888, a crater about 6 feet in diameter, and this was filled with viscous mud from which rose enormous bubbles of inflammable gas with a strong odour of petroleum. The temperature was 76°. Some of the other cones rise about 30 feet from the ground. It seems at first difficult to say why mud volcanoes occur at Minbu and not at Yenangyaung, but Dr. Noetling points out that at Minbu these volcanoes arise through fissures in the Tertiary strata beneath an alluvial cover, and he considers that the pressure of gas and petroleum forced a way through this comparatively thin overlying deposit. No fiery eruptions have been recorded; in fact, there are no known instances of spontaneous combustion.

Dr. Noetling traces some connection between the fluctuating heights of the river and the production of petroleum at the wells.

There is also some relation between the activity of the mud volcanoes and the height of the river. The explanation is that during rains the ground-water presses on the petroliferous sands, and it is noteworthy that the main bed of oil-sand is found at about the level of high-water of the river.

Some signs of exhaustion in the oil-field are noticed by the author, but it is possible that further productive beds may be found by boring. H. B. W.

EXPERIMENTS ON THE WORKING OF GAS-ENGINES.

A GENERAL meeting of the Institution of Mechanical Engineers was held last week, when the President, Mr. Samuel W. Johnson, delivered an inaugural address dealing chiefly with the progress of locomotive engineering on the Midland Railway, of which he is chief mechanical engineer. The most interesting feature in the ordinary proceeding was the discussion of the first report to the Gas-Engine Research Committee of the Institution. The author of the report was Prof. Frederick W. Burstall, under whose superintendence the investigations had been carried out. The object of the experiments was to determine the effect produced upon the economy of gas-engines by altering one or more of the conditions which governed their working. In internal combustion engines there are a much larger number of factors to consider than in steam-engines, and it is difficult to ascertain where to look for economy. The factors to be considered are the amount of compression, the speed, the ratio of air to gas, and the amount of heat which is to be ejected through the walls of the cylinder. An increase of compression, for example, is often regarded as conducive to more economical results; but it is uncertain whether the attendant increase in economy is really due to compression alone. To ascertain this, the conditions of working should be altered successively one at a time. This has been done for the steam-engine, but all published results of tests made on gas-engines are based upon only one fixed set of conditions.

A small engine was used by the committee, but was one specially constructed for experimental purposes. Small size was an advantage, inasmuch as it allowed measurements, such as those of volumes of air, to be made with accuracy. The work of the committee appears to have been undertaken with commendable care, and a precision was aimed at more typical of the physical laboratory than of ordinary engineering experiments. This is particularly noticeable in the arrangement of the apparatus and methods of calibration followed. It would take far too much space to follow these in detail, interesting and instructive as they are to engineers, and we can only hope to give a partial idea of the methods followed. This report, it should be remembered, is but introductory to the description of the actual work of testing, most of which has yet to be undertaken. As the author stated, experimental work is often compromised by being carried out with instruments upon the accuracy of which no information is furnished. When a comparison is made of a number of results, it is always difficult to discover how far differences are due to working conditions or to inevitable experimental error. In purely physical experiments, the report continued, accuracy may be obtained to the degree of one part in a thousand; in a few special cases, even better results may be reached. In an engineering experiment it is hopeless to expect such accuracy, owing to the great difficulty of keeping the working conditions sufficiently steady from beginning to end of the experiment. With ordinary care, and the use of appliances which are found in all works, probably all that can be expected is to get results correct to 3 or 4 per cent. With special care, half of 1 per cent. may be reached; but the author does not suggest that all the results of the experiments made by the committee have this high degree of accuracy, but in the principal measurements probably the experimental error involved does not in any case exceed 1 per cent.

The engine used was of 2-horse nominal power, capable of developing a maximum of 5 I.H.P.; it has a 6-inch cylinder and 12-inch stroke. The valves are worked in the ordinary manner; there is an ordinary Watt governor acting on a small roller, and causing a charge of gas to be cut off when the speed is too high. To effect changes in compression the connecting-rod is made so that its length can be varied. Compressions employed in the experiment varied between 35 and 90 lbs. per square inch; variation in the amount of gas admitted was effected by throttling. For measuring the supply of gas a calibrated holder was used; the wet test meter being discarded, as it does not control the fluctuations of pressure in the mains. By this instrument accuracy to the extent of one-tenth of 1 per cent. was obtained; calibration was effected by means of a standard cubic foot measure. To determine the air supply per stroke, a meter was used in place of trusting to the usual method of calculation. The arrangement followed was practically that employed by Dr. A. Slaby, of Berlin. The meter employed was a 400-light standard wet meter made by Alexander Wright and Co., of Westminster. Air is passed in by a blower, the pressure being kept constant by a governor. After passing through the meter the air is delivered into a safety-box, which is used to prevent inflammable gas from passing back into the meter, and also to give relief in case of back ignition. A rubber-bag is used to prevent fluctuations in the meter during the suction stroke. The direct measurement of air supply is usually considered a difficult and dangerous undertaking; but the author stated that no trouble had been found with this portion of the apparatus. The air meter was checked by blowing air through it into the gas-holder, and was found to be correct to the half of 1 per cent.

The amount of heat passed into the jacket was measured by running all the cooling water for a single test into a tank, and taking the temperature by means of thermometers. Samples of exhaust gases were taken and analysed. In this detail the great difficulty is not in making the analysis, but in obtaining a true sample. A single bubble of gas was taken from just below the exhaust valve after each explosion. The apparatus for doing this was illustrated by means of wall diagrams, which showed that the object aimed at was obtained by an electrical relay which actuated a small needle valve that allowed a single bubble of gas to be sucked into the gas receiver. Power developed was ascertained by a Wayne indicator; an instrument found superior to others tried. Prof. Burstall states that it is in careful hands, apparently the most accurate indicator of the present time. It has a rotating piston in place of the ordinary reciprocating piston. This piston does not touch the containing cylinder at its outer extremities, but is guided at the centre on circular bearings. In this way friction is small and not liable to change, because the bearings can be well lubricated. There are many interesting points about its mechanism which were described in the report. Thin sheets of smoked mica are used in place of the ordinary metallic faced paper or "cards." This device is highly spoken of by those who have had experience in its use.

As the engine was not fitted with a timing valve—a device which the author considers absolutely necessary to all sizes of gas-engines—it was decided to attempt to ignite the charge by means of an electric spark, and it was hoped that electric ignition would prove more certain than any form of hot-tube igniter. This, however, did not prove to be the case; and not the least interesting part of the report is contained in the discussion of the failure in this detail. The rope-break used was of the ordinary kind, having dead weights on the lower end of the rope and a spring balance at the upper end. A Harding counter for ascertaining the number of revolutions was employed, and analyses of the coal-gas were made by Mr. G. N. Huntly, who also supervised the analyses of the exhaust gas. The results of seventeen preliminary experiments made were given in a table contained in the report, and on copies of indicator diagrams attached. The mechanical efficiency of the engine varied from 76 to 84 per cent., the mean value of the whole seventeen tests being 81 per cent. It must be remembered, however, that these experiments are, as stated, preliminary, and, it may be added, they have been carried out under circumstances of exceptional difficulty, which conditions, however, will not recur. The report states that it would seem probable that the influence of increased compression on economy is due to the fact that weaker charges can be burnt completely during the stroke when the compression is high. The tests seem to indicate, the report continues, that economy depends on the choice of the correct ratio of air to gas; and this ratio increases with the compression. The number of experiments, however, are, as the report states, not yet sufficient to determine what this ratio is for any given compression. It is intended to make a series of tests sufficient for determining this important point. Further experiments are to be made at a constant speed; the variables being the load, the ratio of air to gas, and the compression. It is stated that, so far as these additional experiments have been carried, the first results have been borne out in regard to the advantage of using a suitable mixture, and in showing the importance of making an accurate analysis of the exhaust gases.

The discussion which took place on the presentation of the report did not add materially to information on the subject. Some of the criticisms were very wide of the mark, more especially in regard to one point, upon which much stress was laid, viz. the leakage of gas through the indicator. This was supposed by some speakers to be sufficient to vitiate the value of the experiments, but, according to Prof. Burstall's tests, made in order to elucidate this point, the consumption of gas by the indicator was so minute as to be imperceptible. It was stated during the discussion by Mr. Burstall, a brother of the author, that, according to calculation, if diagrams were taken every five minutes, when running at 200 revolutions, and if the whole of the gas escaped on the stroke, the loss would be one-fiftieth of 1 per cent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A combined examination of non-resident candidates for open scholarships, exhibitions, &c., will be held at Trinity College, Clare College and Trinity Hall, beginning on November 1. At Trinity College there will be offered for competition about ten scholarships, about ten exhibitions, and about three sizarships. Scholarships include (1) major scholarships, of the value of 80*l.* a year, (2) minor scholarships, of the value of 75*l.* a year or of 50*l.* a year. Exhibitions are generally of the value of 40*l.* a year. Scholarships and exhibitions are tenable for two years from the commencement of residence. Sizarships are of the value of about 100*l.* a year (namely, a payment in money of 80*l.*, and a remission of College fees and dues to the extent of about 20*l.*). They are tenable until the expiration of nine terms from the commencement of residence, unless the holder is previously elected to a major scholarship. Candidates for sizarships must send satisfactory evidence to one of the Tutors that they are in need of the assistance given to sizars. The subjects of examination will be classics, mathematics, natural sciences, moral sciences, and history. A candidate may take any one of these subjects, or any combination of subjects so far as the arrangement of the papers in the examination permits. At Clare College about eight scholarships of values varying from 80*l.* to 40*l.*, and at Trinity Hall six scholarships at least, ranging between the same values, will be awarded. These scholarships are offered for proficiency in classics, or mathematics, or natural science, or history. Deserving candidates who do not attain the standard for these scholarships may be awarded exhibitions of the annual value of 30*l.* Forms of application for admission to the examination may be obtained from any of the Tutors of the Colleges named.

IN the House of Commons on Thursday, in reply to a question whether it was the intention of the Government to take the second reading of the London University Commission Bill before Whitsuntide, Mr. Balfour said he could not give any definite promise in view of the present state of public business, but he would not discourage the hope that they might have a chance of reaching the Bill as early as some time before Whitsuntide.

A PARLIAMENTARY paper issued by the Science and Art Department states that the total amount expended on technical education during the year 1895–96 in the United Kingdom was 787,467*l.*, and that the estimated total expenditure for the year 1896–97 was 847,62c*l.*, exclusive of the sums allocated to technical education under the Welsh Intermediate Education Act, 1889. The total amount of the residue received under the Local Taxation Act by counties and county boroughs in England in 1895–96 was 775,944*l.*, of which 616,607*l.* was appropriated to educational purposes, and 159,336*l.* to relief of rates, the latter sum including 121,558*l.* devoted by the London County Council to that purpose. In Wales the whole of the residue grant of 37,236*l.* paid to thirteen counties and three county boroughs is devoted to intermediate and technical education. The amount of residue received by Scottish authorities was 38,262*l.*, of which 28,999*l.* was apportioned to technical education, and 9158*l.* to relief of rates. In Ireland the residue is not applicable to technical education, but eleven local authorities are making grants out of the rates for that purpose.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xx. No. 2.—On the focal surfaces of the congruences of tangents to a given surface, by A. Pell. This paper is based upon two theorems given by Darboux ("Théorie générale des Surfaces," vol. iii. p. 121) and Kœnigs ("Sur les propriétés infinitésimal de l'espace réglé"), viz.: the locus of the centres of geodesic curvature of lines of curvature of any surface is the edge of regression of the developable surface, generated by the tangent planes of the surface at all points of the lines of curvature, and the edges of regression of the developable surfaces of a congruence form two families of curves on the focal surfaces (say S_A and S_B corresponding to the focal surfaces A and B), the osculating planes of which are tangent to the surfaces B and A respectively, and the points of contact describe on these surfaces two families of conjugate lines S_A and S_B. Other theorems discussed are due to T. Caronnet (*Comptes rendus*, 1892), E. Cosserat (*C.R.*, 1894) and A. Demoulin (*C.R.*, 1894).—Displacements depending on one, two and three parameters in a space of four dimensions, by T. Craig. This is a concise generalisation to a space of four dimensions of the kinematical methods developed by Darboux in the first two volumes of his "Théorie générale des Surfaces." The author employs Poincaré's nomenclature (*cf.* "Sur les résidus des intégrales doubles," *Acta Math.*, t. 9, p. 385).—Further researches in the theory of quintic equations, by Emory McClintock. The paper contains four parts. The first part is a preliminary classification of quintics into reducible and irreducible, and again into resolvable and unresolvable quintics. The second is a simplified restatement of the author's earlier discoveries. The third contains a presentation of the necessary form of the coefficients of the general resolvable quintic; and the last part is occupied with the development of a theorem according to which any given resolvable quintic engenders another for which the author's sextic resolvent has the same rational value. The memoir was read at the Toronto meeting of the American Mathematical Society in August last.

Symons's Monthly Meteorological Magazine, April.—The climate of Paris, by M. J. Jaubert. This is an account of an interesting and useful book by the meteorologist of the Montsouris Observatory, compiled from all available sources in the Paris district. The mean temperature at the National Observatory is 51°·3, but in the suburbs it is less, *e.g.*, Parc St. Maur, 50°·0. The lowest temperature recorded in the neighbourhood was −17°·5, in December 1871, and the highest was 101°·1 in 1874 and 1881. Fogs are rather frequent, about forty in a year, but a foggy day is defined as one on which objects at a distance of a mile cannot be distinguished. The mean rainfall is about 22 inches, but the amount varies in different parts of the city. About thirty thunderstorms occur in a year, mostly in summer. Very little hail falls, and the stones are seldom more than ¾ of an inch in diameter. The yearly average amount of cloud is 6·0.—Results of meteorological observations at Camden Square for forty years, 1858–97. The average rainfall was 1·71 inches; the amount last March was 1·46 inches. The mean of all the highest shade temperatures was 61°·9, and the mean of all the lowest minimum temperatures was 25°·3. In March last the absolute extremes were 59°·1 and 25°·1, while the temperature on the grass fell below freezing point on twenty-four nights.

Bollettino della Società Sismologica Italiana, vol. iii. No. 7.—Some modifications of the doubly sensitive electric seismoscope, and instructions for its installation and working, by G. Agamennone.—The seismic recorder with increased velocity on the occasion of the earthquake of September 21, 1897, by P. Tacchini.—Diurnal movement of the obelisk of Washington, by E. Oddone.—Notices of earthquakes recorded in Italy (May 14–23, 1897), the most important being an elaborate account of the earthquake of the Tyrrhenian Sea on May 15.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 10.—"On the Rotation of Plane of Polarisation of Electric Waves by a Twisted Structure." By Jagadis Chunder Bose, M.A., D.Sc., Professor of Physical Science, Presidency College, Calcutta. Communicated by Lord Rayleigh, F.R.S.

"On the Production of a 'Dark Cross' in the field of Electromagnetic Radiation." By Jagadis Chunder Bose, M.A., D.Sc., Professor of Physical Science, Presidency College, Calcutta. Communicated by Lord Rayleigh, F.R.S.

Chemical Society, April 21.—Prof. Dewar, President, in the chair.—The following papers were read:—The carbohydrates of barley-straw, by C. F. Cross, E. J. Bevan and C. Smith. The ratio of the furfural-yielding carbohydrates to total carbohydrates in barley-straw is not affected by removing the ears at the flowering stage; the constancy of this ratio under wide variations of the conditions of growth has now been established.—Isomeric bornylamines, by M. O. Forster. The base obtained from the formyl derivative got by heating camphor with ammonium formate, and from the reduction of camphoroxime, is a mixture of bornylamine and an isomeride which the author terms neobornylamine.—Some derivatives of benzophenone, by F. E. Matthews. The author has obtained a benzophenone hexachloride, $C_6H_5Cl_6.COPh$, which yields a mononitro-derivative and a sulphonic acid.—Experiments on lauronolic acid, by S. B. Schryver.—The drying of ammonia and of hydrogen chloride, by H. B. Baker. A repetition of the author's previous work shows that ammonia and hydrogen chloride can be dried by phosphorus pentoxide, and that dry ammonium chloride is not dissociated at 350°; Gutmann's strictures on the work are hence unfounded.—Note on some of the properties of methylene diiodide, by H. G. Madan. Methylene iodide darkens appreciably in colour on a few hours' exposure to sunlight, and in the cold dissolves sufficient sulphur to raise its refractive index for the D line from 1·756 to 1·778; it dissolves phosphorus readily, giving a light yellow solution which has the refractive index for D of 1·95 at 14°, and is not spontaneously inflammable on evaporation in the air.—The condensation of chloral hydrate with orcinol, by J. T. Hewitt and F. G. Pope. Chloral hydrate and orcinol condense on heating in aqueous solution, yielding an acid of the composition $C_{16}H_{16}O_6$, which is easily converted into a lactone $C_{16}H_{14}O_5$.—Note on hexamethylene and its derivatives, by Miss E. C. Fortey. Gallician petroleum, like American light petroleum, contains hexamethylene; it boils at 81·75°, and has the specific gravity of 0·7899 at 0°/0°. Its mono- and dichloro-derivatives have been prepared and investigated.—The yellow colouring matter of the leaves of *Arctostaphylos uva ursi*, by A. G. Perkin. In addition to gallic acid, arbutin, ericolin and gallotannin, the author has separated a yellow colouring matter of the composition $C_{15}H_{10}O_7$ from the leaves of this plant, and has also demonstrated the presence of ellagitannin.—The yellow colouring matters of various adulterants of Sicilian sumach, Part iv., by A. G. Perkin and P. J. Wood.—The hydrolysis of starch by acids, by H. Johnson.—Synthesis of cis- and trans-caronic acids, by W. H. Perkin, jun., and J. F. Thorpe. On hydrolysing the alkylic salts of α-bromodimethylglutarate, a mixture of cis- and trans-caronic acid is obtained; caronic acid is therefore, as Baeyer concluded, a dimethyltrimethylenedicarboxylic acid of the constitution

$$CMe_2\left\langle\begin{array}{l}CH.CO_2H\\ |\\ CH.CO_2H.\end{array}\right.$$

—Preparation of solid ammonium cyanate, by J. Walker and J. K. Wood. On mixing a solution of ammonia and of cyanic acid in anhydrous ether at − 20° and filtering, a residue of solid ammonium cyanate is obtained.—The chlorine derivatives of pyridine, Part i., by W. J. Sell and F. W. Dootson.—Simple experimental illustrations of the law of multiples, by A. W. Jones. Equivalent weights of potassium chlorate and perchlorate are heated, and it is shown that the residues of potassium chloride are equal in weight, and that the volumes of the oxygen evolved are as three to four in the two cases.—Lauronolic acid, by R. W. Collinson and W. H. Perkin, jun. Lauronolic acid yields a hydrobromide, $C_9H_{15}O_2Br$, and when oxidised gives a syrupy acid of the composition $C_9H_{14}O_5$.—The action of aluminium chloride on camphoric anhydride, by F. H. Lees and W. H. Perkin, jun.—On the action of bromacetal on the sodium derivative of ethylic malonate, by W. H. Perkin, jun., and C. H. G. Sprankling. On heating bromacetal with ethylic sodiomalonate at 140-150, ethylic acetalmalonate, $(CO_2Et)_2CH.CH_2.CH(OEt)_2$ is obtained.—The sulphonation of benzophenone and of diphenylmethane, by A. Lapworth.—The separation of optical isomerides, by F. S. Kipping and W. J. Pope. It is shown that enantiomorphously related substances are not equally soluble in a solution containing a third enantiomorphous substance.

Zoological Society, April 19.—Prof. Howes, F.R.S., in the chair.—Mr. Ernest W. L. Holt read a paper on the breeding of the Dragonet (*Callionymus lyra*) in the Marine Biological Association's aquarium at Plymouth, and made some remarks on the significance of the sexual dimorphism of this fish, the courtship and pairing of which were described in detail.—A communication from the Rev. H. S. Gorham contained an account of the Serricorn Coleoptera of St. Vincent, Grenada, and the Grenadines, obtained through the operation of the West India Committee of the Royal Society and the British Association, for the exploration of the fauna of the West Indies.—A second communication from the Rev. H. S. Gorham on the Coleoptera of the families *Erotylidæ*, *Endomychidæ*, and *Coccinellidæ* from the West Indies, obtained in the same manner, was also read.—A communication was read from Dr. Bashford Dean, describing further evidence of the existence of possible paired fins in the problematical Devonian organism *Palæospondylus*. He maintained his former views, as opposed to those of Dr. R. H. Traquair expressed in a former communication to the Society.

Mathematical Society, April 7.—Dr. Hobson, F.R.S., Vice-President, in the chair.—The following communications were made:—An essay towards the generating functions of ternariants, by Prof. Forsyth, F.R.S.—On systems of forces in space of n dimensions, by W. H. Young.—Zeroes of the Bessel functions, by H. M. Macdonald.

PARIS.

Academy of Sciences, April 25.—M. Wolf in the chair.—The Secretary announced to the Academy the death of M. Demontzey, Correspondant in the section of Rural Economy.—Influence of the place and mode of introduction on the development of the immunising effects of anti-diphtheric serum, by M. S. Arloing. When the anti-diphtheric serum is administered separately its complete antitoxic action is at a maximum when it is introduced into the blood, at a minimum when introduced into the conjunctive tissue.—On rectilinear congruences, by M. C. Guichard.—On differential equations of the second order with fixed critical points, by M. Paul Painlevé.—On groups which occur in the generalisation of analytical functions, by M. P. Medolaghi.—On the resistance of thick plates, by M. Ribière.—On a new standard of light, by M. Ch. Féry. The flame proposed is that of acetylene burnt from a special jet of thermometer tube, 0·5 mm. in diameter. For flames whose heights are between 10 mm. and 25 mm., the relation between the intensity and the height of the flame is a linear one. The apparatus is suggested as a suitable one for rapidly determining the quality of a commercial calcium carbide.—On the thermo-electric electromotive forces in crystallised bismuth, by M. Louis Perrot. The chief difficulty in these determinations was obtaining the bismuth in large, clearly-defined crystals, a difficulty surmounted by slowly cooling the pure metal in a Perrot furnace. The other metal chosen for the couple was copper, measurements being made at temperatures varying from 11° to 100° C. on surfaces parallel and perpendicular respectively to the principal axis. The ratios found for the electromotive forces in the two positions of the crystal were between 2·0 and 2·4 according to the temperature, the crystalline structure thus exerting a greater influence than had been previously supposed upon the thermo-electric constants of bismuth.—On the constitution of the explosive spark in a dielectric liquid, by M. L. Décombe. Photographs from a rapidly revolving mirror of a spark between metallic poles in melted vaseline, show that the spark differs from that obtained in air in possessing a uniform brightness throughout its whole length.—Remarks on the kathode rays, by M. E. Goldstein. A discussion of some results of M. Deslandres, and more especially of the relation between the kathode rays, and the repulsion of the tails of comets by the sun.—Study of the speaking voice by the phonograph, by M. Marage. The quality of each vowel is due to a certain number of harmonics, I, U, OU being formed by one only, A by three.—On the industrial treatment of the emerald in the electric furnace, by M. P. Lebeau. A mixture of 100 kilograms of emerald with half its weight of coke, submitted for an hour to a current of 1500 amperes in the electric furnace, gave two layers, the upper consisting of silicides of aluminium and beryllium, the lower of impure crystallised silicon.—On the quinoneoximes, by M. Amand Valeur. A thermochemical paper giving the heats of combustion and formation of quinoneoxime, thymoquinoneoxime, and α- and β-napthoquinoneoximes. As a general result it is found that the replacement of the quinonic oxygen atom by the residue N(OH) raises the heat of combustion about sixty calories.—On the products of hydrolysis of ouabaïne, by M. Arnaud. A study of the sugar produced shows that the crystals were identical in form and habit with rhamnose, with which the other physical constants and chemical properties also agreed. The other product of hydrolysis was a resin, the further study of which is deferred.—Chlorinating action of ferric chloride in the aromatic series, by M. V. Thomas. By the action of ferric chloride upon boiling benzene, monochlorbenzene is readily obtained. This again, submitted to the action of more ferric chloride, gives a mixture of dichlorbenzenes. The reaction can be pushed as far as the hexachloride. Toluene behaves similarly, the substitution being always in the ring and not in the side chain.—On the dialkyl phosphoric ethers, by M. J. Cavalier.—On the acid phosphoglycerates, by MM. Adrian and Trillat.—On the saccharification of starch by malt, by M. Henri Pottevin. The experiments given show that the transformation of starch into maltose is the result of two distinct operations, dextrine being always an intermediate product. The differences observed between the various dextrines are differences in physical state only.—Hepatic pigments in the Vertebrates, by MM. A. Dastre and N. Floresco.—On the ferments causing the diseases of wines, by M. J. Laborde.—On some points of external morphology of the *Aphroditæ*, by M. G. Darboux.—On the nitrogenous nutrition of phanerogamous plants by the aid of amines, salts of ammonium compounds, and alkaloids, by M. L. Lutz. The amines can be assimilated directly without previous conversion into ammoniacal salts or nitrates. Amines of low molecular weight are more easily taken up by the plant.—Influence of some poisons on the antitoxic power of the blood, by MM. C. J. Salomonsen and Th. Madsen.—Remarks on a paper of M. Daniel Berthelot, entitled "On the rigorous determination of the molecular weights of gases," by M. G. Marqfoy.

DIARY OF SOCIETIES.

THURSDAY, MAY 5.

ROYAL SOCIETY, at 4.30.—Observations on the Action of Anæsthetics on Vegetable and Animal Protoplasm: Dr. Waller, F.R.S., and Prof. Farmer.—On certain Structures formed in the Drying of a Fluid with Particles in Suspension: Miss C. A. Raisin.—On Photographic Evidence of the Objective Reality of Combination Tones: R. W. Forsyth and R. J. Sowter.—The Relations between the Hybrid and Parent Forms of Echinoid Larvæ: H. M. Vernon.

LINNEAN SOCIETY, at 8.—On some Spitsbergen Collembola: Sir John Lubbock, Bart., M.P., F.R.S.—On the Structure and Development of *Soranthera*: Miss Ethel Barton.—The Species, the Sex, and the Individual: J. T. Cunningham.

CHEMICAL SOCIETY, at 8.—The Reactions of the Carbohydrates with Hydrogen Peroxide: C. F. Cross, E. J. Bevan, and Claud Smith.—The Properties and Relationships of Dihydroxytartaric Acid, Part II.: H. J. H. Fenton.—The Affinity Constants of certain Hydroxy-acids: S. Skinner.—Molecular Weights in Solution of Permanganates, Perchlorates, and Periodates: J. Murray Crofts.

INSTITUTION OF ELECTRICAL ENGINEERS (Society of Arts), at 8.—The Prevention of Interruptions to Electricity Supply: Leonard Andrews.

FRIDAY, MAY 6.

ROYAL INSTITUTION, at 9.—Living Crystals: Edward A. Minchin.

GEOLOGISTS' ASSOCIATION, at 8.—Notes on Skye: Horace B. Woodward, F.R.S.—Observations in Lapland: Aubrey Strahan.

SATURDAY, MAY 7.

GEOLOGISTS' ASSOCIATION.—Excursion to Hillmorton and Rugby. Director: Beeby Thompson.

MONDAY, MAY 9.

SOCIETY OF ARTS, at 8.—Electric Traction: Prof. Carus Wilson.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journey across Tibet from West to East: Captain M. S. Wellby.

TUESDAY, MAY 10.

ANTHROPOLOGICAL INSTITUTE, at 8.30.

RÖNTGEN SOCIETY, at 8.—Notes on the Description of a New Induction Coil in *Electrical Review*, February 4, 1898: A. Apps.—Some Notes on Contact Breakers: Dr. J. Macintyre.

ROYAL VICTORIA HALL, at 8.30.—A Simple Experiment and its Explanation: Prof. McLeod.

WEDNESDAY, MAY 11.

SOCIETY OF ARTS, at 8.—Water Gas and its Applications: Vivian B. Lewes.

THURSDAY, MAY 12.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Electrical Response of Nerve to a Single Stimulus investigated with the Capillary Electrometer. Preliminary Communication: Prof. Gotch, F.R.S., and G. J. Burch.—A Study of the Phyto-Plankton of the Atlantic: G. Murray, F.R.S., and V. H. Blackman.—Effects of Prolonged Heating on the Magnetic Properties of Iron: S. R. Roget.—On the Connection of Algebraic Functions with Automorphic Functions: E. T. Whittaker.

ROYAL INSTITUTION, at 3.—Heat: Lord Rayleigh.

MATHEMATICAL SOCIETY, at 8.—On the Numerical value of $\int_0^h e^{x^2}\,dx$: H. G. Dawson.—On the Reflection and Transmission of Electric Waves by a Metallic Grating: Prof. Lamb, F.R.S.—Notes on some Fundamental Properties of Manifolds: A. E. H. Love, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS (Society of Arts), at 8.

FRIDAY, MAY 13.

ROYAL INSTITUTION, at 9.—Recent Experiments on certain of the Chemical Elements in Relation to Heat: Prof. W. A. Tilden, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

PHYSICAL SOCIETY, at 5.—Galvanometers, Part II.: Prof. W. E. Ayrton and T. Mather.

MALACOLOGICAL SOCIETY, at 8.

SATURDAY, MAY 14.

GEOLOGISTS' ASSOCIATION (King's Cross, G.N.R.), at 1.20.—Excursion to Ayot and Hatfield. Directors: J. Hopkinson and A. E. Salter.

BOOKS AND SERIALS RECEIVED.

BOOKS.—A Student of Nature: R. M. Fergusson (A. Gardner).—Royal University of Ireland Calendar, 1898 (Dublin, Thom).—A Course in Mechanical Drawing: J. S. Reid (Chapman).—Quantitative Chemical Analysis by Electrolysis: Drs. A. Classen and W. Löb, translated by W. H. Herrick and B. B. Boltwood (Chapman).—Technical Mycology: Dr. F. Lafar, translated by C. T. C. Salter, Vol. 1 (Griffin).—Electro-Physiology: Prof. W. Biedermann, translated by F. A. Welby, Vol. 2 (Macmillan).—Text-Book of Physical Chemistry: Prof. C. L. Speyers (Spon).—Methods for the Analysis of Ores, Pig Iron and Steel (Easton, Pa., Chemical Publishing Company).—First Stage Magnetism and Electricity: Dr. R. H. Jude (Clive).—A Northern Highway of the Tsar: A. Trevor-Battye (Constable).—Elementary General Science: A. T. Simmons and L. M. Jones (Macmillan).—Journal of the Iron and Steel Institute, Name-Index, Vols. I to L: edited by B. H. Brough (Spon).

SERIALS.—National Geographic Magazine, April (Washington).—American Journal of Psychology, Vol. ix. No. 3 (Worcester, Mass.).—Good Words, May (Isbister).—Sunday Magazine, May (Isbister).—Natural Science, May (Dent).—Botanische Jahrbücher, Vierundzwanzigster Band, v. Heft (Leipzig, Engelmann).—Century Magazine, May (Macmillan).—American Naturalist, March (Boston, Ginn).—Humanitarian, May (Hutchinson).—Proceedings of the University of Durham Philosophical Society, Part 1 (Newcastle-on-Tyne).—Journal of the Royal Microscopical Society, April (Williams).—Journal of Botany, May (West).—Bulletin of the American Mathematical Society, April (N.Y., Macmillan).—Contemporary Review, May (Isbister).—Scribner's Magazine, May (Low).—National Review, May (Arnold).—Brain, Part 80, May (Macmillan).—Fortnightly Review, May (Chapman).—Among British Birds in their Nesting Haunts: O. A. J. Lee. Part xi. (Edinburgh, Douglas).—Knowledge, May (High Holborn).—Zeitschrift für Physikalische Chemie, xxv. Band, 4 Heft (Leipzig, Engelmann).

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THURSDAY, MAY 12, 1898.

ZOOLOGY AS A HIGHER STUDY.

A Text-book of Zoology. By Prof. T. Jeffery Parker, D.Sc., F.R.S., and Prof. William A. Haswell, M.A., D.Sc., F.R.S. 2 vols. Pp. xxxv + 779 and xx + 683. (London: Macmillan and Co., Ltd., 1897.)

Traité de Zoologie Concrète. By Prof. Yves Delages and E. Hérouard. Vols. i. and v. Pp. xxx + 584 and xi + 372. (Paris: Reinwald, Schleicher frères, 1896 and 1897.)

THOSE who write books to assist the University professor and the advanced student of zoology are entitled to great consideration on the part of those to whom their work is addressed, for their self-appointed task is a most difficult and in many ways an elusive one. The mass of detailed concrete fact with which such authors attempt to grapple is simply prodigious, and increases yearly at an enormously rapid rate. The generalisations and theories which hold these facts together are in proportion delicate and flimsy structures which, though they are absolutely essential, yet are easily strained, misrepresented, ignored or ludicrously accentuated by any but the most careful and judicious writer.

In judging an expository treatise dealing with a branch of science, it is necessary that a reviewer should not only recognise the claims upon his gratitude which the long labour of an author may possess, but should also distinctly appreciate the precise purpose of the treatise under notice—the point of view adopted by the author, and his reason for adopting it. The book by Profs. Parker and Haswell is addressed to University students, but yet is intended to be fitted for beginners. It consists essentially in an extended application of the method of teaching by detailed examination of a series of types or examples, now used almost universally for a preliminary or elementary course of zoological study. This method was started in this country not by Huxley, as our authors state, but by Rolleston. It is probably the best way of commencing the study of zoology. It should, however, be limited to a course involving some six or eight well-selected examples. To carry it on as the staple or main form of study after the preliminary course is, in my judgment, a serious error. An acquaintance with the large generalisations of zoology, a determined grasp of some of its unsolved problems, a concrete appreciation of the actual range and extent of genera and species, recent and fossil, in at any rate some large groups in a *complete* manner, and not by mere vague sampling, are what the University student needs to have offered him by way of education. He will, of course, examine and dissect carefully as many animals as he can; but they will not necessarily be those selected as examples by our authors. Nor should the student, I venture to think (after his preliminary course), mechanically demonstrate and identify a host of details in animal after animal, simply because those details are there capable of being identified, and are mentioned in the text-book. This would tend to make our delightful and romantic comparative anatomy as dreary and soul-destroying as is what Rolleston termed "Anthropotomy." A kind of training, it is true, may be given in this way, but it is a bad and injurious training, and does not lead to the progress of zoology or comparative anatomy.

It seems to me that, as a book to guide the student to a second course rather than one dealing with a further series of common-place examples treated with measured, not to say exasperating, detail, we should welcome one which treated only of exceptional, puzzling and debateable animals, such, for example, as Trichoplax, Limnocodium, Ctenoplana, a Cystid, Sternaspis, Acanthobdella, Lingula, Limulus, Peripatus, Neomenia, Balanoglossus, Hippocampus, Siphonops, Hatteria, Rhea and Ornithorhynchus. In such a book it would, at any rate, be necessary to consider the *significance* of the structures described, and to make them really the means of *discussing* the affinities of the several animals.

The publication of Profs. Parker's and Haswell's text-book was almost simultaneous with the sad and untimely death of one of its authors, Jeffery Parker. Many of the beautiful original drawings (more than one thousand in number!) with which the book is illustrated are from his pencil. There can be no doubt that his health suffered for a year or more before he succumbed, and hence we are justified in assigning responsibility for the very numerous and curious errors which the book contains to Prof. Haswell and to Prof. W. N. Parker, of Cardiff, who undertook a final revise of the sheets in this country, rather than to Jeffery Parker.

I have already indicated that I do not think that the unlimited extension of the method of teaching by detailed examination of representative types is satisfactory as *the* method to be pursued in a University course. Nevertheless the student will undoubtedly find Parker's and Haswell's book useful in assisting him in dissection and in examination of skeletons. The authors give a general account of the structure of the larger and smaller groups, illustrated by the selected examples, and a brief exposition of the classification and contents of each group of the animal kingdom; but there is no profession of making this exposition complete. Chapters on geographical distribution and the history of zoology are given at the end of the book, which are so well done that one could wish they were longer.

The authors have deliberately adopted a course of procedure with regard to the citation of authorities and references to monographs and other literature, which they defend in their preface at some length. Their procedure is simply this—that they give no references at all; they never cite the name of an authority, nor give the vaguest intimation as to whether the statement they are making is as old as Cuvier, or is a brand-new discovery, or a special opinion of their own. Even when they copy a woodcut from a previous work, they often omit to state the name of the author to whom it is due, and only quote the copyist who preceded them in taking it from the original author. I can not sufficiently strongly condemn this policy of omission. To me it appears simply disastrous. The authors of the present book have only imitated the example of some recent German writers in thus effacing the discoverer's claim to recognition, and, whilst reducing their own statements to a condition of puzzling confusion, have rendered their book useless to the serious student who wishes to consult original authorities.

In addition to this objection to the omission of reference to authors, there is the fact that it suggests (perhaps rightly, perhaps wrongly) that the author is ignorant of the correct name with which to connect a particular view or discovery, or that he is too lazy to look the matter up, or that he wishes fraudulently to give the impression that he makes such and such a statement of his own knowledge and independently. Finally there is the objection, that by the omission of authors' and discoverers' names, and by thus failing to pursue the historical method of exposition, a very great means of lending interest to a vast mass of detail is sacrificed. Not only is the student deprived of what is often, when present, a very important aid to his memory, but what is in many cases the best and simplest scheme for the presentation of the subject to the student—viz. its actual historical development—is rendered impossible. I hope that others who feel as strongly as I do as to the injury done by those zoologists who deliberately ignore or refuse to cite the names and writings of their predecessors and contemporaries, will join in taking steps to condemn and, if possible, arrest, by the expression of authoritative public opinion, what seems to me a mischievous and mean kind of literary injustice.

The omission of reference to authorities is no doubt to some extent the cause of the existence in Parker's and Haswell's "Text-book of Zoology" of mistakes which either Prof. Haswell or Prof. W. N. Parker would have seized upon and corrected had they appeared as unverified by reference to a recent author in an ordinary treatise. But since no statement in the book is so supported, a reader revising the proof for the author would, on seeing an extraordinary assertion, say to himself, "Dear me! I suppose that is something new; something I've missed." It is probably owing to this that blunders have been left to mislead the student, and to undermine our confidence in all the statements made in the book which have any appearance of novelty. I have not searched the "Text-book" for errors, but I have come across the following in "sampling" its pages. Many of them are so serious that they should certainly be corrected in a new edition with the least possible delay, and steps should be taken to ascertain whether others of a like kind exist, and if so to remove them.

The most astonishing of these errors is the assertion by two sons of W. Kitchen Parker, that ossification occurs in the Selachii. They say (vol. ii. p. 158):

"The skeleton is composed of cartilage with, in many cases, deposition of bony matter in special places—notably in the jaws and the vertebral column. The entire spinal column may be nearly completely cartilaginous (Hexanchus and Heptanchus), but usually the centra are strengthened by radiating or concentric lamellæ of bone; or they may be completely ossified."

On the other hand (an inconsistency due probably to duplicate authorship and multiple responsibility) we find in the description of Chiloscyllium on p. 136, the statement that the skeleton is composed entirely of cartilage with, in certain places, depositions of calcareous salts. And, moreover, in the histological introduction in the first volume "calcified cartilage" is very properly mentioned and distinguished from bone. In attempting to follow up this extraordinary blunder, viz. the assertion that ossification takes place in the cartilage of Selachii, I have looked into the translation of Wiedersheim's "Comparative Anatomy of Vertebrates," and there I find the same assertion, the word which in the original German is "Verkalkung" being translated "ossification" (as though the German had been "Verknocherung"). Now the translator who made this mistake is Prof. W. N. Parker, of Cardiff. Hence we may conclude that it is he who is responsible for the similar statement in the "Text-book," and not either the late Jeffery Parker nor Prof. Haswell of Sydney. But whose soever the fault may be, the sooner so grossly misleading a statement is removed from a book addressed to young students, the better.

The following erroneous statements occur in vol. i. On p. 423 we read:

"Externally each nephridium [of the earthworm] opens by one of the small excretory pores which have already been mentioned as occurring on the ventral surface; internally it ends in a funnel-shaped ciliated extremity with an aperture, the *nephrostome*, opening into the cavity of the corresponding segment."

As a matter of fact, it is a curious and characteristic thing that the nephridia of Chætopoda do *not* open into the segment corresponding to the external pore, but into the segment next in front of it.

P. 372. In the description of Holothuria, our authors state:

"Opening into the cloaca is a pair of remarkable organs of doubtful function, the so-called *respiratory trees*. . . . Each of the terminal branches ends in a ciliated funnel opening into the cœlome."

As a matter of fact, the Holothurian respiratory tree does not possess such ciliated funnels, and in this differs notably from the so-called "posterior nephridia" of the Echiurids.

P. 561. In the description of Peripatus we read:

"A layer of cœlomic epithelium lines the wall of the cœlome and invests the contained organs. Incomplete muscular partitions divide the cavity into a median and two lateral compartments."

Nevertheless the authors elsewhere recognise the fact demonstrated by Sedgwick and myself, that the blood-holding body-cavity of Arthropods is *not* the cœlom but an enlarged system of blood-sinuses the hæmocœl; whilst the cœlom is reduced to perigonadial and perinephridial rudiments.

P. 732. We read that in Nautilus

"A large *vena cava* occupies a position corresponding closely with that of Sepia. It presents the remarkable peculiarity of being in free communication by numerous (valvular) apertures with the viscero-pericardial cavity of the cœlome."

A remarkable peculiarity, indeed, and one which has no existence in fact! The vena cava communicates with veinous blood-spaces by those apertures, and *not* with the cœlom.

In addition to such down-right errors as the above, it must be noted that the authors have too readily accepted the statements of some writers whose names, however, as usual, they do not give. Thus they describe and figure the so-called "Salinella" of Frenzel as though some evidence worthy of attention had been produced in support of the existence of such a creature; and they declare that a species of Apus "has been shown to be" hermaphrodite. They allude to the assertions of Mr. H. M. Bernard. It is well that that gentleman's attention should be drawn to the fact, and that he should at once either withdraw or confirm by some evidence his published statement that a species of Apus is hermaphrodite.

As to faults of omission—there is no doubt always room for divergence of opinion as to what should and should not be comprised within the area of a book necessarily selective and limited. But nothing can, it seems to me, justify the omission of all reference to the important Leech, *Acanthobdella*, when the affinities and origin of the Hirudinea are discussed; nor such an inadequate account of the tubular continuations of the pericardial cœlom of Lamellibranchs as that which is given at p. 640, where Keber's organ is treated as an excretory organ, and nothing said of its morphological significance.

Opinions, no doubt, may differ as to the exact form and spelling of many zoological terms. At the same time, I fail to see the justification for writing "cœlome" in the place of "cœlom," "Cœlenterata" in place of "Cœlentera," and "Echinodermata" in the place of "Echinoderma."

It will thus be seen that although there is a great deal of excellent description in the new "Text-book," and many beautiful and useful figures, there is yet a very serious amount of inaccuracy, and in some matters of great importance a want of sound judgment which must seriously interfere with its utility.

It is not uninteresting to compare with the text-book of Parker and Haswell, one of the four text-books of zoology which are in course of publication at the present moment in France. We have that by Prof. Delages and M. Hérouard, also a text-book by Prof. Edmond Perrier of comprehensive scope and abundant detail; one edited by M. Raphael Blanchard, to which a whole series of authors contribute each his fascicle; and one by Prof. Roule, of Toulouse. The work projected by Prof. Delages is the most original of these, on account of the method pursued. Prof. Delages aims at a complete logical exposition of the characters of each phylum, class, order, family and genus of the animal kingdom. Not only that, but he gives a schematic figure which corresponds with his description of each group—so that the student realises in concrete form the characteristics of a class—an order or a family—characteristics which may be modified by greater or less development, but give the essential features of the group. Hence the term "Zoologie Concrète," which forms the title of the work. The plan is a carrying out into a complete system of the method which I (borrowing it from older writers) made use of when in my article Mollusca ("Encycl. Brit."), I drew an Archi-mollusc. Prof. Delages will, when he comes to that group, draw and describe not only an archi-mollusc, but an archi-gastropod, archi-cephalopod, &c., and also an archi-prosobranch, an archi-diotocardian, and an archi-patellid, and similar schematic forms—"types morphologiques," as he terms them—for every group—down to the actual genera. It is essential to the plan of Prof. Delages' work that every genus shall be not only named and cited, but described at sufficient length to enable the reader to identify the genus of a specimen concerning which he is interested, and thus to obtain a reference to more detailed monographic literature.

It is evident at once that the project is a very large one. Such a work fully carried out with complete anatomical detail such as is necessary to give a true conception of the relations of large and small groups, would be an ideal treatise for the advanced student. The only objections to it seem to be (1) that if thoroughly done it must be a work of enormous size, extending to at least twenty large octavo volumes. (2) That it is impossible for one or even two authors to possess a sufficiently detailed knowledge of the whole animal series to produce a really accurate and judicious account of every group with the minuteness proposed.

We have, however, two volumes already published—the first dealing with the structure of the Cell and with the group Protozoa, the second devoted to what MM. Delages and Hérouard call the "Vermidea," namely certain small groups of debated affinities; to wit, the Gephyræa, Polyzoa, Rotifera, Chætognatha, Kinorhyncha (Echinoderes), and Brachiopoda—names which Prof. Delages prefers to alter into Gephyria, Bryozoaria, Trochelmia, Kinorhynchia and Brachiopodia. Some of the changes in names and the classification adopted by MM. Delages and Hérouard (especially in regard to the Protozoa) are valuable and likely to secure general assent. But it is difficult to approve of the word Vermidea—a Greek adjective made from a Latin substantive—and one which, to me at any rate, seems not to be necessary for classificatory purposes.

In these two volumes we can see how the "concrete" system of exposition works. It certainly results in a very useful treatise on the Protozoa. Numerous process blocks (no less than eight hundred and seventy) are introduced into the text, and though they are by no means equal in beauty to the woodcuts of the text-book by Parker and Haswell, they are yet sufficient for their purpose. In the second volume published (that on the Vermidea), which is vol. v. of the series as planned by Prof. Delages, forty-five coloured plates are introduced as well as five hundred and twenty cuts. Many of the coloured plates are occupied with diagrammatic figures, showing by means of strong conventional colouring the anatomy of Gephyræans, Rotifers, Polyzoa and Brachiopods, but two are devoted to highly-finished coloured drawings of the living appearance of selected species of Sipunculids and Echiurids respectively. It is probably the first time that a treatise intended for students has been so fully illustrated. Naturally, in attempting to test the quality of such a book, one looks at the treatment of subjects specially familiar to one's self. In this volume I looked with curiosity at the account of Rhabdopleura. I find it excellent, occupying eight pages, with seven large process blocks—some coloured, which are diagrams, others copied from originals duly acknowledged. The only objection I have to offer is that here as elsewhere the authors yield to a very natural tendency, and instead of using the terms "tubarium," "pectocaulus," and "gymnocaulus," as applied to certain parts in the original description from which their information is derived, invent new descriptive terms which seem neither necessary nor advantageous. As showing how difficult it is to quote accurately detailed accounts of an organism of which the writer who quotes has no special knowledge, the following is an instance. MM. Delages and Hérouard say "Ray Lankester a décrit à droit du rectum un testicule qui s'ouvrirait à la marge de l'anus; mais Fowler a nié son existence." Whilst I thoroughly agree with Prof. Delages in the propriety and usefulness of citing the names of authors responsible for statements, and admire the thorough and conscientious way in which he has thus brought his work up to the latest date so as to make it a really valuable source of references, I note that it is difficult to be always exact in such citations. Fowler had no opportunity for denying the existence of the testis described by me in Rhabdopleura. Of its existence there is no possibility of doubt; it was observed in several specimens, and figures of several of these were published by me. All that Fowler said was that he did not find it in certain specimens observed by him. This is entirely in accordance with what I had stated, since in by far the majority of living specimens studied by me it was absent, and only present in exceptional individuals which happened to be in a state of sexual maturity.

I will venture also to enter a protest against the citation by M. Delages of a genus of Protozoa based on the "ciliated pots" of Sipunculus. Every one knows that these are two-celled structures belonging to Sipunculus itself, and not parasites.

The plan of the "Zoologie Concrète" comprises nine volumes royal octavo of about 500 pages each; but it seems to me impossible that the larger groups can be treated with the same thoroughness as are those dealt with in the two published volumes unless a much larger number of volumes is produced. We are promised a volume on the Prochordata in the present year, a volume on the Cœlentera in 1899, and separate volumes subsequently on each of the following groups:—Echinoderma, Vermes, Articulata, Mollusca, Vertebrata. Whether the work can be thus completed or not, there is no doubt that the volumes published are of considerable value, and their successors will be looked for with great interest by all zoological colleagues of MM. Delages and Hérouard.

The proper limitations of size and the true scope of zoological text-books form a subject which may be endlessly debated. After all, is it not the fact that Bronn's "Thierreich" is the only treatise which is sufficiently comprehensive and detailed? Do we not know that it will never be finished, but that it must be re-written volume by volume so long as zoology endures? And is not Gegenbaur's "Grundriss" the only really masterly condensation and convincing exposition of the great generalisations of comparative anatomy hitherto written?

Gegenbaur's book is nearly twenty-five years old. A brief survey of the genealogical significance of animal structure is needed now, which shall as firmly and clearly present the morphological doctrines of 1900 as did the "Grundriss" present those of 1875.

E. RAY LANKESTER.

WEATHER PREDICTION.

Die Wettervorhersage. Im auftrage der Direktion der deutschen Seewarte bearbeitet von Prof. Dr. W. J. van Bebber, Abtheilungsvorstand der deutschen Seewarte. Zweite verbesserte und vermehrte Auflage. (Stuttgart: Ferdinand Enke, 1898.)

SOME years ago Prof. van Bebber put before the world a popular account of the principles underlying weather prediction. His long experience at the Deutschen Seewarte enabled him to give the latest information concerning the processes employed in the most authoritative manner, and the result was necessarily a very interesting book. It is therefore not a matter of surprise that this treatise should have run out of print, and a second edition be peremptorily called for. Such a result must, however, be gratifying to the Professor, because he has recognised the fact, that the full value of the information supplied to the public through the weather bureau, supplemented as it is by weather charts and tables, cannot be fully appreciated so long as those for whose benefit such information is disseminated, remain ignorant of the general principles of meteorology. Guided by this motive, he has systematically endeavoured to popularise the science, while working in the forefront as a scientific meteorologist. His method of making the information useful, and of instructing those who are possibly far removed from a meteorological station, and therefore thrown to a considerable extent on their own resources, consisted in preparing a large number of weather charts, something like two hundred in all, arranged in a systematic order, in which might be found represented the conditions of the weather obtaining at any subsequent epoch. A judgment or forecast could then be formed from the similar data supplied in the book, and possibly the effect of local circumstances taken into account. The same method is pursued in the present edition; indeed it has not been found necessary to alter the maps in any essential particular, judging by the dates to which they refer.

If there be any who doubt the efficacy of the modern system of forecasting the weather, or the utility of the practice, it will be to a certain extent reassuring to learn that, after twenty-two years' daily study of the weather maps of Europe, Prof. van Bebber still relies confidently on their accuracy and trustworthiness. And although individual judgment may be disposed to prefer its own conclusions in this matter of weather and the value of forecasts, the question is one on which authority should be at least heard with respect. For it is only those who systematically compare the forecasts with actual results, and who also are able to draw their information from reports covering large areas, who can judge of the success of a system which is more or less upon its trial. One failure to issue a storm warning from which suffering and disaster result, is remembered far more easily than the many more numerous cases in which the signal sends out its warning with due effect. It must be admitted that there is apparently not the same tendency to cover the Meteorological Bureau with ridicule, when the forecast proves glaringly incorrect, as was noticeable some years ago; but this greater leniency may simply indicate that the joke has been worn threadbare, and not imply any degree of greater respect to the meteorological authority. Increased confidence can only come with greater knowledge, and therefore we are inclined to welcome the demand for a new edition of Prof. van Bebber's book as an indication that more attention is being paid to a subject, at least abroad, which nearly concerns the comfort of the community and the prosperity of many trades and callings.

Moreover, it is distinctly reassuring to find that the methods of weather prediction are in a measure stereotyped. That no particular change or improvement has been made in these methods, in the space of time covering the issue of the two editions, is a clear indication that they are based on well-ascertained scientific lines, from which the elements of chance have been eliminated. The two sections of the work into which the greatest amount of alteration has been introduced is, first, that dealing with the probable character of the weather over longer periods than twenty-four hours in advance, and in a lesser degree the movements of areas of low barometric pressure. The discussion of the paths along which cyclonic movements preferably travel, has been an inquiry on which Prof. van Bebber has long worked, and though the information derived from the examination of a greater number of instances might be expected to modify the conclusions derived entirely from experience, no great alteration seems to be necessary, and no fresh results appear to be indicated. The percentages of successful forecast or repetition of the same character of weather before, during, and after the passage of a cyclone, shown in the tabular statement, are those derived from a fourteen years' study of the behaviour of these systems. Seven years' further study has apparently only confirmed the conclusions originally drawn.

Only in the section on the possibility of predicting the weather some days in advance, do we meet with weather charts of a tolerably recent date, an evidence of the author's work during the last few years. Taking it for granted, as we may, that the weather of any region is mainly determined by the barometric pressure and the interchange of areas of high and low barometer, Van Bebber defines five conditions of weather type, determined by the relative positions of atmospheric pressure over the continent of Europe, which conditions are repeated in their general features with great frequency, and can be easily recognised. The length of continuance of the same weather after the establishment of one or other of these typical systems will vary at different times of the year, and according to the relative positions of high and low pressure; but, on the average, one can reckon upon the weather remaining unchanged for about three and a half days, and in favourable conditions on even greater permanency. What is now wanted is the means to predict with certainty the transference of one determining type of weather to another. When this knowledge exists, and the author looks forward hopefully to a time when it will be within our reach, we shall be able to make those longer forecasts which are demanded by the necessities of practical life.

OUR BOOK SHELF.

Maryland Geological Survey. Vol. I. Pp. 539. (Baltimore: The Johns Hopkins Press, 1897.)

Iowa Geological Survey. Vol. VI. *Report on Lead, Zinc, Artesian Wells, &c.* (Des Moines: Iowa Geological Survey, 1897.)

THE first volume of the "Maryland Geological Survey" is one of which Prof. W. B. Clark, the State Geologist, and others who have been concerned in its production, should be proud. The volume consists primarily of a summary of past and present knowledge concerning the physical features of Maryland, and embraces an account of the geology, physiography and natural resources of the State, with a bibliography of all publications relating to these matters. Of exceptional interest is an admirable report by Dr. L. A. Bauer upon magnetic surveys in general and the magnetic conditions of Maryland in particular. This report is an inspiring statement of the development and purposes of magnetic surveys, and the valuable information which Dr. Bauer has obtained should induce other States to institute similar inquiries to those carried out by him. The results of such work are not only of great importance to the county surveyors and others who are engaged in determining the boundaries of lands, but are also of wider value on account of the relations which exist between geology and terrestrial magnetism, many magnetic features of a district being related to the geological structure of the underlying rocks. Several fine plates, and other figures, illustrate the report.

A number of separate papers of general economic interest are included in the sixth volume published by the Iowa Geological Survey, under the direction of Dr. S. Calvin, the State Geologist. Prof. A. G. Leonard describes the lead and zinc deposits of the State, and Dr. S. W. Beyer the Sioux quartzite and certain associated rocks. Prof. W. H. Norton gives a detailed account of the artesian wells of Iowa, which should be found of considerable value by the citizens of the State; and Mr. H. F. Bain describes the relations of the Wisconsin and Kansan drifts in Central Iowa. The volume thus constitutes a worthy contribution to the economic geology of Iowa.

Elementary Chemistry, Practical and Theoretical. First Year's Course. By T. A. Cheetham, F.C.S. Pp. 128. (London: Blackie and Son, Ltd., 1898.)

THIS is an addition to the class of school books containing experiments which aim at developing a pupil's thinking powers rather than at supplying "useful knowledge" of the kind contained in elementary books of science a few years ago. It is an exercise book constructed on sound principles by a teacher of experience; therefore the experiments have an educational value, and are also practicable. The pupil is instructed to "observe what happens when mercury is heated," "observe the effects of heating sulphur under different conditions," "heat a weighed quantity of chalk, and find whether there is a gain or loss of weight," and so on, instructions being given how to proceed in each case. The course of work and study follows closely that proposed in the British Association Report on the Teaching of Chemistry, and the scope of the treatment includes the laws of chemical combination. The first part of the book is devoted to practical work, while the second contains material for lecture experiments and theoretical information to be studied in connection with the practical work of the laboratory.

The plan and execution have much to commend them, and the volume is a distinct advance upon the text-books of the days before the new methods of teaching chemistry had been developed. No book of science should, however, be published without an index.

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.*]

Nomenclature and Notation in Calorimetry.

ALL who are engaged in thermal investigations themselves, as well as those who have occasion to study the published work in this department of science, must have been frequently annoyed by the use of the word *calorie* with its varying signification. It has been sought to remove the inconvenience by qualifying the calorie as small or great, and in other ways; but on opening a book at any place where the results of thermal determinations are given, it is in most cases difficult to discover at once what unit of heat the author is using.

As different classes of investigation are carried on on different scales, it is obvious that it is a convenience, if not a necessity, to have different heat units at disposal. The unit which is suitable to express the thermal changes in a beaker in the laboratory, would manifestly be inconvenient when dealing with the daily or seasonal changes in a lake or an ocean. It is therefore natural and necessary to have heat units of different magnitudes, but it is neither natural nor necessary to call them all by the same name, and it is extremely inconvenient not to have a short form of notation which will show on its face the actual heat unit used.

In the early literature of the equivalence of heat and work in this country, one unit of heat is universally used; it is the pound-degree-Fahrenheit, and in the writings of Joule, Thomson, Rankine and others of that time, it is simply called "heat unit," as there was no other competing with it. With the rise and development of thermal chemistry, it was necessary to fashion the compound unit out of the simple units in common use in chemical laboratories; these are the gramme and the Celsius degree.

The heat given out by one gramme of water cooling by 1° C. at ordinary temperatures, is the unit most used in such researches; and it received the name of calorie, sometimes now called small calorie.

For many purposes this unit proved itself inconveniently small, and several larger units have been used, such as the heat given out by one kilogramme of water cooling 1° C. at ordinary temperatures, or the heat given out by one gramme of water cooling from 100° C. to 0° C.; but the name of calorie was retained in connection with them all, and in the specification of a quantity of heat by a number, the nature of the unit was indicated by the syllable cal. or the letter K, neither of which, of itself gives any information.

In my own work, and in the study of the writings of others, I have adopted a form of notation which I have found so useful that I propose to lay it before the readers of NATURE. I do not doubt that others who interest themselves in calorimetric work have been driven to adopt some similar, perhaps the same, perhaps a better form of notation; and I think they will agree with me that some system of self-interpreting notation should be universally adopted without loss of time.

Just as, when dealing with work, we use currently the expressions foot-pound and kilogramme-metre, so in calorimetry it is quite common to talk of a gramme-degree, or a kilogramme-degree; and what I propose is to use no other expression than these compound and self-explaining ones, and, in writing, to express them shortly by $g°$ and $k°$ respectively, to which for clearness the symbol of the thermometric scale must be added, so that they become $g°$ C. and $k°$ C. when Celsius' scale is used, or $g°$ F. and $k°$ F. when Fahrenheit's scale is used.

On this system the expression $g°$ C. would replace the ordinary "cal." and Ostwald's K would be represented by $100\,g°$ C. or $0.1\,k°$ C., or by $h°$ C., to mean hectogramme-degree C. With perfect exactness K would be expressed by $g\,100°$ C., but the difference between $100\,g°$ C. and $g\,100°$ C. is much less than the probable experimental error in any calorimetric operation. In a table containing a column of quantities of heat expressed in numbers of gramme-degrees-Celsius, the nature of the unit would be indicated at the top of the column by $g°$ C.; exactly as, in a column of temperatures, the unit is indicated by the symbol °C. or °F. The original British heat unit is then clearly expressed by lb.° F.

A heat unit made up of any unit of weight and any unit of temperature can be perfectly expressed in this system. Thus, if there were any advantage in doing so, we might have $g°$ F., lb.° C., $k°$ R. and many others, and their meaning would be at once apparent on inspection.

In oceanographical work, where the heat exchanges between one layer of water and another, or between the water and the air are under discussion, I have found the most convenient heat unit to be the fathom-degree-Fahrenheit, or the metre-degree-Celsius, which are abbreviated for the purposes of notation into $f°$ F. and $m°$ C., respectively. The nature of this unit will be most easily understood by considering an example.

In a paper, "On the Distribution of Temperature in Loch Lomond in the Autumn of 1885," read before the Royal Society of Edinburgh, and published in its *Proceedings* for the session 1885–86, I have given, at page 420, a table of the changes in the distribution of heat in the direction of depth, between several pairs of dates, in the Luss basin of Loch Lomond. At a certain depth, indicated by the intersection of the temperature curves, the temperature of the water is the same on both dates. The season being autumn, the layer above this depth has been losing heat, partly to the air above and partly to the water beneath, while the layer below the depth of common temperature has been on the whole the gainer. Thus, taking the dates September 5 and October 15, the intersection of the temperature curves is found at a depth of 16 fathoms; and in the interval of forty days the mean temperature of the water above this depth has fallen by 5·8° F., from 55·0° F. to 49·2° F. The thickness of the layer is 16 fathoms; therefore the loss of heat has been $16 \times 5{\cdot}8 = 92{\cdot}8\,f°$ F., or 92·8 fathom-degrees-Fahrenheit. The total depth of the lake at the spot was 35 fathoms, therefore the layer of water below the depth of common temperature was 19 fathoms thick. The mean temperature of this layer was 47·1° F. on September 5, and 48·9° F. on October 15, showing a rise of 1·8° F. in the interval. This corresponds to a gain of heat represented by $19 \times 1{\cdot}8 = 34{\cdot}7\,f°$ F. Assuming that the heat gained by the lower layer has been entirely at the expense of the upper one, we see that the loss of heat of the upper layer, during the interval, has been to the extent of 37·4 per cent. to the deeper water, and 62·6 per cent. to the air. The upper layer of water has thus been passing heat at the average rate of $1{\cdot}485\,f°$ F. into the air, and into the deeper water at the rate of $0{\cdot}85\,f°$ F. per day.

It is worthy of remark that the fathom-degree-Fahrenheit and the metre-degree-Celsius are interchangeable in heat calculations, because the fathom is 1·8 metre and the Celsius degree is 1·8° F.

This is a great convenience, and its usefulness will be apparent by applying it to the above example.

We have seen that, during the interval of forty days, the average transmission of heat from the upper layer of water has been at the daily rate of $1{\cdot}485\,f°$ F. to the air and of $0{\cdot}85\,f°$ F. to the deeper water. Writing $m°$ C. for $f°$ F., and considering a horizontal area of one square centimetre, we find at once that the average daily supply of heat from the water to the air has been at the rate of $148{\cdot}5\,g°$ C., and to the deeper water at the rate of $85\,g°$ C. (gramme-degrees-Celsius) per square centimetre of superficial area.

It is unnecessary to provide for special cases where specially suitable units will be chosen as a matter of course; but for ordinary work of constantly recurring type it is important to have a system of nomenclature and of notation, each of which will tell its own story. J. Y. BUCHANAN.

May 4.

Future Rainfall.

MOST people probably suppose that we have no light whatever on the fluctuations of our rainfall in future years, and that he would be a bold meteorologist who offered to forecast them. Yet, if there be truth in the conclusions arrived at by Prof. Brückner, we are not wholly without light on the subject; for a part of this country, at least, in common with probably the greater part of the globe, is subject to a regular recurrence of cold and wet periods, at about 35 years intervals (measuring from the centre of one such period to that of the next); these periods alternating with others which are hot and dry. It seems useful to inquire how we at present stand, and, if possible, what are our present prospects in respect of this theory.

For this purpose I will here employ a simple meteorological method, which seems to have been little used among us hitherto, viz. algebraic addition, step by step, of a series of plus and minus values; the resulting figures being then plotted as a curve.

Suppose *e.g.* any set of such values, as follows:

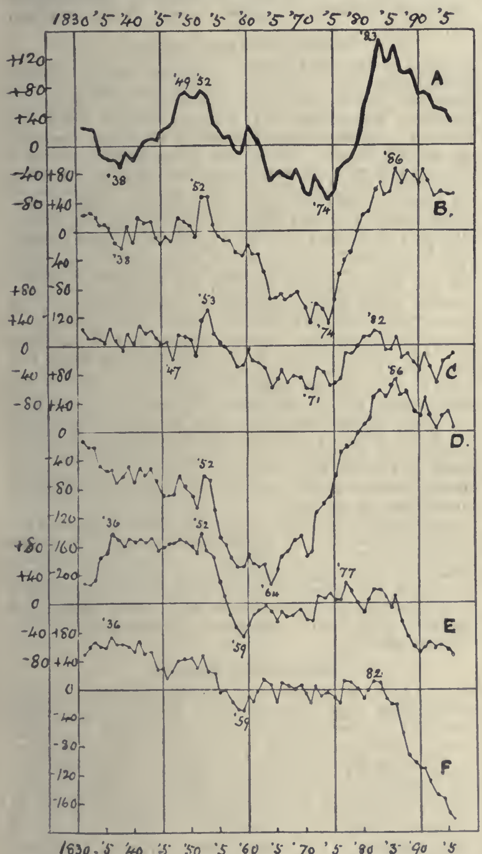
+ 3 + 6 − 2 + 8 + 12 − 3 − 9, &c.

By addition we get this series:

+ 9 + 7 + 15 + 27 + 24 + 15, &c.

This latter series is thrown into a curve.

In his *British Rainfall* for 1881, 1891, &c., Mr. Symons has given a series of rainfall values for a number of stations in



A, Boston; B, Oxford; C, Chilgrove; D, Exeter; E, Kendal; F, Bolton.

different parts of England (from 1830 onwards); also the percentage equivalents of these, the average for each station being taken as 100. These latter I have made use of, taking the excess over 100 as a plus value, and the deficiency under 100 as a minus. Thus *e.g.* 106 would be + 6; 94 would be − 6.

When this has been done with the values for Boston, in Lincolnshire, and the series treated by the addition-method described, we get the curve marked A in the diagram; and it is to this curve I would especially invite attention. For it is to the eastern parts of our country that Brückner's cycle applies; the west belongs to what he calls *Ausnahmegebiete*, or exceptional regions.

Bearing in mind that these curves rise for plus values and fall for minus, we note in this Boston curve a general rise from 1838 to 1849 (or 1852), also from 1874 to 1883; while we have general fall from 1852 to 1874, and from 1883 to 1896 (the last point dealt with). In other words, the two former were *wet* periods, the two latter *dry* periods.

The following figures show this:

	Years.	Dry.	Wet.
1838–52	14	4	10
1874–83	9	none	all
1852–74	22	17	5
1883–96	13	9	4

Between the wave crests 1849 and 1883 are 34 years; and between the wave hollows 1838 and 1874 are 36 years. Or, if we like to take as approximate centres of the wet periods (say) 1843 and 1878, we have about the same interval, 35 years.

These fluctuations, standing alone, would clearly be too slender evidence of a cycle. But Brückner claims that his cycle of 35 years has been in evidence in various parts of the globe through these two centuries at least (since 1700).[1] If the eastern part of England, then, may be expected to conform to the law in future, we might reasonably, perhaps, look for the centre of another wet period somewhere in the second decade of next century. And for the near future (without attempting detail) a continuation for some years of the recent *régime* seems not unlikely, dry years preponderating over wet. That is, the curve should go down further, on the whole, for some years yet.

I have given a number of other curves for comparison, viz. B, Oxford; C, Chilgrove, in Sussex (near Chichester); D, Exeter, less reliable perhaps (see *Brit. Rf.*, 1881); E, Kendal; and F, Bolton, in Lancashire. As we go westwards, the curve seems to degrade somewhat (regarded from our standpoint), though the same type may be discerned. In the northern curves, Kendal and Bolton, we find little in common with the Boston curve, though something like a 35 years' interval may, in cases, be made out.

It may be well to state that other stations in the east of England yield very similar curves to that for Boston.

A. B. M.

Prehistoric Egypt.

I NOTICE a review in NATURE containing some statements about my own work which are inaccurate.

The term "New Race" is quite correct, as the race was entirely new to us, whatever their age; and as a tentative name which commits us to no theories, it can hardly be said that I "did not understand the facts of the case" in using it. In dating the race to at least 3000 B.C., I was doing all that the facts warranted at the time; and if we all agree now that they are older, it is by mere consensus of guessing, for no absolute proof of earlier age by juxtaposition with other things has even yet been found.

Further, Dr. Verneau's erroneous assumption that the condition of the bones could be produced by exposure to the air alone, is quoted, with the remark that my "sensational discovery therefore falls to the ground." How exposure to the air can possibly break off the ends of bones and scoop out the cellular structure, while the bone remains hard and firm, not even Dr. Verneau can explain. To deny cannibalism in such a case, reminds one of the indignant repudiation of the intention to smoke by a man who already has a pipe in his mouth and a match in his fingers.

No one values more than I do the discoveries of M. de Morgan; but had he dealt more with strict evidence and full details, and given weight to many facts which he has ignored, I venture to think that his work would have needed less revision in future.

W. M. FLINDERS PETRIE.

University College, W.C.

I HAVE read Mr. Petrie's letter, and I still think that M. de Morgan is right, and that Mr. Petrie is wrong. I also think that Dr. Verneau is right, and that his "assumption" is not "erroneous." Mr. Petrie's reference to the revision which he thinks M. de Morgan's work will need is remarkable; for his own will—in my opinion—need much more! however much M. de Morgan's may need!

THE REVIEWER.

[1] We may here recall that Bacon seems to have been aware of such a cycle.

Photographic Action of Printer's Ink.

In your issue dated April 28, I notice an article reporting the Bakerian Lecture given by Dr. W. J. Russell.

One paragraph states that printing ink *at a distance* will act upon a photographic film. Is that the explanation of the following curious circumstance?

An Ilford ordinary plate, which I had kept in its box unopened for five years, was exposed recently upon a poorly-lighted subject; upon development I found, instead of my subject, the matter of the advertisement which was upon the outside wrapper. This came up strong and quickly, but nothing was seen of the subject upon which the plate had been exposed in the camera.

The image was a positive, and the large type word "Ilford" was very prominent.

So it would appear that the sensitised plate had been acted upon by the printer's ink, through the lid of the box and three wrappers of paper, two of which were brown.

W. Trueman Tucker.

Parkside, Loughborough, May 8.

A very interesting result. The picture no doubt arose from the printer's ink, and it shows what great length of time will do. The plate must have been face upwards. W. J. R.

May 9.

Electrical Impressions on Photographic Plates.

Some simple variations of the inductoscript may be of general interest.

A photographic glass negative is placed on a plate, and a ¾-inch induction coil is sparked for one or two minutes on the outsides: a perfect positive with fine detail can be developed.

If printed paper is so treated, a clear image of the reading is made, white letters on a dark ground: a coin gives dark letters.

If the exposure to the spark is prolonged, an indistinct image of the print, which is on the other side of the paper, will also appear.

More or less perfect images can be made, if ink or pencil writing or a photographic print be put on the plate. When thin paper is placed between a coin and a plate, a fair, but less perfect, reproduction of the coin will be produced.

It makes very little difference whether fast or slow plates are employed. A. S. Bates.

Winchester College.

Bacteria on an Ancient Bronze Implement.

A few days ago an ancient bronze implement was brought to me showing small excrescences, the centres of rapid oxidisation, which the owner told me had only very recently developed.

On examining the material scraped off one of these excrescences under the microscope with fairly high powers (a ⅙ inch and ⅛ inch objective), it was found to be swarming with bacteria, which seemed to be the cause of the rapid oxidisation. I have not been able to trace any reference to bacteria inhabiting a similar nidus, and I should be much obliged to any correspondent who could direct me to the literature on the subject, and inform me of the best way of sterilising the implement without injury. Wm. Edward Nicholson.

Lewes, May 3.

THE ROYAL SOCIETY SELECTED CANDIDATES.

The following are the names and qualifications of the fifteen candidates selected by the Council of the Royal Society, to be recommended for election into the Society this year:—

Henry Frederick Baker,

M.A., Fellow and Lecturer of St. John's College, Cambridge; University Lecturer in Mathematics. Author of "A Treatise on Abel's Theorem and the Allied Theory" (1897); and of the following papers, among others:—"Weierstrassian Formulæ applied to the Binary Quartic and Ternary Cubic" (*Quart. Journ. Math.*, vol. xxiv., 1889); "Gordon's Series in the Theory of Forms" (*Messenger Math.*, vol. xix., 1889); "The Full System of Concomitants of Three Ternary Quadrics" (*Camb. Phil. Soc. Trans.*, vol. xv., 1889); "The Application of Newton's Polygon to the Singular Points of Algebraic Functions" (*ibid.*, vol. xv., 1893); "On Euler's ϕ-Function" (*Proc. Lond. Math. Soc.*, vol. xxi., 1890); "Fundamental Systems for Algebraic Functions" (*ibid.*, vol. xxvi., 1895); "On Noether's Fundamental Theorem" (*Math. Annalen.*, vol. xlii., 1893); "On a Geometrical Proof of Jacobi's I-Function Formulæ" (*ibid.*, vol. xliii., 1893); "On the Theory of Riemann's Integrals" (*ibid.*, vol. xlv., 1894); "The Practical Determination of the Deficiency and Adjoint ϕ-Curves for a Riemann Surface" (*ibid.*, vol. xlv., 1894); "On a Certain Automorphic Function" (*Camb. Phil. Soc. Proc.*, vol. viii., 1895); "On the Hyperelliptic Sigma-Functions" (*Amer. Journ. Math.*, vol. xx., 1897).

Ernest William Brown,

Professor in Haverford College. Formerly Fellow of Christ's College, Cambridge. Author of the following papers:—In the *American Journal of Mathematics*—"On the Part of the Parallactic Inequalities in the Moon's Motion, which is a Function of the Mean Motions of the Sun and Moon" (vol. xiv., pp. 141–160, 1892); "The Elliptic Inequalities in the Lunar Theory" (vol. xv., pp. 244–263, 321–338, 1893); "Investigations in the Lunar Theory" (vol. xvii., pp. 318–358, 1895). In the *Monthly Notices Royal Astronomical Society*—"On the Determination of a Certain Class of Inequalities in the Moon's Motion" (vol. lii. pp. 71–80, 1891); "Notes on Lunar Theory" (vol. lii. pp. 408–9, 1892; liv. p. 471, 1894; lv. pp. 3–5, 1894); "Note on Hansen's Lunar and Planetary Theories" (lvi. pp. 52–3, 1895); "Note on Mr. Stone's paper, 'Expressions for the Elliptic Coordinates of a Moving Point to the Seventh Order of Small Quantities,'" 1896. In the *Proceedings Cambridge Philosophical Society*—"On the Part of the Parallactic Class of Inequalities in the Moon's Motion which is a Function of the Ratio of the Mean Motions of the Sun and Moon" (vol. vii. pp. 220–1, 1891). Before the London Mathematical Society, November 1896—On "The Application of Jacobi's Dynamical Method to the General Problem of the Three Bodies"; "On Certain Properties of the Mean Motions, and the Secular Accelerations of the Principal Arguments used in the Lunar Theory." Author of "An Introductory Treatise on the Lunar Theory" (Cambridge University Press, 1896, pp. viii.–292).

Supplementary Certificate.—"On the Mean Motions of the Perigee and Node"; "On the Theoretical Values of the Secular Accelerations of the Lunar Theory"; "Note on the Mean Motions of the Perigee and Node," in the *Monthly Notices R. Astron. Soc.*, 1897; "Theory of the Moon, containing a New Calculation of the Coordinates of the Moon in Terms of the Time" (Part I.–IV. *Memoirs R. Astron. Soc.*, vol. liii., 1897, pp. 39–116).

Alexander Buchan,

M.A., LL.D., F.R.S.E. Secretary, Scottish Meteorological Society, from 1860. Member of the Meteorological Council from 1873. Author of the following contributions to Meteorology: "Mean Atmospheric Pressure and Prevailing Winds of the Globe and Handy Book of Meteorology," 1868; "Weather and Health of London," jointly with Sir Arthur Mitchell, 1875; "*Challenger* Report on Atmospheric Circulation in 1889"; "*Challenger* Report on Oceanic Circulation in 1895"; "Specific Gravities and Oceanic Circulation in 1896"; "Meteorology," in the "Encyclopædia Britannica"; Reports on the Meteorology of Ben Nevis, &c.

Sidney Frederic Harmer,

M.A., Superintendent of the University Museum of Zoology, and Fellow of King's College, Cambridge. Engaged for many years in researches in Embryology and Comparative Anatomy. Discoverer of important facts connected with the Anatomy of Cephalodiscus, which largely assisted in fixing its systematic position; and of the occurrence of a process of extensive Embryonic Fission in certain Polyzoa. Author of numerous papers on zoological subjects, including the following:—"On the Structure and Development of *Loxosoma*" (*Quart. Journ. Micros. Sci.*, vol. xxv., 1885); "On the Life-history of Pedicellina" (*ibid.*, xxvii., 1887); "On the British Species of *Crisia*" (*ibid.*, xxxii., 1891); "On the Nature of the Excretory

Processes in Marine Polyzoa" (*ibid.*, xxxiii., 1892); "On the Occurrence of Embryonic Fission in Cyclostomatous Polyzoa" (*ibid.*, xxxiv., 1893); "Preliminary Note on Embryonic Fission in *Lichenopora*" (*Roy. Soc. Proc.*, lvii.); "Appendix to the *Challenger* Report on *Cephalodiscus*" (*Challenger* Reports, vol. xx.); "Sur l'Embryogénie des Bryozoaires Ectoproctes" (*Arch. de Zool.*, 1887); "Notes on the Anatomy of *Sinophilus*" (*Journ. Marine Biol. Assoc.*, 1889). Joint Editor of the Cambridge Natural History. Member of Council of the Marine Biological Association. Is attached to science, and anxious to promote its progress.

ARTHUR LISTER,

F.L.S. Distinguished for his researches on the Mycetozoa. Author of "Notes on the Plasmodium of *Badhamia utricularis* and *Brefeldia maxima*" (*Annals of Botany*, vol. ii., 1888, pp. 1–24, plates 1, 2); "Notes on *Chondrioderma difforme* and other Mycetozoa" (*ibid.*, vol. iv., 1890, pp. 281–298, plate 1); "Notes on the Ingestion of Food-material by the Swarm-cells of Mycetozoa" (*Journ. Linn. Soc.*, vol. xxv., Bot., 1890, pp. 435–441); "Notes on Mycetozoa" (*Journ. of Bot.*, vol. xxix., 1891, pp. 257–268, plates 308–312); "On the Division of the Nuclei in the Mycetozoa" (*Journ. Linn. Soc.*, vol. xxix., Bot., 1893, pp. 529–542, plates 35, 36); "Monograph of the Mycetozoa," being a descriptive Catalogue of the Species in the Herbarium of the British Museum (1894, pp. 224, plate 78); "Guide to the British Mycetozoa exhibited in the Department of Botany, British Museum" (1895, p. 42); "Notes on British Mycetozoa" (*Journ. Bot.*, vol. xxxiii., 1895, pp. 323–325); "A New Variety of *Enteridium olivaceum*" (*ibid.*, vol. xxxiv., 1896, pp. 210–212); "On Some Rare Species of Mycetozoa" (*ibid.*, vol. xxxv., 1897, pp. 209–218); and other memoirs.

CHARLES ALEXANDER MCMAHON,

Lieut.-General. Formerly Commissioner of the Amritsar Division, Punjab. President of the Geologists' Association and Vice-President of the Geological Society of London. Distinguished for his acquaintance with the sciences of Petrology and Geology. He was the first to demonstrate (discover), by study in the field, and with the microscope, the truly granitic origin of the "Granitoid Gneiss" of the N.W. Himalaya, thereby affording a conceivable interpretation of the mountain structure. See his numerous papers (23) in the "Records of the Geological Survey of India" (1876-87). Later, General McMahon has contributed much to the elucidation of the structure and origin of crystalline rocks and rock-making minerals, notably in his papers "On the Rocks of the Lizard" (*Quart. Journ. Geol. Soc.*, vol. xlv., 1889, and, conjointly with Prof. Bonney, in vol. xlvii., 1891); "On the Dartmoor Granite and its Relation to the Surrounding Rocks" (*ibid.*, vol. xlix., 1893); "On Micro-chemical Analysis of Rock-making Minerals" (*Min. Mag.*, vol. x., p. 79); and "On Optical Characters of the Globules and Spherulites of Lithium Phosphate," &c. (*ibid.*, p. 229); and numerous minor papers in the *Geological Magazine* and the *Proceedings* of the Geologists' Association.

WILLIAM OSLER,

M.D., F.R.C.P. Professor of Medicine in the Johns Hopkins University and Physician-in-Chief to the Johns Hopkins Hospital, Baltimore; formerly Professor of the Institutes of Medicine, McGill College, Montreal; and Professor of Clinical Medicine in the University of Pennsylvania, Philadelphia. Has been during many years actively engaged in the advancement of scientific medicine, and has published a large number of communications, some of great interest and importance, chiefly dealing with clinical and pathological matters. Of these only a very few can be here enumerated, viz.: "On the Systolic Brain Murmur of Children" (*Bost. Med. and Surg. Journ.*, 1880); "Infectious Endocarditis" (*Arch. of Med.*, 1881, and Congr., London, 1881); "On Certain Parasites in the Blood of the Frog" (*Canada Naturalist*, 1882); "The Gulstonian Lectures on Malignant Endocarditis" (*Lancet*, 1885); "On the Morbid Anatomy of Typhoid Fever" (*Canada Med. and Surg. Journ.*, 1885); "On Certain Problems in the Physiology of the Blood Corpuscles" (*Phil. Med. News*, 1886); "The Relation of the Corpuscles to Coagulation Thrombosis" (*Brit. Med. Journ.*, 1886); "The Bicuspid Conditions of the Aortic Valves" (*Trans. Assoc. Amer. Physicians*, 1886); "The Cardiac Relations of Chorea" (*Amer. Journ. Med. Sci.*, 1887); "The Cerebral Palsies of Children" (*Med. News*, 1888); "On the Situation of the Anovesical Centre in Man" (*ibid.*); "On Phagocytes" (*ibid.*, 1889); "On Intrathoracic Growths from the Thyroid Gland" (*ibid.*); "Filaria Sanguinis Hominis" (*Johns Hopkins Bull.*, 1890); "On the Amœba Coli" (*ibid.*, 1890); "On Sensory Aphasia" (*Amer. Journ. Med. Sci.*, 1891); "On Typhoid Fever" (*Johns Hopkins Reports*, 1893 and 1894); "On Abdominal Tumours" (1894); "On Addison's Disease" (*Int. Med. Mag.*, 1896). Is also the author of several important articles in systems of medicine, and of a well-known text-book "On the Principles and Practice of Medicine." Has long occupied a leading position in Canada and the United States as a scientific physician, and has also a European reputation as one of the foremost representatives of Clinical Medicine and Pathology of the day.

HON. CHARLES ALGERNON PARSONS,

M.A. (Camb.). Engineer. M.Inst.C.E. Eminently distinguished as an inventor and engineer. By his invention of the compound steam turbine he has made it practicable to use steam economically in an engine without reciprocating parts. He has adapted the steam turbine successfully to dynamo driving and other uses, and his recent application of it to marine propulsion is a new departure of particular interest. In developing his inventions he has shown much scientific knowledge and experimental skill. Author of a number of papers on the steam turbine, its theory and its applications, in *Proc. Inst. Mech. Eng.*, 1888; *Trans. of the North-East Coast Inst. of Engineers and Shipbuilders*, 1887; Inst. of Civil Engineers, Conference, 1897; *Trans. Inst. Naval Architects*, 1887; Inst. of Marine Engineering, 1897. Has investigated experimentally the action of high-speed screw propellers (*Trans. Inst. Nav. Arch.*, April 1897); also the "Behaviour of Carbon at High Temperatures and under Great Pressures" (*Proc. Roy. Soc.*, *Phil. Mag.*, September 1893).

THOMAS PRESTON,

M.A. (Dubl.). Professor of Natural Philosophy, University College, Dublin. Fellow of the Royal University of Ireland. Inspector of Schools under the Science and Art Department. Has published works that have much advanced the study of Light and Heat. Author of treatise on "The Theory of Light" (Macmillan, 1890); and of one on "The Theory of Heat" (Macmillan, 1894); and of Memoirs "On the Motion of a Particle and the Equilibrium of a String on a Spherical Surface" (*Trans. Roy. Irish Acad.*, vol. xxix., 1889), and "On the Mass Inversion of Centrobaric Bodies" (*Proc. Roy. Dubl. Soc.*, 1887).

EDWARD WAYMOUTH REID,

M.B. (Cantab.), B.A. Professor of Physiology, University College, Dundee. Distinguished as a Physiologist, especially in inquiries relating to absorption and secretion, and to electromotive phenomena. Published the following papers on electromotive phenomena:—"On the Action of the Excised Mammalian Heart" (with Dr. Waller) (*Phil. Trans. Roy. Soc.*, 1887); "On the Process of Secretion in the Skin of the Common Eel" (*ibid.*, 1893, and *Journ. Physiol.*, 1894); "The Electromotive Properties of the Skin of the Common Eel" (*ibid.*, 1894); "Electromotive Phenomena of the Iris" (*Journ. Physiol.*, 1895). Also papers on osmose, absorption, and secretion in *Journ. Physiol.*, 1890, 1893, 1895–96.

ALEXANDER SCOTT,

M.A. (Cantab.), D.Sc. (Edin.), F.R.S.E., F.C.S. Late Assistant to the Jacksonian Professor of Experimental and Natural Philosophy. Distinguished by having paid great attention to the exact determination of atomic weights and of combining proportions by volume. Author, in conjunction with Prof. Dewar, of papers on the Vapour Densities of Potassium and Sodium; on the Atomic Weights of Manganese, Oxygen, and Silver; and on the Molecular Weights of substituted Ammonias, published in the *Proceedings of the Royal Society*. Author of papers on Vapour Densities at High Temperatures, and on the Composition of Water by Volume, the last published in the *Phil Trans.*, vol. clxxxiv. Author of a text-book entitled "Introduction to Chemical Theory" (A. and C. Black, 1891).

ALBERT CHARLES SEWARD,

M.A. (Cantab.), F.G.S. University Lecturer in Botany, Cambridge. Has made extended researches in Fossil Botany, the results of which have been published in a series of papers and works, of which the following may be specified:—That on the Wealden Flora gives, for the first time, a critical and comprehensive view of the vegetation of this important geological period, and in many respects enlarges and modifies our previous knowledge of the subject: "On *Calamites undulatus*" (*Geol. Mag.*, vol. v., 1888); "Notes on *Lomatophloios macrolepidotus*, Goldg." (*Proc. Camb. Phil. Soc.*, vol. vii., 1890); "Fossil Plants as Tests of Climate" (Sedgwick Prize Essay for 1892); "On the Genus *Myeloxylon*, Brong." (*Annals of Botany*, vol. vii., 1893); "On *Rachiopteris Williamsoni*, sp. nov., a new Fern from the Coal Measures" (*ibid.*, vol. viii., 1894); "Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Nat. Hist.)"; "The Wealden Flora, Part I., *Thallophyta* to *Pteridophyta.* Part II., Gymnospermæ" (1894-95).

WILLIAM ASHWELL SHENSTONE,

F.I.C., Senior Science Master in Clifton College. Member of Council of the Chemical Society. Distinguished for his skill as an experimenter, for his ability as a teacher, and for his zeal in the introduction of improved methods of teaching physical science as a branch of general education. Author of the following and other papers:—"Ozone from Pure Oxygen" (*Journ. Chem. Soc.*, 1887); "The Volumetric Relation of Ozone and Oxygen," "The Influence of Temperature on the Composition and Solubility of Hydrated Calcium Sulphate and Calcium Hydroxide" (*Journ. Chem. Soc.*, 1888); "Some Improved Vacuum Joints and Taps" (*ibid.*, 1890); "Platinous Chloride as a Source of Chlorine," "The Adhesion of Mercury to Glass in the presence of Halogens" (*Journ. Chem. Soc.*, 1892); "On preparing Phosphoric Anhydride free from the Lower Oxides of Phosphorus," "Studies on the Formation of Ozone from Oxygen," Part II. (*Journ. Chem. Soc.*, 1893). Also author of the article on Ozone in the current edition of Watts' Dictionary; "A Practical Introduction to Chemistry" (Rivington, 1886); "The Methods of Glass Blowing" (Rivington, 1886); Life and Work of Liebig" (Century Series, Cassell, 1895).

HENRY MARTYN TAYLOR,

Barrister-at-Law. Fellow of Trinity College, Cambridge. Formerly Tutor of Trinity College, Cambridge. Third Wrangler and Second Smith's Prizeman in 1865. Author of papers in the *Mathematical Messenger*, as follows:—Vol. iii. p. 189, "Geometrical Explanation of the Equations for the Longitude of the Node and the Inclination of the Orbit"; vol. v. p. 1, 1876, "On the Generation of Developable Surface through Two given Curves"; vol. vii. p. 22, 1877, "On Certain Series in Trigonometry"; vol. vii. p. 145, 1877, "On the Porism of the Ring of Circles touching Two Circles"; vol. xi. p. 177, "On a Six-point Circle connected with a Triangle"; vol. xiii. p. 145, "On a Cubic Surface"; vol. xvi. p. 39, "On a Geometrical Interpretation of the Algebraical Expression which, equated to Zero, represents a Curve or a Surface"; vol. xvi. p. 143, "Extension of an Inversion Property." In the *Proceedings* London Mathematical Society: Vol. v. p. 105, 1874, "Inversion, with Special Reference to the Inversion of an Anchor Ring or Torus"; vol. xiii. p. 102, "A Geometrical Theorem concerning the Division of a p-gon into n-gons (with R. C. Rowe); vol. xv. p. 122, "The Relations of the Intersections of a Circle with a Triangle"; vol. xx. p. 422, a Geometrical note "On the Developable Surface through Two Conics Inscribed (or Escribed) in Two of the Faces of a Tetrahedron." In the *Quarterly Journal of Mathematics:* Vol. xxiv. p. 55, "On the Centre of an Algebraical Curve"; vol. xxvi. p. 148, "Orthogonal Conics"; vol. xxvi. p. 214, "Orthogonal Quadrics." In the *Philosophical Magazine:* Vol. l. p. 221, 1876, "On the Relative Values of the Pieces in Chess." *Philosophical Transactions*, vol. clxxxv. pp. 37-69, 1894, "On a Special Form of the General Equation of a Cubic Surface"; and "On a Diagram representing the Twenty-seven Lines on the Surface." Writer of the article on Geometrical Conics in the last edition of "Encyclopædia Britannica," editor of "Elements of Euclid" for the Syndics of the Cambridge University Press; author of two treatises—"On Great-Circle Sailing"; "On a Method by which a Steamer's Lights might show her Course."

JAMES WIMSHURST.

Member of the Consultative Staff, Board of Trade. Qualifications: (1) Improvements in Electrical Influence Machines, which are now universally approved and adopted by Physicists; (2) an Influence Machine which gives charges of electricity, alternating from positive to negative with each rotation of the disc (in this type the glass discs, without any metal upon them, are freely self-exciting); (3) has delivered a lecture upon Influence Machines at the Royal Institution, April 27, 1888, and read papers at the Physical Society, April 17, 1891, and June 22, 1893.

THE FLOW OF WATER.

MORE than one hundred years ago, the French philosopher Coulomb caused a disc suspended by a torsion wire to oscillate in a vessel of liquid, and he thus ascertained that the resistance to various bodies under such circumstances, when the movement is a slow one, varies directly as the velocity of the motion. This law of resistance, it should be noted, is quite contrary to that of the friction between solid bodies as investigated by General Morin. Colonel Beaufoy, Froude, and others, however, found that, at higher velocities, the resistance varied more nearly as the square of the velocity. The difference of the two conditions in which the variation was directly, or, as the higher power, undoubtedly represented on the one hand the condition of water in which the mere viscosity came into play, resisting the shearing stress of the layers in passing over each other, and on the other hand the condition when the breaking up of the water into eddying motion caused the resistance to become much greater.

Prof. Osborne Reynolds, about 1883, investigated the critical velocity at which this change of state occurs, and gave calculations concerning the critical velocity, accompanied by an account of some beautiful experiments. These experiments showed the sudden breaking up at the critical velocity of the stream in a glass tube, the water in which had been flowing quite steadily until that particular velocity was reached.

Now with water flowing in a tube or channel with wetted sides the velocity is greatest in the middle, and, according to the generally accepted theory, is zero at the sides. If this be the case, it would seem that in no event can the whole body of water in the tube break up into sinuous motion; for it is evident that, although it is possible to have one of the conditions by itself, viz. the condition of lower velocity and parallel flow, it is not possible to have the other condition by itself, viz. the condition of sinuous flow. This leads irresistibly to the conclusion that at some point or other there must be a surface of separation between the two.

Such a surface of separation obviously requires special means in order to make it visible. When colouring material is introduced into water flowing under ordinary conditions, it mixes up at once throughout the whole mass. If, however, air is injected into the water, it has been recently found that, in the portion in which the sinuous state exists, the small particles of air, which appear when viewed by the eye as a sparkling mass, prevent the transmission of light and reveal on a screen, when a special lantern apparatus is employed, the actual behaviour of the flowing water. Figs. 1 and 2 show a rectangular body placed in the stream under such conditions. The lines of flow in Fig. 2 result from the use of slightly soapy water, which is used for the production of air bubbles; whereas in Fig. 1 the air is injected into perfectly clear water, and larger bubbles are consequently formed.

Now, if the above figures are examined, it will be seen that round each there is a clear border line indicating a condition differing from that in the general mass of the stream. This not only occurs with obstacles placed in a flowing stream, but in pipes as in Fig. 3. At the International Congress of Naval Architects held at the Imperial Institute last July, this mode of representing the flow of water was brought forward for the first time. It was then suggested that, in this clear border line the water was flowing in layers with parallel motion, while in the main body of the stream the flow was taking place with sinuous, or broken-up motion, and that the change of critical velocity occurred at the darker border between the two. This dark border is always more intense the higher the velocity of the flow, the width of the border becoming correspondingly reduced.

FIG. 1.—Clear water (thick sheet).

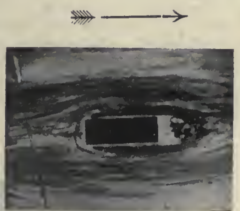


FIG. 2.—Soapy water (thick sheet).

As a good many important results turn upon this point, the subject has been pursued since that time by making a variety of experiments with bodies of varying degrees of roughness of surface, and with passages of various forms. One experiment, however, may be considered as a crucial test, which is to reduce the width of the channel itself, till it actually corresponds with the dimensions of the clear border. This has been done with the result indicated in Fig. 4, when what may be called the air method of making the flow visible entirely fails, the clear border line disappearing and the air passing through, not steadily as before, but spasmodically, while the clear border line of separation

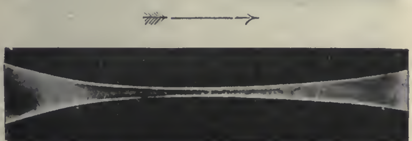


FIG. 3.—Narrow passage showing thin clear film.

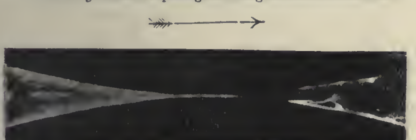


FIG. 4.—Passage still further reduced, showing failure of air method.

entirely disappears. One further step is now obvious, and that is to obtain, if possible, a sheet of water as thin as the border line itself, and examine its behaviour. The result of doing this has been brought forward in a paper read a few weeks ago at the meeting of the Naval Architects in London, when it was shown that in such a thin sheet of water stream line motion exists, thus indicating the absence of sinuous motion and the existence of the motion of parallel flow alone. Under these conditions, while it is impossible to make the motion of water visible, as before, by means of air, colour can be used, and colour bands, corresponding to the stream lines of the mathematician, can be obtained. Figs 5 and 6 indicate a comparison of these two methods to a semi-cylinder. Fig. 5. which is a case of a thick sheet, is an eddying mass of water all round, but is widest, of course, behind where the largest mass of slowly moving water exists. This case is particularly interesting, since it is a case for which the stream lines have been worked out on hydro-dynamical principles,

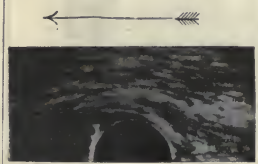


FIG. 5.—Semi-cylinder in thick sheet.

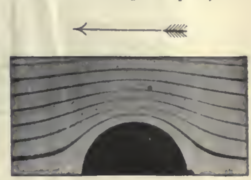


FIG. 6 – Semi-cylinder in thin sheet (test case).

and it is found, by carefully working out a test case, that for all practical purposes the results of the stream lines experimentally produced, agree with those theoretically obtained. As is well known the lines of flow for heat and electricity can be determined mathematically in the same way as those for a perfectly incompressible and frictionless fluid. Hence further verifications can be

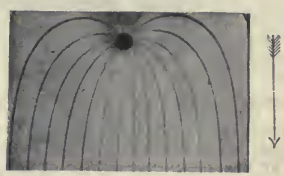


FIG. 7.—Uniform stream and "sink" in channel.

obtained by comparing the theoretical lines of force which have been worked out for electrical and magnetic problems. Fig. 7 is a case of the flow of water through a hole (called in hydro-mechanics a "sink"), and which corresponds to the flow of electricity from an electrified body into one of the wires of a wire grating (see Clerk-Maxwell's "Magnetism and Electricity," Fig. xiii., Art.

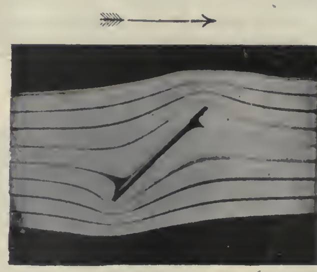


FIG. 8.—Inclined plate in thin sheet.

203, Vol. i.; third edition). A still more remarkable verification is that shown in Fig. 8, which is the case of water flowing past a plate inclined at 45 degrees. The central stream line has been predicted by Prof. Lamb to be a hypérbola, which dividing on the plate would flow round it and re-form on the other side, flowing away exactly as shown in Fig. 8, which figure can be compared with the illustration given in the treatise of Prof. Lamb.

Having thus found a way of representing stream lines by colour bands, various electrical problems, and problems connected with the flow of heat, can be solved in cases

FIG. 9.—Section of screw shaft strut (broad colour bands in thin sheet).

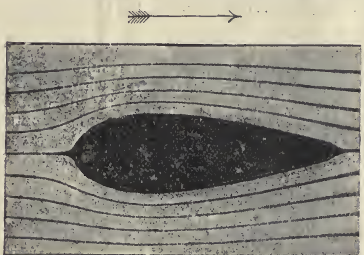


FIG. 10.—Section of screw shaft strut (narrow colour bands in thin sheet).

where it would be impossible to obtain direct mathematical solutions. It is sufficient for the present purpose to give one or two illustrations of the application of the method to problems of interest connected with the flow

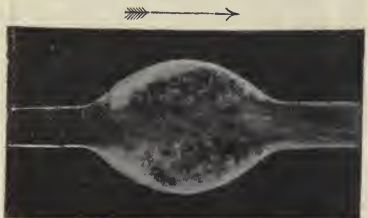


FIG. 11.—Sinuous motion in gradually enlarging and contracting channel (thick sheet).

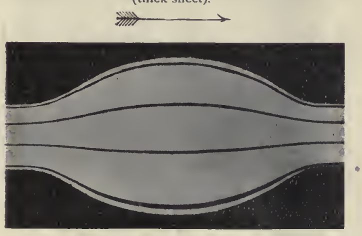


FIG. 12.—Colour bands in gradually enlarging and contracting channel (thin sheet).

of water. Thus, Figs. 9 and 10 illustrate the flow respectively in the case of broad and narrow stream bands round a section of the twin screw strut of one of Her Majesty's cruisers. This might of course be the section of a ship-shaped vessel moving through the water, and as is well known the width apart of the different stream lines would indicate the pressure and velocity in the fluid at every point. Thus stream lines can be obtained in such a case representing a process which for this form of section it would be practically impossible to do by any mathematical process. Figs. 11 and 12 illustrate the flow of water through a passage which gradually enlarges and then contracts. The former case represents the flow under ordinary conditions with the thick sheet of water; the latter case, Fig. 12, being the flow of the colour bands moving in a very thin sheet of water. One more case may be given even more remarkable than any of the foregoing, that is the case of a sudden enlargement of the section of a pipe. Fig. 13 represents the ordinary case of a thick sheet of water in which the eddies and whirls plainly indicate why it is that such a large loss of energy occurs under these conditions in a pipe; while Fig. 14 shows how a perfectly incompressible and frictionless fluid would flow under the same conditions. This is, however, actually what occurs with a thin sheet of water with suitably arranged colour bands.

FIG. 13.—Sudden enlargement (thick sheet.)

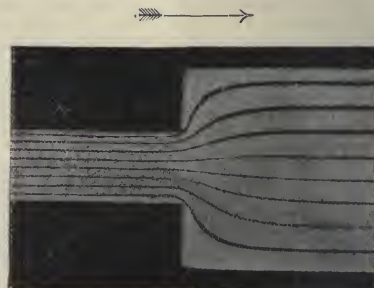


FIG. 14.—Sudden enlargement (thin sheet).

It may be well to remark that all the figures in this article are actual reproductions of photographs of flowing water, which have all been projected on a screen by means of a lantern at the two recent meetings of the Institution of Naval Architects. H. S. HELE-SHAW.

FORTHCOMING MEETING OF THE BRITISH ASSOCIATION.

THE preparations in Bristol for the meeting of the British Association on September 7 proceed apace, and local interest is now thoroughly aroused. The material for the handbook is nearly all in the hands of the editor (Dr. Bertram Rogers), and most of it in type. Among the contributors we note the names of E. J. Lowe, F.R.S. (Meteorology), C. Lloyd Morgan (Geology and Prehistoric Archæology), A. Bulleid (Glastonbury Lake Village), A. T. Martin (Roman Archæology), J. Latimer (History), J. R. Bramble (Architecture), Dr. D. S. Davies (Sanitation), J. W. White (Botany) J. M.

McCurrich (Docks and Tides), J. Holman and H. J. Spear (Economics).

It is hoped that the representation from Canada will be a feature of the meeting, and that many of those who contributed so largely to the success of the Toronto meeting will take this opportunity of paying a return visit. Committees with a view to furthering this object have been formed in Toronto under the presidency of Prof. Macallum, and in Montreal under the presidency of Prof. Bovey. It is hoped that the Mayor and the President of the Board of Trade in Toronto, the Minister of Education (Hon. G. W. Ross), the Secretary of the Royal Society of Canada (Dr. J. G. Bourinot, C.M.G.), the President of the Canadian Pacific Railway (Sir W. Van Horne, K.C.M.G.), and other distinguished guests will be present at the meeting. Among the names of those who are coming from the United States we note the names of Profs. Henry F. Osborn, J. W. Langley, H. P. Bowditch, R. A. Fessenden, R. H. Thurston, and J. Mark Baldwin. From the Continent among those of other eminent visitors are the names of Profs. A. von Kölliker, Ernest Häckel, Gustav Gilson, and Leo Errara, Dr. Paul Topinet, Prof. V. Dwelshauvers-Dery, Prof. Hugo Kronecker, and M. C. de Candolle.

Arrangements are in progress for a biological exhibit at the Clifton Zoological Gardens. Lord Llangattock has, we understand, consented to be the president of a representative honorary committee, and Dr. A. J. Harrison is chairman of the working committee of management. Tanks are being constructed, and arrangements made for an exhibit from the Marine Biological Association's station at Plymouth.

The provisional arrangements for excursions are as follows. Saturday, September 10: (1) Bath; (2) Aust Cliff, with especial reference to geology; (3) Severn Tunnel; (4) Stanton Drew, and Sutton Court, returning over Dundry Hill; (5) Cheddar, *viâ* Yatton, Wrington and Burrington Combe; (6) Avonmouth Docks, including a steamer excursion past Clevedon, Weston, the Holmes, Barry, and Cardiff; (7) Raglan Castle and Tintern Abbey; and (8) Bradford-on-Avon. Thursday, September 15: (1) the Bristol Waterworks; (2) Tortworth, by special invitation of Lord Ducie, for geologists; (3) Wells and Glastonbury, including the Lake Village; (4) Nailsea and Stroud, including Stonehouse, the Stanley Cloth Mills and Dye Works, Dudbridge, Minchinhampton, and Frocester Court; (5) Bowwood, including Avebury and Silbury; (6) Longleat and Sheerwater; (7) the Swindon Railway Works; and (8) Salisbury, Stonehenge and Amesbury. Offers of hospitality in connection with nearly all these excursions have been received and gladly accepted. It is proposed to conclude with a longer excursion, starting on Friday, September 16, to Exeter, Torquay, Dartmouth and Plymouth, returning over Dartmoor.

CITY BANQUET TO THE MEDICAL PROFESSION.

AT the Mansion House on Wednesday in last week, the Lord Mayor gave a banquet to the Presidents of the Royal College of Surgeons and Royal College of Physicians and leading members of the medical profession. This was the first occasion upon which the hospitality of the Mansion House has been extended to the medical profession as such, and a very large and distinguished company was present in response to the Lord Mayor's invitation. Lord Lansdowne, Secretary of State for War, was one of the guests, and in responding to a toast he announced that the Government proposed to make several concessions with regard to the rank of medical officers in the Army. It is proposed to form—out of the Army Medical Staff and the Medical Staff Corps—a Royal Army Medical Corps, the officers of which will bear the same military titles as other officers of the Army. These concessions have been received with great satisfaction by the medical profession, and they will doubtless lead to a marked increase in the number of candidates for the Army medical service. We give below a few extracts from some of the speeches made at the banquet.

In the course of his remarks, Lord Lansdowne spoke as follows:—

We are now about to deal with the large question in which I know the profession takes a deep interest—the question of the status and rank of the medical officers in the army. I have heard it said, Is not the title of "Doctor" or "Surgeon" a title by itself which any one might be proud to wear? But in the army rank means a great deal. It is the outward and visible sign of that authority and consideration with which the place of a man is clearly defined and designated, and it is necessary in the military profession that a man should have a proper military stamp. Let me say in half a dozen words how it is that we intend to deal with this question. We have made in former years various attempts to solve this question of titles by means of ingenious expedients, but the results have not been very satisfactory. In some cases we have, I think, invented titles which for cumbrousness and cacophony would be hard to beat. We now propose that the Army Medical Staff and the Army Medical Corps should be formed into one corps. The titles used shall be the simple, short, intelligible titles to which we are all accustomed. We propose to give the corps military titles up to and inclusive of the rank of Colonel. I have received some forcible hints that our scheme will be unsuccessful unless we proceed to the rank of General. But we in future intend to limit the rank of General to a very restricted number of officers, all of whom will be required to hold certain specific appointments carrying with them general command in the army, and they will be required to command troops, if necessary, in the field. I feel quite sure that it is not intended that any departmental officers shall be given the rank of General under this scheme. Her Majesty the Queen, whose good will towards the profession is well known, has signified her pleasure that the new corps shall be called the Royal Army Medical Corps.

The Lord Mayor, in proposing the toast of "The Medical Profession," remarked: I feel a peculiar pleasure in proposing that toast, because I think that this is the first occasion on which it has been proposed within these walls. I am delighted to welcome you here to-night in the name of the citizens of London. I welcome you for more reasons than one. In the first place I welcome you because for many generations past you have been intimately associated with the City of London. I believe that the Royal College of Physicians commenced in the City of London in 1518. The Royal College of Surgeons was intimately associated with one of our ancient City guilds—I refer to the Barber Surgeons Company. There is another company connected with your profession, also one of the livery companies, which has its residence in the City of London at the present time, and we members of the Corporation welcome you heartily as having some connection with us both in times past and at the present time.

In replying to the toast, Sir Samuel Wilks (President of the Royal College of Physicians of London) expressed the satisfaction of the profession at Lord Lansdowne's statement. Referring to the historical connection touched upon by the Lord Mayor, he said: There was a time when the two Colleges were City companies, and at that time they were under the jurisdiction of the City and of the Lord Mayor; the same, I believe, applied to the other cities of Dublin and Edinburgh. The Physicians and Surgeons existed nearly 500 years ago as distinct companies in the time of Henry VI., and at that time they were closely connected with the Corporation of London, and I believe they had to get their licence from the Lord Mayor. The Lord Mayor of that time had a supervision over the instruments of the Surgeons and also over another class of persons connected with the Surgeons whose names I will not mention, although the Lord Mayor has done so. One reads in books how often they had to fine these members of the College in sums of 6*s*. 8*d*. and 3*s*. 4*d*. for shaving polls and trimming beards on a Sunday. Subsequently came the charter of the College of Physicians which we obey at the present time, and twenty years after that came the charter given by Henry VIII. to the Surgeons. The celebrated picture by Holbein hangs in a hall close by. In that picture the King is presenting the charter to the Surgeons. On his right hand are the physicians, Dr. Chambers and Sir William Butts. Previously to this time I believe the two Colleges held an examination similar to the conjoint scheme at the present day.

Sir William MacCormac (President of the Royal College of Surgeons of England), speaking for surgery, said the members of the profession outside the army and those within its ranks were grateful for what the noble Marquis, the Secretary of State for War, had done for those who thus served their country in the Medical Department of the army. He had agreed to grant the two great wishes which have been pressed upon him—army rank and the formation of an army medical corps. Passing to the historical connection mentioned, Sir William MacCormac said: In the history of the City of London one might recall the names of many distinguished men in our profession who have served their country in the wars. The Father of English Surgery, Richard Wiseman, surgeon to King Charles I. and Sergeant-Surgeon to King Charles II., had an eventful career during the Civil War. He was taken prisoner after the Battle of Worcester, and again while practising his profession as a surgeon in the Old Bailey at the sign of the "King's Head" he was taken to the Tower, and nearly lost his own head during the Commonwealth. About the same time John Woodhall, a surgeon at St. Bartholomew's Hospital, Surgeon-General to the East India Company, also a celebrated surgeon in this old City of London, who had served both in the army and in the navy, dedicates his curious work on surgery and the duties of the surgeon's mate to the "King's most excellent Majestie" Charles I., and also to the Right Hon. Sir Morris Abbot, Lord Mayior. Woodhall speaks of himself as an ancient master of the mysterie of Barber Surgeons, an old City company which became transformed in lapse of time, let us hope improved, into the Royal College of Surgeons, while the Apothecaries, who did so much in their time for the profession of this country, and still do so, continue as one of the City companies. So there are points of contact between our profession and the City of London.

Sir William Turner (President of the General Medical Council) proposed the toast of "The Houses of Lords and Commons," coupled with the names of Lord Lister and Sir Charles Cameron, both of whom replied.

Sir George Duffey proposed "The Health of the Right Hon. the Lord Mayor." In the course of his reply the Lord Mayor said: I have inaugurated this dinner to-night in the hope but not with the assurance that my successors will follow on with it. I see no reason, looking to the facts that almost every other profession has been recognised in this hall, why the medical profession should not be included with them.

NOTES.

The first of the two annual conversaziones of the Royal Society was held yesterday evening, as we went to press.

The following fifteen candidates were selected by the Council of the Royal Society on Thursday last to be recommended for election into the Society:—Mr. H. F. Baker, Prof. E. W. Brown, Dr. A. Buchan, Mr. S. F. Harmer, Mr. A. Lister, Lieut.-General C. A. McMahon, Dr. W. Osler, the Hon. C. A. Parsons, Prof. T. Preston, Prof. E. W. Reid, Mr. A. Scott, Mr. A. C. Seward, Mr. W. A. Shenstone, Mr. H. M. Taylor, and Mr. J. Wimshurst. The certificates of these candidates are given in another part of the present number.

The annual visitation of the Board of Visitors of the Royal Observatory, Greenwich, will take place on Saturday, June 4. The Observatory will be open for inspection by invited guests at 3 o'clock.

The seventieth annual meeting of the German Association of Naturalists and Physicians will be held at Düsseldorf on September 19–24.

At last week's meeting of the Paris Academy of Sciences it was announced that the French Minister of Public Instruction had asked the Academy for an expression of opinion upon the subject of the proposed law to change the national time. The communication was referred to a committee previously appointed to consider the proposed modifications.

The following are the names of the Royal Commissioners appointed to inquire and report as to methods of treating and disposing of sewage:—The Earl of Iddesleigh (chairman), Sir Richard Thorne Thorne, K.C.B., Prof. Michael Foster, Prof. William Ramsay, Major-General Constantine Phipps Carey, Dr. James Burn Russell, Colonel Thomas Walter Harding, Mr. Thomas William Killick, and Mr. Charles Philip Cotton.

On Monday next, May 16, a special evening meeting of the Royal Geographical Society will be held in commemoration of the 400th anniversary of the discovery of the Cape route to India by Vasco Da Gama. A paper on the subject will be read by the President. H.R.H. the Prince of Wales, H.R.H. the Duke of York, and His Excellency the Portuguese Minister, Count de Soveral, have promised to be present. The anniversary meeting of the Society will be held on May 23, and the annual conversazione will be held in the Natural History Museum, South Kensington, on the evening of Thursday, June 23.

The Council of the Royal Geographical Society have awarded one of the two Royal medals to Dr. Sven Hedin for his work in Central Asia, and the other to Lieutenant E. A. Peary, United States Navy, for his explorations in Northern Greenland. The Council have also made the following awards:—The Murchison grant to Mr. H. Warington Smyth for his several journeys in Siam; the Back grant to Mr. George P. Tate for his survey work in Afghanistan, Baluchistan, especially Makran, Aden, and on the Indus; the Gill memorial to Mr. Edmund J. Garwood for his geographical work in Spitsbergen during two seasons, in company with Sir Martin Conway; the Cuthbert Peek grant to Mr. Poulett Weatherley for his exploration of the region between Lakes Mweru and Bangweolo. The following foreign geographers and travellers have been elected honorary corresponding members:—Don Marcos Jimenes de la Espada, Don Francisco Moreno, Buenos Ayres; Marquis of Rio Branco, Brazil; Dr. Thoroddsen, of Iceland; Prof. Ratzel, of Leipzig.

Several changes have have been made on the staff of the Geological Survey. The vacancy caused by the retirement of Mr. George Sharman, senior Palæontologist, has been filled by the appointment of Dr. F. L. Kitchin as Assistant Palæontologist, under Mr. E. T. Newton, F.R.S., Palæontologist. Dr. William Pollard has been appointed an Assistant Geologist in the Petrographical Department of the Survey at Jermyn Street, in the room of Prof. W. W. Watts; and Mr. C. B. Wedd has also been appointed an Assistant Geologist, to fill the vacancy caused by the resignation of Mr. C. E. De Rance. Mr. H. J. Seymour has joined the staff in Ireland as Assistant Geologist, to take charge of the petrographic work, in the room of Prof. W. J. Sollas, F.R.S.

At a recent meeting of the Gesellschaft für Erdkünde held in Berlin, Dr. Gerhard Schott of the Deutsche Seewarte gave an account of the provisional plans for the forthcoming German deep-sea expedition. The expedition was originally suggested by Prof. Chun, of Breslau, and it was at first intended to confine its labours strictly to zoological research; but the sum granted by the Imperial Parliament (15,000*l.*) is considered sufficient to allow of a comprehensive series of physical and chemical observations being undertaken as well. Soundings will be made in little-explored regions in the eastern part of the South Atlantic, on the sub-Antarctic plateau to the east of the Cape, and in the immense stretch of the Indian Ocean between the equator and 30° S. lat. Special attention will be given by the chemists to analyses of the gas-contents of the waters at different depths. The vessel, which will probably be chartered from the Hamburg-American line, is to be a steamer of at least 2000 tons, with a sea-speed of not less than 10 knots: the *personnel* of the expedition will include, besides Prof. Chun, a navigating officer, four zoologists, a botanist, an oceanographer, a chemist, a doctor, and a photographer. The expedition is to start in August, beginning work in the Faëroe-Shetland Channel, and going southward by the Canaries and Cape Verd Islands to the coast of German West Africa, where some special fishery problems are to be studied. From the Cape, the meeting-place of the hot and cold waters to the east is to be examined, and if possible an excursion made southward to Prince Edward Island. Next the waters east of Madagascar will be visited, and after touching at Zanzibar the expedition will work through the region of the Seychelle and Chagos Islands to Colombo, and thence back to Aden by the Eight-degree Channel, returning to Hamburg from Aden direct. The whole time occupied will probably be eight or nine months. We hope shortly to publish a detailed account of the final arrangements of the expedition.

THE death is announced of Prof. D. S. Kellicott, professor of zoology at Ohio State University.

THE Royal Agricultural Society has accepted the invitation to hold its country meeting in York in 1900.

PROF. JOHN MILNE has left England for a few weeks on a short tour, with the object of visiting seismological observatories in Italy, Sicily, and Germany.

THE Croonian Lectures of the Royal College of Physicians of London will be given by Dr. Sidney Martin on June 14, 16, 21 and 23. The subject is the chemical products of pathogenic bacteria considered with special reference to enteric fever.

THE Presidents of the Institute of Chemistry, Society of Chemical Industry, and Society of Public Analysts have sent out invitations for a reception to be held at the Royal Institute of Painters in Water Colours on Tuesday, May 24.

A MEETING of the Federated Institution of Mining Engineers will be held in the rooms of the Geological Society, Burlington House, on Thursday and Friday, May 19 and 20, under the presidency of Mr. A. M. Chambers.

IT is announced in the *Kew Bulletin* that Mr. J. A. Gammie, Deputy Superintendent of the Government Cinchona Plantation in Sikkim, has retired from that post, and Mr. Robert Pantling has been appointed his successor. Both Mr. Gammie and Mr. Pantling went out to Calcutta from Kew.

AT a meeting of the Essex Field Club to be held at Chingford on Saturday, May 21, Dr. H. C. Sorby, F.R.S., will lecture on "The Preparation of Marine Animals as Transparent Lantern-slides, illustrated by Characteristic Forms of the Essex Coast." The subject is one which has occupied Dr. Sorby's attention for some time, during his cruises off the coast in his yacht *Glimpse*. The preparation of marine animals as lantern-slides, so as to show not only their true general form, but also much of their internal structure, is as much a chemical as a biological problem, and different animals require very different treatment. A general account of the methods of preparing such slides was given by Dr. Sorby in a recent number of NATURE (March 31, p. 520). The company of naturalists and others interested in the subject is invited by the Essex Field Club. Cards for the meeting may be had of the Hon. Secretaries, Buckhurst Hill, Essex.

ON Saturday, May 14, the Yorkshire Naturalists' Union, of which Prof. Michael Foster is now the President, will hold a meeting at Clapham, Yorkshire, for the investigation of Ingleborough and Bowland Knotts. Special facilities have been obtained for the examination of the great Ingleborough Cave, which can be traversed for a distance of about half a mile. The cave is of little interest to the archæologist, no remains either of flint implements or bones having been found in it, but it is of surpassing interest to the physical geologist and to those who wish to study the formation of different forms of stalactites and stalagmites. An instructive leaflet containing notes on the geology and biology of the district has been prepared for the information of the members of the Union.

THE third International Congress of Applied Chemistry will be opened in Vienna on July 28, and will last until August 2, inclusive. From the *Chemical News* we learn that the subjects of the Congress are as follows: (*a*) Consultations concerning important questions in all departments of applied chemistry, and particularly of those the solution of which is a matter of public interest. (*b*) Agreement upon methods to be considered internationally valid for the analysis of such products as are valued upon the basis of their chemical composition. (*c*) Agreement upon methods to be considered internationally valid for the use of the different chemical industries. (*d*) Discussion on questions of instruction in applied chemistry, and consultations upon general affairs of chemists. And (*e*) commencement of a friendly understanding between the representatives of the different departments of applied chemistry at home and abroad. Papers to be read at the meeting should be in the hands of the General Secretary, M. F. Strohner, Vienna IV/2, Schönburgstrasse 6, not later than June 1. It is requested that no paper be longer than five pages octavo in print.

AN automatic telephone exchange system, which does away with the necessity for the staff of skilled operators at present required at exchanges, is being introduced into this country from the United States by the Direct Telephone Exchange Syndicate. Instead of ringing up the central station, requesting the attendant to put him in communication with the person to whom he wishes to speak, and waiting while the required alterations are made on the switch-board, the subscriber to an exchange worked on the automatic plan is himself able to connect his telephone with that of any other subscriber without the intervention of a third person. Each subscriber has upon the front of his instrument a circular disc pivoted at the centre, and having one-half of its circumference inscribed with figures from 0 to 9. If he wishes to communicate with another, he sets the disc so that the number of the other subscriber appears upon the dial, and he then finds his telephone in circuit with that of the person whose number he has indicated by his disc. When he has finished his conversation he simply hangs his receiver on its hook. Immediately, the switch which represents him at the exchange returns to its normal position, and communication is cut off. A third subscriber cannot get possession of the line until the first two have done with it; hence there is no possibility of interruption, and secrecy is assured. In the United States a considerable number of exchanges are in regular operation on this plan, and are stated to be proving perfectly satisfactory to their subscribers.

THE Melloni thermo-pile has of late years fallen somewhat into disuse. For the detection and measurement of small thermal changes, the bolometer of Langley, the micro-radiometer of Boys, and the extremely sensitive photo-electric cells of Minchin, have to some extent supplanted the older instrument. In a recent number of the *Zeit. Instrumentenkunde*, Prof. Heinrich Rubens shows that the capabilities of the original apparatus may be greatly increased if proper care is given to the construction, particularly by reducing the thermal capacity of the couples. Antimony and bismuth are mechanically ill-suited for the purpose; he therefore replaces them by iron and the nickel alloy "constantan," in the form of fine wires. The thermo electric "power" of an iron-constantan single couple is only about half that of antimony-bismuth, but the gain in sensitiveness, due to lessened thermal capacity, quite outmeasures this defect. Prof. Rubens has succeeded in making such a thermo-pile with twenty couples in a line of 20 mm.; the resistance is 3·5 ohms, and the E.M.F. 0·00106 of a volt per 1° C. This must be regarded as a very great advance in radiometry. It would be interesting to compare this instrument with photo-electric cells as regards their respective power of measuring stellar radiations. It should be noted that this is not the first time an iron-constantan couple has been applied to thermal investigations.

"THE collapse of a spherical shell under pressure" is a problem which has long puzzled the minds of mathematicians, and one which both engineers and geologists would be glad to see solved. An interesting series of experiments in which a hollow hemisphere of metal was made to collapse by the pressure applied on top of it by another hemisphere or plane, is described by Prof. H. Schoentjes, of Ghent, in the current *Bulletin de l'Académie royale de Belgique* (1898, No. 3). Prof. Schoentjes gives excellent photographs showing various cases of collapse in segments; triangular, quadrangular, pentagonal and hexagonal forms being all represented. The present paper forms the sequel to one published in 1890, and among the author's conclusions the following are noteworthy:—When two similar hemispheres of 10 cm. diameter were crushed together by a hydraulic press with their summits in contact, only one of the hemispheres collapsed; the cavity formed was spherical, and was moulded on the undeformed hemisphere just as if the latter hemisphere were solid. When a hemisphere of 15 cm. diameter was crushed against one of 10 cm, the smaller one penetrated nine times out of ten into the larger one; the cavity was at first spherical, but afterwards its margin became polygonal. In one case only (and the author could not succeed in repeating the experiment), both hemispheres were deformed; the larger one first penetrated the smaller, but under a force of 80 kilogrammes the edge of the cavity began to penetrate the large hemisphere. When a hemisphere was crushed by a plane the normal deformation was found to be hexagonal.

THE mathematical theory of the propagation of earthquake shocks is the subject of a somewhat interesting investigation at the hands of M. P. Rudski, an abstract of whose papers has just reached us (*Anzeiger der Akademie der Wissenschaften in Krakau*, November 1897). The author examines the consequences of the assumption made by Prof. A. Schmidt, of Stuttgart, that the wave-velocity in the interior of the earth is a function of the radius vector, which decreases as the latter increases. Under such circumstances, the rate of propagation of earthquakes along the earth's surface decreases from the epicentre outwards till a certain circle is reached, and then increases up to the antipodes of the epicentre. The position of the bounding circle in question depends on the depth of the disturbance, and M. Rudski considers it possible, from observations of earthquakes, to determine the relation between the wave-velocity and the radius vector.

A SERIES of observations of the temperature of the soil at the observatory of Catania from 1892 to 1896 has been published by Dr. Emmanuele Tringali in the *Atti dell'Accademia Gioenia di Scienze Naturali*. In addition to confirming the well-known laws according to which the diurnal and annual variations of temperature decrease and undergo retardation with increasing depth, Dr. Tringali finds that at Catania the velocity of transmission of the diurnal fluctuations is about 20 cm. for every 7½ hours, and that these fluctuations become practically unimportant at a depth of 60 cm., where they only amount to a few tenths of a degree when the atmospheric temperature changes as much as 17°.

THE summary of the Weekly Weather Report for the first quarter of this year, recently issued by the Meteorological Council, shows that in all the principal wheat-producing districts, except the north of Scotland, there is a considerable deficiency in the amount of the rainfall; while in the grazing, &c., districts a deficiency is everywhere shown. Looking at the values for the winter half-year, the excess in the north of Scotland is 3·5 inches; this is, of course, due to the tracks taken by the areas of low barometric pressure. The greatest deficiency occurs in the south of England and Channel Islands, where it amounts to 7 inches, and it exceeds 5 inches in the midland parts of England. As these values are for large districts, of course at some individual stations the deficiency is much more marked.

WE drew attention last week to the important meteorological station established by the Corporation of Southport, and we are glad to learn that the municipal authorities at many other stations are not behind that place in recognising the value of accurate meteorological observations, and of placing the stations in connection with the Meteorological Office or the Royal Meteorological Society. Among these we may specially mention the station established by the Corporation of Eastbourne, under the superintendence of Mr. R. Sheward, who has for many years published reports of the observations at that favourite sea-side resort, where every care has been taken to place the instruments in the best possible positions. Eastbourne enjoys a large amount of bright sunshine, the average annual duration being 1719 hours, while for London the average is only 1240 hours. Mr. Sheward bears witness to the value of the storm-warning telegrams issued by the Meteorological Office. He states that since the establishment of storm signals there, in 1893, no mishap has occurred to the fishing fleet, although his tables show that some serious gales have been experienced.

THE Bureau of Agriculture and Immigration of the State of Louisiana has recently issued the first volume of a treatise on the history, botany, and agriculture of the sugar-cane, and the chemistry and manufacture of its juices into sugar and other products, by Prof. W. C. Stubbs, Director of the Audubon Park Experimental Station at New Orleans. One chapter is devoted to the botanical relations of the plant, one to its anatomy and physiology, one to its modes of reproduction, and one to bacteriological notes on red cane.

THE plant yielding what is known in commerce as Ceara rubber or Maniçoba, and shipped from the Brazilian ports of Ceara, Bahia and Pernambuco, was identified at Kew eleven years ago as *Manihot Glaziovii*, Muell. Arg. Specimens of the plant were sent from Kew to our Colonies and possessions which seemed suitable for its cultivation, and the results of the attempts to introduce the Ceara rubber tree are described in the latest issues of the *Kew Bulletin* (Nos. 133–134, 1898). The following is a summary of the information thus obtained, and it furnishes another example of the valuable work done by Kew in the endeavour to increase the natural resources of British possessions: (1) The plant is readily propagated both from seeds and cuttings. Seeds are abundantly produced in almost every part of the world where the plant has been introduced. They may be gathered from plants when only three to five years old. There is therefore the great advantage that a large area could be planted within a comparatively short period. Sowing the seeds in the position where they are to grow permanently is universally adopted in Brazil. It is possible, if adopted elsewhere, this plan would greatly reduce the cost of establishing plantations. (2) The Ceara rubber plant is very hardy, a fast grower, free from insect and fungoid attacks, requires little or no attention when once established, and thrives in poor, dry and rocky soils unsuited to almost any other crop. It is evident, however, that the yield of a few trees cannot be remunerative, and only large areas can hope to make the industry a paying one. (3) It produces a good class of rubber, second only when well prepared to the best Para rubber. For this there is a steady and continuous demand. The yield per tree is apparently small, but a return is obtained earlier than from any other rubber plant. With thick planting and judicious thinning as the trees grow up, it may be possible to increase the yield hitherto recorded; while with skilful treatment the permanent trees may be tapped twice yearly, and last in a productive state for fifteen to twenty years. (4) In spite, therefore, of the apparent want of success which so far has attended experiments with Ceara rubber plants in Ceylon and other countries, the increasing importance of rubber as an article in large demand in all civilised countries at good prices, suggests a reconsideration of the merits of this interesting plant. In many of our Colonies possessing a dry climate and a poor stony soil, it is possible that large areas could be profitably occupied with Ceara rubber trees so grown as to provide annual crops for tapping.

MR. D. A. GILCHRIST, Director of the Agricultural Department of the University Extension College, Reading, has issued his fourth annual report upon the field experiments carried on during last year. Since 1894 field experiments have been made at the College, and the results have been of distinct service to agriculturists. The County Councils of Berkshire, Dorset, Hampshire and Oxfordshire co-operate with the College in this work through their Technical Instruction Committees; subsidies being granted by these bodies to the College to meet the expenses. During the season 1897 the work included the testing of manures on most of the principal farm crops, and a further development was made in the direction of carrying out field experiments of a more continuous character, such as the effect of manures, applied at the beginning of a rotation of crops, throughout the whole rotation. The results of all field experiments are of much more value in the locality in which they are carried on than elsewhere; nevertheless, Mr. Gilchrist's report gives much useful information as to the effects of various manures on different crops, under very different conditions of soil; and from this, tolerably safe general conclusions may be drawn. The Agricultural Department of the University Extension College at Reading may indeed be compared with the agricultural experiment stations of Canada and the United States, for it is performing, so far as it is able, the functions of those institutions by conducting inquiries of value to agriculturists, and acting as a reference bureau.

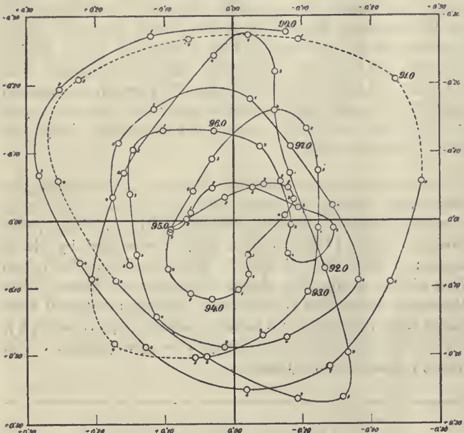
WE have received from P. K. Kozloff, member of the last Russian Tibet expedition, a very interesting contribution to the Lob-nor controversy. It is issued by the Russian Geographical Society as a pamphlet ("Lob-Nor"), and contains the Russian traveller's remarks concerning the lakes discovered by Sven Hedin, for which the Swedish explorer claims to be the true Lob-nor; while the lake Kara-koshun-kul, discovered by Prjevalsky, and described by him as the Lob-nor, would be, in Sven Hedin's opinion, but a secondary and temporary basin. P. K. Kozloff gives in his pamphlet all materials which may enable the reader to come to an independent opinion, namely, a map of the region, embodying the Russian surveys and Hedin's discovery; a copy of the Chinese map upon which Richthoffen and Hedin based their argumentation; and abstracts from Prjevalsky's, Pyevtsoff's, Bogdanovich's, Hedin's, and Kozloff's descriptions of the Lob-nor region. The map already shows to what extent Hedin's claims are admissible. The author then discusses Richthoffen's and Hedin's arguments. The Chinese map, which gives to the Lob-nor a more northern position than the position occupied by Prjevalsky's Lob-nor, Kozloff shows, is wrong, because it gives to the junction of the Tarim with the Konche daria (Airylgan) a much more northern position than was found already in 1765 by the Jesuits, and confirmed since by General Pyevtsoff. In fact, most of the positions on the Chinese map have more northern latitudes than the real ones. The lake Khas of the same map, with which Richthoffen and Hedin wanted to identify Prjevalsky's Lob-nor is, beyond any possible doubt, the lake Ghas of Prjevalsky, situated beyond the Nutsitu ridge marked on the Chinese map. As to the chain of four lakes discovered by Hedin, of which the southern only had been previously visited by Kozloff, they have been formed by the Konche daria, which, coming from the north-west, is continually shifting its bed in its lower part towards the right, *i.e.* westwards. The desert in the north of the Lob-nor has been formed through that shifting of the bed of the Konche daria, and the chain of lake-shaped enlargements of the old bed of the Konche daria, the Ilek, for which Hedin claims to be the historical Lob-nor, is nothing but a temporary formation, due to the rightward shifting of the river bed. Kozloff develops this hypothesis with much skill, and concludes that Prjevalsky's Lob-nor (the Kara-koshun-kul) must have extended much further northwards and eastwards; but the lowest part of the depression, which is occupied by this lake, always was the historical Lob-nor.

THE additions to the Zoological Society's Gardens during the past week include two Sooty Phalangers (*Trichosurus fuliginosus*, ♂ ♀) from Tasmania, presented by Mr. A. Walley; four Common Vipers (*Vipera berus*), British, presented by Mr. J. Amos; a Salvadoris Cassowary (*Casuarius salvadorii*) from New Guinea, a Glaucous Macaw (*Anodorhynchus glaucus*) from Paraguay, a Common Chamæleon (*Chamæleon vulgaris*) from North Africa, deposited; a Common Zebra (*Equus zebra*, ♀), bred in Amsterdam; six Garganey Teal (*Querquedula circia*, 3 ♂, 3 ♀), European, purchased.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF HYDROGEN IN NEBULÆ.—If hydrogen gas in a Geissler tube be examined spectroscopically, the brightest line observed is $H\alpha$. If, on the other hand, the lines of hydrogen in nebulæ be examined, $H\beta$ may sometimes be well seen, while $H\alpha$, the C line, can scarcely be detected. To account for this apparent change of intensity several investigations have been made, and as long ago as 1868 Lockyer and Frankland showed that the hydrogen spectrum could be reduced to the single line $H\beta$ under certain conditions of temperature and pressure. Prof. Scheiner has recently investigated the question of the luminosity of hydrogen in the nebulæ (*Astrophysical Journal*, No. 4, April 1898), and he has attempted to introduce "circumstances approximating to those under which the nebulæ emit light" to find out whether objective changes can be produced in the spectrum of hydrogen in an attenuated state, or whether the subjective weakening of the light is the determining factor, and if so to what extent. By exciting tubes filled with hydrogen in the field of a Tesla high tension transformer, the space surrounding them having a temperature of about − 200° C., Koch's investigations were confirmed that the spectrum of hydrogen did not change when the surrounding temperature was reduced as low as − 200° C. Prof. Scheiner next investigated the physiological disappearance of the $H\alpha$ line, and without entering on the procedure adopted, which is described in the journal referred to above, we will limit ourselves to the result. The absence of the $H\alpha$ line in the hydrogen spectrum is due to physiological reasons, and it is consequently not permissible to deduce from this peculiarity of the hydrogen spectrum in the nebulæ any conclusion whatever concerning the physical conditions under which the light emission of these celestial bodies takes place. Whether certain nebulæ may not prove exceptions to this rule, is to be left an open question; it is certainly not impossible that such may be the case.

THE MOVEMENT OF THE EARTH'S POLAR AXIS 1890·0–1897·5.—To the *Astr. Nachr.* (No. 3489) Prof. Albrecht contributes a short abstract of an investigation which he has just completed on the path of the earth's polar axis. In a previous number of the same journal (No. 3333) he gave the result of a similar piece of work for the period 1890·0–1895·2. The mass of material that has since accumulated has led Prof. Albrecht to reinvestigate the motion from the beginning, or, in other words, to trace the movement of the pole for the whole period 1890·0–1897·5. An examination of the resulting curve shows that from the year 1890 to 1895 a decrease in the amplitude took place, the curve towards the time of the latter year being not very far distant from the position of the mean pole. From 1895 the amplitude began to increase, but without reaching the value of that attained in the year 1890. The curve during the interval 1897·0–97·8 approached the mean pole by quite a tenth of a second more than it did during the period 1890·0–90·5. Prof. Albrecht consequently points out that since the curve does not



Movement of the north pole of the earth's axis.

repeat itself after a period of seven years, the orbit of the pole's movement cannot be represented by a term of twelve and of fourteen months period.

Comparing the observed and calculated values of $\phi-\phi_0$, he is led to infer that a part of the series of observations is more or less affected by systematic errors, the great portion being due to refraction disturbances. To remedy this in future it is pointed out that greater care must be taken to ensure equality of refraction towards the north and south by having large openings (shutters) in the observing room, and by placing the instrument central as regards the shutters. Further, mention is made of the locality of the observatory, and such positions should be chosen where the land and vegetation conditions towards the north and south do not offer great contrasts.

COMET PERRINE (MARCH 19).—The following ephemeris for this comet is continued from *Astr. Nach.*, 3488.

Berlin Midnight.

1898.		R.A. h. m. s.		Decl. ° ′		Br.
May 12	...	1 36 25	...	+54 16·3	...	0·38
13	...	41 42	...	54 29·1		
14	...	46 56	...	54 41·1		
15	...	52 8	...	54 52·2		
16	...	1 57 18	...	55 2·5	...	0·33
17	...	2 2 25	...	55 12·1		
18	...	7 30	...	55 21·0		
19	...	2 12 32	...	+55 29·1		

During the present week the comet approaches the vicinity of the well-known great cluster in Perseus.

THE NORTHERN "DURCHMUSTERUNG."—A committee, consisting of Profs. E. C. Pickering, J. G. Hagen and M. B. Snyder, informs us (*Astrophysical Journal*, No. 4, April 1898) that a new edition of the *Durchmusterung* is being prepared by the Bonn Observatory, and will shortly be published, provided that subscriptions for a hundred copies at seventy marks each are promised. The fact that the original edition of this work is exhausted, and that the price asked was exceptionally low, should have induced many libraries and institutions to have taken this opportunity and become possessors of the work. It is stated that after May 1 of this year the price will be raised to one hundred and twenty marks, so that, if this date be adhered to, the opportunity for obtaining copies at the cheaper price has been missed.

THE ASTRONOMICAL SOCIETY OF WALES.—In this column we have several times referred to the excellent work the Astronomical Society of Wales is doing in promoting the study of astronomy and the allied sciences. The Society has just published in a new form and under somewhat new conditions the first issue of their quarterly journal, the *Cambrian Natural Observer*, which it is hoped will appear regularly. In the introduction we are told, "for some reason or other science does not seem to flourish in Wales; yet, the opportunities for the observation of natural phenomena—using these words in their broadest sense—are neither few nor unimportant." May the influence of the Society be so effective that such a statement as the above will in the next few years cease to be accurate.

SEA-BEACHES AND SANDBANKS.[1]

THIS paper is the sequel to one on "The Formation of Sand-dunes," in the *Geographical Journal*, March 1897. It embodies a research upon the processes which distribute the detritus which enters the sea at its margin, and upon the behaviour of the material distributed.

Fine mud settles through water with such extreme slowness, that wherever the bottom is disturbed by waves (say, to the edge of the continental shelf) it cannot anchor itself upon the bottom even during the slack water of the tides, so that the action of gravity is cheated. This leads to the conclusion that the transit of mud down the slope from the shore is not due to the action of gravity, but that the principal factor determining the well-known direction of mud-transport is the diminution of intensity of bottom agitation from the shallows to the depths.

The usual condition of sea-water is one of oscillation which is not quite symmetrical in amount (*i.e.* there is often a prevailing drift in one direction), and which is scarcely ever symmetrical in intensity, a short quick motion one way being balanced, as far as the movement of the water itself is concerned, by a long slow motion in the reverse direction.

The author shows how suitable oscillation on a seaward slope will set shingle travelling shoreward, and sand simultaneously travelling seaward. The condition of the transport of shingle (great intensity of motion) keeps most of it close against the shore, often in a bank or beach; while the inability of mud to settle except where the water is quiet causes it, as we have seen, to accumulate in mud flats beyond the limits of wave-action. The accumulations of sand are of greater variety, for, although the mean term in size, it possesses a greater independence of motion, or persistence, or effective inertia, than either of the extreme terms. Mud (by which is intended throughout such characteristic marine mud as the well-known "blue mud") obeys each slightest swirl of the water; it follows almost exactly the stream-lines; and it is only in the slow settlement of the mud in still water that muddy water behaves otherwise than as an emulsion. Shingle, again, is not raised to any great height from the bottom, and sinks so swiftly that it does not take a long free flight in water. Hence, when it is moving it follows almost precisely the direction of the momentary movement of the water. Sand, on the other hand, is frequently churned up to a considerable height from the bottom, and often has a long free path; but when the stream-lines of the water are suddenly deflected, whether vertically or horizontally, inertia carries the sand on, the stream-lines of the sand being deflected less than those of the water. Similarly, when the current slackens the sand flings itself forwards, as is so noticeable in the rippling of sand by

[1] By Vaughan Cornish, M.Sc. (Vict. Univ.). (Abstract of a paper read before the Royal Geographical Society on March 16, published in the *Geographical Journal*.)

waves. It is owing to its persistent motion that sea-sand accumulates in vast banks where it is flung by the sudden bending or checking of currents (*e.g.* at tidal nodes), or where it is dropped during tumultuous mixing of waters.

The wash of the waves, owing to percolation, piles up the pebbles thrown forward by the breaker, forming a bank, or ridge, or Full, and this is the action proper to the sea on a shore of shingle.

The piling up of the ridge goes on, its height and steepness increasing, until the wash can reach no higher, and the steepness of the ridge at each point is such that the assistance which gravity gives to the down-flowing surface stream counterbalances the loss of transporting power due to percolation at that level. This is the equilibrium profile or regimen of the Full. Now, the greater the volume of water flung forward by the breaker, the greater is the depth of the back-flowing surface stream, and thus for the same size of beach material the carrying power of the back-wash is more nearly equal to that of the on-wash. Consequently, in a given locality, the regimen slope of beach proper to a rough sea is not so steep as that for a quiet sea.

It is evident that the greatest amount of transport can occur when the sea acts upon the greatest quantity of shingle—that is to say, when the sea is at its highest level. The transporting power increases in a more rapid ratio than the rise of level, owing to the circumstance that most of the shingle is accumulated on the landward side of the beach, where its thickness is greatest. It follows that a wind blowing in the direction of the flood tide will have an advantage in shingle-transport over the wind which blows with the ebb; for the former, by opposing the turn of the tide, tends to increase the duration of tidal high water, and to diminish the duration of tidal low water. Thus, although the forces of currents may be equal and opposite in the two cases, the opportunities of action on shingle are greater when the wind blows with the flood tide. Again, the waves break most violently on the steep beach near high-tide mark, which further increases the effect of prolonged high water in promoting transport. The along-shore wind which is accompanied by a low barometer has a corresponding advantage of opportunity over the along-shore wind which is accompanied by a high barometer, and the wind along-shore which blows from the greater expanse of water over the wind which blows from the less.

No stony particle of less than a certain critical size can remain permanently on a beach, but is ultimately swept out to sea. This critical size is greater on a coarse-grained than on a fine-grained beach, for the regimen slope of the former is steeper, and gravity therefore gives greater assistance to the back-wash. It is well known that every particle upon the surface of a beach suffers attrition, whence the conclusion has been too hastily drawn that the grain of an isolated beach naturally becomes finer as the distance increases from the extremity where the beach is fed with detritus. Now, it is to be noted that whereas the attrition of the particles tends to lower the average size of the shingle, and hence to make the grain of the beach finer, the removal of particles of less than the critical size raises the average dimension of the shingle. Hence we may deduce the following laws of grading of beach shingle applicable to a beach fed entirely at one extremity, whence the material travels along the beach:—

Law 1.—If the material be of uniform size, the grain of the beach becomes finer as we recede from the extremity.

Law 2.—If the material be mostly fine stuff, with a small admixture of coarse stuff, then (unless the coarse stuff be very friable, and the fine stuff very durable) the grain of the beach will become coarser as we recede from the extremity, for the average size is more affected by the removal of a large number of fine grains than by the attrition of a small number of coarse grains. This increase in coarseness will continue until the beach material is brought to a uniform size, when the grading proceeds as in 1.

Law 3.—If the material be mostly coarse stuff, with a small admixture of fine stuff, then, as we recede from the extremity, the grain of the beach will become finer, for the attrition of a great number of large particles has a greater effect upon the average size of the material than the removal of a small number of fine particles.

By combining 2 and 3 we can deduce corollaries applicable to the case of a beach fed from both extremities.

Law 4.—The grain of the beach is (*ceteris paribus*) coarser where the beach is exposed to the heaviest breakers. This law follows from what has been said on the action of the back-wash, and on a "critical size" of beach material.

Law 5.—The grain of the beach is (*ceteris paribus*) coarser near the "weather" end of a promontory. Thus, if west be the weather side, and the end of a long beach is protected from the east by a headland at the eastern extremity, then both large and small pebbles will travel eastward along the beach in a westerly wind, but only the small ones are carried back from the promontory during an east wind, so that the proportion of large pebbles to small is increased as we near the promontory from the west. This is, in fact, similar to the case of the sorting of sand from shingle by unsymmetrical oscillation.

[*From a photograph by the author.*

FIG. 1.—East end of Chesil Beach.

The author considers that the chief factors which determine the observed grading of the Chesil Beach are as follows:—

(1) The beach is fed at both ends (Bridport and Chesilton).

(2) The material fed in at the west end is mostly fine, owing chiefly to the natural groynes at Golden Cap and Thorncombe.

(3) The material fed in at the east end is mostly coarse, owing to the nature of the local rock and the mode in which it is supplied to the foreshore.

(4) The main drift of water is easterly, but

(5) Of the fine shingle carried eastward from Bridport, much is brought back by waves from the east; whereas

(6) The strong outset at Chesilton removes such fine stuff as may be there supplied from Portland.

(7) The largest waves converge on Chesilton from both sides.

The formation of a beach-ridge, or Full of sand, is well seen when the sand is being brought in during off-shore winds. Sand being readily raised by upward-swirling water (which is equivalent to suction dredging), the building up of a Full of sand in front of the breaker is accompanied by the excavation of a trough, or Low, at the back of the breaker. This is roughly similar to the simultaneous excavation and elevation which produces the ridge and furrow so well known as "ripple-mark." Fine dust or mud settles too slowly, coarse shingle too quickly, to lend themselves readily to this mode of distribution by waves. A Low is dredged out in sand when the breaker-line remains stationary for a time, as *e.g.* during tidal high water. During the ebb of spring tides, a lagoon is often left between the beach and a second stretch of sand. This lagoon marks the strip where the breakers act during the period of neap tides. At low water of spring tides, the belt of sand beyond the Low is a sort of beach, the seaward face of which is where the wash of the waves acts. Beyond it, during the continuance of the spring tides the breakers commence the formation of a second Low. When the tide is up and the sea is rough, there is an outer line of breakers on the bank, which is locally called the Ball.

The connection between tidal nodes and the accumulation of sandbanks is dealt with, and the analogies with sand-dunes are pointed out.

With regard to the sandbanks which accumulate on the more sheltered side of headlands, a good example of which is the Shambles shoal, eastward of Portland Bill, it is pointed out that the materials (broken shells, &c.) which form the Shambles sandbank are not deposited in still water. The sand deposits from the mixing waters of meeting streams, an effect that is not surprising when we consider that the mixing of waters is achieved by vortices.

[*From a photograph by the author.*

FIG. 2.—Blacknor Point, Portland.

The checking and deflection of the streams is probably not nearly the whole of the mechanism by which the deposition of sand is brought about where a river meets the sea. A great part of this effect is probably due to the motions which attend the mixing of waters, a process which appears to be almost as potent a factor in the formation of sandbanks as is the mixing of airs in the production of clouds.

THE BACTERIAL CHARACTER OF CALF-LYMPH.

QUITE a flutter of excitement was produced in the ranks of the anti-vaccinators by the public announcement, made rather more than a couple of years ago, that lymph used for vaccination purposes frequently contained an immense number of bacteria, sometimes as many as two and one-half millions in a single cubic centimetre, and that amongst this vast microbial population forms were repeatedly present which, on inoculation, proved fatal to animals. A certain measure of authority was given to this communication, inasmuch as its author, Dr. Landmann, claimed to have carried out a very large number of experiments in support of his assertion; and his results were, moreover, brought before the well-known German Association of Naturalists and Physicians at one of its yearly meetings. Coupled, as Dr. Landmann's conclusions were, with the recommendation that only lymph should be used for inoculation purposes which had been officially declared germ-free—or, at any rate, devoid of pathogenic bacteria—his announcement gave such an impetus to the anti-vaccination crusade, and occasioned so much public discussion, that the Prussian Ministry felt it their duty to appoint a Commission to inquire into the character of calf-lymph. Meanwhile independent experimental inquiries were also started by various investigators, and amongst these Dr. Neidhart was able to show that Landmann's assertion that the red inflammatory margin of the pustules so frequently noticeable was directly due to the action of the bacteria present in the vaccine was not correct, inasmuch as such symptoms were produced when lymph quite free from bacteria was employed, whilst they were often absent in cases where the lymph was proved to be teeming with bacteria. The hysterical excitement caused by the circulation of Landmann's sensational statements was, however, considerably abated by the publication of the masterly report drawn up by Frosch upon the very large number of most valuable experiments undertaken in a purely scientific, uncontroversial spirit by the Prussian Committee of inquiry above referred to.

This document completely refuted Landmann's statements, and showed that the alarming conclusions arrived at by him had no real foundation in fact. Frosch further indicates, as the result of careful experiment, the best methods and most suitable precautions to be adopted in the inoculation of calves and the collection and application of the lymph, pointing out in the latter connection that local irritation from vaccination may be greatly moderated by diluting the lymph with glycerine.

These reassuring results were again independently confirmed by Kirchner, of Hanover, who, in extensive examinations of calf-lymph, found on no single occasion any pathogenic bacteria.

In the current number of the *Zeitschrift für Hygiene* the question has been again brought to the fore by the publication of elaborate experimental researches on the bacterial character of calf-lymph by Dr. Dreyer, of the Hygienic Institute of the University of Giessen.

Careful quantitative determinations of the bacterial contents of calf-lymph showed that the initial number of microbes present may vary considerably, and that in the majority of cases it is very large indeed—on one occasion reaching as many as 17½ millions in one cubic centimetre. Within twenty-four hours, however, a great diminution takes place; but this decrease does not continue at the same rapid rate. Thus, to cite one instance: a sample contained on the first day of its collection over 2½ millions of bacteria per c.c.; after five days, 112,750; after eighteen days there were still, however, 111,765 present. Some forms persist over very long periods of time; Dreyer observed bacteria after a lapse of five months, whilst Kirchner found 550 in a cubic centimetre sample over a year old.

To determine the pathogenic character of lymph-bacteria, Dreyer inoculated, subcutaneously and intraperitoneally, both mice and guinea-pigs. Out of thirty-five mice thus treated only two succumbed, one to subcutaneous and the other to intraperitoneal inoculation; in none of the other animals was any reaction perceptible. As regards the guinea-pigs, in no single instance did any result follow the intraperitoneal inoculations, whilst in nearly every subcutaneous inoculation a small and insignificant abscess was observed to form at the point of inoculation.

Not satisfied with these experiments, Dr. Dreyer experimented upon himself and inoculated his arm each time with some of the same lymph he used for the mice and guinea-pigs respectively, but in no case did any reaction worthy of record follow.

In order to determine more particularly the qualitative bacterial character of these various samples of calf-lymph, plate-cultures were also made and pure cultures obtained of different bacteria, which were subsequently inoculated both into mice and into his own arm. In two cases coccus forms proved fatal to mice, whilst in the other inoculations no symptoms of importance followed. As regards the inoculations practised upon himself with these pure cultures, nothing more significant than a slight abscess resulted, except on one occasion when an affection of the adjoining lymphatic glands was experienced.

In commenting upon these results, Dr. Dreyer states that it should be borne in mind in connection with those instances where fatal results followed the introduction of the lymph into mice, that, in the first place, the mode of inoculation obliged to be adopted was not really comparable to the simple incision made in the case of human vaccination, and that, secondly, the quantity of lymph employed relative to the size of the animal was far greater than is the case in ordinary inoculations. Moreover, the two pathogenic results which followed the inoculation of a pure culture of a coccus form do not constitute any justifiable plea for the abolition of calf-lymph vaccination. It must be remembered that the conditions of such pathogenic infection are very different from those which may be present in ordinary inoculations, should pathogenic bacteria originally be present in the lymph, for, in employing a pure cultivation of a particular micro-organism, the latter is introduced into the system in immeasurably larger numbers than would be the case were it introduced direct with the lymph.

We would, in conclusion, recommend the closing paragraph of Dr. Dreyer's memoir to the consideration of that noisy section of unreasoning obstructionists who may, even in his experiments, endeavour to find some support for their crusade against the vaccination laws: "I consider, therefore, that I may conclude from my investigations that the latter afford no support which justifies the fear that animal lymph as at present prepared can produce any serious injury to those inoculated with it."

G. C. FRANKLAND.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Junior Scientific Club held its 188th meeting at the Museum on May 4. After the Treasurer's balance-sheets had been read and carried, Mr. A. E. Tutton discoursed on the Glaciers of the Pennine Alps, illustrating his remarks by numerous lantern slides. Mr. H. E. Stapleton (St. John's) read a paper on turpentine extraction in the Southern States.—The Officers for this term are: President, Mr. W. E. Moss (Trinity). Chem. Sec., Mr. F. Soddy (Merton). Biolog. Sec., Mr. E. Gurney (New Coll.). Editor, Mr. H. E. Stapleton (St. John's). Treasurer, Mr. W. E. Blackall (Non. Coll.). Committee, Mr. W. B. Billinghurst (St. John's), Mr. C. E. A. Wilson (Ch. Ch.), Mr. F. P. Nunneley (B. N. C.), The conversazione will be held on May 24—Tuesday in Eights' Week—at 8 p.m.

CAMBRIDGE.—A University lectureship in applied mathematics will be vacant at the end of the academical year by the resignation of Mr. R. T. Glazebrook, F.R.S. Applications are to be sent to the Vice-Chancellor by May 17.

The Smith's prizes are awarded (1) to Mr. E. W. Barnes, Trinity, and (2) to Mr. W. A. Houston, St. John's.

Dr. Kanthack proposes to hold, during the Long Vacation, courses of instruction in general pathology, morbid anatomy and histology, bacteriology, and clinical pathology. The courses begin on July 8.

The University tables at Naples and Plymouth are about to be vacant. Applications for facilities for zoological research are to be sent to Prof. Newton by June 1.

Twenty-four candidates have passed the half-yearly examination in sanitary science just completed, and have received the University diploma in public health.

Twenty-eight additional freshmen, including one advanced student, were matriculated on May 5.

The University grant of 100*l.* a year for three years, made to the British School of Archæology at Athens in 1895, is to be renewed for another period of three years.

The Frank Smart studentship in botany, of the annual value of 100*l.* for two or three years, will be vacant on June 20. Candidates must be B.A.s who have taken honours in the Natural Sciences Tripos. Application is to be made to the Master of Caius College by June 11.

A combined examination for entrance scholarships and exhibitions in natural science will be held by Pembroke, Caius, King's, Jesus, Christ's, St. John's, and Emmanuel Colleges next term, beginning on November 1. A large number of major and minor scholarships and exhibitions, varying in annual value from 80*l.* to 30*l.*, will be offered. The subjects include chemistry, physics, elementary biology, physical geography, animal physiology, zoology, and botany; and candidates may offer from two to four of these. In all branches the candidates' practical work will be tested. Full particulars may be obtained from the Tutors of the respective colleges.

THE Duke of Devonshire stated in the House of Lords on Monday that, as soon as the Committee stage of the Irish Local Government Bill was disposed of, the London University Commission Bill would have a prominent place among those measures which the Government intended to pass during the remainder of the Session.

DURING the past fifteen months, says the Paris correspondent of the *Chemist and Druggist*, the sums subscribed by manufacturers and bankers in the district of Nancy for promoting the study of chemistry and physics, as applied to industry, in connection with the University of that town, have reached 400,000f. (16,000*l.*). The Lyons University has been authorised to contract a loan of 626,500f. (25,000*l.*), to be applied (1) to completing the Chemical Institute, (2) extending the laboratories of experimental and comparative medicine and physiology, (3) completing the laboratory of maritime physiology at Tamaris, Var.

THE following items concerning endowments of higher scientific education in the United States are recorded in *Science*:—The West Virginia University has established eleven fellowships yielding 300 dollars yearly and free tuition. The fellows are expected to teach one hour a week or give two hours' supervision in the laboratory. Among the eleven subjects for which the fellowships have been awarded are chemistry, physics, geology, zoology, botany, mathematics, mechanical engineering and civil engineering.—The estate of Mrs. Julia W. James, of Boston, divided by her will between the Museum of Fine Arts and the Massachusetts Institute of Technology, amounts to over 500,000 dollars.—The John Tyndall Fellowship of Columbia University for the encouragement of research in physics has been awarded to R. B. Owen, a graduate of the School of Engineering and professor of engineering in the University of Nebraska. Among the twenty-four fellowships annually awarded are the following: T. E. Hazen, botany; B. H. Owen, philosophy; J. D. Irving, geology; E. Kasner, mathematics; W. C. Kretz, astronomy; J. W. Miller, jun., mechanics; F. C. Paulmier, zoology; F. J. Pope, chemistry; C. E. Prevey, statistics; R. S. Woodworth, psychology.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, April 20.—W. Whitaker, F.R.S., President, in the chair.—Note on an ebbing and flowing well at Newton Nottage (Glamorganshire), by H. G. Madan. This well lies in a direct line drawn north and south from the church of Newton Nottage to the sea, about 80 yards south of the church and 500 yards from the sea. Sand-hills about 20 or 30 feet high lie between it and the sea. A range of carboniferous limestone cliffs runs east and west to the north of the church, while the same formation crops out in the sea at half-tide level. Between the two there is a band of Keuper conglomerate covered in one place at least by 7 feet of brown loamy clay with pebbles. At the shore-junction of conglomerate and limestone numerous springs occur, and it is in the conglomerate that the well is sunk, its bottom being 8 feet above Ordnance datum. A series of about forty observations made at intervals of an hour (and in many cases at the intermediate half-hours), during three consecutive days, enabled the author to construct a curve showing the relationship existing between the rise and fall of the tide on the coast and that of the water in the well. The result is to establish the existence of a wave in the well of the same frequency as the tidal wave, but delayed, or with an establishment of, three hours (*plus* or *minus* a few minutes). The analyses of water taken from the well at its highest and lowest show no difference, so that no sea-water enters the well directly. On the other hand, the slight brackishness of the water appears to prove the diffusion of a small amount of salt water into the well.—*Petalocrinus*, by F. A. Bather. Certain curious fan-like objects, obviously echinodermal, have for a long time been preserved in the Riks-Museum at Stockholm, but their significance was first definitely ascertained when similar fossils were found in Iowa, and brought to England by Mrs. Davidson. The latter were described by Mr. Stuart Weller in a paper entitled "*Petalocrinus mirabilis* (n. sp.), and a New American Fauna"; and the former, with fresh material obtained by Mr. Weller from various American localities, are the subject of the present communication. The Silurian crinoid genus *Petalocrinus*, Weller, is discussed, on the evidence of all the original material from Iowa and of the further material above mentioned.—On the origin of the auriferous conglomerates of the Gold Coast Colony (West Africa), by Thomas B. F. Sam.—This paper gives an account of a recent journey from Adjah Bippo to the Ankobra Junction in the Gold Coast Colony. A range of clay-slate hills is succeeded for 6 miles by flat ground in which diorite was found, and that by a lofty hill in which clay-slate dipping east occurs. The Teberibie range with reefs of conglomerate, and a second range with similar reefs were crossed. Gold-bearing alluvia are briefly described, and the gold is supposed to have come from the hills. The Adjah Bippo, Takwa, and Teberibie formations are considered to be part of a syncline. Some conclusions are drawn as to the method of formation and probable auriferous character of the rocks.

Linnean Society, April 21.—Dr. A. Günther, F.R.S., President, in the chair.—On behalf of Lieut.-Colonel Birch-Reynardson there was exhibited a portion of the trunk of an apple-tree which had been so seriously attacked by water voles (*Arvicola amphibius*) as to cause the death of the tree; and several others, it was stated, had been similarly injured. Such extensive damage from such a cause was regarded as unusual.—Mr. G. E. Barrett Hamilton exhibited a head of the common brown rat (*Mus decumanus*), showing a curious deformity arising from injury to the incisor teeth.—Prof. Douglas Campbell communicated a paper, which was demonstrated by Mr. A. Gepp, on the structure of *Dendroceros*. The chief conclusions arrived at were as follows: (1) In its apical growth and the form of the thallus, *Dendroceros* differs decidedly from other genera of the order Hepaticæ. (2) The archegonium corresponds in its structure to that of the other Anthocerotaceæ, and is intermediate in character between *Notothylus* and *Anthoceros*. (3) The antheridium is solitary, and arises, as in the others of the order, endogenously. (4) The first wall in the embryo is longitudinal, as in *Anthoceros*, but the first transverse wall determines the limits of the foot, as in *Notothylas*. (5) The origin of the archesporium is from the amphithecium as in the other genera, but it is less massive than in either of these. (6) The division of the archesporial cells into sporogenous and sterile ones is less regular than in either of the other genera, and the primary archesporial cells may be transformed directly into sporogenous ones without any further divisions. (7) In *D. Breutelii* the spores remain undivided, but in *D. crispus* (?) they germinate within the capsule and are discharged as multicellular bodies. (8) Leitgeb's statement as to the absence of stomata from the capsule was confirmed.—Mr. W. P. Pycraft read a paper on the morphology of the owls (Part 1, Pterylography). In this, the first instalment of a series of papers in which it is proposed to deal with the affinities and phylogeny of the group, the pterylographic characters were alone considered, descriptions of adults, nestlings, and embryos being given. The author remarked that, so far as the distribution of the feather-tracts is concerned, the owls resemble the *Accipitres* more nearly than any other group. The form of the external aperture of the ear seems to have been originally subject to variations, the most successful of which have become fixed by selection. In some cases there is a marked asymmetry, which may either be confined to the membranes surrounding the aperture, or may extend to the skull itself. The author considered that the facts disclosed by a study of the pterylosis might justify a slight revision and rearrangement of some of the genera.—A paper was read by Mr. J. Johnstone upon the thymus and thyroid glands in the Marsupialia. The author had investigated the neck-glands in adults of nine and pouch-specimens of seven genera, representative of the leading Marsupial families. The thymus was observed to be absent only in the Koala (*Phascolarctus*), and to persist predominantly in the region of the carotid roots.

MANCHESTER.

Literary and Philosophical Society, April 19.—Mr. J. Cosmo Melvill, President, in the chair.—The following were elected officers and members of the Council for the ensuing year:—President, J. Cosmo Melvill; Vice-Presidents, Prof. O. Reynolds, F.R.S., Prof. A. Schuster, F.R.S., Charles Bailey, and W. H. Johnson; Secretaries, R. F. Gwyther and Francis Jones; Treasurer, J. J. Ashworth; Librarian, W. E. Hoyle; other members of the Council, Prof. H. B. Dixon, F.R.S., Prof. H. Lamb, F.R.S., F. Nicholson, J. E. King, R. L. Taylor, and F. J. Faraday.—Mr. Charles Bailey exhibited some living plants of Jacquin's oxlip (*Primula elatior*), which he had gathered ten days ago in a wood at Tindon End, near Thaxted, Essex. He pointed out its peculiar distribution in England—where it is confined to an area within the triangle formed between St. Neots in Huntingdonshire, Stowmarket in Suffolk, and Bishop Stortford in Hertfordshire—and explained the botanical characters which separate it from the primrose and the cowslip. With it Mr. Bailey exhibited a flower-scape from a root which he brought some years ago from Gloddaeth, near Llandudno, which was a natural hybrid between the cowslip and the primrose, and which flowered every spring in his garden. Such hybrids generally pass for the true oxlip, and they are not infrequent in districts where both parents occur; in the neighbourhood of Manchester he had found this spurious oxlip at Ashley, at Mobberley, and in several places in Derbyshire.

EDINBURGH.

Royal Society, April 4.—Prof. Copeland, in the chair.—At the request of the Council, an address on theories concerning the structure and origin of coral reefs and islands was given by Dr. John Murray. After a brief sketch of the history of the subject, and an exposition of the insufficiency of Darwin's famous theory as an explanation of the origin of many coral reefs and islands, Dr. Murray, with the help of lantern slides, gave an account of the theory he himself supported, which was to a large extent a return to the views of Chamisso (1820). The results of recent investigations, such as Mr. Andrews' labours at Christmas Island, the extensive observations by Alexander Agassiz in the Fiji group, the boring in the island of Funafuti, and the work of the Admiralty Surveyors in the Pacific Ocean, were then referred to; and, in spite of statements to the contrary which had been going the round of newspapers, Dr. Murray concluded that all these recent discoveries tended to verify his hypothesis rather than that of Darwin.

May 2.—Dr. Munro, in the chair.—In a paper on consonant sounds, Dr. Lloyd discussed in detail the simplest group of consonantal sounds, known as the spirate fricatives, namely, *f*, *v*, *th* (both forms), *s*, *z*, *sh*, *zh*, the Scottish gutturals *ich*, *och*, and the aspirate *h*. These are all produced by the friction of the air escaping through interstices more or less narrow. They could all be whispered through a range of pitch peculiar to each, the pitch depending upon the length and shape of the resonating cavity, which at the same time determined the vowel sound associated with the consonant.—Prof. D'Arcy Thompson communicated an examination of the so-called bipolar hypothesis. Of the list of ninety forms deduced by Dr. Murray from the *Challenger* Reports in support of this hypothesis, about half were insufficiently authenticated, and a great number more were very minute and described wholly from their hard parts; of the remainder some were not really arctic or antarctic forms, and the few that seemed to present "bipolar" characteristics were remarkable in other respects. Moreover, there were no examples cited from well-marked groups, such as fishes and Crustacea. In the discussion which followed, Dr. Murray argued that the fact of bipolarity had long been recognised, Prof. D'Arcy Thompson maintaining that the data supplied by Dr. Murray were insufficient to establish its existence.—Mr. A. J. Herbertson exhibited maps showing the mean monthly and annual rainfall over the land surface of the globe. This was the first attempt to construct mean monthly rainfall charts for the whole globe. All available data had been used, and many interesting results had been obtained.

DUBLIN.

Royal Dublin Society, April 20.—Prof. W. Noel Hartley, F.R.S., in the chair.—Prof. Emerson Reynolds, F.R.S., gave a demonstration of the properties of some new silicon derivatives discovered in the chemical laboratory of Trinity College, Dublin, and showed their use in photography.—Dr. E. J. McWeeney demonstrated a special method of performing the sero-diagnostic test for typhoid fever. It consisted in causing Eberth's bacillus to grow in a hanging drop of neutral bouillon containing 10 per cent. of the serum under investigation. After a few hours at 37° C. the individuals originally present (which should be very few—one only if possible), would be found to have multiplied in such a way as to form chains of short elements devoid of motility. In twelve hours these chains had become very long and beautifully curved and contorted, occupying the whole area of the drop. This chain formation only occurred with typhoid serum. With non-typhoid serum the drop soon became filled up with actively motile separate individuals. Filament-formation he did not look upon as significant. Similar appearances had been noted by Charrin and Roger for *Pyocyaneus*, by Pfaundler for *Coli*, and by Ledoux-Lebard for pseudo-tuberculosis. Photographs of desiccated and stained hanging-drop cultures were thrown on the screen.—Dr. J. H. Clark contributed a paper on protoplasmic movements: their relation to oxygen pressure. The paper gave a detailed statement of the author's investigations on the subject, of which an abstract appeared in the *Proceedings* of the Royal Society.—Dr. T. Johnson and Miss Hensman presented a paper consisting of a list of Irish Corallinaceæ, with the distribution of the Irish species, and many additions to the list of recorded species.

PARIS.

Academy of Sciences, May 2.—M. Wolf in the chair.—On the legitimacy of the trapezium rule in the study of the resistances of dams built of masonry, by M. Maurice Lévy. A critical examination of the "trapezium" law, according to which the normal pressures exerted upon each arch are connected by a linear relation.—Researches on the state in which silicon and chromium occur in steels, by MM. A. Carnot and Goutal. From a sample of ferrosilicon, by the prolonged action of dilute sulphuric acid, the silicide $SiFe_2$ was isolated, which differs from the substance of the same composition obtained by M. Moissan in being easily attacked by warm dilute acids. From alloys containing manganese, a double silicide of manganese and iron is obtained. Starting from chrome steels, similar methods gave $Fe_3Cr_9C_7$ or $CFe_3.3C_2Cr_3$ and $Fe_9Cr_3C_5$.—Remarks on some Crustacea obtained from the six scientific voyages of the Prince of Monaco, by MM. Milne-Edwards and E. L. Bouvier. Amongst the decapod Crustaceæ only one new form was found, *Sympagurus Grimaldii*.—On ortho-benzyl-benzoic and dimethylamido-diethylamido-ortho-benzoyl-benzoic acids and some of their derivatives, by MM. A. Haller and Guyot.—On the autoplastic grafts obtained by the transplantation of large dermic strips. Their stability and the slow modifications which they undergo, by M. Ollier. The transplanted skin undergoes a progressive atrophy, losing always its original dimensions.—The return of the first periodic Tempel Comet (1867 II.) in 1898, by M. R. Gautier. A revision of the elements of this comet, rendered necessary by the varying perturbations caused by the planet Jupiter.—Relations of commensurability between the mean movements of the satellites of Saturn, by M. Jean Mascart.—Reply to a reclamation of priority of M. Marqfoy, by M. Daniel Berthelot.—On the radiations emitted by thorium and its compounds, by M. G. C. Schmidt. Thorium salts emit rays similar to those discovered by M. Becquerel for uranium salts. Quantitative comparisons of the times required to discharge an electrified plate by the rays from thorium and uranium salts showed that the latter act more powerfully. The sign of the charge in either case is without effect upon the results.—On the cycles of magnetic torsion of a steel wire, by M. G. Moreau.—A receiver for Hertzian telegraphy without wires, by M. E. Ducretet. An improvement upon a similar instrument devised by M. Popoff. A Branly tube, which undergoes sudden changes of resistance under the influence of the Hertzian waves, forms part of a delicate relay system. The whole apparatus is automatic, the message being printed in Morse character upon a strip in the usual way, the strip ceasing to unroll when the waves stop.—On the electrical conductivity of potassium permanganate, by M. G. Bredig. Remarks on the paper of M. Legrand in a recent number of the *Comptes rendus*, pointing out the prior measurements of M. Bredig and MM. Franke and Lovén.—The Perpetual Secretary remarked that the conductivity of some solutions of potassium permanganate was measured by M. Bouty as early as 1884.—Effects of solar and lunar attractions upon the atmosphere. Example of the application of formulæ, by M. A. Poincaré.—On the iodide of beryllium, by M. P. Lebeau. By the action of dry hydriodic acid gas upon beryllium carbide at 700°, the pure iodide BeI_2 is readily obtained as a crystalline sublimate. It forms colourless crystals, readily attacked by moist air, boiling between 585° and 595° C. It reacts violently with water, and with many organic substances, and from it new compounds of beryllium with sulphur, phosphorus, and cyanogen can be obtained.—On the presence of the chlorides of potassium and sodium in large proportions in the juice of grapes, and in the wines of the salt regions of Oranie, by M. Edmond Bonjean.—New reaction of tertiary alcohols and their ethers, by M. G. Denigès. The reaction employed is an acid solution of mercuric sulphate; characteristic yellow mercury compounds are formed.—Action of alkalis upon ouabaine, by M. Arnaud. An acid is formed, termed ouabaic acid, the sodium, strontium, and barium salts of which are described.—Action of bromine upon some phenols in presence of aluminium bromide, by M. F. Bodroux.—On the mono-alkyl-phosphoric ethers, by M. J. Cavalier.—Influence of diffused daylight upon the development of plants, by M. J. Wiesner.—On chocolate-coloured oats, by M. Balland. No differences in the results of analysis could be found between the brown grains and the ordinary white ones.—The bitterness of wines, by MM. F. Bordas, Joulin, and de Raczkowski. A description of the habit and mode of growth of the bacillus causing the bitterness in wine.—Pathogeny and histogenesis of cancer, a parasitic disease, by M. F. J. Bosc. The only specific element in malignant tumours is the parasitic sporozoa described in previous papers.—Softening of bone by phloroglucinol, by M. J. J. Andeer. A solution of phloroglucinol in hydrochloric acid forms a valuable histological reagent for softening bone without changing its relation to other structures.

AMSTERDAM.

Royal Academy of Sciences, March 26.—Prof. van de Sande Bakhuyzen in the chair—Prof. Franchimont and Dr. H. Umbgrove on the action of sulphuric acid of 35 to 40 per cent. at the ordinary temperature upon acid aliphatic nitramines, upon neutral ones and upon their isomers. The first mentioned (methyl-, ethyl-, propyl- and butylnitramine) very slowly yielded nitrous oxide and an alcohol, and in addition—excepting methyl nitramine—a small quantity of non-saturated carburetted hydrogen. The same result was obtained with their potassium, barium and silver derivatives. The neutral nitramines were not attacked; their isomers, however, were attacked very rapidly. Experiments were made with the isomers of propylethylnitramine, of methylethylnitramine, of dimethylnitramine, and of ethylmethylnitramine. All of them, except the last, in which again CH_3 is united with nitrogen, yielded a little ethane, besides N_2O and one or two alcohols. The authors think that through the action of sulphuric acid the acid nitramines

$$C_nH_{2n+1}NH-N\begin{matrix}\nearrow O\\ \searrow O\end{matrix}$$

slowly change into

$$C_nH_{2n+1}N=N\begin{matrix}\nearrow O\\ \searrow OH\end{matrix},$$

and that the latter, being diazonitramines, are rapidly decomposed, as well as their alkyl derivatives, the isomers of the neutral nitramines.—Dr. G. C. J. Vosmaer and Prof. C. A. Pekelharing on the reception of food by sponges. When sponges (Spongillæ and Sycones) were fed with carmine, the colouring matter was always found first in the collar cells. Metschnikoff's objection against the view, according to which the food is received into the flagellated chambers, may perhaps have arisen from the circumstance that Metschnikoff allowed the moment favourable for the inquiry to slip by. In the case of Leucosolenia just taken out of the sea-water and cut open longitudinally, the movements of the flagellated chambers were found to be most irregular, and without a trace of coordination. The authors think that the regular passage of water through sponges, in consequence of an irregular movement in the flagellated chambers, is to be explained by taking into account (1) the shape of the supplying and discharging apertures, from which it may be concluded that the collar cells counteract, like valves, the discharging of water through the supplying apertures, and (2) the shape of the discharging channels, which may serve as suction channels.—Prof. van Bemmelen made a communication on the absorptive power of colloidal silicic acid.—Prof. H. A. Lorentz on optical phenomena, depending on the electrical charge and the mass of the ions. Part I. Measurements on the Zeeman effect give the value of $\frac{l}{m}$, l being the charge and m the mass of the ions. The author remarks that some other phenomena depend on the quantity $\frac{l^2}{m}$; in particular he discusses the dispersion and the absorption coefficient of gaseous media.—Prof Korteweg presented a communication by Mr. W. A. Wijthoff, entitled "A system of operations in the space of four dimensions analogous with Hamilton's quaternions." The geometrical operations described in it are represented by biquaternions, which prove to be identical with those of Clifford for the elliptical space.

DIARY OF SOCIETIES.

THURSDAY, May 12.

Royal Society, at 4.30.—A Study of the Phyto-Plankton of the Atlantic: G. Murray, F.R.S., and V. H. Blackman.—The Electrical Response of Nerve to a Single Stimulus investigated with the Capillary Electrometer. Preliminary Communication: Prof. Gotch, F.R.S., and G. J. Burch.—Effects of Prolonged Heating on the Magnetic Properties of Iron: S. R. Roget.—On the Connection of Algebraic Functions with Automorphic Functions: E. T. Whittaker.

Royal Institution, at 3.—Heat: Lord Rayleigh.

Mathematical Society, at 8.—On the Numerical value of $\int_0^h e^{x^2} dx$: H. G. Dawson.—On the Reflection and Transmission of Electric Waves by a Metallic Grating: Prof. Lamb, F.R.S.—Notes on some Fundamental Properties of Manifolds: A. E. H. Love, F.R S.

Institution of Electrical Engineers (Society of Arts), at 8.—The Registration of Small Currents used for Electric Lighting and other Purposes: A. H. Gibbings.—A Magnetic Balance for Workshop Test of Permeability: Prof. J. A. Ewing, F.R.S.

FRIDAY, May 13.

Royal Institution, at 9.—Recent Experiments on certain of the Chemical Elements in Relation to Heat: Prof. W. A. Tilden, F.R.S.

Royal Astronomical Society, at 8.—Micrometrical Measures of the Double Stars β 883, Sirius, and Procyon: T. J. J. See.—The Relative Motion of the Components of γ Leonis: S. W. Burnham.—Vanadium in the Spectrum (C to D) of Sun-spots: Rev. A. L. Cortie.—Notes on the Zodiacal Light: Wm. Anderson.

Physical Society, at 5.—Galvanometers, Part II.: Prof. W. E. Ayrton and T. Mather.

Malacological Society, at 8.—Note on a very large Specimen of *Hippopus Hippopus*: Edgar A. Smith.—Description of New, or Imperfectly-known Species of *Nautilus* from the Inferior Oolite, contained in the British Museum (Natural History): G. C. Crick.—On the Anatomy of *Adeorbis subcarinatus* (Montagu): Martin F. Woodward.—Phylogeny of the Genera of Arionidæ: Henry A. Pilsbry.

SATURDAY, May 14.

Geologists' Association (King's Cross, G.N.R.), at 1.20.—Excursion to Ayot and Hatfield. Directors: J. Hopkinson and A. E. Salter.

Essex Field Club, at 7.—Notes on the Trees and Shrubs of Epping Forest: F. W. Elliott.

MONDAY, May 16.

Society of Arts, at 8.—Electric Traction: Prof. Carus Wilson.

Victoria Institute, at 4.30.—The Philosophy of Education: Dr. A. T. Schofield.

TUESDAY, May 17.

Zoological Society, at 8.30.—On a Small Collection of Mammals obtained by Mr. Alfred Sharpe in Nyasaland: Oldfield Thomas.—On a Collection of Lepidoptera made in British East Africa by Mr. C. S Betton: Dr. A. G. Butler —On some Earthworms from India: Miss Sophie M. Fedarb.

Royal Statistical Society, at 5.—Local Taxation in London: G. Laurence Gomme.

Royal Victoria Hall, at 8.30.—Three Months on a Coral Island: Prof. Sollas, F.R.S.

WEDNESDAY, May 18.

Society of Arts, at 8.—The Evolution of the Cycle: J. K. Starley.

Geological Society, at 8.—The Garnet-actinolite Schists on the Southern Side of the St. Gothard Pass: Prof. T. G. Bonney, F.R.S.—On the Metamorphism of a Series of Grits and Shales in Northern Anglesey: Dr. C Callaway.—On a Volcanic Series in the Malvern Hills near the Herefordshire Beacon: H D. Acland.

Royal Meteorological Society (Burlington House), at 4.30.—The Frequency of Rainy Days in the British Islands: Robert H. Scott, F.R S.—The Abnormal Weather of January, 1898: Frederick J. Brodie.

Royal Microscopical Society, at 8.—Exhibition of Aquatic Life.

THURSDAY, May 19.

Royal Institution, at 3.—Heat: Lord Rayleigh.

Chemical Society, at 8.—The Action of Formaldehyde on Amines of the Naphthalene Series: G. T. Morgan.—On the Constitution of Oleic Acid and its Derivatives. Part I.: F. G. Edmed.

SATURDAY, May 21.

Royal Institution, at 3.—Biology of Spring: J. Arthur Thomson.

Geologists' Association (Paddington Station, G.W.R.), at 1.40.—Excursion to Penn and Coleshill. Director: W. P. D. Stebbing.

Essex Field Club (at Chingford), at 7.—On the Preparation of Marine Animals as Transparent Lantern Slides: Dr. H. C. Sorby, F R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—The Flora of Perthshire: Dr. F. B. White (Blackwood).—Submarine Telegraphs: C. Bright (Lockwood).—The Origin and Growth of the Moral Instinct: A. Sutherland, 2 Vols. (Longmans).—Birds in London: W. H. Hudson (Longmans).—Experimental Mechanics: G. H. Wyatt (Rivingtons).—La Famille Névropathique: C. Féré, deux edition (Paris, Alcan).—Missouri Botanical Garden, 9th Annual Report (St. Louis, Missouri).—Garden-Making: L. H. Bailey (Macmillan).—William Stokes (Masters of Medicine Series): W. Stokes (Unwin).—The Fauna of British India, including Ceylon and Burma. Birds, Vol. iv.: W. T. Blanford (Taylor).

Pamphlets.—Science and Engineering: C. Bright (Constable).—Technical Education. Application of Funds by Local Authorities (Eyre).—Mines and Quarries. General Report and Statistics for 1897. Part 1. District Statistics (Eyre).

Serials.—Strand Magazine, May (Newnes).—Science Progress, April (Scientific Press).—Chambers's Journal, May (Chambers).—Report of the Marlborough College Natural History Society, No. 46 (Marlborough).—Atlantic Monthly, May (Gay).—Quarterly Journal of the Geological Society, May (Longmans).—Observatory, May (Taylor).—Geographical Journal, May (Stanford)—Astrophysical Journal, April (Chicago)—Proceedings of the Royal Physical Society, Session 1896–97 (Edinburgh).—Monthly Weather Review, January (Washington).—Ditto, Annual Summary for 1897 (Washington).—Travaux de la Société Impériale des Naturalistes de St. Pétersbourg. Section de Géologie et de Minéralogie, vol. xxvi. livr. 5.—Ditto, Atlas de Vingt Planches in 4° du Vol. xxv. (St. Pétersbourg).

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THURSDAY, MAY 19, 1898.

AMBROISE PARÉ, SURGEON TO THE KING.

Ambroise Paré and his Times, 1510–1590. By Stephen Paget. Illustrated. (New York and London: G. P. Putnam's Sons; The Knickerbocker Press, 1897.)

ON October 1, 1889, Mr. Rickman J. Godlee delivered the introductory address in the Faculty of Medicine at University College, London. He chose for his subject a comparison of the methods of Ambroise Paré and those of a surgeon of the present time. This address, according to Mr. Paget's preface, was the moving cause of this present work. Seldom has it fallen to our lot to read a better bit of literary work, or a more stimulating biography. The author has extracted from the larger works of Malgaigue, Le Paulmier, and others the most salient points in Paré's life, and pieced them together in such a way that one has a real view of the life of the most celebrated surgeon of the sixteenth century. He has added to our literary medical store by a new translation of the "Journeys in Diverse Places," which, for faithful rendering and for the preservation of the quaint phraseology of the period, might have been done by Thomas Johnson himself, he who translated "The Works of that Famous Chirurgeon Ambrose Parey" into the vigorous and picturesque language of the earlier part of the seventeenth century. The interest to the modern general reader consists in the vivid picture of life as painted by one who saw it under every possible circumstance in the sixteenth century, and to the yet young practitioner, inasmuch as the surgery of Paré was practically the art of but yesterday until the total revolution, caused in it by the discoveries of Lister, had changed it to what it is now. Paré used to be mostly remembered at opening lectures as Hannibal was in Juvenal's time, "Ut pueris placeas et declamatio fias," and his memory was called to mind chiefly as the inventor of the ligature of arteries. Now this he did not, but only reintroduced the practice which had been restored about a century before by the German school of surgery, and lost sight of in the meanwhile. He was, however, the first to use the ligature in amputation wounds. He found out, by a scarcity of boiling oil on one occasion, that a mild application was infinitely to be preferred to that dreadfully severe one, and so set the practice of a more rational treatment of gunshot wounds. But Paré added little to the actual knowledge or practice of his art; his chief fame is due to the admirably clear writings he has left of that art as he practised it, and to the straightforward honest life he led in the midst of the most horribly cruel, licentious and debased surroundings it is possible to imagine. It is generally stated that Paré was a Protestant, and one of the very few who were spared at the St. Bartholomew massacre; but we think Mr. Paget has shown that there is good cause to believe that he was, nominally at least, a Gallican Romanist of the tolerant sort. We have selected a few extracts showing the conditions of war as Paré met with them. In the first journey, viz. to Turin, 1537, after the taking of the city, he writes:—

"We entered pell-mell into the city, and passed over the dead bodies and some not yet dead, hearing them cry under our horses' feet, and they made my heart ache to hear them. And truly I repented I had left Paris to see such a pitiful spectacle. Being come into the city, I entered into a stable, thinking to lodge my own and my man's horse, and found four dead soldiers and three propped against the wall, their features all changed, and they neither heard, saw, nor spoke, and their clothes were still smouldering where the gunpowder had burned them. As I was looking at them with pity, there came an old soldier, who asked me if there was any way to cure them. I said no. And then he went up to them and cut their throats, gently, and without ill-will toward them. Seeing this great cruelty, I told him he was a villain: he answered me, he prayed God, when he should be in such a plight he might find some one to do the same for him, that he should not linger in misery."

Again, on page 71 is an appreciation of the Spaniard of that time, which is the same that the English had, and is curiously like some of the denunciations one reads in the State papers and writings of the latter part of the reign of Elizabeth: it is as follows. After describing the departure of the Imperials from Metz, he goes on:—

"M. de Guise had their dead buried and their sick people treated. Also the enemy left behind them, in the abbey of St. Arnoul, many of their wounded soldiers, whom they could not possibly take with them. M. de Guise sent them victuals enough, and ordered me and other surgeons to go dress and physick them, which we did with a good will; and I think they would not have done the like for our men. For the Spaniard is very cruel, treacherous and inhuman, and so far enemy of all nations: which is proved by Lopez the Spaniard, and Benzo of Milan, and others who have written the history of America and the West Indies; who have had to confess that the cruelty, avarice, blasphemies and wickedness of the Spaniards have utterly estranged the poor Indians from the religion that these Spaniards professed. And all write that they are of less worth than the idolatrous Indians for their cruel treatment of these Indians."

As pointing out the immense slaughter in the battles of those times, note the account of the battle of Dreux, 1562:—

"The day after I came, I would go to the camp where the battle had been to see the dead bodies. I saw for a long league round the earth all covered. They estimated it at 25,000 men or more, and it was all done in less than two hours."

We believe that no modern battle of a like duration has produced such a loss. One more extract, and we have done; it relates to the evacuation of Havre by the English in 1563.

"When our artillery came before the walls of the town, the English within the walls killed some of our men and several pioneers who were making gabions; and, seeing they were so wounded that there was no hope of curing them, their comrades stripped them and put them living inside the gabions, which served to fill them up. When the English saw they could not withstand our attack because they were hard hit by sickness, and especially by the plague, they surrendered. The king gave them ships to return to England, very glad to be out of this plague-stricken place. The greater part of them died, and they took the plague to England, and they have not got rid of it since."

The book is well illustrated by reproductions of old prints and pictures and drawings of the places as they exist to-day. It is one of the most entrancing studies we have met with, and can be read over and over again. We heartily congratulate Mr. Paget on his work.

CAYLEY'S MATHEMATICAL PAPERS.

The Collected Mathematical Papers of Arthur Cayley, Sc.D., F.R.S. Vols. x., xi. Pp. xiv + 616; xvi + 644. (Cambridge: at the University Press, 1896.)

THIS instalment of the papers illustrates in a remarkable way Cayley's power of commenting upon and developing the work of his predecessors. The various memoirs on single and double theta-functions are, of course, based upon the results of Rosenhain, Göpel, and Kummer; and it is instructive to see how Cayley's instinct for symmetry and logical consistency has enabled him to present the theory in a compact and intelligible form. In the case of the single theta-functions, defined by their expansions in series, we have equations such as

$$\theta^2_{00}\theta_{00}(u+v)\theta_{00}(u-v)=\theta^2_{00}(u)\theta^2_{00}(v)+\theta^2_{11}(u)\theta^2_{11}(v) \quad . \quad . \quad . \quad \text{(i.)}$$

and from these it appears that any three of the squared functions $\theta^2_{gh}(u)$ are connected by a linear relation. Hence we may take the squared functions to be proportional to $A(a-x)$, $B(b-x)$, $C(c-x)$, $D(d-x)$ with x a variable, and the other quantities constant. Finally it is shown that x and u are connected by a differential equation of the form

$$du = \frac{Mdx}{\sqrt{(a-x)(b-x)(c-x)(d-x)}}.$$

Proceeding next to the double theta-functions, Cayley gives a set of 256 equations analogous to (i.); from these are derived quadric relations between the 16 functions which give, in all, 72 asyzygetic relations; it is assumed, and is fairly evident, that these are *all* the independent relations. The existence of the Kummer hexads and Göpel tetrads gives a special character to these relations. The next step is to find algebraic functions of two variables x, y and a proper number of constants which, on being substituted for the 16 theta-functions, satisfy the quadric relations identically. This Cayley succeeded in doing, apparently by a series of happy guesses; and this is his main contribution to the theory. He also shows that the two sets of variables u, v and x, y are connected by differential relations of the form

$$\sigma du+\tau dv=\tfrac{1}{2}\left(\frac{dx}{\sqrt{X}}-\frac{dy}{\sqrt{Y}}\right),\ \varpi du+\rho dv = -\tfrac{1}{2}\left(\frac{xdx}{\sqrt{X}}-\frac{ydy}{\sqrt{Y}}\right),$$

where $\varpi, \rho, \sigma, \tau$ are constants, $X=(a-x)(b-x)\ldots(f-x)$, a sextic in x, and Y is the same function of y that X is of x.

In order to complete the theory, from this point of view, it is necessary to find the connection between the constants which occur in the theta-functions as originally defined and those which are contained in the corresponding algebraical expressions. This can, in fact, be done for the single theta-functions (vol. x. p. 482); Cayley began, but did not finish the corresponding investigation for the double theta-functions (*ibid.*, pp. 563–564).

It would probably be well worth while to work out the relations of Cayley's theory to recent researches on hyperelliptic sigma-functions by Klein, Burckhardt and others. The best general view of Cayley's results is to be found in the "Memoir on the Single and Double Theta-Functions" (No. 704).

Suggested by the theta-function theory, there are several important geometrical papers, as, for example, on the 16-nodal quartic surface, and on the bitangents of a plane quartic.

The memoir "On the Schwarzian Derivative and the Polyhedral Functions" is chiefly valuable for its detailed analytical work, which is a great help to the proper appreciation of the papers of Kummer and Schwarz, especially the latter. In this connection it is proper to mention Cayley's own papers on the correspondence of homographics and rotations and on finite groups of linear substitutions (Nos. 660, 752).

Of the other papers on group-theory the most important is No. 690; this contains the "colour-diagram," and the maxim, adopted by Dyck as the motto of his "Gruppentheoretische Studien": "A group is defined by means of the laws of combinations of its symbols." This ultimate symbolical form of a group is, so to speak, its transcendental essence, which may become incarnate in an endless variety of shapes, such as sets of permutations, geometrical configurations, motions in space, and so on.

In the region of pure algebra we may notice the tenth memoir on quantics, which gives a very complete account of the binary quintic; tables for the binary sextic and ternary cubic; and a paper on the Jacobian sextic equation.

Vol. xi. contains a reprint of the articles contributed by Cayley to the "Encyclopædia Britannica." These, perhaps, will convey to the general reader some sense of his characteristic qualities as a writer; clearness, order, philosophical breadth and independence of view, combined with a studied restraint of manner which sometimes inclines to coldness. This reserve arose, probably, from an excess of sensitiveness, which made him follow an ideal of classic severity and shrink from any open expression of emotion. That he fully appreciated the æsthetic side of mathematics is clear from the well-known passage in his presidential address to the British Association, where he describes the extent and variety of modern mathematics by a metaphor of great beauty and appropriateness. But this is a rare, if not solitary exception to his usual custom; to gain a true idea of his personal charm we must appeal, not to his published work, but to the testimony of the friends who knew him well. For them the portrait prefixed to vol. xi., which shows Cayley as he was in 1885, will form a touching memorial.

Of the numerous minor papers, and of the problems and solutions contributed to the *Educational Times*, it is needless to say anything here. Diamond-dust from the lapidary's workshop, they will doubtless help to polish gems not yet extracted from the mine. G. B. M.

OUR BOOK SHELF.

An Elementary Course of Physics. Edited by Rev. J. C. P. Aldous, M.A. Pp. 862 + vi. (London: Macmillan and Co., Ltd., 1898.)

In this book an attempt is made to give a modern and practical course of natural philosophy in a compendious form, and it may be stated at once that the effort is a most successful one. It is the joint work of the editor, who is chief instructor on H.M.S. *Britannia*, Mr. W. D. Eggar, and Prof. F. R. Barrell. The editor is himself responsible for the sections dealing with mechanics, properties of matter, hydrostatics, and heat, in which the readers are provided with "a groundwork of theoretical knowledge which may enable them to understand and use the simple processes of the kinetic method, to express themselves with accuracy when necessary, and to deal with simple mechanical problems." Wave-motion, sound, and light are admirably treated by Mr. Eggar, while Prof. Barrell's contribution deals with the subjects of magnetism and electricity.

The treatment of the various subjects is most lucid and thorough, and is evidently based on an intimate acquaintance with the requirements of students. Great pains have been taken to avoid looseness of statement; and the fact that some of the sections have had the advantage of the criticisms and suggestions of Lord Kelvin, Lord Rayleigh, and others, makes it a trustworthy book of reference. Where everything is so well done it is difficult to select points for special mention, but it may be remarked that examples drawn from naval sources form a notable and valuable feature, and graphical methods of representing experimental results are largely utilised and encouraged. The generous supply of illustrations, which number nearly six hundred, and not one that fails to serve a useful purpose, enhances the value of the book, and will make it acceptable to a wider circle of readers than that comprised by students following a specified curriculum. The book is of convenient size, and is printed in very clear type; we believe it is destined to take a high place in our schools and colleges.

L'Algérie. Le Sol et les Habitants, &c. Par J. A. Battandier et L. Trabut. Pp. viii + 360. (Paris: Baillière et fils, 1898.)

This little volume is one of a class of books which is much better represented abroad than in this country—one, that is, in which a complete picture is given of a limited part of the earth's surface, under the varied aspects which make up its geography in the widest sense of the term. It is written on a scientific plan, the broad physical features of the country being taken as the basis of the whole description. In Algeria the authors distinguish three main zones, the Tell (or cultivable region), the Steppe, and the Sahara, holding that the plateaux, which some writers have made into a separate division, do not form a natural region, but fall within the Tell or the Steppe according to the amount of rain which falls. The determining factor, indeed, in the geography of the whole region, is the preponderance of the moist rain-bearing winds from the north-west, or of the parching desert winds from the south and south-east. Each of the zones is in turn described, special attention being given to their natural resources; and the fact that for over twenty years the authors have traversed the country in the prosecution of their botanical researches, enables them to speak with the accurate knowledge which can only be acquired at first hand. The inhabitants, the fauna and the geology of Algeria are also sketched in outline, so that we have in small compass a useful summary of all that is known of the country. The general conclusion arrived at is that Algeria is capable of supporting a large population, and that, in spite of the slow modification the climate has undergone since the dawn of history, cultivation will still be possible for many centuries to come.

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.*]

Electric Light Wires as Telephonic Circuits.

I wish to put on record the following method of using electric lighting wires as telephonic circuits. I was requested some time ago to try to localise a fault in an electric light main, by means of a certain form of inductor used in conjunction with a telephone but not connected to the main. While using it, it occurred to me that probably the main might be used instead of a telephone wire. My first experiments were not productive of good results, as a small fraction of the Company's current passed continuously through the telephone. In October 1897, I placed $\frac{1}{3}$ microfarad condensers in my telephone circuit at each end; these stopped the current, but in no way reduced the telephonic effects. If the note given out by virtue of the rotation of the armature of the dynamo is great, it can be very greatly reduced by placing an inductively wound resistance in the circuit.

The resistance does not appear to modify the telephonic effects in any marked degree. This probably arises from the fact that the E.M.F. due to the secondary coil of the telephone transmitter is high. The experiment was successfully made over two miles of a main which was carrying the full load used in lighting the town. F. J. Jervis-Smith.

Oxford, May 16.

Sub-Oceanic Terraces and River Channels off the Coast of Spain and Portugal.

Will you allow me once more to briefly describe in advance the physical features under the Atlantic off the coast of Spain and Portugal, continuous with those opposite the coasts of the British Isles and the Bay of Biscay, already reported in your columns (Nature, March 24 and April 21)?

The great escarpment already described as descending into deep waters from the margin of the British-Continental platform is still traceable southwards along the coast of Portugal from Cape Finisterre as far at least as the mouth of the Tagus estuary, where it appears to begin to broaden out and merge into a generally rapid slope—or probably a succession of terraces. The breadth of the platform along this coast averages only 30 to 40 miles from the shore, and its margin very nearly follows the 200-fathom contour; but here the descent to the 1000-fathom contour is steep, though seldom precipitous, and is varied by numerous bays and headlands. Owing to the insufficiency of the soundings, especially off Vigo Bay, the definition of the cañons, or old river channels, is scarcely as clear as in the region further north. Still, I have been able to determine several with a great degree of certainty, such as those formerly continuous with the rivers Padron, Lima, Douro, and Tagus. There are also a few which cannot apparently be followed to their sources in the present land, such as one of special depth and precipitancy in lat. 40° 31′ N., distant about 40 miles off the coast of Portugal at Barra Nova. The continuation of these features to the Straits of Gibraltar and into the Mediterranean remains for future investigation.

20 Arundel Gardens, W., May 16. Edward Hull.

Bacteria on an Ancient Bronze Implement.

Mr. Nicholson probably refers to what is known to archæologists as "bronze cancroid."

In the last number of the *Journal* of the Royal Society of Antiquaries of Ireland, March 31, this subject is referred to under the name of "Ulcerative Disease of Bronze or 'Bronze Cancroid,'" by Dr. William Frazer.

As many readers of Nature interested in bacteria may not be able to conveniently refer to this journal, the following points brought forward by the author will be read with interest. He says, "all objects of antiquity fabricated from metallic copper, and its important alloy made by adding tin in certain proportions, are liable to be attacked by this destructive corroding affection." The "bronze disease," says Dr. Frazer, "produces a remarkable disintegrating effect on the object it attacks, and there are good reasons for considering that it possesses infective powers, spreading like a leprosy through the substance of the metal, and slowly reducing it to amorphous powder; further, there are substantial grounds for believing it capable of being conveyed from surfaces already suffering with it to those yet uninfected. So that dishonest counterfeiters of antiques now propagate it on their modern forgeries to deceive intended purchasers. This infamous act is as yet understood to be confined to Italy, where the greater part of these forgeries are made." "In genuine antiques, it unfortunately happens occasionally that the patinated surface of bronze, soon after its discovery from recent excavations, becomes affected with this distinctive bronze disease, which makes its appearance in a number of small spots of clear pale blue colour, that swell and form farinaceous elevations; in the course of time, especially when kept in a moist atmosphere, these spots enlarge, run together and multiply, gradually invading the greater part of the surface, and reducing the object to a powdery condition."

Dr. Frazer says a remedy is found in ink made from sulphate of iron and oak galls, and that scraping "risks a fresh outbreak of this infectious malady." Further on he says the chief operator in Rome is well known, and "It would appear that those skilful artists of false antiques having succeeded in counterfeiting genuine patinations, so as to deceive the most learned collectors, have subsequently gone to the length of infecting their reproductions with spots of the bronze disease. This is no mere superficial imitation which they cause, but absolute inoculation of the destructive canker itself."

In conclusion, Dr. Frazer refers to an article in the *Revue Archæologique* on the same subject by the late Count Michel Kyskiewicz, under the title, "Notes and Souvenirs of an Old Collector." W. G. S.

Dunstable.

I AM not aware of any book on the subject, but Mr. Nicholson will find scattered notices in the *Zeitschrift für Hygiene* and *Arch. für Hygiene*, also the *Journals* of the Chemical Society and Society of Chemical Industry, and *British Journal of Photography* (development of bacteria in silver gelatine films).

The best way to sterilise ancient implements is to suspend them in an oven at a temperature of 150° C.–180° C. for two hours, and let them cool in a free current of air in order to prevent deposit of moisture. This method is quite harmless to the metal, and will sterilise the most resisting spores. It presents obvious advantages over the use of antiseptic fluids.

36 Finsbury Pavement, E.C. G. LINDSAY JOHNSON.

Ebbing and Flowing Wells.

I HAVE had occasion to live for many months of several years close to a well that was sometimes affected by the tide like that at Newton Nottage (NATURE, May 12, p. 45). This was at Alibag, a few miles south of Bombay. The bed-rock is a sheet of basalt of rather uneven surface, sloping westwards at the general rate of about six feet to the nautical mile. Over this, at the spot in question, were low sand-dunes, covered with palm orchards, and full of brick wells. One of my wells was twenty or twenty-five yards from true high-water mark of spring tides, though the surf washed light objects much nearer.

In the dry weather the ebb and flow did not perceptibly affect the well; but during the monsoon the sand-dunes were saturated by the heavy rainfall, and all along their seaward foot, where the sand lay on the sheet-rock, well below high-water mark, the fresh water poured out at ebb tide. When high spring tides were coincident with heavy rain the water in this well rose a little later than the tide, and several feet higher, almost to the level of the ground around the well. Its taste was not affected. At such times the surface in the well was two feet higher than the floor of my house, which stood in a hollow of the dune, a few yards to the eastward. The house was a notorious death-trap (as might be expected); and it was in the course of endeavours to get it condemned and pulled down, that I made the observations related. As it was a Government building, the records are official; and I write from memory. But the well is probably still there; and the observations, in that case, could be verified during any monsoon.

May 13. W. F. SINCLAIR.

TECHNICAL HIGH SCHOOLS—A COMPARISON.

AT different times attempts have been made to convey to English readers interested in scientific education some idea of the facilities provided abroad, particularly in Germany and Switzerland, for the higher technical instruction. The reports of the Technical Instruction Commissioners, and of other persons who have inspected the principal foreign schools, give full particulars of the courses of study pursued in those schools, of the rapidly increasing number of students in attendance, and of the large professorial staff attached to each institution. Exact details, however, as to the magnitude of the technical high schools of Germany have not been hitherto presented in such a form, as might readily show the full importance which our German neighbours attach to the higher scientific training, as a means of advancing their commercial interests. On my return, in the autumn of 1896, from a short visit to Bavaria and Würtemberg, in company with some of my colleagues of the Technical Instruction Commission, I gave some account, in the pages of this journal, of the new electro-technical and electro-chemical institutions, recently erected in Darmstadt in connection with the polytechnic of that town. A few weeks since, I had occasion to pay a flying visit to Aachen, and there I found close to the old polytechnic, erected in 1870, an entirely new building, opened only in 1897, and devoted almost exclusively to electrical work. This school, although not so large, nor so well equipped, as the schools in Stuttgart and Darmstadt, forms a very important addition to the facilities for the higher technical instruction which previously existed in the Rhenish city. It will be seen from the accompanying illustration (Fig. 1) that this new building is a plain structure of four stories, with no pretensions to architectural effect. It is about 140 feet long, and is of a mean depth of about 90 feet, the total area covered by the building being little less than that of the science schools of South Kensington, and about half of that of the Technical Institute of the City Guilds. Yet this building is devoted almost exclusively to the teaching of one branch of applied physics.

Dr. Bosse, the well-known energetic Minister of Education for Prussia, in his dedicatory address at the opening of this school in May last, correctly expressed German opinion when he said: "Neither the technical sciences nor the technical high schools can be said to have yet reached their goal. Both stand in the midst of a restless and irresistible movement and development pressing ever forwards." This recognition on the part of the Prussian Minister of the necessity of constantly improving educational facilities so that they may keep pace with the advance of science, is characteristic of the progressive policy of Germany.

The progress I found this year in Aachen, and eighteen months ago in Stuttgart and Darmstadt, might be observed equally in other parts of Germany, showing that our German neighbours are fully as determined, that their high schools of science shall be ahead of those of other countries, as we may be resolved, that our fleet shall be equal to that of any two other nations.

It is well known to most of the readers of this journal, but must be emphasised with a view to a comparison between the provision for scientific education in Great Britain and Germany, that the polytechnics or technical high schools are institutions exclusively devoted to the teaching of science in its practical application to engineering, manufacturing and professional pursuits. They are quite distinct from the universities, which, situated in the same town or in an adjoining city, as the case may be, comprise other faculties besides science, and, although far larger and more important, belong rather to the class of institutions known in this country as University Colleges. Not far from the polytechnic at Aachen is the University of Bonn; at Munich, and within a few yards of each other, are found the university and polytechnic, and the magnificent institution at Charlottenberg is almost as near to the science laboratories of the Berlin University as is University College to the City Guilds Institute. It must also be remembered that the universities comprise schools of science of the highest grade, for each of which, as at Zürich, Strassburg and Berlin, separate buildings are provided, presided over by professors of European celebrity. In the figures I am about to quote, it will be understood, therefore, that I am dealing with a part only of the accommodation which the different German States have made for the teaching of the higher branches of science.

In order to show the relative sizes of some of the Continental institutions for instruction and research work in technical or applied science, I have obtained plans, accompanied by descriptive matter, of certain typical technical high schools, and have made squares corresponding to the areas covered by the existing buildings. In most cases the buildings erected in the early building in this country which correctly corresponds with a German polytechnic, although its courses of instruction are restricted to fewer branches of professional work. The Royal College of Science embraces a much wider range of scientific work, but, except as regards its mining department, its functions differ in many respects from those of a technical high school. University and King's Colleges may be described as imperfect and undeveloped universities, the specially technical departments of which would alone correspond to the buildings now under consideration.

Taking the areas of the sites of some of the principal foreign schools, we have the following figures arranged in order:

	Square metres
Site of the Berlin Polytechnic	82,460
,, Aachen ,, ...	21,900
,, Darmstadt ,, ...	16,150
,, Hanover ,, ...	15,294
,, Chemnitz ,, ...	12,418
,, Stuttgart ,, ...	11,189
,, London—City Guilds College ...	3,344
,, ,, Royal College of Science	1,189

Fig. 1.—Electro-technical and Mining Laboratory—Aachen.

'seventies have proved too small and ill-adapted or such practical teaching as requires the use of steam power. Separate buildings have accordingly been added for the accommodation of the engineering, chemical, and electrotechnical laboratories, for engine and boiler houses, and for other purposes. The areas of these separate buildings I have added together, and where a building consists of a front portion, and of separate wings at right angles to it, as is so frequently the case, I have taken only those parts of the site which the buildings actually cover. With a view to further accuracy I have endeavoured, where the plans enabled me to do so, to reduce the several parts of the building to a uniform height. The figures quoted may be taken, therefore, as approximately correct.

The Central Technical College of London is the only

The relative areas of these sites are shown by the squares in Fig. 2.

If we consider the buildings erected on these sites, we have the following figures representing in square metres the areas already covered:—

	Square metres
Berlin	16,500
Zürich (exclusive of observatory building) ...	15,412
Aachen (exclusive of engineering laboratory, being built)	8,255
Stuttgart	6,375
Darmstadt	6,084
Chemnitz	3,964
London—City Guilds College...	1,837
,, Royal College of Science	1,189

The accompanying squares (Fig. 3) show the relative sizes of the buildings.

I have not been able to obtain the dimensions of the building in Hanover, nor have I those of the site of the Zürich Polytechnic.

It will be seen at a glance how very inadequate is the provision in London for the higher scientific and technical teaching, as compared with what is found in even a small German town. But, as has frequently been pointed out, it is not only in the size and arrangements of the buildings devoted to science, that we in England are so far behind our German and Swiss neighbours, but also in the organisation of the instruction. In some of our best schools at home each professor has to do the work of three or four experts abroad. In a German university or polytechnic, there is a large staff of professors, each occupied with a particular section of science, in which he is specially interested, and presiding over a laboratory in which he has time and opportunity to make investigations, with the view of advancing science in some one direction. It is the combination of professorial work and the coordination of teaching that make the German university or polytechnic so powerful a machine not only for scientific training, but also for discovery and research. In London, unfortunately, we have too many separate schools, each under-staffed, and each doing much the same kind of work, and the professors are consequently required to discharge a number of duties which are wisely divided in Germany among separate specialists. The multiplication of the schools, and the overlapping of the functions of the teachers stand in the way of any organisation on broad lines of the higher scientific education in London. It appears that a much-needed extension of the Royal College of Science at South Kensington is now under consideration; and it is understood that a more ample site than was originally suggested will be provided for the new buildings on the west side of Exhibition Road, which will bring the Royal College of Science in closer proximity to the Central Technical College. This is as it should be. It is to be hoped, however, that no hasty and half measures will now be adopted. In these days of military and naval expenditure it may be well to point out that the sinews of war come not only from the tax-payers' pockets, but equally, if not to a greater extent, from our high schools of science. Advantage should be taken of the avowed intention of the Government to extend the Royal College of Science, to consider the wider but more important question of the organisation of a faculty of pure and applied science, in connection with the University of London, and of bringing together, for the advantage of the same students, the various agencies for the higher scientific training which are now scattered and separated. Any change or extension that may be now made in any one institution cannot fail to have an important influence on university teaching in London, and should be considered only in relation to the best possible arrangements for developing and improving the joint facilities which London now offers for scientific education of the highest grade.

PHILIP MAGNUS.

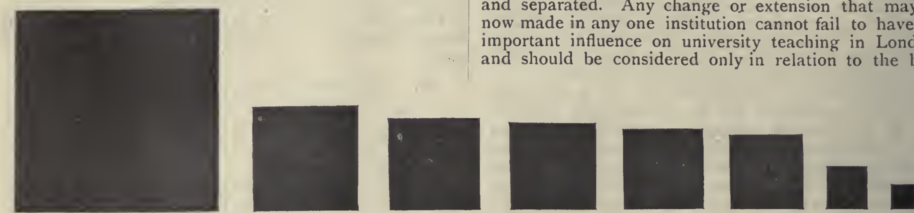

Fig. 2.—Squares showing areas of sites.

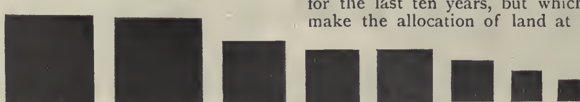

Fig. 3.—Squares showing areas of buildings.

THE SCIENCE BUILDINGS AT SOUTH KENSINGTON.

In Nature for May 5 we printed the report of the Select Committee of the House of Commons which has recently been inquiring into the Museums of the Science and Art Department, relating to the recent proposal of the Government to build the new laboratories for the Royal College of Science on the east side of Exhibition Road. We have received for publication the following memorial recently presented to Lord Salisbury by Lord Lister, the President of the Royal Society, which has been signed by the president and officers, all the living past presidents, and many fellows of the Society, entirely endorsing the views of the Select Committee, and urging the Government to refrain from a step which is not only contrary to the policy which has been pursued for the last ten years, but which, if carried out, would make the allocation of land at South Kensington for Science and Art purposes respectively ridiculous. Nor is this all. So far as science and science teaching is concerned, we should be landed in a position far inferior to that occupied by such towns as Gratz, Chemnitz, or Aachen, not to speak of some chief cities of the Continent, Berlin, Vienna, Paris.

Memorial to the Most Honourable the Marquis of Salisbury, K.G., F.R.S., Premier and Secretary of State for Foreign Affairs.

I. Whereas in 1890 Parliament voted 100,000*l.* for the purchase of a site at South Kensington upon which to erect suitable buildings for the Science Museum of the Department of Science and Art, and for the extension of its Science Schools, in accordance with the recommendations of the Royal Commission over which the Duke of Devonshire presided in 1874, as well as of various Committees and other high scientific authorities, and of a Treasury Committee appointed in 1889.

II. And whereas when in 1891 the Government had proposed to erect an Art Gallery on the site, a Memorial, signed by the President and Officers of the Royal Society and representatives of the Universities of Oxford, Cambridge, and of many other learned bodies both in London and in the provinces, was addressed to the Most Honourable the Marquis of Salisbury, K.G., F.R.S., Premier and Secretary of State for Foreign Affairs, showing cause why the site should not thus be allocated.

III. And whereas the scheme was withdrawn, and it was stated by the late Right Honourable W. H. Smith, M.P., that "additions to the College of Science must, in any case, take the form of a separate building divided from the present building by Exhibition Road," and since then plans have been prepared on information supplied on the instructions of Her Majesty's Treasury by the professors concerned.

IV. And whereas this arrangement has been generally accepted since 1876, when the Royal Commission for the Exhibition of 1851 offered land and a building with a view of carrying out the recommendations of the Duke of Devonshire's Commission to provide the needed accommodation for Science at South Kensington.

V. And whereas it was expected that this arrangement would be carried out, when in 1890 the Government acquired the land on the West side of Exhibition Road, which was sold by the Royal Commission of the Exhibition of 1851 at one-third its market value, on the condition that buildings for Science and the Arts should be erected on it.

VI. And whereas we are informed that this arrangement is in danger of being altered by the erection of Science buildings on the East side of Exhibition Road.

We, the undersigned Fellows of the Royal Society, desire most respectfully to express to your Lordship our strong opinion that it is desirable to adhere to the policy, namely, that the needful expansion of the Science Buildings at South Kensington should be provided for on the West side of Exhibition Road, which has been acted upon and publicly acknowledged by the Government since 1890, and is in strict harmony with the recommendation of the Duke of Devonshire's Commission. We are confirmed in this opinion by the fact that the space which we understand is available for Science on the East side of Exhibition Road is but a small fraction of that which is devoted to similar purposes in many foreign towns.

(Signed)

LISTER, President of the Royal Society.
JOHN EVANS, Treasurer of the Royal Society.
M. FOSTER, Secretary of the Royal Society, Professor of Physiology, Cambridge.
ARTHUR W. RÜCKER, Secretary of the Royal Society.
E. FRANKLAND, Foreign Secretary of the Royal Society.
JOS. D. HOOKER, Past President of the Royal Society.
G. G. STOKES, Past President of the Royal Society.
KELVIN, Past President of the Royal Society.
WILLIAM CROOKES, Past President, Chemical Society and Institution of Electrical Engineers.
T. CLIFFORD ALLBUTT, Regius Professor of Physic, Cambridge.
G. CAREY FOSTER, Professor of Physics, University College, London.
A. W. REINOLD, Professor of Physics, Royal Naval College, Greenwich.
WILLIAM RAMSAY, Professor of Chemistry, University College, London.
JAMES DEWAR, Professor of Chemistry, Royal Institution.
OSBERT SALVIN.
LUDWIG MOND, Past President of the Society of Chemical Industry.
W. H. M. CHRISTIE, Astronomer Royal.
W. H. WHITE, Vice-President, Institute of Naval Architects.
BENJAMIN BAKER, Past President, Institution of Civil Engineers.
W. H. PREECE, Engineer in Chief, G.P.O.
RICHARD TEMPLE.
W. CAWTHORNE UNWIN, Professor of Engineering, Central Technical College.
R. H. INGLIS PALGRAVE.
W. M. HICKS, Principal, University College, Sheffield.
JOHN KIRK, G.C.M.G., K.C.B.
RICHARD STRACHEY, Chairman, Meteorological Council.
C. W. WILSON, Major-General R.E.
FRANCIS ELGAR, Vice-President, Institute of Naval Architects.
E. RAY LANKESTER, Linacre Professor, Oxford.
RICHARD T. THORNE.
A. B. KEMPE, Past President, Mathematical Society.
SHELFORD BIDWELL, President, Physical Society.
SILVANUS P. THOMPSON, Principal and Professor of Physics, Technical College, Finsbury.
ROSSE.
P. L. SCLATER.
JOHN PERRY.
G. M. MINCHIN.
SIDNEY MARTIN, M.D., Professor of Pathology, University College, London.
G. D. LIVEING, Professor of Chemistry, Cambridge.
HENRY E. ARMSTRONG, Professor of Chemistry, Central Technical College.
R. MELDOLA, Professor of Chemistry, Technical College, Finsbury.
P. H. PYE-SMITH, M.D.
A. A. COMMON, Past President, Royal Astronomical Society.
RAYLEIGH.
J. BURDON-SANDERSON, Regius Professor of Medicine, Oxford.
W. GRYLLS ADAMS, Professor of Natural Philosophy and Astronomy, King's College, London.
H. CHARLTON BASTIAN, M.D.
J. G. BAKER.
J. WOLFE BARRY, Past President, Institution of Civil Engineers.
G. JOHNSTONE STONEY, Vice-President, Royal Dublin Society.
HENRY E. ROSCOE, Past President, Chemical Society.
WYNDHAM R. DUNSTAN.
J. H. GLADSTONE, Past President, Chemical Society.
F. D. GODMAN, Past President, Entomological Society.
J. VIRIAMU JONES, Professor of Physics, University College, Cardiff.
EDWARD B. POULTON, Hope Professor of Zoology, Oxford.
FREDERICK J. JERVIS-SMITH, University Lecturer in Mechanics, Oxford.
J. NORMAN LOCKYER, Member of the Royal Commission for the Exhibition of 1851.
W. J. L. WHARTON, Hydrographer to the Admiralty.
W. PALMER WYNNE, Hon. Secretary, Chemical Society.
J. W. SWAN, President, Institution of Electrical Engineers.
C. V. BOYS, Vice-President of the Physical Society.

LIQUID HYDROGEN.

A VERY remarkable achievement, which will redound to the credit of English science, has been performed within the walls of the Royal Institution. For some time past it has been a matter of general knowledge that Prof. Dewar has been preparing for an attempt to produce liquid hydrogen on a large scale. Money has been freely subscribed for investigations to be carried on at low temperatures, and the laboratories of the Royal Institution have gradually approached more and more nearly to the likeness of an engineering workshop. Very grave difficulties had to be encountered, and success seemed long in coming; but on Tuesday, May 10, Prof. Dewar was able to inform the President of the Royal Society that on that day both hydrogen and helium had succumbed to his attack.

All this is typical of British methods. The members of a great private Institution have secured the services of a man in whose abilities they believe. They supply him freely with the sinews of war, and he justifies their confidence by achieving a success which, as far as our present knowledge goes, could only have been won by a combination of great resources and very great skill. We heartily congratulate Prof. Dewar and his supporters on this result, and on the fact that the world now possesses liquid hydrogen—so to speak—on tap.

The conditions of the experiment give some idea of the difficulties which have been overcome. Hydrogen cooled to $-205°$ C. escaped, under a pressure of 180 atmospheres, into a vacuum vessel surrounded by a space which was itself maintained at a temperature of $-200°$ C. Thus constrained it liquefied.

About 20 c.c. of the liquid were collected in another protected vessel, into which it dripped from that above described. It is transparent, colourless, with a well-defined meniscus, and apparently with a relatively high refractive index.

We sincerely hope that this great success will not be marred by a controversy as to priority, of which some symptoms have already appeared in a leading article in the *Standard* and elsewhere. The time is long past in which the liquefaction of a gas was interesting as proving that under proper conditions all substances can be liquefied. For many years nobody has had doubts on that point. We have learned to look upon the liquefaction of a gas as important, mainly because it affords a means of studying at very low temperatures not only the liquefied gas itself, but also other kinds of matter. Experiments in which momentary liquefaction is attained are chiefly interesting as showing that some approach is made to realising the condition under which more stable results may be expected. They take a much higher rank if the skilful experimenter can wrest from the substance in a transitory condition some information as to the properties which the material would have if it were reduced to the state which has been called a "static liquid." To attain these results in the case of so intractable a substance as hydrogen is an achievement of a very high order. But when this has been done it cannot be fairly contended that all the rest follows as a matter of course.

There have been discoveries in which the first step was all-important. The discovery, for instance, of the Röntgen rays opened an entirely new range of facts to scientific investigation. In other cases the root-idea had long been common property, and the merit, like that of Captain Bunsby's observation, "lays in the application of it." It has long been known that if hydrogen were ever liquefied in quantity, both cooling to a very low temperature, and a rapid expansion would play a large part in the operation. The difficulties of the experiment lay, not in understanding these principles, but in applying them, and the difficulties were so enormous that the investigator who has overcome them deserves our admiration. He has performed not only a great "tour de force," but has cleared the way to a region hitherto unexplored, to a whole series of researches which become more interesting and important as the absolute zero is more nearly approached.

It appears to us, therefore, that there is no necessity to belittle the work either of Prof. Dewar or of others who have been active in the same line of research. Cailletet and Wroblewski obtained results which, to judge from his address to the French Academy, reported in the *Times* of May 17, are regarded as inconclusive by so high an authority as M. Moissan. At the best, and assuming the liquid obtained to have been hydrogen, its existence in the liquid form was very brief. Prof. Olszewski also has published a full account of how he obtained hydrogen for a moment in a mist-like state, in which he measured some of the constants of the liquid. Yet nothing but the paucity of language could lead to the idea that this feat was the same as that which Prof. Dewar has accomplished. Had we no other evidence of the existence of water, something might be learned from the study of clouds; but nobody contends, on that ground, that a cloud is the same thing as a duck-pond. Yet the difference between the two is hardly, if at all, greater than the practical difference between hydrogen without visible form or surface, in a state of momentary or "dynamical" liquefaction, and hydrogen as a "static" liquid, with a clearly defined meniscus, boiling away quietly under conditions which enable the observer to record its appearance, to handle and to use it.

By insisting on this difference, we do not for a moment wish to question the merits of Prof. Olszewski's work. He used the means at his disposal admirably, and made measurements of the critical temperature and boiling-point of hydrogen, which, tested as they were by check experiments on oxygen and ethylene, were of great value.

Prof. Olszewski was, however, fully conscious of the difference between these results and those which Prof. Dewar has now achieved. He again and again explained with the utmost candour that he had seen no meniscus, and that he had failed to reduce hydrogen to the state of a "static liquid." He further expressed the opinion that these desiderata would not be attained until a cooling agent was discovered in the form of a gas, with a density between those of hydrogen and nitrogen. No such gas has been used by Prof. Dewar, yet hydrogen has now been seen by himself, by Lord Rayleigh and others as a well-defined liquid mass. The merits of this achievement will be in no wise diminished by a generous recognition of the researches of Olszewski, but on the other hand it would be most unfair to minimise the magnitude of Prof. Dewar's success by classing it merely as a repetition, on a larger scale, of another man's work. It is in the words of M. Moissan a "wonder of modern chemistry."

The following abstract of the paper will give further details :—

In a paper entitled "The Liquefaction of Air and Research at Low Temperatures," read before the Chemical Society, and published in the *Proceedings*, No. 158, an account is given of the history of the hydrogen problem and the result of my own experiments up to the end of the year 1895. The subject is again discussed in a Friday evening lecture on "New Researches on Liquid Air" (*Roy. Inst. Proc.*, 1896), which contains a drawing of the apparatus employed for the production of a jet of hydrogen containing liquid. It was shown that such a jet could be used to cool bodies below the temperature that could be reached by the use of liquid air, but all attempts to collect the liquid in vacuum vessels failed. No other investigator has so far improved on the results described in 1895. The type of apparatus used in these experiments worked well, so it was resolved to construct a much larger liquid air plant, and to combine with it circuits and arrangements for the liquefaction of hydrogen, which will be described in a subsequent paper. This apparatus, admirably constructed by the engineers, Messrs. Lennox, Reynolds, and Fyfe, took a year to build up, and many months have been occupied in testing and making preliminary trials. The many failures and defeats need not be detailed.

On May 10, starting with hydrogen cooled to $-205°$ C., and under a pressure of 180 atmospheres, escaping continuously from the nozzle of a coil of pipe at the rate of about 10 cubic feet to 15 cubic feet per minute, in a vacuum vessel double silvered and of special construction, all surrounded with a space kept below $-200°$ C. Liquid hydrogen commenced to drop from this vacuum vessel into another doubly isolated by being surrounded with a third vacuum vessel. In about five minutes, 20 c.c. of liquid hydrogen were collected, when the hydrogen jet froze up from the solidification of air in the pipes. The yield of liquid was about 1 per cent. of the gas. The hydrogen in the liquid condition is clear and colourless, showing no absorption spectrum, and the meniscus is as well defined as in the case of liquid air. The liquid must have a relatively high refractive index and dispersion, and the density must also be in excess of the theoretical density, viz. 0·18 to 0·12, which we deduce respectively from the atomic volume of organic compounds, and the limiting density found by Amagat for hydrogen gas under infinite compression. My old experiments on the density of hydrogen in palladium gave a value for the combined body of 0·62, and it will be interesting to find the real density of the liquid substance at its boiling-point. Not having arrangements at hand to determine the boiling-point, two experiments were made to prove the excessively low temperature of the boiling fluid. In the first place, if a long piece of glass tubing, sealed at one end and open to the air at the other, is cooled by immersing the closed end in the liquid hydrogen, the tube immediately fills, where it is cooled, with solid air. The second experiment was made with a tube containing helium.

The *Cracow Academy Bulletin* for 1896 contains a paper by Prof. Olszewski, entitled "A Research on the Liquefaction of Helium," in which he states "as far as my experiments go, helium remains a permanent gas, and apparently is much more difficult to liquefy than hydrogen." In a paper of my own in the *Proceedings* of the Chemical Society, No. 183 (1896–97), in which the separation of helium from bath gas was effected by a liquefaction method, the suggestion was made that the volatility of hydrogen and helium would probably be found close together, just like those of fluorine and oxygen. Having a specimen of helium which had been extracted from bath gas, sealed up in a bulb with a narrow tube attached, the latter was placed in liquid hydrogen, when a distinct liquid was seen to condense. From this result it would appear that there cannot be any great difference in the boiling points of helium and hydrogen.

All known gases have now been condensed into liquids which can be manipulated at their boiling points under atmospheric pressure in suitably arranged vacuum vessels. With hydrogen as a cooling agent, we shall get within 20° or 30° of the zero of absolute temperature, and its use will open up an entirely new field of scientific inquiry. Even as great a man as James Clerk Maxwell had doubts as to the possibility of ever liquefying hydrogen (see "Scientific Papers," vol. ii. p. 412). No one can predict the properties of matter near the zero of temperature. Faraday liquefied chlorine in the year 1823. Sixty years afterwards Wroblewski and Olszewski produced liquid air, and now, after a fifteen years' interval, the remaining gases, hydrogen and helium, appear as static liquids. Considering the step from the liquefaction of air to that of hydrogen is relatively as great in the thermo-dynamic sense as that from liquid chlorine to liquid air, the fact that the former result has been achieved in one-fourth the time needed to accomplish the latter, proves the greatly accelerated race of scientific progress in our time.

The efficient cultivation of this field of research depends upon combination and assistance of an exceptional kind; but in the first instance money must be available, and the members of the Royal Institution deserve my especial gratitude for their handsome donations to the conduct of this research. Unfortunately its prosecution will demand a further large expenditure.

During the whole course of the low temperature work carried out at the Royal Institution, the invaluable aid of Mr. Robert Lennox has been at my disposal; and it is not too much to say that but for his engineering skill, manipulative ability, and loyal perseverance, the present successful issue might have been indefinitely delayed. My thanks are also due to Mr. J. W. Heath for valuable assistance in the conduct of these experiments.

NOTES.

M. MARCELLIN BOULE, of Paris; Dr. W. H. Dall, of Washington (D.C.), U.S.A.; and M. A. Karpinsky, of St. Petersburg, have been elected Foreign Correspondents of the Geological Society.

PROF. MICHAEL FOSTER has been elected President of the British Association for the meeting to be held at Dover next year.

THE annual conversazione of the Society of Arts will take place at the Natural History Museum, Cromwell Road, S.W., on Wednesday, June 22. The reception will commence at 9 p.m.

A CONVERSAZIONE of the Metropolitan Counties Branch of the British Medical Association will be held in the Museum of the Royal College of Surgeons on Tuesday, June 7.

THE Prince of Wales and the Duke of York were present on Monday night at a special meeting of the Royal Geographical Society, held in commemoration of the 400th anniversary of the discovery of the Cape route to India by Vasco da Gama. The president, Sir Clements Markham, was in the chair, and the address delivered by him upon the occasion is published in another part of this issue. At Lisbon the Vasco da Gama celebrations were inaugurated on Tuesday by the firing of a salute of 101 guns by the forts and the ships anchored in the Tagus. At a meeting of the Lisbon Geographical Society, Baron von Kell, the Dutch Minister to Portugal, presented to King Charles an album and a gold wreath, as the homage of Holland to Vasco da Gama. His Majesty accepted the gift, and said that Portugal was grateful for this act of homage.

THE Judicial Committee of the Privy Council recently granted the Hon. C. A. Parsons an extension of five years for his patent, dated April 23, 1884, for "improvements in rotary motors actuated by elastic fluid pressure and applicable also as pumps." The reasons for this decision were stated on Saturday to be that Mr. Parsons had not yet been adequately remunerated for his invention.

DR. D. J. LEECH, Professor of Materia Medica and Therapeutics in the Victoria University; Prof. W. Ramsay, of University College, London; and Prof. Ira Remsen, the Professor of Chemistry at the Johns Hopkins University, Baltimore, have been elected honorary members of the Pharmaceutical Society of Great Britain.

IN the High Court of Justice on Saturday an application was made on behalf of the shareholders of the Sheffield Botanical and Horticultural Society, that the trustees might be ordered to sell its property in pursuance of resolutions passed at meetings of the members, and distribute the proceeds of the sale among the members. It was urged by the Attorney-General that the property of the Society ought not to be so divided, but ought to be given to some other institution of a like character. The judgment was, however, that the applicants were entitled to the order they asked for.

PROF. J. M. SCHAEBERLE has resigned his post as astronomer at the Lick Observatory, California.

MR. HENRY WILDE, F.R.S., has been elected an honorary member of the Institution of Electrical Engineers.

THE Boston Society of Natural History has awarded the Grand Honorary Walker Prize of one thousand dollars to Mr. Samuel Hubbard Scudder, of Cambridge, Mass., for his contributions to entomology. The prize is awarded every five years, and the four previous recipients have been Mr. Alexander Agassiz, Prof. Joseph Leidy, Prof. James Hall, and Prof. James D. Dana.

THE annual electrical exhibition was opened at New York City on May 2. The President of the United States, following the usual custom, set the machinery in motion by pressing a button at Washington. He also sent congratulatory messages, as did the Vice-President. The opening address was by Chauncey Depew, who supplemented his remarks by firing off a dynamite gun, without wires by the long-distance system of telegraphy, and by blowing up a mimic steamer in the tank by a submarine mine.

WE regret to record the death of Mr. W. C. Lucy, F.G.S., formerly of Brookthorpe, near Gloucester. For upwards of forty years Mr. Lucy was one of the most active and enthusiastic members of the Cotteswold Naturalists' Field Club. To the *Proceedings* of the Club he contributed numerous papers, including observations on the Drifts of the Severn, Avon and

Evenlode Valleys, on the Oolites and Lias of the Cotteswold Hills, &c. In 1887 he published an essay on the origin of the Cotteswold Club, with an epitome of its *Proceedings*. He died on May 11, aged seventy-five.

The *British Medical Journal* states that the Pasteur Institute at Constantinople, which recently had to close its doors owing to want of funds and the utter indifference as to its well-being shown by the Turkish Government, has been reopened. This gratifying result is due partly to the intervention of M. Boulinière, Chargé d'Affaires of the French Embassy, and partly to the action taken by the Imperial Society of Medicine, which addressed a strong protest on the subject to the Sultan. His Majesty's attention having thus been drawn to the condition of the institution, in which he had always taken the keenest interest, at once gave instructions that Dr. Nicolle should be furnished with everything that he required, and satisfactory guarantees were given that funds and all other assistance that might be needed should henceforth be abundantly supplied. It is expected that the outcome of the affair will be a considerable development of the usefulness of the Institute.

We regret to see the announcement, in the *Manchester Guardian*, of the untimely death of Dr. C. Herbert Hurst, formerly on the staff of the Zoological Department of the Owens College. Dr. Hurst was an alumnus of the Manchester Grammar School, and studied biology under Prof. Huxley with conspicuous success. After some experience as resident science master in a boys' school he entered the Owens College as a student in 1881, and in January 1883 was appointed to the post of demonstrator and assistant lecturer in zoology under the late Prof. Milnes Marshall. For eleven years he filled this office with conspicuous diligence and success, and not only earned the grateful recollection of several generations of students of the College, but also laid under obligation a much wider circle of zoologists by his share in the production of the "Text-book of Practical Zoology," which has made the names of Marshall and Hurst familiar in every biological laboratory not only in this country but in the world. In 1889 he took advantage of a prolonged leave of absence granted by the College authorities to pursue his studies at the University of Leipzig, where he carried out a valuable investigation into the life-history of the gnat *Culex*, for which he was awarded the degree of Ph.D. Latterly he had undertaken what he termed "a systematic criticism of biological theory," in the course of which he published discussions on "The Nature of Heredity," "Evolution and Heredity," "The Recapitulation Theory," and other kindred topics. In these essays certain modern views were subjected to trenchant and unsparing criticism, for Dr. Hurst was a keen controversial writer, and never hesitated to express himself clearly and forcibly even at the risk of obloquy and unpopularity. His last writings were "The Structure and Habits of Archæopteryx" and "A New Theory of Hearing." In 1895 Dr. Hurst left the Owens College to fill a similar position in the Royal College of Science, Dublin. His premature death deprives zoology of a zealous and upright worker, who was most esteemed by those who knew him best.

During the past two months the Plymouth laboratory of the Marine Biological Association has been well filled with investigators, particularly during the Easter vacation, when all the available space was in requisition. The following is a list of the gentlemen who visited the laboratory during this period, together with the subjects of their researches:—Dr. N. B. Hartman, St John's College, Cambridge (Sense-organs of Fishes), Mr. T. H. Taylor, Yorkshire College, Leeds (Polyzoa), Mr. F. W. Gamble, Owens College, Manchester (Nervous System of Polychæta), Mr. A. H. Church, Jesus College, Oxford (Algæ), Mr. E. T. Browne, University College, London (Hydroids and Medusæ), Mr. E. S. Goodrich, Merton College, Oxford (Nephridia of Polychæta), Mr. G. Brebner, University College, Bristol (Algæ), Mr. S. D. Scott, King's College, Cambridge (Excretory Organs of Tunicata), and Mr. W. I. Beaumont, Emmanuel College, Cambridge (General). Mr. Garstang's Easter class for the study of marine biology was attended by eight undergraduate students from Oxford, Cambridge, Eton, and the Yorkshire College, Leeds. Among the more recent captures of interest may be specially mentioned Mr. Browne's rediscovery in quantity of the remarkable bitentaculate Hydroid known as *Lar sabellarum*, which gives rise to the aberrant Medusa *Willia stellata*.

The Council and Parliamentary Bills Committee of the British Medical Association have drawn up a report on the Vaccination Bill now before Parliament. Referring to the clause for the extension of the age limit for infantile vaccination, the opinion is expressed that the proposal to extend the limit from three to twelve months is injudicious and would prove prejudicial in the presence of an outbreak of small-pox. In Scotland the age limit is six months; and this is the limit which is recommended. As vaccination should be practically an aseptic operation, it is suggested that some modification of the clause referring to domiciliary vaccination is needed. The home of a child may be in a slum, dirty, overcrowded, and infected; and asepsis cannot be secured in such surroundings. The proposal is therefore made that, where the house is uncleanly, it should be possible to insist on the child being taken not necessarily to a public station but to the consulting-room, either of the public vaccinator or of some private practitioner. The main defect of the Bill is considered to be the omission of all reference to re-vaccination, and the Council and Committee are of the opinion that re-vaccination should be insisted upon at the age of twelve years.

A plea for a kinematograph bureau is put forward by M. Boleslas Matuszewski, Paris, in a pamphlet of which a copy has been sent to us. His view is that a national or international bureau, directed by a responsible Government official, should be established to receive kinematographs and preserve them for their historical value.

From the *Bulletin* of the Royal Botanic Gardens, Trinidad, we learn that in the botanical department of the Agricultural Exhibition, recently held in the Colony, a new form of machine for the extraction of rubber was exhibited in action. The rubber in the space of two minutes is separated from the *latex*, or milk, of the Castilloa tree, and is then put to dry. In the space of some three hours, sheets or slabs of fine clear marketable rubber is produced, free from the usual amount of proteid and albuminoid matters which are usually found in rubber produced by the ordinary process.

An important contribution to the theory of warning colours and mimicry is made to the *Journal* of the Asiatic Society of Bengal (vol. lxvii. part 2, No. 4, 1897) by Mr. F. Finn, Deputy Superintendent of the Indian Museum. The paper is the final one of a series of four, and in it Mr. Finn gives an account of his experiments with birds other than the Babblers, to which his first paper was devoted, together with a general summary of the results and inferences. He concludes from his experiments: (1) That there is a general appetite for butterflies among insectivorous birds, even though they are rarely seen when wild to attack them. (2) That many, probably most, species dislike, if not intensely, at any rate in comparison with other butterflies, the "warningly-coloured" *Danainæ*, *Acræa violæ*, *Delias eucharis*, and *Papilio aristolochiæ*; of these the last being most distasteful, and the *Danainæ* the least so. (3)

That the mimics of these are, at any rate, relatively palatable, and that the mimicry is commonly effectual under natural conditions. (4) That each bird has separately to acquire its experience, and well remembers what it has learned. On the whole, therefore, the theory of Wallace and Bates is supported by the facts detailed in Mr. Finn's papers, so far as they deal with birds (and with the one mammal used). Prof. Poulton's suggestion that animals may be forced by hunger to eat unpalatable forms is also more than confirmed by Mr. Finn's experiments, as the unpalatable forms were commonly eaten without the stimulus of actual hunger—generally, Mr. Finn adds, without signs of dislike.

IN *Bulletin* No. 2 of the Blue Hill Meteorological Observatory, Mr. H. H. Clayton gives some very interesting examples of the diurnal changes in temperature and humidity at different heights in the free air. The observations were made by means of kites, and on two occasions these were maintained in the air during a large part of twenty-four consecutive hours. The results show that the diurnal variation of temperature was very slight or had entirely disappeared at about 2300 feet, and that the relative humidity curve at that height was exactly opposite in phase to that recorded at lower levels; the minimum humidity was recorded at night, and the maximum during the day. The records during the day show that to a certain height (which varies under different conditions) the temperature in the lowest stratum decreases with increase of altitude approximately at 1°·7 per 330 feet. Above that height the air is suddenly found warmer, and then the temperature decreases with increasing height at a somewhat lower rate. During the night there is a marked inversion of temperature between the ground and 600 to 1000 feet. Above that height the temperature decreases at a fairly uniform rate. The experiments were made under the superintendence of Mr. A. L. Rotch, the proprietor of the observatory.

THE latest contribution to the question of the age of the earth comes from Mr. J. G. Goodchild, of H.M. Geological Survey, in the form of a presidential address delivered before the Royal Physical Society of Edinburgh, and just published in the Society's *Proceedings* (Session cxxvi., 1896–97). Many geologists have attempted to estimate the length of the interval between the present time and the period when the oldest strata containing fossils were laid down; and "vague, indefinite, but unquestionably vast beyond conception" have been the conclusions. Mr. Goodchild passes in review certain changes which are known to have taken place in the past, working backwards from the Glacial Period, and estimates the time required for the formation of the rocks of the various geological periods. He concludes that ninety-three millions of years have elapsed since the commencement of the Tertiary Period, and seven hundred millions of years since the commencement of the Cambrian Period. Moreover, the beginning of life upon the earth may be as much further back from Cambrian times as Cambrian times are removed from our own, so that the total estimate assumes tremendous proportions.

IN the paper referred to in the preceding note, Mr. Goodchild confines his attention to the purely geological side of the question of the age of the earth, leaving the physicists to take up the discussion and deal with it in the light of new facts and views. He suggests in conclusion that the following points need consideration: (1) Is it certain that the whole of the downward increment of heat within the earth is due to any vestige of the earth's original heat? If not, why may not part of it be due to the conversion of the energy of motion arising from terrestrial undulation (set up mainly by luni-solar gravitational energy) into the energy of heat? (2) Is it certain that radiant energy in general differs from gravitational energy in operating only between two solid bodies? If radiant energy acts only between any two material bodies, how do we know that the radiant energy of the sun, or the heat of the earth, is being dissipated into space at anything like the rate which is generally assumed to be the case?

WE learn from the *Lancet* that the use of Röntgen rays as a means of certifying the existence of death was demonstrated at a recent meeting of the Biological Society of Paris. M. Bougarde showed three photographs of the thorax, two of them from living persons and the third from a corpse, all taken by the X-rays. In the two first the different thoracic organs and the walls of the thorax itself exhibited a hazy outline, so that their limits could not be exactly made out. This, of course, was owing to the natural movements of the parts, the pulsations of the heart and the great vessels, and the movements of the diaphragm. Even when the subjects held their breath so as to minimise movement as much as possible the outlines were still hazy, and the outline of the diaphragm was seen as a shadow varying in depth and extending over the ninth and tenth intercostal spaces. The heart and great vessels were seen to occupy the centre of the chest as a dark oval mass, the shadow of which was dense in the centre, and gradually faded away towards the periphery until the almost transparent lungs were reached. In the radiograph of the corpse, however, the appearance was quite different, for all the organs had sharp and well-defined edges.

THE *Proceedings* of the Academy of Natural Sciences of Philadelphia contains an account of the discovery of a complete volcanic crater of Mesozoic age near Pottstown, Montgomery County, Pennsylvania, by Mr. E. Goldsmith. The chief interest of the paper centres round the microscopical examination of some varieties of de-vitrified obsidian and of gabbro-phonolite. Some specimens of amygdaloid were obtained from a boring which showed remarkable fluidal texture even to the unaided eye. Basaltic columns of exceptional size were observed, the diameters of the six-sided sections measuring in some cases ten, eleven, and even fifteen feet across.

MR. E. GOLDSMITH contributes an interesting note on the petrification of fossil bones to the *Proceedings* of the Academy of Natural Sciences of Philadelphia. In digging for human remains in the deposits of the Port Kennedy limestone quarry, a fissure in the Silurian limestone on the Schuylkill River, Pennsylvania, it was found that many of the fossil bones obtained "fell to a mealy powder" when touched. Mr. Goldsmith has subjected specimens in various stages of petrifaction to analysis, and finds that the "bone meal" contains little or no calcium phosphate, but that it consists essentially of dolomite. It is supposed that the change is effected by carbon dioxide in the water retained in the fissure, the phosphoric acid being transferred and reunited with ferric oxide and alumina to form vivianite (which was found in the neighbourhood), and magnesia being taken up at the same time.

THE current number of the *Annales de l'Institut Pasteur* contains the report for the past year of the anti-rabic inoculations carried out in Paris. No less than 1521 persons underwent the treatment, which is 213 in excess of the number recorded for the year 1897. In all, eight deaths from rabies occurred, two of which, however, took place during the course of treatment and before it could have taken effect. In one case a patient was admitted in April, and underwent the inoculations, but succumbed to rabies in the middle of October. Out of the total number of patients 175 were foreigners, and of the latter Egypt contributed 2, Greece 1, the United States 1, Germany 8, Belgium 14, Switzerland 33, British India 33; whilst England, as usual, far exceeds in its contribution that of any other nation, the substantial number of 83 being sent from this country. By far the largest number of patients were admitted suffering from bites on the hands; next in order come bites on the limbs, whilst in 151 cases the injuries were inflicted on the head. The Seine Department appears to be the district where rabies is most prevalent in France, more than one-third of all the cases coming from this part of the country.

A PAMPHLET on "Science and Engineering during the Victorian Era (1837-1897)," by Mr. Charles Bright, has been published by Messrs. Archibald Constable and Co. The pamphlet is a reprint of an introduction which Mr. Bright wrote for the Victorian Era Exhibition held at Earl's Court last year.

To encourage and facilitate the use of the metric system in the United Kingdom, the *Pharmaceutical Journal* recently published a series of tables of metric equivalents of Imperial Weights and Measures, and thermometric equivalents. The tables have been found of great assistance, and they have now been reprinted in a convenient form for reference by pharmacists, chemists, and medical men.

WE have received the fourth number of the new *Journal of Applied Microscopy*, published monthly by the Bausch and Lomb Optical Company, of Rochester, N.Y. The present part is chiefly devoted to methods of imbedding and staining sections, but photo-micrography also receives its share of attention.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. W. H. Lewis; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mrs. Eyre; a Red-backed Buzzard (*Buteo erythronotus*), captured at sea, presented by Mr. Ernest Hartley; two Banded Parrakeets (*Palæornis fasciata*, ♂ ♂) from India, presented by Lady Lumsden; a Cardinal Grosbeak (*Cardinalis virginianus*) from North America, presented by Mrs. Harry Blades; two Crested Screamers (*Chauna cristata*) from Buenos Ayres, two Scaly-breasted Lorikeets (*Psittenteles chlorolepidotus*) from New South Wales, purchased; two Black-backed Geese (*Sareidiornis melanonota*) from India, two Grey-lag Geese (*Anser cinereus*), British, received in exchange.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF VARIABLE STARS.—A most useful and valuable series of variable star observations has just been published by Dr. Francesco Porro in a memoir in the *Pubblicazioni del Reale Osservatorinio Astronomico di Torino*, No. 4. The observations were made at Torino and Soperga, and extend over the years 1889-95.

COMET PERRINE (MARCH 19).—The following is a continuation of the ephemeris of Comet Perrine for the ensuing week:—

1898.	R.A. h. m. s.	Decl. ° ′	Br.
May 20	2 17 30	+55 36·6	0·30
21	22 25	43·4	
22	27 18	49·5	
23	32 6	55·0	
24	36 52	59·9	0·27
25	41 34	56 4·3	
26	46 13	8·1	
27	5 50 48	+56 11·3	

FRANCE AND INTERNATIONAL TIME.—Slowly but surely the scheme for dividing the time all over the world into an equal number of zones, differing from one another by one hour, is extending, and we hope before long that such a rational system of international time will be universally adopted. Even now there are some notable outstanding countries which as yet have not thought fit to adopt this principle. Before, however, one can say anything more in the matter, the case of Ireland must be remembered. There is no doubt that if we wish other countries to adopt a system of time zones, we should see that, at least, Great Britain, if not all British colonies, is one in the adoption of the scheme. There is absolutely no reason why Ireland should not adopt Greenwich time; but yet Dublin time is daily used, and all the while we are laughing at the prejudices of France for not instantly adopting the Greenwich meridian, which is only a matter of less than ten minutes. For Ireland there is absolutely no excuse for not coming under the new *régime*, but with France it is different. A change from mean Paris to mean Greenwich time would necessitate a great amount of work in altering their numerous publications, such as the *Connaissance de Temps* and other almanacks, to say nothing of charts, &c. Such difficulties have not, however, hindered her from adopting the international system of time zones; and although the new time she has adopted is really Greenwich time, yet the "national hour" is that "of the meridian of Paris diminished by 9m. 21s." In an interesting article (*Revue Scientifique*, May 7, 1898) on this subject, M. Bouquet de la Grye does not seem to advocate the step taken by France, and concludes that this adoption will be "contrary to the interests of our country, tradition, scientific spirit." The following list of meridians successively adopted, which is of interest, we have taken from the above-mentioned article:—

Dicéarque, of Messina, adopted the island of Rhodes, 300 B.C.

Eratosthenes chose the meridian of Alexandria, 270 B.C.

Marin de Tyr took for the origin the meridian of the islands of Fortune in the year 80 A.D.

The Arabians chose the meridian of Mecca, and also that of the column of Hercules, 800 A.D.

The Alphonsine tables assumed as their origin the meridian of Toledo, 1250 A.D.

Mercator took the Azores for the initial meridian, 1569 A.D.

The Paris Congress chose the island of Fer, 1633 A.D.

It was decided, after the example of Guillaume Delille, to place the meridian of the island of Fer 20° to the west of that of Paris, 1724 A.D.

A NEW LONG PERIOD VARIABLE.—Herren Müller and Kempf describe some observations which have led them to discover an interesting variable star of evidently long period (*Astr. Nachr.*, No. 3491). The star in question is B.D. + 30°·591, R.A. 3h. 49m. 8s., Decln. + 30° 46′·0 1900·0, and was included in their list of comparison stars for the Potsdam Photographic Durchmusterung. As soon as this star was found to vary its magnitude, observations were at once begun to determine its period. The following table shows the magnitudes, as yet, obtained.

Appearance in	Mean date.	No. of obs.	Mag.	Curve.	Mag. curve.
1887–88	1888 March 10	4	6·36	6·31	+0·05
1888–89	Nov. 24	16	6·29	6·31	−0·02
1889–90	1890 Jan. 11	14	6·33	6·31	+0·02
1890–91	Dec. 12	16	6·30	6·31	−0·01
1891–92	—	—	—	—	—
1892–93	—	—	—	—	—
1893–94	1894 Feb. 22	5	6·44	6·46	−0·02
1894–95	1895 March 6	9	6·60	6·59	+0·01
1895–96	1896 Jan. 19	41	6·69	6·70	−0·01
1896–97	Dec. 21	28	6·82	6·81	+0·01
1897–98	1897 Dec. 1	26	6·92	6·93	−0·01

The fourth column gives the observed magnitudes of the variable, the fifth the magnitudes as obtained by drawing a curve through the points when plotted with the time as abscissæ and the magnitudes as ordinates; and, lastly, the sixth denotes the differences between the two latter. A glance at the curve shows that the star from 1887 to the middle of 1891 retained its original brightness, namely 6·31 mag. It began then to dim off, and from the beginning of 1894 it has decreased 0·01 magnitudes monthly, or a little over one-tenth of a magnitude in a year. This new variable is said to be of a yellowish-white colour. With the help of the 30-inch Pulkova refractor Herr Renz has examined the star for duplicity, but could not detect a second body. Probably the spectroscope may tell us more about the constitution of this interesting variable: it is hoped that both spectroscopic and photometric observations will be made to unravel the mystery of such a long period variable as this appears to be.

THE ROYAL SOCIETY'S CONVERSAZIONE.

THE first soirée this year was held on the 11th inst. It was numerously attended, and a large number of objects had been brought together. We have not space to refer to all the exhibits.

Prof. Hele-Shaw exhibited experiments on the flow of water. We have already given an account of some of these (p. 34). Prof. Hele-Shaw also showed instruments for describing cycloidal curves and envelopes. By means of the instrument exhibited, two surfaces of cardboard or paper are made to revolve so that imaginary pitch circles on each roll upon one another. This is effected by employing auxiliary circles within or without the pitch circles, the auxiliary circles being made to move at the same velocity by passing between two pairs of equal wheels, each wheel being connected by an axle with the corresponding wheel for the other auxiliary circle. By a further combination of wheels the actual centres of rotation are dispensed with, only virtual centres being used. Hence it is possible to draw with a small instrument cycloidal or involute curves for circles of any radius, however large, and to find envelopes or centrodes under any conditions of fixed or varying radii. A simple practical application is that to the teeth of wheels, examples of which were exhibited.

Mr. J. Mackenzie Davidson exhibited Röntgen ray apparatus for localisation purposes.

Mr. T. Andrews, F.R.S., exhibited (1) micrographic illustrations of deterioration in steel rails. These high power investigations of old rails, which have worn well, afford an indication of the microscopic structure and composition best adapted to ensure endurance and safety in rail service. (2) Micro-crystalline structure of iron. The micrographs indicate the existence of a primary and secondary crystalline formation in large masses of iron which have been slowly cooled.

Mr. C Orme Bastian showed an electric current meter acting by electrolysis. The height of a column of liquid (sulphuric acid and water) contained in a glass tube is caused to decrease by electro-decomposition, and this decrease in height is utilised to indicate the quantity of current (in ampère hours) that has passed through the meter in any given time. Assuming the voltage of the supply to be constant, a perfectly accurate measure of the electric energy, which has passed through the meter, is recorded by means of a scale in front of the above-mentioned tube, which can be calibrated in Board of Trade or other units. A hole in a rubber plug at the top of the tube allows the gases resulting from the electro-decomposition of the liquid to pass away into the atmosphere, through the gauze tray and holes in the top of the meter case. Paraffin on the surface of the fluid prevents atmospheric evaporation. The instrument starts registering with an infinitely small current; it is accurate at all temperatures and at all loads; its accuracy is unaffected by temporary excess currents; and it is not capable of being affected by outside disturbing influences.

Dr. Leonard Hill and Mr. Harold Barnard showed simple forms of sphygmo-manometers.

Admiral Sir W. J. L. Wharton, K.C.B., F.R.S., and Prof. J. W. Judd, C.B., F.R.S., exhibited, on behalf of the Coral-Reef Committee of the Royal Society, charts, sections and specimens, illustrating some of the results of the investigations carried on in the atoll of Funafuti (Ellice Group), South Pacific.

Prof. Poulton, F R.S., showed insects captured in Canada and some adjacent States during a visit in connection with the meeting of the British Association in 1897. The insects in this collection are not of any special interest on account of rarity, but they serve to convey an impression of the general characteristics of this section of the fauna by which the traveller is surrounded as he proceeds, at the time of the year indicated in the labels, across the American Continent on a line not far distant from the Canadian southern boundary. The general similarity of the Lepidoptera to those of Europe is remarkable. Attention is directed to the geographical data on the small printed labels. The cases are arranged so that the left hand represents the westernmost locality (Vancouver Island), the right hand the easternmost (Quebec).

Dr. H. Gadow, F.R.S., and Mr. W. F. Blandford exhibited a series of models, illustrating the composition of vertebræ in the various groups of vertebrata.

Prof. T. Rupert Jones, F.R.S., and Mr. J. Ballot showed a series of large stone implements, collected by Sidney Ryan, Esq., from the tin-bearing gravels of the River Embabaan, in Swaziland, South Africa.

Mr. Alan A. Campbell Swinton exhibited (1) experiments upon the circulation of the residual gaseous matter in Crookes' tubes. Radiometer mill wheels are employed to detect the direction and velocity of the gaseous streams, and the experiments indicate that in very highly exhausted tubes of the focus type, in addition to the well-known negative stream from the kathode, discovered by Crookes, there exists also a positively electrified stream from the anode, which travels in the opposite direction to the kathode stream, and is exterior to the latter. Mill wheels of various forms and of both non-conducting and conducting material show these effects. (2) Röntgen ray camera, showing the position, dimensions and form of the source of the X-rays in a Crookes' tube. (3) Kathode ray lamps. The kathode rays from two concave kathodes placed opposite to one another and supplied with an alternating electric current of about 20,000 volts pressure, are focussed upon a button of refractory material, which is thus raised to a very high temperature and becomes brilliantly incandescent. The efficiency in terms of the amount of light produced for a given quantity of energy supplied to the lamp, appears to be much superior to that obtained in ordinary incandescent electric lamps, and under suitable conditions may even exceed that of the arc.

Mr. J. Wimshurst showed improved apparatus for holding, and for the excitement of Röntgen ray tubes; Mr. Killingworth Hedges, specimens of copper rapidly deposited at high current densities; and Prof. J. P. O'Reilly, a set of fourteen original coloured drawings of the principal cromlechs existing in the vicinity of Dublin. The drawings being plans and sections to scale, tend to show that the cromlechs in question were oriented truly: (*a*) either as regards their side walls (Druid's Glen) (Shankell), or (*b*) present in their arrangement indications, which point to bearings either N. by S. and E. by W., or to the points of the summer and winter solstices; or, as the case of the Glen Druid Cromlech, an inclination of the cap stone marking the altitude of the winter sun at the solstice (14° approx.), and consequently tending to prove that the cromlechs were designed, amongst other uses, to allow of astronomical observations being made with a view to the determination of fixed periods of the year or commencements of seasons.

The Rev. Walter Sidgreaves, S.J., showed the spectrum of Mira (*o* Ceti) compared with the spectra of other stars of Secchi's third type; and Mr. K. J. Tarrant, photographs of electrical discharges.

Mr. W. Ellis, F.R.S., showed smoothed curves of sun-spot frequency (Wolf), compared with corresponding curves showing the variation in diurnal range of the magnetic elements of declination and horizontal force from observations made at the Royal Observatory, Greenwich. A graphical representation of the periodical variation in frequency of sun-spots, and of the amplitude of the diurnal magnetic movement. The average length of the period is about eleven years, subject, however, to a variation of one or two years or more, which the sun-spot and the magnetic curves alike exhibit. There is also a corresponding variation in intensity at the different epochs of maximum effect.

Mr. R. B. Roxby had on view specimens of "Naturographs" (prints produced by Dr. Selle's process of photography in natural colours).

Mr. C. V. Boys, F.R.S., showed phase reversal and silver zone plates made by Mr. R. W. Wood, of the University of Wisconsin. These plates are made with 230 zones. In consequence of the great number, their equivalence to a lens in image-making is very complete. Some are printed on bichromated gelatine. These are stated to be "phase reversal," *i e.* the thickness is such that alternate zones are in opposite phases, so the whole surface is operative. Two of these, of about 70 and 13 cms. focus, are mounted as a telescope, and show a magnified image of incandescent electric lamps. Others are photographed upon metallic silver by coating a deposited film on glass with bichromated gelatine, exposing, washing, exposing to iodine, dissolving with "hypo," and finally washing off the remaining gelatine when the lines acted upon by light are left as bright silver, the rest being transparent glass. One is elliptical, with axes in the ratio of $\sqrt{2}:1$. If this is placed on the hypothenuse of a right-angled prism with Canada balsam, it will give images due to the difference of phase between the light totally reflected and that metallically reflected on alternate zones.

Three photographs, taken with some of the plates, were exhibited.

Dr. Armstrong, F.R.S., exhibited coloured photographs of Yellowstone Park, U.S.A., by Mr. F. Jay Haynes, of St. Paul, Minn.; Mr. A. E. Tutton, an interference dilatometer of increased sensitiveness; and Mr. Edwin Edser, apparatus exhibiting peculiarities of interference fringes when formed between silvered surfaces. When interference bands similar to Newton's rings are formed with monochromatic light between two partially silvered surfaces, the appearance presented is that of narrow sharply defined bright bands separated by broad dark intervals. When the light used consists of two different wave-lengths (such as that from a Bunsen burner into which some salt of sodium has been introduced) the interference bands become alternately double and single as the distance between the silvered surfaces is increased. This principle has been used by MM. Fabry and Perot to confirm Michelson's results as to the homogeneity or otherwise of spectral lines incapable of resolution by spectroscopic methods.

Mr. Edwin Edser and Mr. C. P. Butler showed a simple interference method of calibrating a spectrometer. Two pieces of plate glass, each thinly silvered on one surface, are placed with these surfaces parallel and very nearly in contact. This arrangement is placed immediately in front of the collimator slit of a spectrometer. A ray of slightly convergent white light being directed on the slit through the air film between the silvered surfaces, the resulting spectrum consists of bright bands separated by dark intervals. If the wave-lengths corresponding to any two interference bands be known, that corresponding to any other band can be calculated or determined graphically with great accuracy. It is proposed to use such a system of interference bands as a reference spectrum, to facilitate the reduction of prismatic spectra in terms of wave-lengths.

Prof. W. C. Roberts-Austen, C.B., F.R.S., exhibited apparatus to illustrate M. Daniel Berthelot's interference method of measuring high temperatures. One of the beams of light in an interference apparatus traverses a heated porcelain tube, and the other beam traverses a tube of equal length containing rarefied air. When interference takes place it indicates that the air in the two tubes is equally rarefied, and therefore the temperature of the heated tube can be calculated from the pressure of the air in the other tube. The interference apparatus employed is that exhibited by Messrs. Edser and Stansfield at the conversazione last year. Prof. Roberts-Austen also showed a complete installation of apparatus for the microphotography of metals.

Mr. A. Stansfield exhibited (1) experiments of showing an exception to the law of Magnus; (2) a method of demonstrating the existence of an allotropic change in iron. An electric current may be generated by heating unequally a circuit composed of a single metal, if very steep temperature gradients are maintained in the wire of which it is composed. The Thomson E.M.F. must therefore be abnormal under these conditions. Experiments were arranged to demonstrate this in the case of platinum and other metals, and to show readily the allotropic change which takes place in iron at about 800° C.

Dr. Alexander Muirhead and Prof. Oliver Lodge, F.R.S., showed improvements in Hertz-wave space-telegraphy; Prof. Ewing, F.R.S., a magnetic balance for permeability tests of iron; Mr. J. E. Stead, specimen and photographs illustrating the crystalline structure of iron and steel; and Mr. Joseph Goold, experiments in relation to resonance.

An exhibit by the Hon. C. A. Parsons consisted of (1) one of the earlier Parsons steam turbines of three-horse power driving a dynamo; speed of working, 12,000 revolutions per minute; (2) photographs of the *Turbinia*; (3) screw propeller cavitating the water, the atmospheric pressure being removed from the surface by an air-pump. A small screw propeller is driven by an electric motor at a speed of 1000 revolutions per minute within a tank in the form of a hollow oval ring, around which the water flows under the action of the propeller, the conditions of flow resembling closely those in the case of an ordinary screw propeller driving a ship. The illumination is effected by a beam from an electric lamp reflected from a mirror attached to and rotating with the screw shaft, and again reflected on to the propeller by a concave fixed reflector. The propeller thus illuminated appears stationary, and the cavities in the water formed by and around the blades can be clearly seen or photographed. To facilitate the formation of cavities, and to reproduce the conditions of very fast ships at convenient speeds for observation, the whole of the atmospheric pressure is removed from the upper surface of the water by an air-pump. The pressure then remaining to hold the water together is that due to the head of water above the screw, plus capillarity. The relation holding between the model and screws on fast ships, with the same slip ratio, when cavities are formed appears to be—lineal speed of blade varies as the square root of the total pressure holding the water together.

Prof. W. A. Herdman, F.R.S., and Prof. R. Boyce, exhibited healthy and unhealthy green oysters, showing the causes of the coloration, and the connection between oysters and disease.

The Marine Biological Association had an exhibit showing the adaptations of marine animals to their environment, illustrated by living examples of the higher Crustacea.

The Joint Permanent Eclipse Committee and Eclipse Commission of the British Astronomical Association showed photographic and other observations made in India at the total solar eclipse of 1898, January 22.

Prof. Sherrington, F.R.S., exhibited specimens of sensorial organs, illustrated by the microscope.

Sir Richard T. Thorne, F.R.S., and Dr. Copeman had an exhibit illustrating the bacteriology of calf vaccine lymph.

Mr. Horace Seymour, Deputy Master of the Mint, exhibited a case of medals bronzed by Japanese methods. Various solutions are employed by the Japanese for this purpose, but "rokusho," or verdigris, is the main constituent of most of them. The medals shown are the result of experiments made in the Mint with a view to reproduce Japanese effects.

Dr. Russell, F.R.S., showed pictures taken on photographic plates by vapours from certain metals and certain organic bodies.

Sir David Salomons, Bart., exhibited the pseudoscope for producing stereoscopic effects by means of a single picture.

Prof. Unwin, F.R.S., exhibited apparatus for indentation tests of metals. The relative hardness is measured by the indentation per ton per inch of knife edge.

Dr. MacMunn showed microscopic preparations illustrating the structure of the digestive gland of Mollusca and Decapod Crustacea.

Electrical recording apparatus was shown by Prof. H. L. Callendar, F.R.S.

Mr. C. T. R. Wilson demonstrated production of cloud by the action of ultra-violet light. When the light from an arc lamp is brought by means of a quartz lens to a focus within a vessel containing moist, dust-free air, a bluish fog gradually develops along the path of the light. The effect is entirely prevented if the ultra-violet rays be cut off by interposing a sheet of glass or mica, no cloud or rain resulting under these conditions even when supersaturation is brought about by sudden expansion. Possibly the small particles which give rise to the blue of the sky are produced by the ultra-violet rays of sunlight absorbed in the upper layers of our atmosphere.

Prof. Oliver Lodge, F.R.S., exhibited improvements in magnetic space-telegraphy. The discharge of a condenser or Leyden round a large wire coil sets up an alternating magnetic field, which excites induced currents in another distant condenser-circuit tuned to the same frequency, causing the second Leyden either to overflow into a coherer, or to disturb a Rutherford detector or a telephone so as to give a signal.

The detector shown was a special series of small free coils and granular microphones, each coil in a permanent magnetic field and so connected to the microphone of the next that a very feeble alternating current in the first of the series is able to make a telephone in the last emit a loud sound, or, through a Langdon-Davies relay, to ring an electric bell and work a Morse sounder. A tone-telephone was also shown, which acts as a highly syntonised "call."

The magnetic vibrations in the sending current can be maintained in various ways, but the way shown is a device due to Dr. Pupin, with a vibrating string and battery contact. A signalling key enables the ordinary Morse alphabet to be sent without any connecting wire, and independently of obstacles. It may be regarded as, in some respects, a modification and improvement of the induction method of telegraphy inaugurated by Mr. Willoughby Smith and practised by Mr. Preece; but, with suitable circuits, the tuning must be nearly exact to evoke much response, and with enough copper in each circuit there is no assignable limit of distance.

Prof. A. Barr and Prof. W. Stroud exhibited range-finders.

THE PRESENT POSITION OF SOME CELL PROBLEMS.

DURING the last two decades or so a new branch of science has been quietly, but rapidly, working its way from a position of comparative obscurity to one of considerable importance. This new-comer has been designated Cytology, and it embraces as its province that department of knowledge which centres around the cell, whether this body be regarded from its structural or from its functional aspect. And cytology, which is still a young offshoot both from botany and zoology, possesses one strongly marked advantage, viz. that of providing a common ground on which the botanist and the zoologist may still meet to discuss questions of equal interest to each. For in dealing with the cell we are approaching facts and phenomena which are essentially shared or exhibited by animals and plants alike, and, indeed, the measure of their relative importance can be gauged by the degree in which they reappear in each of the two great divisions of organic life; although in most other respects the animals and plants have followed widely diverging paths of development.

The cell was long ago recognised as the structural unit of an organism, but the relations of its various parts to one another were overlooked or misunderstood, and we are still far from arriving at a satisfactory solution of the difficulties which each investigator meets when attacking the problems presented by any special case; nevertheless, some general facts have been discovered which serve as landmarks to guide future exploration.

In all but the very lowest forms of life, and in some others which are probably degenerate, we recognise clearly enough that the protoplasm of an organism contains one or more nuclei within its substance. Commonly, though by no means invariably, each nucleus is associated with a definite mass of protoplasm which is segregated, more or less strictly, from the rest by means of membranous partitions. These partitions are not, however, necessarily always present. Some animals, and many of the lower plants, possess a protoplasm in which are distributed large numbers of nuclei, which thus appear to lie embedded in a common matrix. Instances of this are seen in *Vaucheria* and in the embryonic stages of *Peripatus*. But although the nuclei are thus scattered, there is a considerable body of evidence to show that their respective spheres of influence are tolerably clearly defined, just as are those of different countries, even when these are not delimited by obvious boundaries like rivers or mountain ranges.

On the other hand, just as there are roads and traffic between two neighbouring countries, so it has been shown by several observers that even where the "cells" are separated by walls from each other, the adjacent protoplasms are often connected by fine threads of the living substance which traverse the intervening cell walls. The phenomenon seems to have been occasionally seen without apparently its importance being realised, but Tangl clearly demonstrated it for plant cells (Endosperm) almost twenty years ago. Since that time the investigations of Gardiner, Kienitz-Gerloff, and others have shown that what were once thought to be merely isolated cases may possibly turn out to form rather the rule than the exception. There can be but little doubt that the improved uranium-osmium method of Kolossow, which has recently been employed with considerable success by Gardiner, will materially extend our knowledge in this direction, and will confirm what most of us have for a long time held, that the difference between such a plant as *Caulerpa* and the ordinary multicellular forms is rather one of degree, the result of specialisation, than one of kind. Thus during the germination of some algæ, certain of the *Fucaceæ* for example, the embryo exists for a considerable time in a multinucleate condition, the cell walls only appearing at a later stage. The same is also seen during the development of the endosperm in a flowering plant, and still more strikingly during the germination of the spore of *Isoëtes* or of *Selaginella*. The occurrence of a stage in the development of many plant tissues, during which the constituent cells are sliding past each other in adjacent rows, is seen to furnish no real argument for a protoplasmic discontinuity at this period, when it is remembered that not only are the walls still soft, but that they actually contain a nitrogenous body which is almost certainly protoplasm in their substance. On the animal side also evidence is not lacking to show that in some of the higher forms, at least in the earlier stages, protoplasmic continuity is of frequent occurrence; and it also obtains, according to Schuberg and others, between the cells of some tissues in the adult animal.

Nevertheless, the want of such a continuity in nerves, *e.g.* in the ganglionic cells, suffices to show that it is unsafe to generalise on *à priori* grounds too freely, for it is in nerves, perhaps more than in most other tissues, that a direct continuity might have been expected. And it is the more necessary to emphasise the lesson derived from a study of the histology of nervous tissues, inasmuch as a continuity of protoplasm has been generally assumed to exist in the tissues of motile organs of plants, on purely physiological grounds, although it may not have been demonstrated histologically.

The *rôle* played by the nucleus in influencing or in determining the mode of special activity manifested by its attendant protoplasm is one of great interest, and a great deal of light has been thrown upon it within recent years. Haberlandt and others have clearly shown that in cases where metabolism was more active in one region of the cell than in another, the nucleus commonly migrates to this locality. Beautiful examples of this may be observed during the thickening of the walls so frequently met with in the protective layer of seeds or fruits. Thus if the development of the seed of the common night-shade (*Solanum Dulcamara*) be followed, it will be seen that in the young stages of the large cells which ultimately give rise to the hard shell of the seed, the nucleus occupies a central position. Later on, the nucleus becomes lodged in close proximity to the inner wall of the cell, and this then begins to thicken. This deposition of thickening substances spreads to the lower (or inner) parts of the lateral walls; whilst their outer portions, as well as the whole of the external wall, which is remote from the nucleus, remains thin. Again, it has been observed by Istvanffi that when the hypha of a fungus is about to branch, the nucleus is discoverable at a spot just beneath which the outgrowth is about to arise.

The well-known and highly characteristic appearance of the large nuclei met with in tissues the cells of which are in an active state of division, is all evidence of the important influence of these bodies over the process. So also is the fact that those cells which are the last to lose the faculty of resuming an embryonic condition (*i.e.* of giving rise to fresh tissues) retain these nuclear peculiarities longest. This point is well brought out in a study of the cells of a growing root, for it is easily seen that those which form the layer known as the pericycle keep the primitive appearance of their nuclei the longest, and it is in this layer that the new structures, the lateral roots, when they occur do actually originate. Again, when new structures are about to be formed from tissues already adult, or even senescent, the first obvious sign of the new impulse is detected in a change in the nuclei of the cells, a change which depends as much on chemical as on physical differences. In cells which are secreting, whether belonging to animals or to plants, the nuclei are observed to pass through a remarkable series of changes, which may even result in the temporary differentiation of the peculiar so-called *chromatic* elements, resembling if indeed not identical with those appearing during nuclear division. Much the same is to be seen in the huge nuclei often present in the "foot cells" in an animal testis, around which the young immature spermatozoids cluster in groups, apparently deriving from the chemical activity of these cells the nourishment requisite for the completion of their development.

Even more conclusive evidence as to the close relation between the metabolism of the external protoplasm (conveniently distinguished as *cytoplasm*) and the nucleus is furnished by the different behaviour of nucleated and non-nucleated fragments of protoplasm respectively. It is quite possible, by taking appropriate measures, to vivisect a single cell, so that one portion shall contain a nucleus and the other not. The former half commonly regenerates itself, and if derived from a plant cell, forms around itself a new cell wall; on the other hand, the non-nucleated fragment sooner or later perishes, although it may continue for a time to exhibit normal vital functions. Usually, however, it is able neither to secrete on its surface a membrane, nor to engage on constructive metabolism.

But interesting and suggestive as are the relations which can be discerned between the cytoplasm and the nuclei of cells in a condition of comparative repose, they are almost eclipsed by the wonderful series of changes which recur with surprising uniformity each time the nucleus and the cell divides. Nor is it always easy correctly to estimate the relative importance of the various structural elements which are involved or concerned in the process.

Of late years we have heard a great deal about a minute particle which is present, sometimes in the nucleus, oftener in the external cytoplasm, and which is by many assumed to play the part of a directive agent in the matter of nuclear division. This body, known as the Centrosome, was first brought into prominence by the researches of Van Beneden on the developing eggs of *Ascaris*, and it has since been recognised in an enormous number of animals, and also in the cells of some plants.

The centrosome is frequently a body of extraordinary minuteness, and it is most easily recognised during certain stages of nuclear division, on account of the central position which it occupies with respect to the radiations which accompany the process.

It has, however, been identified in many cells which are in a state of repose, as a minute particle which may or may not be surrounded by differentiated zones of specialised protoplasm, though it is certain that in many cases this appearance is due merely to a diffraction-phenomenon. Furthermore, it is not unfrequently observed that its division precedes any change in the nucleus, and that when the division of this latter body is approaching, the two daughter centrosomes diverge from each other, each situated in a definite protoplasmic mass and forming one of the two poles of the spindle structure which arises during the process of karyokinesis.[1] Sometimes, indeed, this spindle structure is seen to be spun out, as it were, between the two centrosomes at the moment of their separation, and to grow as they move further apart. Even more important, perhaps, than these observations was the statement made by Fol, that during the process of fertilisation both the male and female cells contributed a distinct centrosome, each of which then divided, and the half of the one then fused with the corresponding half of the other, a proceeding to which he gave the name of the Quadrille of the Centrosomes. This statement, which was supported by precisely similar statements on the part of Guignard for plants, as well as by other zoologists, has, however, proved to be due to misinterpreted or mistaken observation. It is quite certain that at present there is no really authenticated example of such a proceeding occurring either in plants or in animals, although a glance at many modern text-books testifies to the hold which these erroneous accounts have taken on receptive minds.

In the enthusiasm to which the first discovery of the centrosome, and its subsequent identification in so many kinds of cells, gave birth, it has not always perhaps been sufficiently remembered that *post hoc* by no means necessarily implies *propter hoc*; and that neither its reappearance at the period of karyokinetic activity, nor yet its observed persistence through the resting stage in some cells, are of themselves sufficient to establish its claims to be regarded as the *primary directive agent* in bringing about a nuclear division. Supposing, however, that it could be shown to be really possessed of all the occult powers which have been claimed for it by its numerous devotees, the main result would be to remove to an immeasurably greater distance all chance of penetrating more deeply into the mysteries of cell life. For its very minuteness renders it almost immune from the critical gaze of the curious.

Possibly some light may be thrown on the method of action (if indeed it really possesses any at all) of this enigmatical body, by a consideration of some of the cases in which it cannot be said to exist at all. For some years past it has been known (and the number of examples has been recently multiplied) that in certain plants the nuclear division is not inaugurated by the appearance of two diverging centrosomes, which could occupy a definite position with regard to the radiations at this time visible in the protoplasm. On the contrary, radiations start out from many centres in the cell, and run in various directions, though with a general tendency towards the nucleus. Later on these numerous centres become, so to speak, polarised, and commonly come together at two principal points occupying opposite ends of the cell. Thus a final condition of affairs is reached, resembling the more regular arrangement obtained by the centrosome mechanism (Figs. 1 and 2). What starts these radiations in the first instance? It is difficult to imagine them to be otherwise than due to a chemical change in the protoplasm, or of some of its included substances, and this view is strengthened by the observations made by Hertwig and others on the stimulating and modifying action of drugs, such as quinine or strychnine. Morgan, by merely altering the salinity of the sea-water, was able to produce centrosomes and radiations at will, and the irregularity in number and size which they displayed was just such as might have been expected, on the hypothesis here advanced.

These observations—and many similar ones could be cited—go to show that the impulse to division, which some have tried to identify exclusively with the centrosome, is more probably dependent on the condition of the protoplasm as a whole. It is quite probable that, as in so many other cases, the stimulus may be at bottom a chemical one, connected with the elaboration of some substance producing the disturbances which result in the formation of the machinery for cell division. It is even possible that the substance may, in the more specialised cells, or in those of rapidly dividing tissues, be aggregated into a mass which assumes the manifold appearance that one finds in the centrosomes, centrospheres, and so on. From what we know of protoplasm it would hardly be surprising if this were so. Carbohydrate can be stored as starch, to be again lost to sight as sugar, &c.; why not the substance which may be supposed to be capable of reacting with the rest of the protoplasm in the

Fig 1

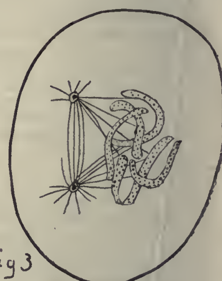

Fig 3

Fig. 2

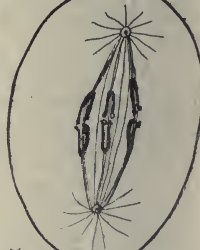

Fig. 4

production of the karyokinetic phenomena? But this is a very different thing from considering the centrosome as a sort of autocrat presiding over the destinies of the cell, as its more enthusiastic supporters have claimed. It would not even be necessarily a *permanent structure* inaugurating the cell changes, but would represent a substance, which might merely be formed *ad hoc*, and which, after the period of activity, might either lose its identity—sinking to the general level of the substances contained in the protoplasm—or if present, in sufficient quantity, over and above what proved to be needed for a given occasion, it might remain as a formed substance to be used up later.

There is a large body of evidence to show that, when present, it is intimately associated with the processes of nuclear division, though whether in an active or passive connection it is difficult, perhaps impossible, to say. Certainly, taking the most favourable view as to its autocratic powers, it can effect nothing unless the protoplasm be ready to receive it. The centrosome of a spermatozoid introduced into a ripe egg may become the centre of a system of radiations, but none are produced if the ovum happens to be immature. And on the whole, especially in view

[1] A word used to signify nuclear division, introduced by Schleicher; it is equivalent to the term *Mitosis*, employed by Flemming.

of the behaviour of those cells in which no centrosomes have been discovered in spite of infinite toil having been spent on the attempt to prove their existence, it seems more probable that they are not to be regarded as morphological structures ranking with nuclei or plastids, but at most as consisting of matter which may be condensed to a granular form, or which may be present or be manufactured in a state diffused through the protoplasm. Indeed this matter may perhaps not be inappropriately compared with zymogens, which, when suitably acted upon, liberate substances capable of exerting an influence altogether incommensurable with their amount on materials within the scope of their power. But no one would probably go so far as to elevate a lump of zymogen, if it could be shown to exist in a given cell or tissue, to the rank of a cell organ, any more than most people regard the elaborated spindle fibres as representing anything but a specialised phase of protoplasmic structure, at most temporarily differentiated from the rest of the cell substance, and destined, sooner or later, to be re-absorbed into it, although the remains of some spindles persist long after the cells in which they were formed (*de novo*) have completed their division.

Having briefly glanced at the centrosome, we may pass on to consider some of the more important peculiarities connected with the actual process of division of the nucleus. And, first, we will consider the mode of the formation and division of those remarkable structures—the chromosomes. During its resting state, a nucleus presents a granular or spongy appearance, and is commonly seen to contain one or more refractive bodies—the nucleoli. As the stages of approaching division are passed through, a substance (which can be identified also in the resting state), known as the chromatin, begins to assume a growing importance. This substance, which consists largely of nucleic acid, aggregates along more or less definite tracts of the colourless and less stainable matrix (linin) within the nucleus, and finally nearly all the linin is used to provide a substratum in which the chromatin is embedded. This linin scaffolding assumes the appearance of a much convoluted thread or threads, and, owing to the predominance of the chromatin, its existence is easily (and often) overlooked. The thread then shortens and thickens, and eventually breaks transversely into a definite number of segments constant for the particular species. Meantime the well-known *spindle* is formed, and the chromosomes become arrayed around it (Figs. 2, 4). They are now seen to split longitudinally, and finally the two halves separate, passing to opposite ends of the spindle, where they help to reconstitute the daughter-nuclei which arise in this way. Now, since the original chromatin-containing thread appears to be symmetrical about its long axis, it is clear that there exists no obvious grounds for assuming that the two groups of chromosomes, which have ultimately arisen as the result of a longitudinal fission of this thread, represent anything but the reflected images of each other; and indeed there is a great deal which strongly suggests that the significance of the complicated stages passed through, lies in the ensuring of a qualitatively equal distribution of material to each of the two daughter cells; *quantitative* equality is also secured far more accurately than would probably be the case if each chromosome divided transversely instead of longitudinally.

The reappearance of a definite number of chromosomes, as well as *à priori* considerations, based on the relations which on good grounds believed to obtain between the chromosomes and the existence of hereditary qualities in an organism, have led many investigators to believe that they are the *same* chromosomes which constantly reappear at each karyokinetic period; although, in the majority of instances, they cannot be recognised in the intervening state of rest between the successive divisions. This view is, perhaps, hardly sufficiently warranted by the facts, and some of its warmest supporters have been obliged to take refuge in expressions such as a "physiological persistence"; a sort of persistence which may be entertained as a pious opinion, but which, when one tries to rigorously define it, proves as elusive as metaphors usually are.

But the chief interest which centres in the chromosomes depends on the remarkable part played by these bodies in connection with the reproductive processes. Since every act of fertilisation consists essentially in the union of two cells and of their contained nuclei, it is clear that the resulting nucleus will possess twice as many chromosomes as that in each of the cells which have fused together. And if this is repeated in consecutive generations it is obvious that the chromosomes, increasing in geometrical progression, will soon become too numerous to be contained within the limits of any one nucleus. Hence the necessity of a reduction in their number at some period between each act of fertilisation. This reduction regularly occurs, and always happens at a definite period in the history of the organism, although the exact epoch may differ considerably in different groups of plants or animals.

A considerable discussion has arisen as to the exact significance to be attached to the process, over and above the bare fact of the halving of the number of the chromosomes. Some have tried to show that variation, so characteristic of animals and plants, is ensured by the distribution of entire chromosomes between the two daughter-nuclei; others have seen in it a return to an "embryonic condition" which renders the act of fertilisation a necessary antecedent to further development; others, including Strasburger, whilst recognising that it is preparatory to fertilisation, and that it indirectly promotes variation by rendering the fusion with another cell possible, regard it as the expression of a return to an ancestral condition which prevailed before fertilisation by the union of two individuals had come into existence. Of the explanations here mentioned the first is the most consistent, or at least is, at first sight, less obviously contradicted by facts than the rest. But, nevertheless, it will be seen that it does not by any means embrace all the well worked-out cases, and therefore cannot be considered as of general application. It will, however, be specially considered here, because it is so often brought forward as a most important argument in support of Weismann's theory of Heredity.

Weismann, as is well known, regarded the hereditary qualities of an individual as closely bound up with certain cellular structures, and he has identified these with the minute particles of chromatin which in the aggregate go to form a chromosome. Each chromosome is conceived of as possessing the material substrata for all the specific characters of the organism, but the arrangement or constitution of these is slightly different in the different chromosomes. The actual course of development, followed by the organism as a whole, depends on the degree in which one or other group of characters becomes predominant, or on the result of a compromise between them.

Clearly, therefore, whilst an organism which had lost half its chromosomes could not be expected to exhibit as many possibilities of variation as one which retained its full number (if development were possible at all under such circumstances), by the elimination of the half, and subsequent replacement of them by corresponding (but slightly differing) chromosomes from another individual, the chances of new variation would certainly, if we accept the premises, be greatly increased.

These views have been worked out in great detail, and they have received quite a remarkable confirmation as the result of the researches of Rückert, Häcker, vom Rath, and others. But, whilst recognising the great interest attaching to the results obtained by these investigations, it is at present quite impossible to regard them as affording more than a local confirmation of Weismann's theories, simply because, although they may possibly bear this interpretation, there are (as already indicated) other cases which even Procrustes himself could not fit into the same bed.

As regards the general character of the "reduction divisions," there naturally exists a certain amount of variety in detail; but in the following summary an attempt will be made to present the more salient and fundamental features of the process. If one takes as an example a higher animal, the reduction divisions are seen to be closely related with the formation of the actual sexual cells—ova and spermatozoa; up to the penultimate divisions the line of cell generations have possessed nuclei with a definite number of chromosomes, which we will designate as $2n$. Then follows a long period of repose and of growth, and when the nuclei of these cells emerge from their quiescent condition, the number of their contained chromosomes is seen not to be $2n$, but only n. That is to say that a numerical reduction has, somehow, been accomplished in the resting period. There is no question here of any chromosomes having been *eliminated*; nothing has been expelled (so far as can be seen) from the nucleus, but there has been a rearrangement. It has been suggested, and the view is stoutly maintained by Häcker and others, that the reduction here is only *apparent*, and that what has really occurred is that the original thread has only, so to speak, broken transversely at every other joint, leaving two chromosomes attached end to end. Each apparent chromosome then would be really double. Be this as it may, these chromosomes behave essentially like those of other preceding cells as regards their fission, dividing longitudinally, as before. But the process is here very complicated, and it is only as the result of very many and careful researches that this fact has been definitely ascertained. Quite apart from the altered (reduced) numbers of the actual chromosomes present, the course of their development deviates so widely from the normal type of karyokinesis in whatever the animal or plant one may happen to be investigating, that it has been designated by Flemming as the Heterotype[1] division.

It has already been stated that some writers hold that no true reduction has occurred at this period, and by them (Häcker, Rückert, &c.), it is termed a *pseudo-reduction*, for they consider that in the next, and rapidly following, division the real reduction occurs. In the latter division it is believed, in the cases investigated, which belong chiefly to the Arthropoda, that a real *qualitative* reduction occurs by the splitting transversely of each of the pseudo-chromosomes, and by the distribution of the halves thus produced to the two daughter-nuclei. In other words, the two genuine chromosomes which remain united as a pseudo-chromosome during the heterotype karyokinesis, now separate from each other, and thus each daughter-nucleus receives half the number of original entire chromosomes, and consequently comes to contain slightly different sets of hereditary potentialities. However this may be for Arthropoda, in which the process is by no means easy to follow, it is certain, as the researches of Meves, conducted under the auspices of Flemming, clearly prove, that such a sorting of chromosomes does not occur during the development of the sexual cells of Salamander, but that the second (and last), like the heterotype division preceding it, passes through a longitudinal-fission stage. And it is equally certain that the same is true, at least, for the higher plants. Ischikawa's recent results with *Allium*, which seem to point to a contrary conclusion, can hardly be admitted as evidence one way or another, since, judging from his own account of the process, he seems to have misunderstood the stages with which he was dealing. And in any case, the existence of numerous exactly worked-out examples in which a transverse fission certainly does not occur, obviously disposes of any attempt to make it serve as the basis for a general theory of the mechanism by which variation may be supposed to be secured.

In spite of all the efforts which have been made, we are still without a certain clue to the meaning of the reduction. Unquestionably Weismann's view, which has been supported by Häcker and others, offers the most attractive solution of the puzzle; but, as has been pointed out, it clearly will not explain the facts in all cases. Others believe the essential feature to lie in the sudden reduction in the amount of chromatin consequent on two so rapidly consecutive divisions But the divisions do not invariably succeed each other with no intervening period of rest. Strasburger has suggested that it represents a return to an ancestral pre-fertilisation state, and it is possible that there may be found to be some probability for this. But against it is to be set the question why organisms with different numbers of chromosomes in their nuclei always halve that number, whatever it may happen to be, and do not all come to possess a common number of reduced, and consequently of duplicated chromosomes, for even closely related forms often differ widely in this respect. However we explain it, it seems clear that no theory which depends on the continued permanence of chromosomes can be admitted. Each one of the reduced number cannot be compounded of two original ones, as such, but must be a new structure; else it is obvious that we have no real reduction at all, but only a series of pseudo-reductions—a view which would soon land us into an impossible position. But if the chromosomes are not really permanent structures, then the whole process of the two divisions of which we are speaking, resolves itself into a mechanism which, whilst providing for a halving, provides equally for an accurate distribution of the halved substance between the two final daughter-nuclei. And although the acceptance of such a view of the matter would involve a modification of those opinions shared by many as to the nature of the architectural configuration of the hereditary substance, in accordance with which discrete particles of it are commonly assumed to be associated with definite hereditary qualities, still the alternative hypothesis by no means negatives the possibility of regarding heredity as the outcome of the constitution of some such substance taken as a whole. The qualities of the organism would depend on the structure of the material basis, just as the structure of a crystal—to use an old illustration—depends on the ultimate configuration of the constituent molecules. An analogy of this sort is perhaps not worth much—it is a comparison of a relatively simple with an infinitely complex case—but still we are more likely to make a definite advance by arguing, even imperfectly, from things of which we know something, than by abandoning ourselves to phantasies which are intangible, and consequently incontestible.

During the course of a nuclear division, there are few phenomena which are more striking than the genesis and mode of operation of that extraordinary structure known as the achromatic spindle. This body provides the framework for the whole process, as well as the machinery by which it is effected. It originates in many different ways, and exhibits various degrees of perfection in different organisms; but the ultimate result attained is much the same in all.

Two extreme types of its modes of origin may be briefly outlined. In the less perfect form, as the period of nuclear division is about to commence, radiations are seen to start out in the protoplasm. Sometimes these are connected with the nucleus itself, but more often they seem to be focussed in groups on many of the granules with which, at this stage, the protoplasm is filled. But there is no sort of order in their arrangement. Later on it is seen, however, that the lines become gradually and with increasing rapidity focussed to two opposite spots in the cell, and then the normal spindle is fully formed. It is idle here to speak of the existence of centrosomes as initiating a process which thus begins so irregularly, and the assumption that they are really secretly existent all the time, and by their hidden activity cause the astral radiations to converge to the two poles, suggests if not a *petitio principii*, at least a revelation derived from some source from which mere mundane minds are debarred.

In the more perfectly formed mechanism, the spindle originates from a definite mass of protoplasm which is intimately related to centrosomes, and consequently it only is formed in this manner when these structures are actually present.

It appears to be, so to speak, spun out between the diverging centrosomes, and either to pass into a groove in the nucleus, or to rope up towards itself the chromosomes which by this time are differentiating. But whatever be the manner of its origin, when it is fully formed it provides a structure upon which the chromosomes are arrayed, and upon which, after the separation of the two halves into which they severally split, the daughter chromosomes travel to the respective poles. In many cases additional fibres can be distinguished which have become attached to these retreating bodies, and thus, by contracting, drag them towards the two ends of the spindle.

The advantage, mechanically speaking, of two poles to which all the achromatic fibres running between them converge, is clearly recognised during the changing conditions of stress and strain which occur during the course of a karyokinesis, and it serves to throw some light on certain phenomena which have attracted less attention than they seem to deserve.

Hitherto the poles have been treated of here as though they were only marked by the convergence of the nuclear spindle fibres; but, over and above these, there are numerous other fibres which radiate into the cell protoplasm, and which may even reach the cell wall. Now, it is a significant fact that these radiations are most apparent during the first formation of the spindle and during the end phases of division, *i.e.* whilst the daughter chromosomes are being pulled up to the poles. Often, as in germinating spores of *Pellia* (a liverwort), they entirely die away in the interval separating these two stages. The whole appearance strongly suggests that the function of these radiations, differentiated out of the cytoplasm, is to steady the poles, and thus render the achromatic framework a rigid one. Indeed without some such arrangement it is difficult, if one watches the process going on, to imagine how the necessary stability would be secured.

When the chromosomes have reached their respective

[1] The chief differences which distinguish the heterotype from other divisions lies in (α) the long period of growth preparation; (β) the relatively early appearance of longitudinal fission in the chromatic thread; (γ) the frequent separation of the halves thus formed at this early stage, and their subsequent approximation to one another of the halves in a variety of ways, *before* they become grouped on the spindle; (δ) the curious and very characteristic appearance of the mature chromosomes on the spindle, sometimes taking that of closed rings, with (commonly) local equatorial thickening, or the chromosome at this stage may, in some forms, assume the form of four spheres, loosely held together, constituting the *vierer gruppe* of the German authors.

destinations, and whilst they are gradually forming into the daughter-nuclei, a curious change usually occurs at the equator of the spindle in the fibres which still stretch across the intervening space between the two poles. The threads become more numerous and present over the area mentioned a thickening of their substance, and by the fusion of the swellings a cell wall, dividing the original cell into two halves, may be formed. And whilst this is happening, there is evidence to show that the fibres themselves, which become strongly arched, are in a state of compression and thus the young wall is stretched to its utmost extent. The plane of equilibrium within the spindle depends on the shape of the cell; and thus at first, and whilst still plastic, one can predict what position it will

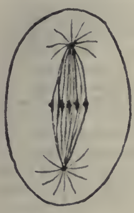

Fig. 5

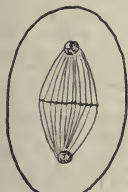

Fig. 6

Fig. 7

take up as regards the existing boundaries of the cell. Indeed the resemblance of such a nascent wall to a soap film has struck more than one investigator, and has been worked out in some detail by Wildemann.

The general relation of cell division to mechanical conditions is well illustrated during the development of pollen cells. In the monocotyledons the original pollen-mother-cell gives rise to the pollen grains by two succeeding divisions with an interval of rest between them. The first karyokinesis is followed by a partitioning of the cell, which is thus divided into two symmetrical halves, often hemispheres. When the latter finally divide, they also are symmetrically partitioned, though this, of course, can (and usually does) happen by means of walls which are not similarly orientated in both of the two first formed cells. In Dicotyledons, on the other hand, in which also there are two successive bipartitions of the nucleus, the appearance of the cell walls is deferred until the full number (four) of nuclei has been produced. And, just as might have been expected, the way in which the actual partitioning takes place is consequently modified. If spherical, as is commonly the case, the quadrinucleated cell is simultaneously divided into four tetrahedral cells by walls converging to the centre at an angle of 60°.

It would be difficult to find an example which more strongly witnesses to the influence of the form of the cell as governing

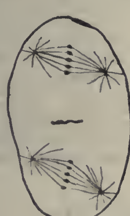

Fig. 8

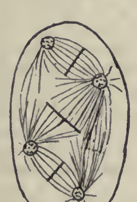

Fig. 9

the disposition of the walls which partition it, than is furnished by the spore formation of a common liverwort, *Fegatella conica*. And as it also illustrates some other points touched upon in the preceding pages, this paper may be fitly brought to a close by a description of the more salient peculiarities attendant on the process. The spore-mother-cell, which ultimately gives rise to four spores, is shaped like an oval box flattened above and below. When its nucleus divides (Fig. 5), the two daughter-nuclei lie in the line of its major axis, and a rudimentary cell wall begins to be formed at the equator of the spindle (Fig. 6), after the fashion already indicated above. But, unlike most structures of this kind, it does not extend to the peripheral walls owing, apparently, to the relatively small size of the spindle. As the two daughter-nuclei pass into the resting condition, the spindle fibres die away, and an interesting change comes over the character of the uncompleted division-wall. It ceases to be stretched out, and becomes somewhat crumpled and obviously thicker, whilst its area correspondingly diminishes (Fig. 7).

Then, after a time, the two daughter-nuclei again divide (Fig. 8), and after this division, resulting in the production of four nuclei, preparations for the real partitioning of the cell begins. Whatever position they may have previously occupied, the nuclei now take up that shown in Figs. 9 and 11; and they are apparently compelled to do so by the action of the radiations, which extend from each one of them into the surrounding cytoplasm. Whilst they are settling down to their final positions, the original cell-plate, above spoken of, is caused to rotate through an angle of 90°, so that it now is parallel with, instead of at right angles to, the major axis of the elliptical cell. Its motion is clearly seen to be the result of a directive action on the part of the highly developed systems of radiating fibres, and when it has turned round it is seen to have lost its thick crumpled appearance, and to have become thin and tense. As soon as it has ceased to cut across the line of protoplasm between the nuclei belonging to opposite pairs, the radiations are seen to arrange themselves into a spindle form, just like that formed between the daughter-nuclei of each pair, a fact of considerable theoretical importance in the elucidation of the genesis of spindle structures generally. In the equators of these two newly differentiated spindles, as in each of the two normal ones, cell-plates are formed, four in all, and they become attached in pairs to the ends of the primary plate, now lying longitudinally in the cell (see Figs. 9 and 10), and thus the partition of the space is completed (Fig. 11). A point of special interest in

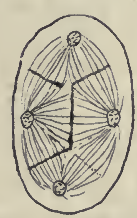

Fig 10

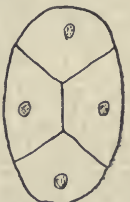

Fig. 11

this case of *Fegatella* lies in the remarkable fact that we here meet with two perfectly different conditions of cell division, and that the transition from the one to the other can be followed in every stage. Theoretical requirements are here demonstrably satisfied in a manner such as we can seldom hope to equal in our attempts to solve the many problems with which cytology has to deal.

J. B. FARMER.

VASCO DA GAMA.[1]

WE are assembled this evening to commemorate one of the greatest events in the history of the world—the discovery of the ocean route to India by the Portuguese. Vasco da Gama completed the mighty enterprise on the day when the ghâts of India were sighted from the deck of his ship just four hundred years ago to-morrow. The credit of this discovery is due to the Portuguese people, to their constancy and heroic perseverance, even more than to the skill and ability of their leaders; and I think that many of the illustrious navigators of Portugal are equal in merit, and should be equal in renown. We contemplate the perseverance of this people and the continuity of their work during a century and a half of mighty effort, rather than a single stroke of genius. Yet it is right that Vasco da Gama, who forged the last link, should have the first place which Camoens has assigned to him, *primus inter pares*.

Prince Henry gave the first impetus, and during a quarter of a century he created a school of seamen who rounded Cape Bojador in 1435, Cape Blanco in 1443, Cape Verde in 1445, and

1 Address delivered before the Royal Geographical Society, on May 16, by the President.

reached the Gambia in 1454. All this was done in the lifetime of the Prince Navigator. At his death the work was continued, with almost equal zeal, by the kings—his nephews—Alfonso the African, Joaõ the Perfect Prince, Manoel the Fortunate. Portugal was indeed fortunate in her sovereigns of the house of Avis, fit guides and leaders of the little hero nation, as Schlegel calls her. The ships of Alfonso reached Sierra Leone in 1462, made a colony at Lamina, on the coast of Guinea, crossed the equator, and sailed as far south as Cape St. Catherine. His son, "O Principe perfeito," sent Diogo de Azambuja to found the castle at Lamina, and Diogo Cam to push southward, until at length the Congo was reached.

The *padraos* were intended to be eternal monuments of Portuguese achievement. They were stone pillars with an inscription, and the arms of Portugal carved upon them—the well-known "cinco chagas," with the orle of the seven castles of Algarve. Each explorer was to plant one on a conspicuous point at his furthest point. The "padraos" were named after saints. That of Santo Agostinho (once planted in 13° 27′ 15″ S., south of Benguela) is now in the museum of the Geographical Society at Lisbon, as well as that once on Cabo Negro, in 15° 40′ 30″ S. Two of these "padraos" were on the arms granted to Diogo Cam, the discoverer of the Congo.

It was the ambition of each successive Portuguese voyager to plant a national monument beyond the furthest point reached by his predecessor. None had been so zealous in this glorious work as the family of Diaz, whose first sailor scions were trained in the school of Prince Henry. Joaõ Diaz rounded Cape Bojador, Dinis Diaz first reached Cape Verde, and Bartholomew Diaz was destined to complete the maritime fame of his family by being the first to round the southernmost point of Africa, planting "padraos" as he proceeded. In 1487, Bartholomew Diaz passed the Table mountain undiscerned amidst the stormy waves, rounded Cape Agulhas, the southernmost point of Africa, and reached the Great Fish river, which he named after his companion, Joaõ Infanta. It was with great reluctance that the gallant Diaz, complying with the urgent entreaties of his crew, shaped a course homewards; and then it was that he first sighted the cape, which received from him the name of Cabo Tormentoso, and which the King changed to the Cape of Good Hope. Covilham, exploring southwards from Egypt, had discovered the whole east coast of Africa as far as Sofala, and had sent a full report from Cairo to King Joaõ. So that there was nothing left to discover, except the bit of African coast from the Great Fish river to Sofala.

The goal was well in sight. The eastern side of Africa had been reached by Diaz, and was known through the report of Covilham. Thence the next explorer would stretch across to the shores of India. King Joaõ prepared for the final and crowning expedition by the building of two suitable ships, which were commenced under the superintendence of Bartholomew Diaz, the ablest and most successful Portuguese explorer of that age. But in 1495 the king died, and the great work remained to be achieved in the reign of his successor, King Manoel ("O Fortunado"), who was at the head of Portuguese affairs for the next fifty-six years. He continued the equipment of the expedition, which had been commenced by his predecessor.

Then it was that Da Gama appeared on the scene. Camoens introduces him—

> "Vasco da Gama, valiant capitayne,
> For deiring do the noblest volunteer;
> Of notable courage and of noble strain,
> Whom smiles of constant fortune love to cheer."

The Da Gamas came of an ancient, valiant, and loyal house, their ancestors having fought by the side of Alfonso III. in the conquest of Algarve from the Moors, and by the side of Alfonso V., "the Brave," at the battle of Salado. Estevan da Gama, their father, was chief magistrate of Sines; and here Vasco and his brothers were born. The little town of Sines is situated in a bay, about half-way between Lisbon and Cape St. Vincent. To the west are the blue waves of the Atlantic, but to landward an undulating sandy plain extends for several leagues. On the north side of the bay there is a granite ridge running out into the sea, and on the top of the cliff there is a small church built by Vasco da Gama towards the end of his life.

The four sons of Estevan da Gama appear to have been born and brought up at Sines; but I believe that little or nothing is known of them before the date of the great expedition. The two ships had been built, the *Sam Gabriel* of 120 and the *Sam Rafael* of 100 tons; another vessel was purchased from a Lagos pilot named Berrio, and named after him; and a provision-ship of 200 tons was also got ready. Then it was that Vasco da Gama was selected by King Manoel to command the expedition. He was not more than twenty-eight years of age. His eldest brother, Paulo, was equally fitted for the post, and he insisted upon accompanying and serving under Vasco, in command of the second ship. They both looked upon Nicholas Coelho, who was captain of the *Berrio*, as their brother.

Paulo da Gama was one of the kindest and most lovable of men, and his presence in the fleet was an influence for good. The best trait in the character of Vasco was his love for and devotion to his elder brother.

All things were prepared for the great enterprise, and the ships were ready in the Tagus. The beautiful church of Belem was not then built on the beach of Restrello, but Vasco da Gama passed the night before his departure in prayer in a little chapel which had been erected there by Prince Henry. He embarked next morning, and the expedition sailed on Saturday, July 8, 1497; there were about 160 souls all told. Six *padraos* were taken out, to be set up on prominent headlands, but not one of them is now known to exist. The fleet was accompanied by the great navigator, Bartholomew Diaz, as far as the Cape Verde Islands. He was going out in a fast caravel, to take up his command of the new Portuguese settlement of Lamina, on the coast of Guinea.

In December the expedition reached the "Rio do Infante," the furthest point of Bartholomew Diaz on the eastern side of Africa, and entered upon new ground. There was a mutiny at this critical time. The men feared to proceed further, and wanted to return, according to Correa, who adds that Vasco da Gama put the master and pilot in irons for giving the same advice, and threw all their instruments overboard. His brother Paulo induced his crew to obey orders by argument and persuasion, and interceded for Vasco's prisoners. This mutiny is not mentioned in the "Roteiro."

The first experience of the explorers on entering the previously unknown ocean was the force of the current, so strong that they feared it might frustrate their plans, until a fresh stern wind sprang up, which enabled them to overcome it. This Agulhas current was first scientifically investigated by Major Rennell in 1777.

Vasco da Gama passed the coast, which was named by him "Natal," on Christmas Day, and was well received by the natives of Delagoa Bay. He was at Quillimane in January 1498; at Mozambique in March; and he reached Melinde on April 15. There was a terrible outbreak of scurvy off Mozambique, and again on the way home; and then it was that Paulo da Gama proved the guardian spirit of the expedition, giving up all his own private stores for the use of the sick, ministering to them, and warding off despondency by his words of encouragement and by his example.

The King of Melinde supplied the Portuguese with an Indian pilot, a native of Gujarat, and on April 24 the voyage was commenced across the Indian Ocean, from the east coast of Africa to Malabar. Before starting, Vasco da Gama, with the hearty concurrence of the King of Melinde, set up one of the *padraos*, with the escutcheon of the *Quinas* carved on one side, and a shield bearing a sphere on the other. Beneath was King Manoel's name. It was placed on a hill above the town.

A voyage of twenty-three days brought the adventurous discoverers in sight of the mountains above Malabar—an event which Camoens thus relates:

> "Pale shone the wave beneath the golden beam,
> Blue o'er the silver flood Malabria's mountains gleam;
> The sailors on the maintop's airy round
> 'Land! Land!' aloud with waving hands resound.
> Aloud the pilot of Melinda cries,
> 'Behold, O Chief, the shores of India rise!'
> Elate the joyful crew on tiptoe trod,
> And every breast with swelling raptures glowed.
> Prone on his manly knees the hero fell;
> 'Oh, bounteous Heaven!' he cries, and spreads his hands
> To bounteous Heaven, while boundless joy commands
> No further word to flow."

Then the immortal poet, in words of fire, declares how this mighty deed was done, and by what kind of men:

> "*Not* those who ever lean on ancient strain,
> Imping on noble trunk a barren chain;
> *Not* those reclining on the golden beds,
> Where Moscow's zebelin downy softness spreads;

> *Not* with the novel viands exquisite;
> *Not* with the languid wanton promenade;
> *Not* with the pleasures varied infinite,
> Which generous souls effeminate, degrade;
> *Not* with the never conquer'd appetite,
> By fortune pamper'd as by fortune made.
> *But* by the doughty arm and sword that chase
> Honour which man may proudly hail his own;
> In weary vigil, in the steely case,
> 'Mid wrothsome winds and bitter billows thrown,
> Suffering the frigid rigours in th' embrace
> Of South, and regions lorn and lere, and lone,
> Swallowing the tainted rations scanty dole,
> Salted with toil of body, moil of soul.
> Thus honour'd hardness shall the heart prevail,
> To scoff at honours, and vile gold disdain.
> Whoso shall rule his life by reasons light,
> Which feeble passion ne'er hath power to hide,
> Shall rise (as rise he ought) to *honour true*.
> Maugre his will that ne'er hath stooped to sue."

And thus was the Portuguese empire in India founded by two of Portugal's noblest sons, Vasco and Paulo da Gama. Time will not allow us to linger with them on the coast of Malabar. On March 20, 1499, they cleared the Cape, and returned to Lisbon on September 18. But Paulo da Gama had died at Terceira, in the Azores. Equal to Vasco in heroism and constancy, Paulo excelled him in the more Christian virtues, and was, as I have already said, the guardian spirit of the voyage. When Vasco is remembered, Paulo da Gama should never be forgotten. They are equal in merit, and both equally deserve to have their memories honoured by their country, and by the civilised world.

True to the spirit of perseverance and energy which had led the Portuguese to this crowning success, a large fleet was despatched to India in the year after the return of Vasco da Gama, and in each succeeding year. Vasco da Gama commanded the fourth voyage in 1502, and on his return he was created Count of Vidigueira. Then followed the brilliant achievements of Alfonso d'Albuquerque, who occupied Goa, Ormuz, and Malacca, and established Portuguese power in India on a solid foundation. It was to last unchallenged for eighty years, when the disaster of El Kasr-el Kebir brought on what the Portuguese called the sixty-years captivity.

For twenty years Vasco da Gama was unemployed, living at a house in Evora, the walls of which were painted with figures of Indian animals and plants, and hence the street in which it stood is still called "Rua das Casas Pintadas." Here he brought up a family of six sons; but in 1524 he was called from his retirement to rule over Portuguese India. He went out with a large fleet, surrounded by all the pomp and circumstance of a viceroy, and he died at Cochin, on the scene of his discoveries, on Christmas Day 1524, aged 55.

Vasco da Gama is described as a man of middle stature, rather stout, and of a florid complexion. The portrait, which belonged to Count Lavradio, is given by Lord Stanley of Alderley, in his translation of the account of Da Gama's voyages in the "Lendas da India," of Correa. It is a copy of the portrait in the Museu das Bellas Artes at Lisbon, a photograph from which is given in Ravenstein's "Roteiro." It represents a handsome man, aged about fifty, with a white beard and severe expression, wearing a furred robe, and the cross of the order of Christ hanging from a chain round his neck. *His crest* was a girthed doe trippant, or. *Arms*—chequy of fifteen, or and gules; two bars argent; over all an escutcheon with the *quinas* of Portugal.

Luis Camoens, the great epic poet, is said to have been born in the year that Da Gama died; and Lord Stanley says, I think truly, that the name Vasco da Gama has left in history is due largely to the great genius of Camoens. "The discovery of India," says Schlegel, "the greatest event of modern times, could only be worthily celebrated by one who had himself passed a portion of his life in those regions. A warrior could only thus have written."

"At the proudest moment of that brief but glorious period of Portugal's greatness, one great national song broke forth, like the dying note of the fabled swan, a dirge for the departing hero-nation. The remembrance of her departed glory is enshrined in this immortal work, created by the divine genius of her national poet to immortalise her fame. The exquisite bloom and grace of the diction of Camoens are unparalleled among modern writers." [1]

The most learned and accomplished English traveller of modern times, the late Sir Richard Burton, devoted twenty years of his life to the study and translation of the "Lusiads of Camoens." He declared that he felt a glow of pleasure at having undertaken it—at having lived so long in contact with so noble a spirit as that of his master. He also took pride in the ambition of familiarising his fellow-countrymen with a workman and a work not readily to be rivalled in the region of literature. No single publication extant gives so full and general a portrait of Camoens, his life and his work, as that of Sir Richard Burton, and his translation is undoubtedly the most faithful and the best in our language. The Hakluyt Society, of which I have the honour to be President, has also laboured to make the achievement of Vasco da Gama better known in this country. In 1869 we brought out the "Lendas" by Gaspar Correa, translated and edited by Lord Stanley of Alderley; and this year, with a view to celebrating the present commemoration, we have published the "Roteiro" of the first voyage, which has been ably translated and edited by Mr. Ravenstein.

After the sixty years of captivity came to an end, Portugal rose like a phœnix from its ashes. The old alliance with England was renewed. It was commenced when the founder of the house of Avis, the great King Joaõ of Good Memory married that English princess, who bore him five noble sons, including Prince Henry the Navigator. Since 1640, the year of liberation, English and Portuguese have fought side by side on many a battle-field for freedom, we have formed alliances, and now our royal houses are nearly related. There are many reasons why England should feel warm sympathy for Portugal in the commemoration of the mighty deeds of her sons. The nation of heroic memories has a glorious history to be proud of; and by the commemoration of the discovery of India by Vasco da Gama, we hope that those memories will impress themselves even more strongly than ever on the minds of her sons, leading them on to an honourable and prosperous future. We wish health and happiness to his faithful Majesty, and success and prosperity to our old and tried ally, the noble Portuguese nation.

[1] Schlegel.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A proposal to establish a final honour school of agricultural science, the examination in which was to be partly of a practical character, with the condition that the candidates must have obtained honours or passed the preliminary examinations in natural science, was rejected by Congregation on Tuesday.

CAMBRIDGE.—Mr. H. Yule Oldham, of King's College, has been appointed Reader in Geography for five years from Midsummer 1898. Mr. A. C. Seward, of St. John's College, has been reappointed University Lecturer in Botany.

The grace for the recognition as a public hostel of St. Edmund's House, established as a place of general education for candidates for the Roman Catholic priesthood, has been rejected by 471 votes to 218.

MRS. ELIZABETH H. BATES, of Port Chester, N.Y., has left, by her will, property valued at 135,000 dollars to the University of Michigan.

A COURSE of six lectures on electric traction, by Prof. Schwartz and Dr. D. K. Morris, was commenced on Tuesday evening at the South-West London Polytechnic, Manresa Road, Chelsea, and will be continued on succeeding Tuesdays.

THE Town Council of the county borough of West Ham have made the following appointments on the teaching staff of the new Municipal Technical Institute: Head of the Chemical department, Dr. Harold A. Auden, of the Owens College, Manchester; Lecturer in Mechanical Engineering, Mr. John Duncan, of University College, Nottingham.

THE fifth annual report of the Technical Education Board, presented to the London County Council on Tuesday, is a document of fifty foolscap pages. It includes a general account of the work of the Board, showing the lines on which the work has been organised, and giving a survey of the provision for technical education which now exists in the metropolis. Several maps are appended at the end of the report, which give a general idea of the character and locality of the various institutions in which technical and scientific education is provided. During the year covered by the report, the Board has continued its policy of attempting primarily to coordinate and develop the provision for technical education made by the various public institutions of the metropolis. In the secondary schools the Board's regulations have lead to a great increase in the number of teachers of science and of domestic economy, while facilities for teaching practical chemistry and practical physics have been provided in the majority of boys' schools, some of which possess first-class physical laboratories and workshops. At the same time, the School Board has done much to equip its upper standard schools with laboratories and appliances for the practical teaching of science. To the polytechnics and the established schools of art, and to many secondary schools, the Board has made annual or maintenance grants. Provision has also been made in two polytechnics for courses of practical work for elementary teachers, and special classes of somewhat similar type have been provided at the cost of the Board in connection with University College, King's College. and Bedford College. Day classes in particular branches of science and technology are, in addition, conducted at some of the polytechnics. The Board contemplates making provision for developing commercial education, and is considering how to advance the interests of electro-chemistry, electro-metallurgy, and other subjects. The "Monotechnic" schools for particular subjects are also engaging its serious attention. When the Board commenced its work in 1893, there were only six polytechnics at work in London; there are now eleven. Last year the Board contributed a sum of 28,129*l*. to these institutions. During the year a total of 117,744*l*. 12*s*. 11*d*. was expended by the Board, leaving a balance in hand of 41,144*l*. 14*s*. The aggregate expenditure and liabilities for the year ended March 31, 1898, may be stated in round figures to be 150,000*l*., but this amount cannot be precisely estimated until all the claims for attendance grants are received. The Board estimates that during the year 1898-99 170,000*l*. will be required for the Council to meet the increased expenditure (possibly amounting to 184,175*l*.) necessitated by the development of the work of the Board.

The Chancellor, Lord Herschell, presided over the annual celebration of the University of London, at the presentation of degrees last week. After congratulating the winners of distinctions he referred to the University of London Bill in the following words:—They were all aware that the Government had introduced a Bill which was to effect a reorganisation of the University, and that Bill had already passed one of the Houses of Parliament. The Government had announced their intention to bring the subject to a discussion and, if possible, to a solution in the House of Commons. On this question there were certain facts which were beyond dispute which it was necessary that they should take into account in estimating the situation as it stood to-day. In the first place there was a very strong public opinion—he might say conviction—that the University work of London needed some fresh organisation. There was also, he believed, a preponderating public opinion that those needs should be supplied, not by the creation side by side of the existing University of another University in London, but by the organisation of that existing University. But when they got beyond this they came no doubt into the region of controversy. There was, however, a further proposition about which they might be quite agreed, and that was this. If there was some further University provision to be made in London, and if it was to be accomplished by the reorganisation of the University of London, it would be utterly impossible to frame any scheme or to produce any solution of the question which would satisfy everybody. There were two points on which there seemed to be some misapprehension. He referred first to the position taken by some that the existing charter gave to the graduates a right which would be infringed if any measure were passed dealing with the University or its reorganisation except with their sanction and consent. That view he held to be quite erroneous. It was quite true that in the existing charter a provision was to be found that no new charter could be applied for by the Senate if Convocation vetoed the proceedings. It was, however, to be observed that the right was given by the charter to Convocation and not to the graduates otherwise than by or through Convocation. The Senate remained the executive of the University, and it was from the Senate that the petition for a new charter must come. Thus it was merely a domestic provision regulating the rights of the Senate and Convocation as between themselves. But since the charter was granted a most important change had taken place. Parliament was not content that the Government of the day should have power to advise Her Majesty to grant a charter to a new University or a new charter to the old University, and consequently every new charter had to be placed upon the table of Parliament; and Parliament had a distinct right of intervention with reference to the grant or refusal of a new charter. It was, therefore, a false attitude to say that the members of that University were in a position to dictate to Parliament what change should take place when it had come to the conclusion that some change was necessary in the public interest. It was Parliament alone which could finally determine such a question.

SOCIETIES AND ACADEMIES.

London.

Royal Society, May 12.—"A Study of the Phyto-Plankton of the Atlantic." By George Murray, F.R.S., Keeper of Botany, British Museum, and V. H. Blackman, B.A., F.L.S., Hutchinson Student, St. John's College, Cambridge, and Assistant, Department of Botany, British Museum.

The authors record their observations on a year's work in collecting phyto-plankton along a track from the Channel to Panama carried out by Captains Milner and Rudge, and also during one voyage to Brazil by Captain Tindall. They also give the results of their own observations on living material at sea. The material was obtained by the pumping method.

One of the objects of their work was to determine, if possible, the nature of the Coccospheres and Rhabdospheres. They describe the minute structure of the calcareous plates or coccoliths and rhabdoliths, and record the existence in the Coccospheres of a single central green chromatophore, separating into two on the division of the cell. They regard Coccosphæraceæ as a group of Unicellular Algæ, and they define the group, the limits of the genera and species. The Coccospheres and Rhabdospheres from the surface are compared with those of the deep-sea deposits and their identity established. They are also compared with geological coccoliths and rhabdoliths from various beds, and many objects regarded by geologists as true coccoliths and rhabdoliths are rejected. A large number of new Peridiniaceæ were discovered and are formally described and figured. No specific diagnoses of marine Peridiniaceæ have previously been published, authors of species having depended on figures, and, at most, a few words of description. It is hoped that the present systematic treatment of the subject will conduce to greater order in the group. The authors record the occurrence of all the forms in seven tabular statements, one for each collecting voyage.

Observations of the diatoms and Cyanophyceæ are also made, and are briefly treated.

A study was also made of the species of Pyrocystis, of which they describe a new one. The facts they record tend, in their opinion, to confirm the view originally expressed of it by Dr. John Murray, its describer, that it is an unicellular alga, doubts having been entertained of the accuracy of this opinion by several biologists.

Zoological Society, May 3.—Prof. Howes, F.R.S., in the chair.—Sir Harry Johnston, K.C.B., made remarks on the larger mammals of Tunisia, and selected for special mention the lion, leopard, cheetah, wild cat, Caracal lynx, hyæna, jackal, Fennec and common foxes, genet, ichneumon, porcupine, Barbary wild sheep, Addax antelope, hartebeest, and three gazelles. He mentioned the possibility of the leucoryx penetrating into Southern Tunisia, and noted the importation into Tunis from Morocco of a baboon (*Cynocephalus hamadryas?*), which was brought there by natives of Morocco. He also commented on the representations of the African elephant as a Tunisian animal in the Roman mosaics.—A communication was read from Prof. Robert Collett containing descriptions of three species of pigeons and two species of parrots from Northern Australia, of which the following were characterised as new: *Petrophassa rufipennis*, *Ptilopus* (*Leucotreron*) *alligator*, and *Psephotus dissimilis*.—A communication was read from Mr. W. T. Blanford, F.R.S., stating his reasons for regarding *Lepus oiostolus* Hodgs. and *L. pallipes* Hodgs. as identical, suggesting that the hare identified with *L. oiostolus* by Büchner was *L. hypsileius* Blanford, and showing that *Macacus rhesus villosus* True was identical with *M. assamensis* McClelland.—A communication was read from Dr. F. A. Dixey, Mr. Malcolm Burr, and the Rev. O. Pickard Cambridge, F.R.S., on the insects and arachnida collected in Socotra by Mr. E. N. Bennett, who had visited that island in 1896 and 1897 in company with the late Mr. Theodore Bent. It was pointed out that though the Socotran lepidoptera showed, as might have been expected, strongly marked African affinities, some of them, by their relation to forms belonging to West Africa and South Africa and the Mascarene group, suggested the conclusion that remains of a more primitive fauna still survived in Socotra.—A communication was read from Miss E. M. Sharpe on a collection of lepidoptera from San Domingo. This was accompanied by field-notes by the collector, Dr. Cuthbert Christy. Ninety-one species were enumerated, of which one—*Telegonus christyi*—was described as new.—A second communication from Miss Sharpe contained a list of lepidoptera lately collected by Mrs. Lort Phillips in Somaliland. Two new species of *Lycænidæ* were described, viz. *Tarucus louisæ* and *Spindacis waggæ*.

Geological Society, May 4.—W. Whitaker, F.R.S., President, in the chair.—The carboniferous limestone of the country around Llandudno, by G. H. Morton. At Llandudno the precipitous Great Orme's Head presents fine sections of the carboniferous limestone and its subdivisions referred to, and may be easily examined in a continuous series of cliffs, ridges, and quarries. The entire succession is, however, not perfect, for the highest beds of the "Upper Grey Limestone" have been denuded, and at the Little Orme's Head the subdivision is altogether absent. Copper-lodes on the Great Orme's Head appear to have been worked by the Romans, and again in recent years until abandoned fully thirty years ago. Some of the lodes are faults, but little can be ascertained about them now, and only two or three are faults with any appreciable amount of dislocation. It is to the undulation of the limestone that the ever-varying dip of the beds is attributed. Numerous fossils occur in the "Upper Grey Limestone," and a few are peculiar to the subdivision and the locality, but of these only a single specimen of each has been found.—The dolomitisation of the carboniferous limestone is remarkable, and almost peculiar to that around Llandudno, though it also occurs at Penmon in Anglesey. The "Lower Brown Limestone" has been almost entirely converted into dolomite, and portions of the overlying subdivisions. The filling of the faults has often been changed into dolomite, and the alteration of the limestone has generally been very capricious: the author's opinion being that the change took place after the dislocation of the strata in post-Triassic times.—The graptolite-fauna of the Skiddaw Slates, by Miss G. L. Elles. This paper deals, not only with the collections of the author, but with the Dover Collection and others preserved in the Woodwardian Museum, with the collections of Prof. H. A. Nicholson, Mr. Postlethwaite, and that of the Keswick Museum of Natural History. An account of the literature, both stratigraphical and palæontological, of the Skiddaw Slates is given, followed by a list of all the graptolites known from the beds. This list comprises twenty-two genera and fifty-nine species.

Entomological Society, May 4.—Mr. G. H. Verrall, Vice-President, in the chair.—Colonel Yerbury exhibited a series of Diptera collected at Hyères during March and April 1898, and including *Brachypalpus valgus*, Panz., *Callicera fagesii*, Guér., and a species of *Platystoma* which appeared to be undescribed.—Mr. Barrett showed aberrant forms of British species of Lepidoptera from Gloucestershire and Warwickshire.—Mr. Waterhouse exhibited two burnished golden beetles, *Anoplognathus aureus* from Queensland, and *Plusiotis resplendens* from Panama, which he stated to be interesting examples of a similar result being attained by a process of natural selection in two species of the same family in widely separated localities. Many members of the family had a slight tendency to show metallic colours. It would be interesting to ascertain whether there were any similarity in their surroundings in the two countries which would make this golden appearance an advantage, or whether it might be considered a "warning colour." Allied species, however, appeared to be edible.—Mr. Walker exhibited specimens of the rare *Philonthus fuscus*, Grav., found in a *Cossus*-eaten poplar in Chatham Dockyard at the end of April.—Mr. R. McLachlan communicated a paper on "Neuroptera-Planipennia belonging to the families Osmylidæ, Hemerobiidæ and Chrysopidæ, taken by the Rev. A. E. Eaton in Algeria."

PARIS.

Academy of Sciences, May 9.—M. Wolf in the chair.—Method for detecting and estimating small amounts of carbon monoxide in air in presence of traces of hydrocarbons, by M. Armand Gautier. The method described in previous papers on the same subject at 60° C. (the action of carbon monoxide upon iodic anhydrides) is here further developed. It is shown that the iodine set free can be determined with great exactness by passing the gases over copper at 100° C.; the loss of weight of the iodic anhydride, and the amounts of carbon dioxide and water produced can also be accurately estimated. Test analyses of known gas-mixtures containing 1 part per 1000, and 1 part per 10,000 respectively, gave very satisfactory results: samples of Paris air taken at different times gave from 0·0 to 0·9 parts CO per million, while the air of the laboratory contained as much as 12·3 parts per million.—On the losses of ammonia which accompany the manufacture of farm manure, by M. P. P. Déherain. The results of the experiments are given in the form of three rules to be followed by the farmer, the chief point being that in presence of an excess of carbonic acid the losses of ammonia are much reduced.—Researches on the progressive development of the grape, by MM. Aimé Girard and Lindet. A series of proximate analyses of the pulp, skins and stones of the grape at various stages in its development.—The modifications undergone by strips of skin in autoplastic grafting, and the conditions which favour their growth in area, by M. Ollier.—On a mode of obtaining cultures and homogeneous emulsions of the human tuberculosis bacillus in a liquid medium, and on a mobile variety of this bacillus, by M. S. Arloing. Minute details are given of the methods of preparing homogeneous liquid cultures and emulsions of the tubercle bacillus. The immobility of this bacillus is not absolutely characteristic, as has hitherto been supposed.—Simple explanation of some celestial phenomena by the kathode rays, by M. H. Deslandres. A recognition of priority of M. Goldstein in his work on kathode rays, and a discussion of the application of this to the solar chromosphere and comets.—On the magnification of the discs of the sun and moon on the horizon, by M. D. Eginitis. The observations of the author show that none of the suggestions hitherto put forward to explain the increase in size of the sun and moon when low down in the horizon are sufficient. They may contribute to the phenomenon to a small extent, but the principal cause is still unknown.—On the explicit determination of differential equations of the second order at fixed critical points, by M. Paul Painlevé.—On the general theory of the characteristics of partial differential equations, by M. E. Goursat.—On total differential equations, by M. Alf. Guldberg.—On the evaporation of iron at the ordinary temperature, by M. H. Pellat. The effect previously shown to be produced upon a sensitised plate is shown to be due to a vapour given off by the iron, and not to any radiations of the nature of uranium rays.—On the kathode rays, by M. P. Villard.—Strengthening the X-rays, by M. Virgilio Machado. The tubular portion of the bulb is wrapped round with metal foil, or with an insulated spiral of copper wire.—The effect of diffusion in developing baths, by M. Adrien Guébhard.—On the limits of inflammability of carbon monoxide, by MM. H. Le Chatelier and Boudouard. Under ordinary conditions gas mixtures containing between 16 and 75 per cent. of carbonic oxide are inflammable. The effects of the size of tube, temperature, and pressure of gas were also studied.—On a boro-carbide of beryllium, by M. P. Lebeau. The substance $C_4B_6Be_6$ is produced by heating an intimate mixture of glucina and boron in a carbon boat at the temperature of the electric furnace.—On some halogen salts of lead, by M. V. Thomas. Treatment with nitrogen peroxide distinguishes between mixtures of lead chloride and iodide, and a true chloro-iodide, only the latter giving the corresponding oxychlorides.—Note on the micro-structure of the alloys of iron and nickel, by M. F. Osmond. The study of the micro-structure of these alloys confirms the classification into three groups based upon their mechanical properties.—Thermal data relating to ethyl-malonic acid. Comparison with its isomers glutaric and methyl-succinic acids, by M. G. Massol.—Formation of furfurol by cellulose and some of its derivatives, by M. Léo Vignon.—Preliminary note on the geographical distribution and evolution of the *Peripatæ*, by M. E. L. Bouvier. The specimens studied were collected in Africa by the late M. Thollon, in whose memory the one new species is named *Peripatus Tholloni*. This species is intermediate between the American forms and those of the Cape.—On the organisation of the *Pleurotomariæ*, by MM. E. L.

Bouvier and H. Fischer.—On the structure and evolution of the protoplasm of the Mucorinaceæ, by M. L. Matruchot.—On the resistance of seeds to immersion in water, by M. Henri Coupin. Seeds differ greatly in their resistance to water, some living about the same time whether the water be renewed or not, others dying much sooner in the latter case.—Contributions to the knowledge of volcanic rocks in the French Alps, by MM. W. Kilian and P. Termier.—On a quaternary tufa recognised at Montigny, near Vernon, by M. Gustave F. Dollfus.—On the land-slip of Saint-Pierre-de-Livron, and the infiltration of layers of tufa, by M. E. A. Martel.—Embryological notes on the migration of spinal ganglia, by M. A. Cannieu.—Contribution to the study of the albumenoid materials contained in cereal and leguminous flours, by M. E. Fleurent.—On the periods of treatment of black rot in the south-east of France.—A local magnetic pole in Europe, note by M. Mascart. M. Leïst, of Moscow, has discovered at Kotchétovka, a village in the province of Koursk, a local magnetic pole where the magnetic needle stands vertically. A distance of 20 metres from this spot suffices to change the angle of dip by 1°.—Earthquake of May 6, 1898, communicated by M. Lœwy.

St. Louis.

Academy of Science, April 18.—Mr. Carl Kinsley read a paper on series dynamo electric machines. He showed, by the results of tests of machines, that the relations between electromotive force, current, and speed can be represented by a surface. This is easily done, since for widely different currents, and for both dynamos and motors, the total induced electromotive force is strictly proportional to the speed when the current is constant. He stated that Frölich's empirical equation can be used to represent large portions of this surface, as suggested by Prof. F. E. Nipher. It was stated that the way in which a series motor will operate from a series generator can be predetermined; and, for cases reported, it was shown that computed results, throughout the complete range of working conditions, gave an average agreement with observed results to within 0·05 per cent. The method explained in the paper enables an engineer to design such a power transmission circuit accurately from shop tests of the machinery, and to operate the series motor at constant speed under all loads. It was shown that the resistance of the generator does not vary with the speed. This makes it possible to use a small series generator as a speed indicator, and so obtain instantaneous values of engine speeds from the voltmeter or ammeter readings, if the resistance of the outside circuit is kept constant. The practicability of this method of determining engine speeds was fully shown by the results reported in the paper.—Prof. J. H. Kinealy made some informal remarks on the ventilation of schools, and by means of a number of stereopticon views showed the different methods adopted for supplying the air required to the different rooms of school-houses.

DIARY OF SOCIETIES.

THURSDAY, May 19.

Royal Institution, at 3.—Heat: Lord Rayleigh.
Chemical Society, at 8.—The Action of Formaldehyde on Amines of the Naphthalene Series: G. T. Morgan.—On the Constitution of Oleic Acid and its Derivatives. Part I.: F. G. Edmed.

FRIDAY, May 20.

Royal United Service Institution, at 3.—Experiences with Röntgen Apparatus in Afghanistan: Surgeon-Major Beevor.

SATURDAY, May 21.

Royal Institution, at 3.—Biology of Spring: J. Arthur Thomson.
Geologists' Association (Paddington Station, G.W.R.), at 1.40.—Excursion to Penn and Coleshill. Director: W. P. D. Stebbing.
Essex Field Club (at Chingford), at 7.—On the Preparation of Marine Animals as Transparent Lantern Slides: Dr. H. C. Sorby, F.R.S.

MONDAY, May 23.

Society of Arts, at 8.—Electric Traction: Prof. Carus Wilson.
Royal Geographical Society, at 3.—Anniversary Meeting.

TUESDAY, May 24.

Society of Arts, at 8.—The Goldfields of British Columbia: W. Hamilton Merritt.
Linnean Society, at 3.—Anniversary Meeting.
Royal Victoria Hall, at 8.30.—Wood: Prof. H. Marshall Ward, F.R.S.

THURSDAY, May 26.

Royal Society, at 4.30.
Royal Institution, at 3.—Heat: Lord Rayleigh.
Institution of Electrical Engineers at 8.

FRIDAY, May 27.

Royal Institution, at 9.—Sir Stamford Raffles and the Malay States: Lieut.-General the Hon. Sir Andrew Clarke.
Physical Society, at 5.—A Simple Interference Method of Reducing Prismatic Spectra: Mr. Edser and Mr. Butler.—Some further Experiments on the Circulation of the Residual Gaseous Matter in Crookes' Tubes: Campbell Swinton.

SATURDAY, May 28.

Royal Institution, at 3.—The Biology of Spring: J. Arthur Thomson.
Geologists' Association (Liverpool Street Station, G.E.R.), at 11 45.—Long Excursion to Aldeburgh and Westleton. Directors: W. Whitaker, F.R.S., F. W. Harmer, and E. P. Ridley.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Praktikum der Wissenschaftlichen Photographie: Dr. C. Kaiserling (Berlin, Schmidt).—Industrial Electricity: translated and adapted from the French of H. de Graffigny, and edited by A. G. Elliott (Whittaker).—Alternating Currents of Electricity: A. Still (Whittaker).—The Angora Goat: S. C. Cronwright Schreiner (Longmans).—Scientific Method in Biology: Dr. E. Blackwell (E. Stock).—Report of Investigations on the Life History of Salmon (Glasgow).—Supplement to the Bibliography of Algeria from the Earliest Times to 1895: Sir R. L. Playfair (Murray).—The Blood: how to examine and diagnose its Diseases: Dr. A. C. Coles (Churchill).—Applied Bacteriology: T. H. Pearmain and C. G Moor, 2nd edition (Baillière).—Elementary Conics: Dr. W. H. Besant (Bell).—Examples in Analytical Conics for Beginners: W. M. Baker (Bell).—Five Years in Siam: H. Warington Smyth, 2 Vols. (Murray).—De Danske Barkbiller: E. A. Lovendal (Kjobenhavn, Det Schubotheske Forlag).

Pamphlets.—West Florida and its Relation to the Historical Cartography of the United States (Baltimore).—Die Jungfraubahn Elektrischer Betrieb und Bau: C. Wüst-Kunz and L. Thormann (Zürich, Fussli).—Second Annual Report of the New York Zoological Society (New York).—London County Council: Report of the Technical Education Board for the Year 1897–98 (King). Light and Fire Making; H. C. Mercer (Philadelphia, MacCalla).—Metric Equivalents of Imperial Weights and Measures and Thermometric Equivalents (*Pharmaceutical Journal* Office).—The Adulteration of Dairy Produce: R. H. Wallace (Edinburgh, Anderson).—Krömscōp Colour Photography: F. Ives (Photochromoscope Syndicate).

Serials.—Engineering Magazine, May (222 Strand).—Journal of the Franklin Institute, May (Philadelphia).—American Journal of Science, May (New Haven).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1897, No. 3 (Moscou).—Notes from the Leyden Museum, January (Leiden, Brill). Psychological Review, May (Macmillan).—Papers and Proceedings of the Royal Society of Tasmania for 1897 (Hobart).

CONTENTS.

THURSDAY, MAY 26, 1898.

MODERN PHYSIOLOGY FROM THE CHEMICAL STANDPOINT.

Text-book of Physiology. Edited by E. A. Schäfer, LL.D., F.R.S. Vol. i. (Edinburgh and London: Young J. Pentland, 1898.)

UNDOUBTEDLY, as the editor remarks in his preface to the above work, there has been a great desire on the part of teachers of physiology in this country to obtain a complete text-book on their subject, written in English, somewhat similar to the classical Handbuch of Hermann. Prof. Schäfer, with the aid of some of the best-known physiologists in Britain at the present day, has succeeded in bringing out a work which, if one may judge from the first volume, is destined to supply more or less completely the want that has been so long felt. It is a text-book essentially intended for advanced students; and although all the parts are not treated with like fulness, still the fact remains undoubted that at present no text-book in English is so complete as this one. The first volume deals practically entirely with the subject from the chemical standpoint. The first two chapters, by Halliburton, on the chemical constituents of the body and food, and on the chemistry of the tissues and organs respectively, are praiseworthy in so far as they give a fairly full account of the subjects with which they deal. But, seeing that these chapters must contain from their very nature many of the points to be discussed afterwards under special chapters, it would have been better, perhaps, had they been slightly shorter and more interestingly written. Then, again, a number of errors have crept in that ought not to have appeared. For example, the statement that the sugars are designated according to the number of carbon atoms they contain is hardly correct, as one may see by taking one of the examples given in the book. Rhamnose, although it contains six carbon atoms, is not a hexose but a pentose, viz. a methyl-pentose $CH_3(CHOH)_4COH$. They are designated not by the number of carbon atoms they contain, but by the number of oxygen atoms they possess. Here and there careless methods of expression are used, especially in the case of the sugars. Levulose is a ketone of sorbite as well as mannite. The note at the foot of p. 6 is slightly vague in meaning. Of course, as the writer says, the letters *d*, *l*, *i* do not refer to the rotatory power of the sugars, but to their genetic relationship to a fixed aldo-hexose. The letters only agree with the rotatory power in the case of the natural aldo-hexoses. Small points here and there are vaguely expressed. There is absolutely no doubt that vitellin is not a globulin, but a nucleo-albumin. The statement that Kossel has described four nucleic acids corresponding to four separate nuclein bases is hardly correct. He merely surmised that there might be a nucleic acid furnishing on decomposition a single definite alloxur base, and he based this supposition upon his investigation of the nucleic acid obtained from the nuclein of the thymus gland, which he at first termed adenylic acid because he imagined that adenin only was obtained from its decomposition. This, of course, has been shown by Kossel himself to be incorrect. Up to the present no such nucleic acids have been prepared. Again, it is more than doubtful whether any genetic relationship exists between hæmatogen and hæmoglobin, as Bunge thought. The way in which the iron is bound in the former is absolutely different from that in the case of the latter. Again, there are points of the greatest interest that might have been put in a more interesting fashion; for example, the extremely important relationship between chitin and chondrin. The classification of the proteids which is given is not a particularly good one. There are too many repetitions, and the divisions into which the author has classed the different members are so scattered that it is difficult to grasp the subject at all well. There are many other points that would have been the better for a little fuller description, *e.g.* carnic acid (Siegfried) and the paired acids of glycuronic acid.

These articles have entailed undoubtedly a great deal of labour, and contain much that is interesting and difficult elsewhere to obtain, but they are hardly intended for students.

The part dealing with hæmoglobin and the principal products of its decomposition, by Gamgee, is exceedingly well written. It suffers, however, from its more or less one-sided character. Some of the more recent work—as, for example, the acids obtained from hæmatin—by Küster has been wholly disregarded. Through it all, however, the reader can easily perceive that it is a subject with which the writer is familiar.

The section on the blood, by Schäfer, is very well written.

The effect of acids on the reaction of the blood of herbivora might have been more clearly explained.

The proteids of the tissues in herbivora do not break down to furnish ammonia to neutralise the acid introduced, and hence the alkali of the blood is taken up with the result that mineral acids act as poisons in such a case.

The equation given on p. 157, showing the action of disodic phosphate in the transmission of CO_2 in the blood, is incorrect. It ought to be

$$Na_2HPO_4 + H_2CO_3 = NaH_2PO_4 + NaHCO_3.$$

Some reference might have been made to the important work done before Hürthle on the cholesterin esters in the blood; and it would also have been better if Nasse's work contradicting that done by Lépine on the absence of the glycolytic action of the blood in diabetes had been mentioned, as it is so important.

The recent work of Hammarsten on the coagulation of the blood might have been more fully referred to, as it was so carefully done, and the results obtained were so important. Many of the important points in Hammarsten's paper are referred to, but the source is not always acknowledged.

Diffusion, osmosis and filtration are treated of by Waymouth Reid in a very interesting chapter. This subject has been so much worked at in Germany within recent years, that the author would have no difficulty in gathering together and weaving into an interesting whole a number of facts scattered through the *Zeitschrift für physikalische Chemie* and Pfeffer's new text-book.

The chapter on the production and absorption of lymph, by Starling, is short but good, and gives a succinct account of our present-day knowledge of this very interesting subject.

The next chapter, by Moore, on the chemistry of the digestive processes, must have entailed a large amount of labour, as the literature is overwhelming. It might have benefited by curtailment, and by the omission of such words as "flocky," "unsolvable," and some others. The mass of unproved details with which Kühne deluged physiology has been largely made use of. Those who wish to be able to criticise this work of Kühne might with advantage look up the original papers by Kühne and Chittenden and Neumeister. They will then perceive that a number of bodies there referred to depend for their separate and definite existence upon very insufficient data. The physiological chemist of a later date will smile when he reads of anti-albumid, anti-albumate, anti-albumose, and so on. A lot of details given in this paper might have been, perhaps, with advantage omitted, as after all they are only of use to those working at the subject, and later on will be merely of historical interest. Paijkull's work on the mucin of bile requires to be repeated. It is by no means certain that the mucin is a nucleo-proteid. This chapter, however, gives as good an account of the subject as any one could desire. It has been kept well up to date, including as it does such recent work as that of Nuttall and Thierfelder.

The chapter, by Langley, on the salivary glands is an excellent one, distinguished alike by its clearness and suggestiveness as well as its succinctness.

The mechanism of the secretion of gastric, pancreatic, and intestinal juices is discussed in an interesting way by Edkins, as is also the section on the secretion of bile, by Noël Paton.

The important chapter on the chemistry of the urine has been entrusted to Hopkins, who has succeeded, in the space at his disposal, in giving a most excellent account of the subject. Here, of course, an author must exercise the gift of selection, as, in order to be complete, one would require to give another Huppert and Thomas' Handbuch. It ought to have been noted that the Krüger and Wulff method for estimation of the nuclein bases and uric acid is not a trustworthy one, as other nitrogen-holding bodies are precipitated. The inorganic constituents of the urine have received but scant attention.

The chapters on the secretion of urine and on that of milk, by Starling and Schäfer respectively, are clearly written; as is also that on the secretion and absorption of the skin, by Waymouth Reid.

The chapter on the chemistry of respiration, by Pembrey, is a good one; as are also those on animal heat, by the same author, and on metabolism, by Schäfer.

It is a pity that in such a book as this there is not only a necessary repetition, but also a tendency to omission of certain facts because they fall under two headings. An example of this may be given. The relationship between leucocytosis and the excretion of uric acid and nuclein bases is referred to in the section dealing with the chemistry of the urine, and also in that on metabolism. The result has been that in neither is there a proper description of Horbaczewski's experiments, nor are the conclusions which Horbaczewski arrived at clearly defined.

The work of Sandmeyer, on the effect of giving pancreas by the stomach to dogs that have had their pancreas removed, has not been referred to. This volume closes with an exceedingly interesting account of the internal secretions of the ductless glands and their effects upon metabolism. As one would expect from the writer of this article, the supra-renal extracts have received a good deal of attention, a little of which might have been bestowed on the thyroid therapy.

The points which have been drawn attention to in this review as perhaps admitting of improvement are few in number. The book stands as a monument of industry care and thought on the part of the editor and his coadjutors. It is, without doubt, the best book that we at present possess in English on the subjects dealt with in the first volume of what will prove to be a text-book of the greatest advantage to all interested in the subject of physiology. Before the value of such a book can be accurately appraised, it must be read carefully and intelligently, and compared with the original papers from which all such books must be built up. Those working at a special department of the subject may think that there might have been some additions or omissions; but one must remember that the subject is such a huge one, and the mass of literature to be consulted so immense, that after all such a complete text-book for the scientific worker must always remain mainly as a stepping-stone between the ordinary smaller text-book and the original papers. It is the conscientious perusal of the latter that must always remain, if the slowest, still the surest way to gain a knowledge of that most fascinating subject, physiology. T. H. MILROY.

VEGETABLE ORGANOGRAPHY.

Organographie der Pflanzen. By Dr. K. Goebel. Part i. With 130 figures in the text. Pp. ix + 232. (Jena: Gustav Fischer, 1898.)

IT is difficult to realise that this book is the work of the same author who wrote the now classical text-book of morphology. Later publications of Dr. Goebel's have been largely occupied with biological subjects, and he appears in the book before us to have abandoned the morphologist's standpoint, and assumed a physiological or, perhaps more correctly, a biological position. In making this change he admits that phyllogenetic speculations are, without doubt, more attractive than the investigation of the illusive causes, external or internal, which determine modifications of form; yet for him the recognition of the factors which bring about the unsymmetrical form of a leaf is of more importance than the construction of insubstantial theories of phyllogenetic development.

In the introduction the author further insists on the insufficiency of morphology, and quotes from Herbert Spencer to emphasise the fact that function and form are mutually interdependent. In the strict study of morphology the functions have been treated as something extraneous, and as having nothing at all to do with the characteristics of the organs.

The latter part of the introduction is devoted to a discussion of the two rival hypotheses as to the formation of the organs of plants, *e.g.* the theory of the differentiation of indifferent rudiments and that of the metamorphosis of rudiments materially differing from one another. Dr. Goebel shows a strong bias in favour of the latter. Thus he says a foliage leaf is not a foliage leaf in the later stages of its development only, but the material constitution of its rudiment determines its development. Internal or external influences may, however, direct this development along other lines. To illustrate this point of view he describes the metamorphosis of the rudiment of a foliage leaf of a maple into a scale-leaf. But it must be confessed that although his arguments and illustrations are interesting, he fails to convince the reader that there are less difficulties in the way of the theory of metamorphosis, involving as it does some form of evolution in ontogeny, than are presented to the theory of differentiation, which in this case appears to be based on epigenesis. The indisputably indifferent nature of the cells forming the archesporial tissues and those in other positions in leaves, which are able to give rise to adventitious buds, are arguments in favour of the indifferent nature of all the leaf-cells, even in comparatively late stages of development. That no absolute material difference exists between the rudiments of different categories of organs is rendered probable by the absence of any definite demarcation between stem and leaf, as is shown by the example of Utricularia, which Dr. Goebel himself has investigated. Indeed in this direction Dr. Goebel goes further than the majority in maintaining that the vegetative body of Lemna is composed of branching leaves, and is not a leafless stem.

The purely morphological view, without regard to the functions of the organs considered, may often lead to misconception, and Dr. Goebel takes hairs as an example of this possibility. Thus according to him no sensible man would call a fern sporangium a "trichome"; for one cannot believe that either in the life-history of the individual, or of the race, that a sporangium arose by the metamorphosis of a hair. And yet the belief, which Dr. Goebel himself seems to share, that a stamen is a metamorphosed foliage leaf appears to rest on similar grounds, especially when viewed in the light of Bower's researches on spore-producing members.

Of great interest are those sections of the book dealing with the symmetry of organs and with the effect of light on dorsi-ventrality. The author finds that *Selaginella sanguinolenta* possesses leaves of two kinds, and is dorsiventral when subject to bright illumination; while if it is exposed to feeble light, it possesses leaves of one kind only and is radially symmetrical. The arrangement which is induced by the situation of the individual of this species, occurs normally on different parts of the same individual of other species. In these the individual is radially symmetrical in the lower portions of the stem, while the upper parts are anisophyllous. Furthermore, Dr. Goebel has been able to cause *S. helvetica*, which is normally anisophyllous, to considerably lessen the contrast between the two kinds of leaves by simple etiolation. Thus it appears that in some the adaptation is ontogenetic in its nature, and is brought about by the actual circumstances of the individual; in others it is inherited, and not materially affected by the immediate surroundings, although probably brought about by the relations of a succession of individuals to light.

In the succeeding section, on the difference between the structures of organs in the adult and early stages of development, there is much of interest. *Polysiphonia Benderi*, one of the most remarkable examples of this difference, has been already described by Dr. Goebel. In this alga the first stage resembles the adult in possessing a cylindrical thallus. This gives rise to one or more flat structures, which apply themselves to the surface of other algæ, and which are wholly different from both the first and final stages in appearance. Only before the formation of the reproductive organs are the adult cylindrical branches developed.

Passing on to the development of the higher plants, perhaps every one will not agree with the author in his view that the simpler form of the primary leaves of seedlings is due to an arrest of development. The existence of a more complicated form in some primary leaves than in those of the adult stages, must make one hesitate before accepting the theory of arrested development in every case, and may suggest that a similar reason for the difference between the leaves of the seedling and those of the adult exists both when the former are more simple and when they are more complex than those of the latter.

The section on vegetable teratology may be noted, as in it Dr. Goebel gives his support to Beyrinck's extension of Sachs' hypothesis, that the difference in form of plant organs is due to a difference of substance, and that changes in form are referable to alterations in the nutrition of the parts involved. Beyrinck's view is that galls are caused by such an alteration in the nutrition of the part in response to the stimulation by the gall-producing animal.

The last part of the book is devoted to a discussion of the influence of correlation and external stimuli on the form of plants. It is not behind the earlier parts in interest and wealth of example. Among the more important matters touched upon in this part are Lindemuth's experiments on the production of seeds in bulbous plants, Sachs' investigations on the relation of flower-production to light, and Lothelier's observations on the conversion of the spinous leaves of Ulex into flattened forms, in a moist atmosphere. Dr. Goebel doubts that this modification of spines due to moisture is of frequent occurrence, and believes that Lothelier observed isolated examples.

With confidence Dr. Goebel's book may be recommended to all who are interested in theoretical botany. It is full of suggestion and novelty, and its occasionally dogmatic style in no way lessens its tendency to arouse interest and discussion.

H. H. D.

A GREAT NORTH ROAD.

A Northern Highway of the Tzar. By Aubyn Trevor-Battye. Pp. xiv + 256. (London: Archibald Constable and Co., 1898.)

MR. TREVOR-BATTYE gives in this book a very interesting account of his journey home from Kolguev, an island in the Arctic Ocean, on which he was for some time ice-bound.

The journey was undertaken in October, a time known in Northern Russia as the Rasputnya season. Mr. Trevor-Battye describes the season as follows :—

"Rasputnya, as I have been since informed, means, literally, 'the separation of the roads,' but by some process of thought has now come to be the term for a fifth season, for the time which lies between autumn and winter; in short, for the month of October. It means in Northern Russia that the first frosts have thawed and the first snows melted; that the rivers are blocked with streams of broken ice, the morasses like a quagmire, the tracks, where any advance has been attempted upon old forest bog, a mixture of treacle and glue. Finally, it means, as I have said before, that no one dreams of trying to move until the country is sound and hard under the settled frost. During the whole of October the Government postal service is stopped, labour contracts are off, and the keepers of the stages are entirely freed from their usual obligation to supply the traveller with horses and sleighs."

Undertaking a journey at such a time seemed an act of madness, but it certainly was the means of getting an insight into the character of the North Russian peasant, and of seeing a side of it which might not have been revealed under ordinary circumstances. Their kindly good nature is striking, and throughout the journey, although at first objections were raised and the impossibility of accomplishing the various stages of the journey put forward, still some one was always found willing to supply horses and sleighs, and to accompany the travellers.

After crossing from Kolguev to the mainland, Mr. Trevor-Battye, together with his camp-man Thomas Hyland, and his old spaniel "Sailor," made their way across country to the small village of Askino, on the river Pechora. They were assisted in getting there by the Samoyeds, inhabitants of the *tundra* in the west. Askino is practically the only place where the Russians speak Samoyed, and where there is any apparent intercourse between the two races. At their next destination, Ust Tsilma, also on the Pechora, and which they reached by boat, the condition was quite changed; for on inquiry not one person could be found who spoke Samoyed, although the two places were only about 180 miles apart.

From Ust Tsilma the journey was continued overland, from *stantsyia* to *stantsyia*, which are log buildings put up by the Government at variable distances apart, and in charge of a *yamshstchik* (driver), who is bound to supply horses and conveyances to any travellers on production of a printed permission. The difficulties of getting conveyances, owing to Rasputnya, and the descriptions of the numerous adventures, especially those connected with crossing the ice-blocked rivers, are of great interest. Archangel was eventually reached, and the travellers considered their difficulties over. The sleigh drive to Vologda, a distance of about 700 miles, was accomplished without any difficulty, as the track was good. Having reached Vologda, the journey home was continued by rail.

The book gives us a good insight into the peasant life. The houses, or rather huts, occupied by the peasants are simple in the extreme, and consist generally of two rooms. In a prominent position in the front room there is always an *ikon*, before which lamps or candles are lighted. Attention is also drawn to the oven or *paitch*, which forms such a feature in these small buildings; and we are told that a characteristic proceeding of a *yamshstchik* on entering a house, "is to cross himself many times before the *ikon*, and the next to climb up to the oven top, from which simmering pulpit he holds forth on the events of the day."

Except for some references to birds and fishes, natural science does not form the same feature in the present book that it did in Mr. Trevor-Battye's previous one, "Ice-bound on Kolguev." This, however, is to be expected, for the journey had to be made with all possible speed. The book is written in a very instructive and pleasing style, and the map and illustrations by the author add much interest to it.

OUR BOOK SHELF.

Vorlesungen über Bacterien. Von Dr. Alfred Fischer, A.O. Professor der Botanik in Leipzig. Pp. 186. (Jena: Gustav Fischer, 1897.)

It is sometimes alleged that bacteriology has suffered, as a pure science, from its association with medicine, since its pathological side has become disproportionately developed. This statement is certainly no longer justified, for the applications of the science to agricultural and manufacturing industries have been found almost as important to the farmer, the dairyman, and the chemist as they have been to the pathologist. Prof. Fischer's book is one which fills a distinct gap in bacteriological literature. Himself a botanist, he treats the subject from a broad and general standpoint. Without neglecting the pathogenic organisms he deals with them only, as it were, incidentally, and the book presents an admirable and judicial summary of the present state of knowledge of bacteriology in its widest and truest sense. It forms a valuable introduction to the subject from whatever point of view it is to be studied, since it affords a solid groundwork upon which more technical and special knowledge may afterwards be built.

The earlier chapters deal with morphology and with the intimate structure of bacteria—matters upon which Prof. Fischer's well-known researches on "plasmolysis" render him well qualified to speak. In the chapters on specificity and classification he shows himself no advocate of the extreme views on pleomorphism which have been advanced by some. In his remarks on classification he insists, with much justice, that strictly morphological characters must form the basis of generic distinctions, and that this matter lies within the province of the botanist alone. The classification which he proposes is a reasonable one, based largely on the character and distribution of the cilia, and the nature of the spores. The mode of life, and physiological properties of bacteria are next described, the chemistry of aërobiosis and anaërobiosis being fully dealt with; and two chapters are then devoted to the influence of physical and chemical agents, especially in relation to the problems of disinfection. The most fascinating part of the book will, however, be found in the sections devoted to the circulation of nitrogen and of carbonic acid in nature. The assimilation of free nitrogen by bacteria in the soil and in the nodules of Leguminosæ, and the decomposition and nitrification of proteids are set forth by the author with admirable clearness, and the same may be said of the various processes of fermentation with which he also deals. The last three chapters are devoted to pathogenic bacteria, and contain a short account of some of the more important species and their mode of action, with a sketch on serum-therapeutics and immunity. The writer is throughout thoroughly impartial and judicial, and shows a healthy scepticism as regards theories unsupported by adequate fact. There can be no doubt that a translation into English of this admirable book would be of great assistance to all those students of bacteriology who are unable to read it in the original.

Lehrbuch der Entwicklungsgeschichte des Menschen. Von Dr. J. Kollmann, o.ö. Professor der Anatomie in Basel. Pp. xii + 658. (Jena: Gustav Fischer, 1898.)

THIS work appears to approach in method the ideal of an elementary text-book of science, since it gives a sound and well-balanced *résumé* of its subject to date, with references to authorities sufficient to place the student in direct touch with original description of detail. The pages of the book never pall, and in treatment and mode of expression it is one of the least "German" of German text-books with which we are familiar. It is illustrated by 386 excellent processed drawings, many of which are coloured, and where original these are very good and such as are likely to become popular. The investigations of His, of course, come in for a full share of recognition, and good use has been made of those of Keibel, Mall, Röse, Toldt, and others among recent workers. The book is divided into five leading sections. An introduction of sixteen pages is followed by portions dealing with the earlier stages of development ("Progenie" and "Blastogenie"), treated as far as is necessary comparatively. The fœtal membranes and progressive development of the human fœtus next come in for consideration; but the bulk of the work (405 pages) is of necessity devoted to a description of the development of systems and organs, and there is appended a twenty-page dissertation on heredity. Not the least pleasing feature of the book is its consummately artistic plan. Illustrations never obtrude themselves upon the margin nor overpower the text. In the placing of the figures, choice of their colour and descriptive letterpress, there are evidences of the bestowal of great care and forethought and of painstaking consideration of detail, which are alone a strong recommendation of the work. It is carefully written and non-pedantic, and should be deservedly popular.

Missouri Botanical Garden. Ninth Annual Report. Pp. 160. (St. Louis, Missouri: published by the Board of Trustees, 1898.)

ADMINISTRATIVE details occupy but a small part of this report, the chief contents being a collection of scientific papers and notes on interesting plants, illustrated by several half-tone plates. The results of the studies of the American Lemnaceæ occurring north of Mexico, by various botanists, are brought together by Mr. C. H. Thompson, and are combined with his own researches into a revision of the order. Mr. H. C. Irish contributes to the report a revision of the genus Capsicum, with especial reference to garden varieties. Mr. J. N. Rose describes five species of agaves which flowered in the Washington Botanic Garden in 1897, and were identified by him. One of these (*A. Washingtonensis*) appears to have been hitherto undescribed. Among the notes, Mr. William Trelease, the Director of the Gardens, records some interesting observations on Yuccas. He points out that *Yucca gigantea* is distinct from *Y. gloriosa* and *Y. Guatemalensis*—its nearest allies—and gives a figure of an Azorean specimen which is a good example of the species. With reference to the extent of the pollination of Yuccas by the Yucca moth, Mr. Trelease has now obtained information which proves the moth to be "the active agent in the pollination of Yuccas from Florida northward as far as fruit is set as a result of *Pronuba* activity, westward as far as southern California, and into the mountains of northern Mexico to the south."

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.*]

Liquefaction of Hydrogen.

YOUR last issue contains a report of Prof. Dewar's remarkable achievement in the liquefaction of hydrogen and helium. In his account of it, which you quote, Prof. Dewar describes the apparatus employed as an enlarged plant of the same type as that used in his hydrogen-jet experiments discussed in his paper before the Chemical Society of December 19, 1895 (see *Proceedings*, No. 158), and in his lecture at the Royal Institution (see *Proceedings*, 1896), and illustrated in a figure printed with this lecture. An examination of that illustrative figure and of the description shows that the type of apparatus used involves an entirely new departure as compared with the methods of all who had liquefied air before 1895, including Prof. Dewar himself. The new self-intensive method then and now employed is a combination of the following four points: *a long tube conveying compressed gas, expansion of the compressed gas through a nozzle or throttle-valve, direct return of all the expanded gas over the tube of compressed gas, good interchange of temperatures between the compressed and expanded gas.* The new method embodying the above combination will be found fully described and illustrated in my patent, No. 10,165, 1895 (May 23). What is equally important historically: in November 1894, more than twelve months before Prof. Dewar first showed this new method in action, liquefying air, I had called, with an introduction, on his chief assistant, Mr. R. N. Lennox, at the Royal Institution, had there explained to him this self-intensive method, and had proposed it as a means of obtaining intensely low temperatures. By employing this method I was afterwards the first in this country to liquefy air and oxygen without employing other refrigerants. Since then, at the Royal Institution, where alone sufficient means are available for the prosecution of these researches, the same method has bridged over the space, impassable by former methods, between the temperature of liquid air and that of liquid hydrogen and helium, thus proving itself a new and valuable scientific instrument.

Under these circumstances I think that Prof. Dewar, seeing he was aware of the facts at the time of his account, ought not to have been content with eulogising the services of his assistant Mr. Lennox, but should also have given me credit for the invention of the method which has procured him so great a success. Although he has been easily able to find in old patents the separate elements which go to make up the new method—this can be done for any new invention—he has nowhere found, before the date of my communication to Mr. Lennox, that combination of the four points given above which is absolutely necessary to his apparatus for liquefying hydrogen.

The facts referred to above are stated and discussed in greater detail in a paper, to be printed shortly, which was read by me before the Society of Chemical Industry at Burlington House on the 2nd inst., with illustrative diagrams, and in letters by me to *Engineering* for April 15 and May 6. W. HAMPSON.

Concerning the Thermodynamic Correction for an Air-Thermometer.

IT is common in works on thermodynamics to give a formula for the thermodynamic correction applicable to an air-thermometer; the following is substantially the usual proof.

Accepting the current theory of the Joule-Thomson experiments, we may show that

$$t\frac{dv}{dt} - v = k\frac{\delta t}{\delta p},$$

where k is the specific heat at constant pressure measured dynamically. From this we obtain

$$t\frac{dv}{dt} = v + k\frac{\delta t}{\delta p}$$

and

$$t = \left(v + k\frac{\delta t}{\delta p}\right) \div \frac{dv}{dt}.$$

Thus t is seen to consist of two terms; the second term

$k\frac{\delta t}{\delta p} \div \frac{dv}{dt}$ is the smaller of the two, and we proceed to find its value. We have as a first approximation to the behaviour of gases,

$$pv = C(1 + \alpha T),$$

where T is the temperature centigrade on a gas-thermometer.

We therefore have, as approximate equations,

$$v = \frac{C}{p}\left(1 + \alpha T\right),$$

$$\frac{dv}{dT} = \frac{C\alpha}{p}.$$

We may further assume that $\frac{dv}{dt} = \frac{dv}{dT}$, since the degrees are practically equal on the two scales.

We therefore obtain, approximately,

$$v = \frac{C}{p}\left(1 + \alpha T\right),$$

$$\frac{dv}{dt} = \frac{C\alpha}{p}.$$

Using these approximate values, we have

$$k\frac{\delta t}{\delta p} \div \frac{dv}{dt} = \frac{kp}{C\alpha}\frac{\delta t}{\delta p}$$

$$= \frac{k}{C\alpha}\frac{\delta t}{\delta \log p},$$

and the equation for t becomes

$$t = v \div \frac{dv}{dt} + \frac{k}{C\alpha}\frac{\delta t}{\delta \log p}.$$

If now, further, we use the approximate values of v and $\frac{dv}{dt}$ in the term $v \div \frac{dv}{dt}$, we shall obtain

$$t = \frac{1}{\alpha} + T + \frac{k}{C\alpha}\frac{\delta t}{\delta \log p}.$$

This is the formula usually given.

This method of working appears to me to be incorrect, for the following reason:—

In the equation

$$t = \left(v + k\frac{\delta t}{\delta p}\right) \div \frac{dv}{dt}$$

there are two terms on the right-hand side, one of which, $k\frac{\delta t}{\delta p} \div \frac{dv}{dt}$, is small compared with the other. We may therefore neglect it as a first approximation, and we then obtain $\frac{v}{t}$ = function of p, in accordance with the laws of a perfect gas. If we wish to proceed to a closer approximation, we may use the perfect-gas laws as sufficiently good in the term $k\frac{\delta t}{\delta p} \div \frac{dv}{dt}$, because that is a small term, and the departure of the actual gas from the perfect gaseous laws will consequently in this term introduce only errors which depend on the squares of small quantities. But we are not at liberty to use the perfect gas laws in the remaining term $v \div \frac{dv}{dt}$, because it is *not* a small quantity, and we have therefore no guarantee that the use of such an approximation will not introduce errors of the first order of small quantities—that is to say, comparable with the term $k\frac{\delta t}{\delta p} \div \frac{dv}{dt}$ itself. With such errors introduced, the second approximation would not necessarily be better than the first.

The mistake in principle, which I have indicated, appears to be widespread, since it has crept into several of our well-known text-books. Thus the discussions given in Tait's "Heat" (pp. 338–339), in Baynes' "Thermodynamics" (pp. 126–127), and in Maxwell's "Heat" (pp. 211–214), all appear to me infected by this source of error. It is true that in these discussions the mistake is introduced more subtly, and is covered with a mass of symbols; whereas in the faulty investigation given above, I have purposely made the paralogism as glaring as possible. But *in substance* the mistake occurs in each of the discussions above named. JOHN ROSE-INNES.

May 13.

Printer's Ink and Photographic Plates.

IN a paper on the action exerted by certain metals and other substances on a photographic plate, by Dr. W. J. Russell (*Proc. R.S.*, vol. lxi. p. 424), the author mentions that the *Westminster Gazette* is printed with an ink which readily acts on a photographic plate. The printed paper in some experiments is placed in contact with the photographic plate, in the dark, and after being left in contact for some time, in the dark, the plate is developed, and the printed letters come out clearly. Dr. Russell mentions the names of several periodicals the print of which acts on a sensitive plate. To these the following example of the same phenomenon may be added: a photographic plate wrapped up in an advertisement sheet of *Modern Society* on development showed the printed characters very clearly, the words reading from left to right, not being reversed, so that the action must have taken place through the thickness of the paper. This sample of the action of printer's ink on a photographic plate (the property of Mr. W. B. Croft) has been in the excellent physical laboratory museum at Winchester since 1892. The print is good and clear, and probably one of the earliest observed instances of the action of printer's ink on a photographic plate in the dark, in which the physical conditions were known and recorded. F. J. JERVIS-SMITH.

Oxford, May 16.

Heavy Rainfalls.

I THINK it worthy of record that at a place called Nedunkeni, in the Northern Province of Ceylon, the rainfall on December 15–16, 1897 (24 hours), was 31·76 inches. The average annual rainfall of this place was 64·70, but in 1897 the amount totalled 121·85 inches.

The heaviest recorded rainfalls (as given in the "Encyclop. Britt.") are at Joyeuse, France, 31·17 inches in 22 hours; at Genoa, 30·00 inches in 26 hours; at Gibraltar, 33·00 inches in 26 hours; on the hills above Bombay, 24 inches in one night; and on the Khasia Hills, India, 30·00 inches on each of five successive days.

The rainfall in Ceylon, referred to above, is therefore notable. The greatest annual rainfall occurs, as is well known, on the Khasia Hills, with 600 inches. The wettest station in Ceylon is Padupola, in the Central Province, with 230·85 inches (mean of 26 years), the rainfall for last year being 243·07 inches. C. DRIEBERG.

School of Agriculture, Colombo, Ceylon.

Hermaphroditism in the Apodidæ.

I AM not sure but that the tone of Prof. Lankester's demand, in NATURE of May 12, that I should "at once" withdraw my "assertions," or confirm them by "some evidence," would not have justified my ignoring it altogether. For those of your readers, however, who may be interested in this subject, may I say that I *have* produced "some evidence" (*Ann. and Mag. Nat. History*, xvii., 1896, plates xi. and xii.), and no counter evidence whatever has yet been forthcoming to shake my faith in the justness of my conclusions. HENRY BERNARD.

Streatham, May 17.

MAGNETISM AND SUN-SPOTS.

WHEN Sir Edward Sabine was preparing his paper[1] "On Periodical Laws discoverable in the mean effects of the larger Magnetic Disturbances—No. ii.," in which he discussed the magnetic observations made at the temporarily established Colonial observatories at Toronto and Hobarton, he found that there existed at these places, in the years 1843 to 1848, a progressive increase in amount both of magnetic disturbance and in extent of diurnal range of the declination magnet, the values of diurnal range for the year 1843 having become in 1848 increased by some 40 per cent., the Toronto values for these years being 8'·90 and 12'·11 respectively, and the Hobarton values 7'·66 and 10'·63. This was an altogether unlooked-for result, one that engaged his special attention, such increase of value from year to year

[1] Read before the Royal Society, May 6, 1852.

in two quarters of the globe so widely separated as Toronto and Hobarton presumably indicating not simply a local effect, but one rather of cosmical character. He pointed out that as the sun must be recognised as at least the primary cause of all magnetic variations that conform to a law of local hours, as does the solar diurnal range, it seems not unreasonable to suppose that in the case of other magnetic variations we should look, in the first instance, to any periodical variation by which the sun is affected, to ascertain whether any coincidence of period or epoch is traceable. And he draws attention to the circumstance that, according to Schwabe's then recently-published table of frequency of solar spots, a minimum in number of spots occurred in 1843 and a maximum in 1848, with progressive increase in the intermediate years similar to that of the diurnal magnetic range during the same interval as shown by the Toronto and Hobarton observations. This led Sabine to infer the probable existence of a periodical variation in magnetism similar to that—one of about ten years—which Schwabe had detected in sun-spots from observations extending over a period of twenty-five years.

In the meantime another worker had been busy with the same subject. In *Poggendorff's Annalen* for December 1851 there appeared the well-known paper by Dr. Lamont, "on the ten-yearly period," in which he gave the following values of diurnal range of the declination magnet as observed at Munich.

1841 = 7′·82	1846 = 8′·81
1842 = 7·08	1847 = 9·55
1843 = 7·15	1848 = 11·15
1844 = 6·61	1849 = 10·64
1845 = 8·13	1850 = 10·44

Lamont considered that these numbers indicated a periodical variation, and from them he found by graphical construction that a minimum apparently occurred in 1843 and a maximum in 1848. He further discussed such older magnetic observations as were found to be available, and came to the following conclusion, which it may be interesting to give in his own words. "Die grösse der Declinations-Variationen hat eine zehnjährige Periode, so zwar, dass sie mit regelmässigen Uebergange fünf Jahre im Zunehmen, und fünf Jahre im Abnehmen begriffen ist."

Sabine became acquainted with Lamont's paper whilst writing his own, and quotes Lamont's figures from 1843 to 1848, showing how the Munich results confirmed those of Toronto and Hobarton. It would seem that Lamont and Sabine each independently suspected the existence of a periodical variation in diurnal magnetic range, which Lamont appears to have first distinctly formulated in the words quoted; whilst it was to Sabine that the suggestion that the periodical variation was one apparently concurrent with that of sun-spots was due. Lamont considered the variation to be so real that in any theory of the diurnal movement it could not be disregarded. Sabine more cautiously wrote: "As the physical agency by which the phenomena are produced is in both cases unknown to us, our only resource for distinguishing between accidental coincidence and causal connection seems to be *perseverance in observation*, until either the inferences from a possibly too limited induction are disproved, or until a more extensive induction has sufficed to establish the existence of a connection, although its precise nature may still be imperfectly understood." In a postscript to Sabine's paper (dated May 24, 1852) he gives a table of mean diurnal range of declination for Toronto and Hobarton from 1841 to 1851, which clearly shows, as do the Munich numbers, the minimum of 1843 and the maximum of 1848; and in 1856 he showed that at Toronto, from 1844 to 1848, there was a progressive increase in the amount of magnetic disturbance in all three elements of declination and horizontal and vertical force.

Considering that the periodical variation of diurnal range was found to exist in regions of the earth so far apart as Toronto, Hobarton and Munich, the results at the three places being distinctly corroborative, and, further, the circumstance that it appeared to be closely in accord with the established solar-spot variation, it seems to be matter for reflection as to how it happened that in some quarters the agreement between the magnetic and solar variations was thought to be only of apparent or accidental nature. Sir George Airy, in his paper[1] "On the Diurnal Inequalities of Terrestrial Magnetism," had occasion to give therein a list of the days of greater magnetic disturbance at Greenwich in the years 1841 to 1857, and he incidentally remarks that "there is no appearance of decennial cycle in their recurrence." But this is not surprising, for although magnetic disturbance does cluster about the epochs of maximum of sun-spots, it is on occasions by no means closely confined thereto, though nearly or quite absent at epochs of minimum of sun-spots. Thus the periodical variation, as regards the disturbance element, although existing, is not so distinctly traceable unless longer periods are examined, accompanying sun-spot maxima as disturbance does in a somewhat loose fashion as compared with the more regular increase and decrease of diurnal magnetic range with variation of sun-spot frequency. The behaviour of magnetic disturbance in this respect is indeed a matter that I am yet hoping to investigate more exactly.

Then, again, Lamont appears to have adopted for the diurnal magnetic range the difference between the positions of the magnet at 8h. in the morning and 1h. in the afternoon, as being the times of the greatest easterly and westerly deviation respectively. It is true that the positions of the magnet at these hours would not be likely to represent the extreme positions at Munich throughout the year, especially as regards the easterly deviation; still the diurnal range resulting from the employment of such fixed hours approximates in such degree to the true range for Munich, as very well serves clearly to bring out the decennial variation, of which indeed the good agreement between Lamont's and Sabine's results is of itself further proof, since the latter do depend on observations extending through the twenty-four hours of the day. From whatever cause, however, there were those in earlier days who doubted the existence of any real relation between magnetic and solar variations. The so-called decennial period, it may be here mentioned, seems to be more nearly an eleven-year period, this being about the mean value, although it is variable in length to the extent of several years.

When, in the year 1875, I was transferred at the Royal Observatory from the Astronomical to the Magnetical and Meteorological Department, I had then paid no particular attention to this question, and had an open mind thereon. But the daily examination of the photographic records after a time convinced me that change was in progress in the character of the records from year to year, such as even in this simple daily inspection of the records could not be well overlooked; and acting involuntarily on Sabine's principle of perseverance in observation, I came to the conclusion that it would be well to endeavour further to investigate the facts of observation, especially as the long series of Greenwich observations, made throughout on the same general plan and with instruments of the same kind, furnished so excellent an opportunity for applying an independent test of the reality or otherwise of the relation supposed to exist, which the late Dr. Wolf, of Zürich, had already done so much to establish. My first paper appeared in the *Philosophical Transactions* for the year 1880, and deals with the Greenwich observations from 1841 to 1877. This I have recently supplemented by a second paper, read before the Royal Society on March 10 of the

[1] Read before the Royal Society, April 23, 1863.

present year, which appears in the *Proceedings* of the Society. The results here employed extend from 1841 to 1896, a period of fifty-six years. The addition of the more recent observations is especially interesting as contrasting in some respects with the earlier portion, the

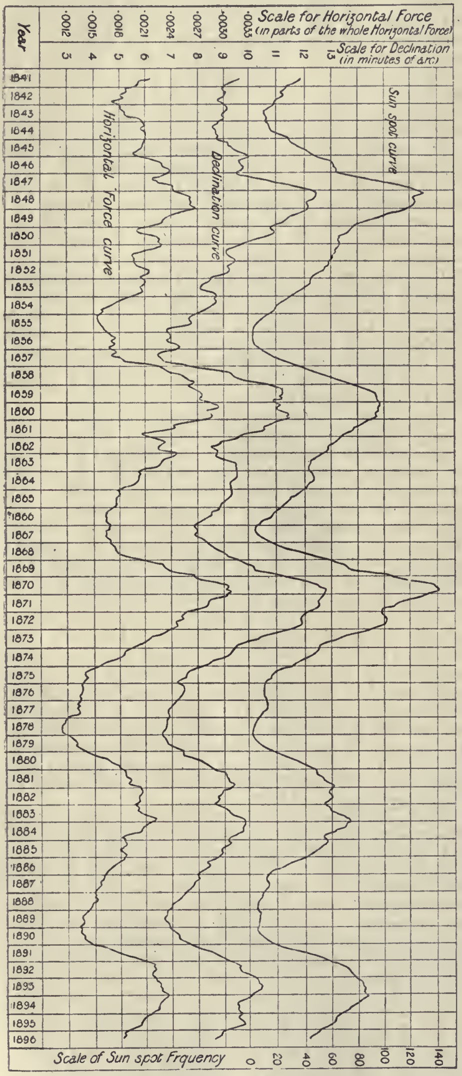

Fig. 1.—Smoothed curves of sun-spot frequency (Wolf), compared with corresponding curves showing the variation in diurnal range of the magnetic elements of declination and horizontal force from observations made at the Royal Observatory, Greenwich.

whole forming one continuous chain of evidence that much strengthens the argument for relation between the two classes of phenomena. The records of horizontal magnetic force, as well as those of declination, are employed. From 1841 to 1847 the results depend on eye observations made at intervals of two hours. In 1848 and afterwards, they depend on hourly tabulations from the photographic records. The mean diurnal range in each month is taken to represent (relatively to other months) the magnetic energy of the month. By the mean diurnal range of declination or horizontal force is to be understood the difference between the least and the greatest of the mean hourly values in each month.

In any graphical representation of unexplained phenomena it is important to give ready reference to the numerical data employed. Consequently in both papers complete tables of the elements used are either included, or indication given where such collected results can be found. The numbers for declination are in minutes of arc, those for horizontal force are in parts of the force, taken as unity. There being in the numbers a strongly marked annual period (the summer values being greater than those for winter), numbers that shall be free of annual inequality have (as explained in the paper) been prepared and used to construct the middle and lower curves of the diagram of collected curves. For sun-spot frequency the numbers published for so many years by Dr. Wolf, and since his death continued by his successor, Prof. Wolfer, have been employed. It is impossible to value too highly work of this kind, carried on for so many years on one fixed plan; such steady adherence to a definite method having many advantages. The monthly sun-spot numbers show considerable irregularities which Wolf smoothed by a process similar to that employed to free the magnetic numbers from the annual inequality, the resulting numbers being used for the upper curve of the diagram.

The collected curves show striking points of interest. The epochs of the extreme points of the curves are given in the following table:—

Table of Epochs of Magnetic and Sun-spot Minima and Maxima.

Reference No.	Phase.	Magnetic epochs.			Sun-spot epoch.	Excess above sun-spot epoch.		
		Declination.	Horizontal force.	Mean magnetic.		Declination.	Horizontal force.	Mean magnetic.
						y.	y.	y.
1	Minimum ...	1844·3	1842·9	1843·60	1843·5	+0·8	−0·6	+0·10
2	Maximum ...	1848·1	1849·0	1848·55	1848·1	0·0	+0·9	+0·45
3	Minimum ...	1857·2	1855·1	1856·15	1856·0	+1·2	−0·9	+0·15
4	Maximum ...	1860·6	1860·2	1860·40	1860·1	+0·5	+0·1	+0·30
5	Minimum ...	1867·5	1867·6	1867·55	1867·2	+0·3	+0·4	+0·35
6	Maximum ...	1870·8	1870·9	1870·85	1870·6	+0·2	+0·3	+0·25
7	Minimum ...	1879·0	1878·7	1878·85	1879·0	0·0	−0·3	−0·15
8	Maximum ...	1884·0	1883·8	1883·90	1884·0	0·0	−0·2	−0·10
9	Minimum ...	1889·5	1890·0	1889·75	1890·2	−0·7	−0·2	−0·45
10	Maximum ...	1893·5	1894·0	1893·75	1894·0	−0·5	0·0	−0·25
	Mean excess (five epochs of minimum)					+0·32	−0·32	0·00
	Mean excess (five epochs of maximum)					+0·04	+0·22	+0·13
	General mean excess					+0·18	−0·05	+0·06

The intervals between the successive mean magnetic epochs and the corresponding sun-spot epochs run, it will be seen, closely together. And if instead of successive intervals we take successive periods, as from No. 1 to No. 3, No. 2 to 4, &c., of the table, we have—

Length of Magnetic Period.

1–3	2–4	3–5	4–6	5–7	6–8	7–9	8–10
y.	y.	y.	y.	y.	y.	y.	y.
12·55	11·85	11·40	10·45	11·30	13·05	10·90	9·85

Length of Sun-spot Period.

y.	y.	y.	y.	y.	y.	y.	y.
12·50	12·00	11·20	10·50	11·80	13·40	11·20	10·00

Nos. 1 to 3, 3 to 5, &c., represent intervals between successive minimum epochs, and Nos. 2 to 4, 4 to 6, &c., intervals between successive maximum epochs. These are shown graphically in the annexed figure.

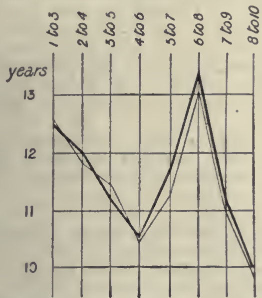

FIG. 2.—Length of sun-spot and magnetic periods compared. The thick line shows the variation in length of successive sun-spot periods, and the thin line that between successive magnetic periods. Odd numbers indicate periods from minimum to minimum, and even numbers periods from maximum to maximum.

Examining further the collected curves, it is seen that the several maximum points have at different epochs very different degrees of intensity. Arranged in order of intensity these are as follows:—

Order of Epochs.

Sun-spot curve	1870	1848	1860	1894	1884
Declination curve ...	1870	1848	1860	1894	1884
Horizontal force curve...	1870	1860	1848	1894	1884

The agreement is complete, excepting that in horizontal force the epochs 1848 and 1860 are transposed, although otherwise falling in with the order of the other curves.

The paper goes on to point out that—considering how the irregularities in the length of the sun-spot and magnetic periods, and also the order of epochs as regards elevation or depression of the maximum points of the curves, so entirely synchronise, and, further, the usually sharp rise from minimum to maximum and the more gradual fall again to minimum, a characteristic of all three curves—"there would appear to be no escape from the conclusion that such close correspondence, both in period and activity, indicates a more or less direct relation between the two phenomena, or otherwise the existence of some common cause producing both." Reference is also made to the question of the supposed lagging of the magnetic epoch, as referred to the sun-spot epoch, which the results presented do not appear much to confirm.

The paper concludes with an inquiry as to how far the practice of including in the Greenwich tabulation of magnetic elements all days (except those of extreme disturbance) may have affected the results presented, for which purpose diurnal ranges were deduced for the years 1889 to 1896 from five selected quiet days in each month —days free from magnetic disturbance—with result that the diurnal ranges so found show the same variation with sun-spots as do the diurnal ranges of the ordinary tabulation. WILLIAM ELLIS.

MONOGRAPHS OF THE UNITED STATES GEOLOGICAL SURVEY.

THE GLACIAL LAKE AGASSIZ.[1]

ONCE upon a time in North America the continental ice-sheet attained an area of about four million square miles, while its maximum thickness, in the central portion, was probably from one to two miles. It extended from the Atlantic to the Pacific, and from the northern United States to the Arctic Sea. During the closing stage of this glaciation there existed an immense lake, whose area is estimated to have been about 110,000 square miles; a lake which extended 700 miles in length, and attained a width of 250 miles. Its maximum depth was 700 feet above the present level of Lake Winnipeg.

That the idea of the former existence of this great lake is no romance of modern days, no "glacial nightmare," is indicated by the fact that so long ago as 1823 the traces of it were recognised by Keating. Not, however, until 1879 was its present name applied to it in honour of Louis Agassiz.

Placed almost in the centre of North America, and occupying what is now part of the plain of the Red River and Lake Winnipeg, together with the Lake of the Woods and other smaller sheets of water, it lay for the most part in territory now Canadian, but a fifth part occurring within the United States. In the southern region, however, its ancient shore-lines have been more exactly explored. A very large part of its area in Canada, besides a considerable tract within its limits in northern Minnesota, is covered by forest, which makes it impracticable to trace there the beach-ridges and deltas, usually but a few feet high, the low escarpments of erosion, which range from 10 to 30 feet, and the other evidences of this lake, which in the prairie region could far more readily and definitely be followed.

It was evident that the scientific study of this interesting region should not be restricted by national geographical circumstances, and it is pleasing to note that arrangements were made between Director Powell (of the U.S. Geological Survey) and Director Selwyn (of the Canadian Survey), that the work of mapping the shores of Lake Agassiz should be continued by Mr. Upham through the prairie region of south-western Manitoba. Altogether this work comprises the results of field-observations carried on during six years.

Over the greater part of the old lacustrine area there is boulder clay from 100 to 300 feet thick. A series of terminal moraines marks the stages of retreat of the ice-sheet. For a while the lake gradually increased in size northwards, finding an outlet to the south in the "glacial" River Warren, whose channel was cut to a depth of 90 feet, and whose course is now occupied by Lakes Traverse and Big Stone and by the Minnesota River. As the ice-front retreated the lake was eventually drained by the natural slope of the land to the north-east, excepting in those areas which now form the lakes of Manitoba.

The steady uplifting of the area of Lake Agassiz, resulting from the unburdening of the land by the recession of the ice-sheet, gave to its beaches a northward ascent, and caused the several shores of its southern part to become double or multiple as they are traced northward.

The author gives a full and particular account of the beaches formed at different stages in the history of the lake, and discusses various earth-movements, some of which were independent of glaciation.

His work is by no means devoid of practical value. A chapter is devoted to artesian and common wells, and to the distribution and origin of certain saline waters; and another chapter is given to the agricultural and material resources of the area.

THE FLORA OF THE AMBOY CLAYS.[1]

This work, which was very nearly finished in 1890, by the late Dr. Newberry, was placed in the hands of Mr. Hollick in 1892. His task has not been unattended with difficulty, but he has carefully indicated his necessary alterations and additions.

The Amboy Clays take their name from Perth Amboy

[1] By Warren Upham. ("Monographs of the U.S. Geological Survey," vol. xxv. Pp. xxiv + 658; 38 maps, and 35 other illustrations.)

[1] By John Strong Newberry. Edited by Arthur Hollick. ("Monographs of the U.S. Geological Survey," vol. xxvi. Pp. x + 137, with 58 plates.)

and South Amboy in New Jersey, where they form the local base of the Cretaceous group. The clays constitute an important item in the mineral resources of the State. The mollusca found in the Amboy Clays prove them to be of estuarine origin. Compared with European strata it seems probable that they may be regarded as Upper Cretaceous.

156 species of plants are described, and these include 8 ferns, 17 conifers, and 5 cycads, in addition to the many dicotyledonous angiosperms, and a few doubtful forms. No palms are recorded.

Geology of the Denver Basin in Colorado.[1]

In this work the authors describe an area of about one thousand square miles, in the centre of which stands the city of Denver in Colorado. Topographically the area itself forms a kind of basin, but geologically it has been found that the rocks of the Cretaceous system, which occur over a large part of the country, constitute a well-defined syncline which is named the Denver Basin.

The mountain range on the west comprises a crystalline complex of pre-Cambrian rocks, flanked by highly inclined rocks of the age of the Jura-Trias, and these are succeeded with apparent though deceptive conformity by Cretaceous deposits which assume a fairly horizontal position beneath Denver, and are uptilted slightly on the east so as to form the before-mentioned basin.

It is held that considerable portions of the crystalline nucleus of the Rocky Mountains constituted an archipelago of large islands in the Palæozoic seas. Within the area now described no outcrops of Lower Palæozoic rocks are found, but there is good reason to believe that they underlie the later sediments, and are concealed along the Archæan borders by the overlapping Mesozoic and later deposits.

The movements that took place at various intervals subsequently to the early Palæozoic times are briefly indicated. They are complex, and have variously affected the character and distribution of the strata. The present relations of the Jura-Trias and Cretaceous to the crystalline nucleus are not due to a simple vertical upward movement of that core: the structure has rather been produced by tangential compression, the effect of which was to produce a structure somewhat analogous to a vertical upthrust, but as a result of a horizontally rather than of a vertically acting force.

The strata referred to the Trias consist, curiously enough, of brilliant red conglomerates, sandstones and shales, with thin limestones and gypsums in the upper part. They are known as the Wyoming formation, and are overlaid by a series of freshwater marls—the Morrison formation—grouped as Jurassic. This group is also known as the Atlantosaurus clays, from its abundant reptilian remains.

The geology of these and of the succeeding Cretaceous, Tertiary and Pleistocene formations, is exhaustively treated, and there is a full account of the igneous rocks. In the chapter on Economic Geology, coal, fire-clays and other clays, building-stones, and artesian wells are dealt with. The coal occurs in the Laramie formation of the Cretaceous. A final chapter is devoted to Palæontology, including some account of the Cretaceous plants, by F. H. Knowlton; and of the Jurassic, Cretaceous, and Tertiary vertebrates, by Prof. O. C. Marsh.

The work is well illustrated with maps, sections and pictorial plates. The "spherical sundering in basalt" is well shown in Plate xiv. Among other plates we have restorations of the Jurassic *Brontosaurus*, *Stegosaurus*, *Camptosaurus*, *Laosaurus*, and *Ceratosaurus*; of Cretaceous Birds and Dinosaurs; of the Tertiary Mammals, *Brontops* and *Entelodon*; and of the Quaternary *Mastodon*.

[1] By S. F. Emmons, Whitman Cross, and G. H. Eldridge. ("Monographs of the U.S. Geological Survey," vol. xxvii. Pp. xvii + 556.)

The Marquette Iron-bearing District of Michigan.[1]

The Marquette district occupies an area extending from Marquette on Lake Superior westwards to Michigamme, a distance of rather less than forty miles, and with a breadth of from one to over six miles. From the western part of the main area two arms project for several miles, one known as the Republic trough and one as the Western trough. The district is the oldest important iron-producing area of the Lake Superior region.

The rocks comprise three series, separated by unconformities. These are the Basement Complex or Archæan, the Lower Marquette, and the Upper Marquette; the two latter constituting the Algonkian of the district, and perhaps equivalent to Huronian. The Marquette series is mainly sedimentary, although among the strata are included large masses of igneous rocks. The succession of the series is somewhat obscured by irregularities of deposition, and by inter-Marquette erosion. After the Upper Marquette series was deposited the district was folded, faulted and fractured in a complex fashion, with resultant profound metamorphism.

The greater iron-ore deposits occur in the Negaunee formation, which is from 1000 to 1500 feet thick, and occurs in the Lower Marquette series. Petrographically the formation comprises sideritic slate, ferruginous slate, ferruginous chert, jaspilite, and iron-ore. The ferruginous chert and jaspilite are frequently brecciated. The iron-ores resulted from the concentration of the iron-oxides through the agency of downward percolating waters. These concentration-bodies usually occur upon impervious basements in pitching troughs.

The various features connected with this iron-producing region are all worked out in great detail, and the memoir is beautifully illustrated with coloured plates of banded and brecciated rocks, and various pictorial views and sections.

H. B. W.

[1] By C. R. Van Hise and W. S. Bayley, including a chapter on the Republic Trough, by H. Lloyd Smith. ("Monographs of the U.S. Geological Survey," vol. xxviii. Pp. xxvii + 608; 35 plates, and 27 other illustrations, together with large folio atlas of maps.)

ANTHROPOLOGY IN MADRAS.

When recently on furlough in England, I was greatly interested in hunting up the facilities for the study of anthropology in London, and in the scheme for the establishment of a bureau of ethnology for the British Empire. And it has been suggested to me that it may interest those concerned in the development of anthropological research to know what is being done, in a mild way, in a remote possession of the Empire, the Madras Presidency, viz. the southern portion of the Indian peninsula. I add this geographical explanation, inasmuch as a friendly critic, in a recent review of my work, got hopelessly mixed between Madras and Bengal, reminding me of the story of the Viceroy-elect, who was overheard murmuring to himself, "Bombay in the west, Calcutta in the east, Madras in the south." Wide as is the area, and numerous as are the tribes, castes, and races included within my limited beat of 150,000 square miles, I have set myself the task, which must perforce occupy many years, of carrying out a detailed anthropological survey. This survey was, with the approval of the Madras Government, inaugurated in 1894. In that year, equipped with a set of anthropometric instruments obtained on loan from the Asiatic Society of Bengal, I commenced an investigation of the hill-tribes of the Nīlgiris, the Todas, Kotas, and Badagas, bringing down on myself the unofficial criticism that "anthropological research at high altitudes is eminently indicated when the thermometer registers 100° in Madras." From this modest beginning have resulted: (1) investigation of the various classes which inhabit the city of Madras, during my residence at headquarters; (2) periodical tours to various parts of the Presidency, with a view to the study of the more important tribes and classes; (3) the publication of bulletins, wherein the results of my work are embodied; (4) the establishment of an anthropological laboratory (Fig. 1), equipped with the apparatus necessary for carrying out anthropometric research; apparatus for testing sight, hearing, vital capacity, handgrip, &c.; a small series of Hindu, Muhammadan, Burmese and Sinhalese skulls; and an anthropomorphic series, still in a very early stage of development, but including the finger-print impressions of an Orang-utan; (5) a collection of photographs of native types, arranged in albums; (6) a series of lantern-slides for lecture purposes.

A museum, such as that of Madras, the visitors to which sign their names in Tamil, Telugu, Kanarese, Malayalam, Nāgari, Hindustani, Mahrāti, Guzarāti, Bengāli, Burmese, Sinhalese, and Chinese, lends itself to the requirements of the anthropologist, as it is resorted to by very large numbers of the poorer classes, who, in return for a small fee, are ofttimes willing to lend their bodies for the purposes of anthropometry. And, nearly every morning, I am to be seen measuring Hindus or Muhammadans, amid an admiring crowd of native visitors (the females dressed in gaudy English piece-goods), in the surrounding corridor. Quite recently, when I was engaged in an inquiry into the Eurasian or half-breed community, the booking for places was almost as keen as on the occasion of a first night at the Lyceum, and the Sepoys of a native infantry regiment, quartered in Madras, entered heartily into the spirit of what they called the "Mujeum gymnashtik shparts," cheering the possessor of the biggest handgrip, and chaffing those who came to grief over the spirometer. Anthropological research in the city of Madras, where the native community has become accustomed to the European, and discovered that, if his ways are peculiar, he is at any rate harmless, is all plain sailing. But, in the jungles and places remote from civilisation, one has to deal with simple-minded folk, unfamiliar with the eccentricities of the investigator, and suspicious of his motives. Well do I remember a native remarking at a pearl-fishery camp, "Mr. Thurston is a pleasant man, and it is a great pity he is so mad." The fact indicating insanity being that I used to sit outside my tent in the sun, at mid-day in the month of April, examining oyster after oyster in connection with the pearl-producing area.

The essential ingredients of a successful campaign in the wilds are tact, patience, 4-anna pieces, cheap cheerots, and, as a final resource, raw whiskey or brandy. The Paniyan women of the Wynaad, when I appeared in their midst, ran away, believing that I was going to have the finest specimens among them stuffed for the museum. Oh, that this were possible! The difficult problem of obtaining models from the living subject would then be disposed of. The Muppas of Malabar mistook me for a recruiting sergeant, bent on enlisting the strongest of them to fight against the Moplahs. An Irula of the Nīlgiris, who was "wanted" for some ancient offence relating to a forest elephant, refused to be measured on the plea that the height-measuring standard was the gallows. A mischievous rumour found credence among the Irulas that I had in my train a wizard Kurumba, who would bewitch their women and compel me to abduct them. The Malaiālis of the Shevaroys got it into their heads that I was about to annex their lands on behalf of the Crown, and transport them to the penal settlement in the Andaman islands; and one of them informed me that he would rather have his throat cut than be measured. On one occasion I casually photographed a group of Badagas in their bazaar, and, on the following day, a deputation waited on me with a petition to the effect that "we, the undersigned, beg to submit that your honour made 'botos' of us, and have paid us nothing. We, therefore, beg you to do this act of common justice." The deputation was made happy with a *pour boire*. Would that official deputations could be disposed of as easily!

Despite the trifling obstacles at the outset, confidence was eventually established with the various tribes just referred to, though not without a good deal of palavering and mild bribery, and a sufficient number of individuals for statistical purposes were investigated.

The main objects, which are systematically kept in sight during my wanderings, are:—

(1) To record at least the essential measurements of men, and (when they will permit) women.

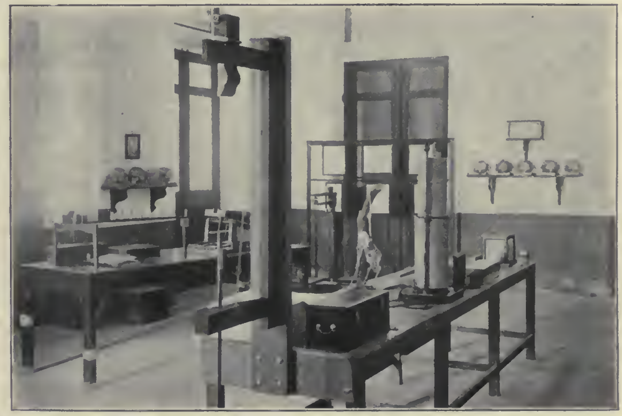

FIG. 1.—Anthropological Laboratory.

(2) To study the characteristics of external anatomy.

(3) To record "manners and customs," tattoo-marks, clothing, personal adornment, &c.

(4) To take photographs of typical individuals, dwelling-huts, &c.

(5) To acquire by purchase "specimens" illustrating clothing, jewellery, musical instruments, games, &c.

As a general rule the traveller, who makes collections in any branch of science, hands them over, as a gift or by purchase, to some national or provincial museum, and honours are divided; the museum securing the collection, and the collector being immortalised on a label or in a monograph. Possibly, with luck, a new species, or even genus, is named after him, and his reputation is enhanced in the family circle. Looking recently, on a depressing November day such as we in the East know not, at a collection of sponges which to the casual visitor possess no special attraction, exhibited in or by my name at the British Museum (Natural History), I recalled to mind the many pleasant hours spent in a dug-out (canoe) on the coral reefs, an attack by a saw-fish, and a severe sun-head. And the museum, whose destinies I have steered since 1885, teems with happy memories of camp and jungle life; for, by the fortune of circumstances, it falls within my province not only to make collections, but to preside over their arrangement for exhibition. And the advantages of this dual function are self-evident: a tour concluded, the work of museum arrangement commences; and here one is met with an obvious difficulty at the outset. For two systems of arrangement are possible, each with much to be said both for and against it, and a selection of one or the other has to be made; for the material collected, and available space will not, as a rule, suffice for both. Either the collections may be arranged according to the nature of the exhibit, *e.g.* models of boats, sacrificial utensils, musical instruments, games, images, &c.; or each tribe or community may be represented in its various aspects, animal and social, in a single case or in adjacent cases. For myself, I give the preference to the latter system, mainly on the score of convenience and finality of arrangement. Very effective, I remember, in one of my galleries, were some life-size photographic transparencies of Andamanese heads, presented by Mr. Portman to the ethnological section of the Indian Museum, Calcutta, when I was in temporary charge thereof some years ago. So, too, were the models of the Andamanese, executed, if my memory serves me rightly, by a Bengāli modeller. But the utility of most models, which I have seen, is marred by the want of care in representing the colour of the skin, and in decorating the model with the proper jewellery, which, in many cases, is absolutely characteristic of a particular tribe.

Writing elsewhere, I said: "The more remote and unknown the race or tribe, the more valuable is the evidence afforded by the study of its institutions, from the probability of their being less mixed with those of European origin." Tribes which, only a few years ago, were living in a wild state, clad in a cool and simple garb of forest leaves, buried away in the depths of the jungle, and living, like pigs and bears, on roots, honey, and other forest produce, have now come under the domesticating, and sometimes detrimental influence of contact with Europeans, with a resulting modification of their conditions of life, morality, and even language. The Paniyans of the Wynaad and the Irulas, who inhabit the slopes of the Nīlgiris, now work regularly for daily wage on planters' estates; and I was lately shocked by seeing a Toda boy studying for the third standard, instead of tending the buffaloes of his "mand." Ample proof can be adduced in support of the fact that European influence, import-trade with other countries, and the struggle for existence, are bringing about a rapid change (sad from an ethnographic standpoint) among the natives of Southern India, both tame and wild. It has recently been said that "there will be plenty of money and people available for anthropological research when there are no more aborigines"; and it behoves our museums in Great Britain and its dependencies to waste no time in completing their anthropological collections.

I gathered from observation when in London (1) that man as a social and intellectual being is illustrated with the unavoidable want of proportion, when no systematic scheme for the regular expansion of the collections is at work at the British Museum, Bloomsbury; (2) that it is under contemplation to illustrate man and the varieties of the human family from a purely animal point of view at the British Museum (Natural History), South Kensington; (3) that skulls must be sought for at the Royal College of Surgeons, Lincoln's Inn Fields; (4) that lectures and anthropological literature are available to members at the Anthropological Institute, Hanover Square. To this must be added (5) Mr. Galton's laboratory. Surely a great want of centralisation, such as might well be remedied, is indicated here. And as I wandered, both in and out of the London season, through the deserted galleries of the Imperial Institute, I could not refrain from speculating whether, with a radical change of policy for good, this much-discussed building could not be converted into our great National Museum of Ethnology, where man shall be represented fully and in every aspect, and where those interested in ethnological research could find under one roof a skilled staff to appeal to in their amateur difficulties, collections, literature, lectures, and anthropological laboratory. For the great mass of visitors to popular museums, who come under the heading of sightseers, it is of primary importance that the exhibits should be attractive. And I feel convinced that, were an ethnological museum up to the high standard of the British Museum (Natural History) established, it would, when its reputation became known, be, like Madame Tussaud's, widely resorted to by the general public, and that, by an admixture of free and paying days, and by the charge of a small fee for examination in the laboratory, it might be made to a certain extent self-supporting, and not entail a great burthen of expenditure on the State. EDGAR THURSTON.

Madras Government Museum.

NOTES.

WE are glad to notice that the Queen's birthday honours include the name of Dr. John Murray, F.R.S., of *Challenger* renown, who has been appointed a Knight Commander of the Order of the Bath (K.C.B.).

THE Chemical Society's banquet to Lord Playfair and six other past presidents who have completed fifty years' fellowship of the Society, is to be held at the Hôtel Métropole on Thursday, June 9.

THE death is announced of M. Souillart, professor of astronomy in the University of Lille, and correspondant in the Section of Astronomy of the Paris Academy of Sciences.

THE Department of Science and Art has received information that the fifth International Congress of Hydrology, Climatology, and Geology will be opened at Liége on September 25.

THE eighty-first annual meeting of the Sociéte helvétique des sciences naturelles will be held at Berne on August 1–3. This will be the sixth occasion upon which Berne has been the meeting-place of the Society. The reception will take place in the great hall of the Museum on the evening of Sunday, July 31. On the following day there will be a general meeting, a banquet, and a fête, and the sections will meet for the consideration of papers on August 2. The sections and their presidents are as follows:—Mathematics, astronomy and physics, MM. Graf, Huber, Sidler; chemistry, MM. de Kostanecki, Friedheim; botany, M. L. Fischer; zoology, M. Th. Studer; anthropology, M. Th. Studer; geology, mineralogy, petrography and palæontology, M. A. Baltzer; physical geography (comprising geodesy and meteorology), M. E. Brückner; anatomy and physiology, MM. Strasser and Kronecker; medical clinics, MM. Kocher, Müller, Sahli; hygiene and bacteriology, MM. Girard, Tavel; pharmacy and alimentation, M. Tschirch; veterinary science, M. Berdez; agriculture and sylviculture, M. Coaz.

AT the Royal Institution on Thursday, June 2, Dr. Edward E. Klein delivers the first of two lectures on "Modern Methods and their Achievements in Bacteriology," and on Saturday, June 4, Dr. Richard Caton begins a course of two lectures on "The Temples and Ritual of Asklepios at Epidaurus and Athens." The Friday evening discourse on June 3 is by Prof. W. M. Flinders Petrie, on "The Development of the Tomb in Egypt"; that on June 10 is by Lord Rayleigh, whose subject is "Some Experiments with the Telephone."

As the result of a bacteriological examination, Dr. Haffkine has reported that the recent sudden outbreak in Calcutta was due to true bubonic plague. A long and detailed statement of the facts referring to the outbreak, and the measures taken by the Government of Bengal to prevent its spread, is given in the *Pioneer Mail* of May 6. As a preventive measure, inoculation with the prophylactic virus prepared by Dr. Haffkine is recommended. It has been found that inoculation by this material prevents from 80 to 90 per cent. of deaths from plague, and reduces the plague from an epidemic form to the position of a sporadic disease. Surgeon-General Harvey was deputed by the Government of India last month to Bombay specially to examine the results of Dr. Haffkine's methods, and his report is stated to be generally favourable to the system of inoculation. The Government of Bengal have therefore decided to exempt from liability to segregation all families which have been entirely inoculated prior to the occurrence of any case of plague among them. Inoculation is not to be forced on the people, but if a member of a completely inoculated family is attacked by the plague, neither he nor his family will be liable to removal to a segregation camp.

At the anniversary meeting of the Royal Geographical Society on Monday, the medals were presented as already announced (p. 38). In the course of his address, the President said that a very sympathetic reply had been received from the Prime Minister's private secretary to the appeal on behalf of a Government Antarctic expedition. A German expedition was being organised on a liberal scale, and funds were being collected throughout Germany for the purpose. Moreover there was reason to hope that the Norwegian Government might send out an expedition also, perhaps under the leadership of Dr. Nansen, to carry out exploration mainly on land. Meanwhile the Belgian expedition, under M. de Gerlache, had been actively engaged, and the expedition, liberally supported by Sir George Newnes, under Mr. Borchgrevink, was in an advanced state of preparation. After a brief reference to Mr. Jackson's account of the Jackson-Harmsworth expedition, to Lieutenant Peary's labours, and to those of Captain Sverdrup, Colonel Fielden, Mr. Pearson, Mr. Arnold Pike, and Sir Martin Conway, the President said that German and Swedish expeditions were in progress for Spitsbergen and Franz Josef Land. Germany was setting an admirable example in scientific exploration. Besides the Antarctic expedition referred to, the German Government had made a grant of 15,000*l.* for oceanic research, especially in the Atlantic and Indian oceans. In the North Atlantic much good work was done under the joint co-operation of the Swedish, Norwegian, German, and British Governments. He hoped that during the coming summer authentic and satisfactory information concerning the hazardous balloon expedition undertaken by M. Andrée would be received.

Mr. Borchgrevink has given to a representative of Reuter's Agency some details of the arrangements for the Antarctic expedition which will shortly leave for Australia and South Victoria Land. He said that his ship, the *Southern Cross*, has been designed by the builder of the *Fram*, and has 10 feet of solid oak at her bows, and at her weakest point is 32 inches in thickness. Over all she is sheathed with 3 inches of American greenheart—a wood which never splits, and is very hard and slippery. The *Southern Cross* will fly the British flag, and will leave London in July. A pack of sixty-five Siberian sledge-dogs will be taken, and a number of sledges for the inland journey on the South Victorian continent. The object of the expedition is to explore South Victoria Land, and to investigate the seas and islands between there and Australia. Mr. Borchgrevink is taking with him stores for three years and a supply of carrier-pigeons.

Information of the death of Mr. Edward Wilson, F.G.S., who for the past fourteen years has been Curator of the Bristol Museum, has been received from Mr. F. W. Knocker, Sub-Curator of the Museum. Having a good general knowledge of zoology and botany, and an extensive acquaintance with geology, Mr. Wilson was admirably fitted for his position. His efforts to enrich the Museum were zealous and untiring, and he was engaged during the last month of his life in procuring a large collection of mammalian remains and some worked flints from the cavern-deposits of Uphill, near Weston-super-Mare. He had likewise arranged in the Museum a special students' collection of minerals, rocks and fossils, of which he prepared a separate catalogue, in addition to his numerous issues of the "Guide to the Bristol Museum." For many years prior to his removal to Bristol, Mr. Wilson had been a science teacher at Nottingham, and he was there led to pay particular attention to the Permian and Triassic strata, the Rhætic beds and the Lias, to our knowledge of which he made considerable additions in papers dating from 1868. In 1885 he published an important article on the Marlstone of Leicestershire as a source of iron. Later on he devoted himself more especially to the study of the Liassic Gasteropoda, on which subject he had become our chief authority. He was joint-author, with Mr. W. H. Hudleston, F.R.S., of a Catalogue of British Gasteropoda, 1892. More recently he has laboured in company with Mr. S. S. Buckman at the palæontology of Dundry Hill. A new Liassic Gasteropod was named *Wilsonia* in honour of Mr. Wilson, by Mr. Hudleston, and the Council of the Geological Society awarded to him in 1888 the Murchison Geological Fund. He died after a short illness on May 21, at the early age of forty-nine, and his loss will be widely felt by his many friends. All acquainted with him entertained the highest regard for his gentle unassuming character, as well as for his able and painstaking researches.

The report of the Committee appointed by the Society of Arts to consider the causes of the deterioration of paper is printed in the current number (May 20) of the Society's *Journal*, and is here summarised. At the outset, the report points out that during the present century the paper-making industry has undergone many revolutionary changes. As an industry it has grown considerably, and to meet the requirements of the enormously increased production a quantity of new fibrous raw materials have been introduced and have taken their place in due course as indispensable staples. The more important of these, so far as concerns this country, are esparto, in the period 1860–70; "mechanical wood" or ground wood pulp, in 1870–80; the wood celluloses, in the period 1880–90. These substances differ in chemical composition from the celluloses obtained from cotton, flax and hemp, which were the exclusive staple raw materials for paper making up to this century; and although they are efficient substitutes in most respects, it must be admitted that time has not yet been able to pronounce a judgment upon the relative permanence of the papers made from them. There is more than a suspicion that many of them are very inferior in this important respect, and it has been the main purpose of the work of the Committee to sift the evidence upon which such suspicions have been engendered.

The Committee referred to above have examined a number of books as evidence of "deterioration of paper"; some submitted by librarians in a condition of complete disintegration; some of their own selection exhibiting various grades of deterioration of the paper of which they are composed. They conclude on the evidence before them as follows:—As to the two tendencies to deterioration of papers these are marked (1) by disintegration, (2) by discoloration. They are independent effects, but may be concurrent. They are notably so in papers containing mechanical wood pulp. Actual disintegration has been brought to light in papers of all grades; from those of the best quality as regards the fibrous materials of which they are composed, *i.e.* rag papers; also of course in those of lowest quality, *i.e.* containing mechanical wood pulp in large proportions. It is generally the result of chemical change of the fibres themselves. As to the causes determining such changes: in the case of the rag papers examined the effects appear to be due to acid bodies; the disintegration may be generally referred to acidity. In the case of mechanical wood pulp the effects are traceable to oxidation pure and simple; the disintegration is accompanied by a basic or alkaline reaction of the paper. Discoloration may be said also to affect all papers more or less, and without discussing minutely the chemistry of the changes, the evidence obtained certainly warrants the general conclusion that discoloration of ordinary cellulose papers (as distinguished from those containing mechanical wood pulp) under usual conditions of storage is proportional to the amount of rosin which they contain, or more generally to the rosin and the conditions employed for fixing it in the ordinary process of engine-sizing. The Committee have been desirous of bringing their investigations to a practical conclusion in specific terms, viz. by the suggestion of standards of quality. They limit their specific findings to the following, viz. (1) normal standard of quality for book papers required for publications of permanent value. For such papers they specify as follows:—Fibres: not less than 70 per cent. of fibres of the cotton, flax, and hemp class. Sizing: not more than 2 per cent. rosin, and finished with the normal acidity of pure alum. Loading: not more than 10 per cent. total mineral matter (ash).

The Röntgen Society has appointed a Committee to inquire into the alleged injuries produced by exposure to Röntgen radiation. In order to obtain accurate information, the committee has prepared a set of questions framed with a view of determining the cause or causes of the injuries received.

A note in *Comptes rendus* (May 9) states that M. Mascart has received information that Prof. Leist has found at Kotchétovka, in the province of Kursk (Russia) a local magnetic pole; that is to say, a point where a dipping needle stands vertical. It is necessary to move twenty metres from this point to change the direction of the needle by 1°. The declination needle sets itself indifferently in any direction in the spot where this magnetic anomaly occurs.

M. Vincent stated at a meeting of the Academy of Medicine, held on May 10 (says the *Lancet*), that he has found that French soldiers are on an average a hundred times more subject to typhoid fever than native soldiers—a singular observation, because this disease is in general serious when it attacks Arabs. The comparative exemption of the Arabs depends, in his opinion, neither on a previous attack nor on a slow acclimatisation consequent on residence in towns, but on a natural immunity comparable to the immunity of negroes against yellow fever, or of Algerian sheep against anthrax.

The U.S. Weather Bureau has published in its *Bulletin* No. 21, an abstract of a report on solar and terrestrial magnetism in their relations to meteorology, by Prof. F. H. Bigelow, who has during the last six years devoted much time to the study of the fundamental principles of this important subject. It is stated in the introductory text that he is of opinion that the atmospheric conditions which culminate in the storms traversing the United States are in part dependent upon the solar energy that reaches the earth in the form of magnetic force, and that there are synchronous fluctuations in the pressures and temperatures of the north-western regions of the American continent in the neighbourhood of the magnetic pole. Prof. W. L. Moore, the chief of the Weather Bureau, is of opinion that while at this stage of the investigation the sequence of cause and effect is not shown with sufficient definiteness to justify the weather forecaster in attempting to apply these theories in predicting marked atmospheric disturbances, the paper will lead to discussion and result in further additions to our knowledge of magnetic science.

Petermann's Mittheilungen publishes a new map of the central highlands of northern German East Africa. Much new matter is introduced by the addition of the surveys made by Premier-Lieut. Werther on the so-called Irangi expedition during 1896 and 1897; the map itself is drawn by Dr. B. Hassenstein. A paper describing the main features of the country traversed by the expedition is appended by Lieut. Werther.

Prof. A. Supan contributes a careful analysis of the reports and statistics of trade in China for the year 1896 to *Petermann's Mittheilungen*. The results lead him to expect immense developments from the construction of railways, even within the next decade, and he believes the establishment of Germany at Kiaou-tschou will mark the beginning of a new era in the trade of that country.

We have received the index to the first ten volumes of the *Mittheilungen von Forschungsreisenden und Gelehrten aus den Deutschen Schutzgebieten*. The index, which covers the years 1888 to 1897, is arranged under six separate headings, four of which are subdivided according to the different colonies. Dr. von Danckelman is the editor.

The *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande* contains a long paper, by Herr R. Hundt, on the petrography and palæontology of the middle Devonian rocks of south-west Prussia. The geology of the *Lenneschiefer* beds is discussed in detail, and a comparison with the Calceola beds of the Eifel is based on the distribution of fossils of Calceola and Stringocephalus. A map of the region is appended.

A recently issued part of the *Proceedings* of the U.S. National Museum (vol. xx., No. 1134) contains an important contribution to our knowledge of the ornithology of the Philippine Islands, by Messrs. Worcester and Bourns. The first portion of this memoir consists of a complete list of the 526 birds as yet known to inhabit the various islands of the Philippine archipelago and of those of the adjoining group of Palawan in a tabular form, and shows their occurrence or absence in thirty-seven islands of the two series. Taking this list as a text, Mr. Worcester proceeds in the second portion to discuss the very interesting problems presented by the distribution of the birds in these islands. Each island is taken in order, a list of its known birds is given, and its relationships, as thus shown, are worked out. Mr. Worcester comes to the conclusion that Mr. Everett's view (*Proc. Zool. Soc.*, 1889) that Palawan and its satellites belong ornithologically to Borneo, and not to the Philippines, is amply confirmed by recent evidence. Turning to the Philippines proper, the author shows that the five "sub-provinces" into which Dr. Steere, in 1894, proposed to divide the Philippine area are not maintainable. Nor is Mr. Worcester better satisfied with Dr. Steere's deduction that each genus of Philippine birds is represented by a single species only in each island. The contrary is manifestly the case in many instances. The memoir is illustrated by a map and numerous diagrams, and is worthy of careful study by all who are interested in laws of geographical distribution.

One of the most important services performed by the Agricultural Experiment Stations found in almost every one of the United States, is the instruction of the farmer and the fruit-grower in the life-history of the animal and vegetable foes which destroy or injure his crops, and in the mode of combating them.

From the Cornell University Experiment Station, located at Ithaca, N.Y., we have received *Bulletin* No. 145, devoted to two important diseases of the pear, the "leaf-spot" (*Septoria piricola*), and the "leaf-blight" (*Entomosporium maculatum*), by Mr. B. M. Duggar, admirably illustrated; and from that for the University of Wisconsin *Bulletin* No. 65, on a bacterial rot of cabbage and allied plants (*Bacillus campestris*), by Mr. H. L. Russell, also well illustrated. These bulletins and the annual reports are sent free to all residents in the State on request. From the Michigan State Station we have also received *Bulletins* Nos. 151-153, containing a very large amount of practical information on the growth of vegetables and fruits suitable for cultivation in that State.

IN a recent article (March 17, p. 464) on the resources of the West India Islands, reference was made to the necessity for supplementing the staple products by the introduction of a variety of cultural industries which would increase the wealth of these Colonies. The obvious way to lead to such developments is to establish a department of economic botany, for the purpose of carrying out systematic experiments concerned with agricultural cultivation, wherever necessary, and to extend the equipment of existing botanic gardens so that proper attention can be given to the introduction of new plants. Mr. J. H. Hart, the Director of the Royal Botanic Gardens at Trinidad, in a lecture reprinted in the *Bulletin* of the Gardens, shows that many at present minor industries might be developed with profit in the Colony. He points out that Trinidad could grow enough mahogany and cedar to supply the markets of Great Britain, and if the island was simply a mahogany and cedar forest, it would be one of the richest of our colonial possessions. Yet no one plants cedar trees in the island, and no one plants mahogany. Jamaica exports logwood to the value of 300,000*l*. annually, but Trinidad, where logwood of the very finest quality can be grown, sends none to market. Rubber trees grow well in the Island, the trees in the Botanic Gardens yielding from four to six pounds of rubber per tree per annum, but they are not cultivated to any extent outside the Gardens. In addition to these potential crops, Mr. Hart enumerates fifty other products which could be successfully grown in Trinidad. His lecture shows the valuable assistance which botanic gardens are able to give to cultivators; and we are glad to see that the botanical department under his direction is to be extended, land having now been allotted for the purpose of establishing a section for economic and scientific work. The extension encourages the hope that the reproach, that "Trinidad has the wealth of the Straits Settlements going to waste," will soon be removed.

THE fifth and sixth Reports on the Yorkshire Carboniferous Flora, by Mr. Robert Kidston, are reprinted from the *Transactions* of the Yorkshire Naturalists' Union.

THE third edition of Mr. W. T. Lynn's little book on "Remarkable Eclipses" has just been issued by Mr. Edward Stanford. The book has been brought up to date by mention of the total solar eclipses of August 1896, and January last.

A SECOND edition of "Applied Bacteriology," by Messrs. T. H. Pearmain and C. G. Moor, has just been published by Messrs. Baillière, Tindall, and Cox. Several parts of the book have been enlarged and improved, and the whole has undergone revision. A short account of the bacteriology of sewage has been added. The volume provides students, medical officers of health, analysts and sanitarians with a good general survey of the science of bacteriology.

THE second part of Mr. W. P. Hiern's "Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853-61," comprising the natural orders of Dicotyledons from Combretaceæ to Rubiaceæ, has just been published by the Trustees of the British Museum (Natural History). Another publication which has just been issued from the Museum is a list of the types and figured specimens of fossil Cephalopoda in the collection, prepared by Mr. G. C. Crick.

THREE papers of interest to anthropologists appear in the *Proceedings* of the Royal Society of Tasmania (1897). One contains the results of measurements of the crania of Tasmanian aboriginals now in the Hobart Museum, compared with measurements of the skulls of Europeans, by Dr. A. H. Clarke and Mr. W. E. Harper. The authors do not attempt to draw conclusions as to the origin of the Tasmanian aboriginals, nor to define their characteristics; but the measurements of the skulls of an extinct race constitute a work of value to anthropologists. The two other anthropological papers in the *Proceedings* are by Mr. J. B. Walker; they contain a number of interesting notes on the Tasmanian aborigines, extracted from the journals of his father.

THE Rev. Prof. G. Henslow has in preparation a volume entitled "Medical Works of the Fourteenth Century," consisting of transcripts with notes from four MS. volumes contemporary with the works of Wiclif and Chaucer. These transcripts will furnish illustrations of the crude and quaint conceptions of the value of plants as drugs prevailing in the Middle Ages. The volume will also contain an alphabetical list of upwards of 700 medical and other plants mentioned in works of the fourteenth century, compiled and identified with their modern English and Latin equivalent names.

PROF. T. W. RICHARDS, of Harvard, whose name is already identified with the accurate determination of atomic weights, has recently published the results of a redetermination of the atomic weights of nickel and cobalt. The close approach to equality in the atomic weights of these elements has always given a special interest to any such redetermination, and this interest has been increased in recent times by the suggestion that the two elements are ordinarily associated with a third new element—"gnomium," which is not separated from them in the usual course of analysis. The evidence on which this suggestion was based by Krüss and Schmidt was subsequently rebutted by the work of Winkler; yet Winkler's own determinations of the atomic weight of cobalt by two different methods gave results which differed by 1 part in 200, viz. 59·82 and 59·52. Still later determinations by Hempel and Thiele, by three methods, gave respectively 58·99, 58·78 and 58·91. The method employed by Prof. Richards consisted in the preparation of the bromides of nickel and cobalt, and their analysis by means of pure silver nitrate. The greatest precautions were taken in order to obtain pure anhydrous materials, and the same methods of manipulation employed as in the previous case of the determination of the atomic weight of magnesium. The fourteen experiments with nickel bromide agree remarkably, the extreme differences being just over 1 part in 1000. Thirteen experiments with cobalt bromide show an equally good agreement. The numbers given finally are for nickel 58·69 and cobalt 58·99 (O = 16). Prof. Richards, anticipating the criticism that his determinations are based on a single method, remarks that a series of carefully conducted determinations by a single reliable method have especial value in the case of nickel and cobalt, where hitherto accuracy has been sought by varying the methods rather than by securing constancy in the results attainable by any one of them. Prof. Richards concludes that discrepancies among previous determinations of the atomic weights of nickel and cobalt afford no evidence of the existence of the hypothetical gnomium, nor do his own observations in any way indicate the existence of such an element.

THE additions to the Zoological Society's Gardens during the past week include a Guinea Baboon (*Cynocephalus sphinx*, ♂) from West Africa, presented by Captain H. de la Cour Travers; a Vervet Monkey (*Cercopithecus lalandii*, ♂) from South Africa, presented by Mr. C. J. Barratt; a Common Raccoon (*Procyon lotor*) from North America, presented by Mr. A. D. Jenkins; a Reindeer (*Rangifer tarandus*, ♂) from Newfoundland, presented by the Hon. M. A. Bourke, H.M.S. *Cordelia*; a Common Guillemot (*Lomvia troile*), British, presented by Mr. Ernest Horne; a Seven-banded Snake (*Tropidonotus septemvittatus*) from North America, presented by Mr. James Meldrum; a Barbary Ape (*Macacus innus*, ♂) from North Africa, a Red-River Hog (*Potamochœrus penicillatus*) from West Africa, a Beccaris Cassowary (*Casuarius beccarii*) from New Guinea, two Orange-winged Amazons (*Chrysotis amazonica*), two Blue-fronted Amazons (*Chrysotis æstiva*) from South America, deposited; a Leucoryx Antelope (*Oryx leucoryx*, ♂) from North Africa, purchased; a Red-winged Parrakeet (*Ptisles erythropterus*, ♀), a Long-billed Butcher-Crow (*Barita destructor*) from Australia, received in exchange; two Japanese Deer (*Cervus sika*, ♂ ♀), three Shaw's Gerbilles (*Gerbillus shawi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE :—

June 3. 6h. 34m. to 9h. 25m. Transit of Jupiter's Sat. III.
4. 8h. Eastern elongation of Saturn's Sat. Japetus.
4. 8h. 10m. to 9h 11m. Occultation of A Ophiuchi (mag. 4·7) by the moon.
4. 15h. 43m. to 16h. 34m. Occultation of B.A.C. 5909 (mag. 6·2) by the moon.
5. 10h. 15m. to 11h. 22m. Occultation of λ Sagittarii (mag. 3·1) by the moon.
9. 11h. 31m. to 12h. 23m. Occultation of B.A.C. 7804 (mag. 6·1) by the moon.
9. Saturn. Outer minor axis of outer ring, 18″·62.
10. 10h. 23m. to 13h. 16m. Transit of Jupiter's Sat. III.
12. 19h. Neptune in conjunction with the sun.
15. Venus. Illuminated portion of disc 0·853.
15. Mars. ,, ,, ,, 0·919.
15. Jupiter. Polar diameter, 34″·8.
15. Saturn. ,, ,, 17″·0.
17. 9h. 45m. to 11h. 23m. Transit of Jupiter's Sat. IV.
18. 10h. 59m. Minimum of β Persei (Algol).
23. 5h. Inferior conjunction of Saturn's Sat. Japetus.
29. Saturn. Outer minor axis of outer ring, 18″·33.

The transit of Jupiter's fourth satellite on June 17 is the only one visible during 1898.

BLURRING ABERRATION IN THE TELESCOPE. — Some time ago we referred in this journal (December 30, 1897, p. 200) to a communication by Prof. Schæberle which pointed out that the optical image of a celestial object, formed in the focus of a reflecting telescope of great angular aperture, is possessed of errors of definition which arise from a cause hitherto unrecognised by mathematical and practical opticians. The main results of this paper briefly summed up are as follows:—First, that the focal plans of a curved reflecting surface for parallel rays impinging thereon is situated upon the axis, half-way between the centre of curvature and the reflecting surface itself; and, second, that the plane of the image formed by each small patch of the converging surface tends to lie at right angles to the path of the focussed rays, so that the images formed from every minute portion of the reflecting surface, while their centres may coincide on the axis of the telescope, all tilt from the focal plane directly as the extreme of aperture is approached, or as the focal point is shifted from the axis. In the *Transactions* of the Astronomical and Physical Society of Toronto for 1897, Mr. J. R. Collins, in referring to Prof. Schæberle's paper, points out that it is possible to so proportion the curvatures of the reflecting surfaces of the Gregorian form of reflecting telescope (where the image is formed by the large reflector in front of the small concave mirror, and the light is thrown back to a focus on the axis through an opening in the centre of the large reflector to the eye-piece), as to completely correct the tilt and want of uniformity of dimensions of the components of the compound image, that it may reach the front of the eye-piece entirely freed from these defects. It may be remarked that the tilting of the image not only occurs in the case of the reflector, but in that of the refractor also, the effect in the latter case being twice as great as that in the former. In fact, the Schæberle aberration is a defect that exists in all forms or combinations of lenses, and must, therefore, be taken into account if we wish to attain maximum efficiency in definition.

PHOTOGRAPHY BY THE AURORA BOREALIS.—Mr. J. E. Turner, writing in *The Amateur Photographer* for May 6, describes a unique photograph which he has obtained. It seems that on April 15 Gourock was visited by a very vivid display of the aurora borealis, which lasted from 10 to midnight. The moon having set at 9.13 p.m. and not rising again until 4.5 a.m. the next morning, he thought it might be possible to get a photograph merely by the light of the aurora borealis, and he consequently exposed a plate towards the northern horizon, giving an exposure of only two minutes with f/8 and a Paget xxxxx. plate. The negative, when developed with a very weak pyro and ammonia developer for about one hour, came out well and showed clearly the nearest land that was three miles distant, together with the houses, which were clearly defined, besides numerous trees in the foreground. The photograph is reproduced in the above-named journal. It is not mentioned whether an impress of the aurora itself was obtained, but only the statement: "the stars also nearest the zenith are faintly seen, the light from the aurora, of course, obscuring them."

MR. TEBBUTT'S OBSERVATORY.—The Report of Mr. Tebbutt's Observatory at Windsor, New South Wales, for the year 1897, shows that the number of observations made is up to the standard of former years. The 8-inch equatorial was employed for observing occultations of stars by the moon, 134 phases being noted, and numerous minor planets. Perrine's comet was also diligently watched for several weeks, and many variable stars and phenomena of Jupiter's satellites observed. The meteorological observations have been as usual regularly made. Seven years' meteorological observations are now in hand, and will be soon published; and when this is completed, there will be a period of thirty-five years of published data which will be invaluable for investigating the local climate. In consequence of recent local legislation, Mr. Tebbutt writes: "A notice was sent to the Minister of Public Instruction on October 11 last, that it was intended at the close of the year to discontinue the meteorological department, and the hope was expressed that the Government would see fit to continue the work at its own expense. A reply was received stating that the work would be continued . . . at the Hawkesbury Agricultural College, about four miles west of the Observatory." Such an arrangement as this was evidently very satisfactory, for it would have been a crime to have suddenly broken the continuity of what must be valuable data for investigating the climatic conditions of New South Wales. "After due inquiry," as Mr. Tebbutt further states, "at the close of the year, it turned out, however, that provision had not been made for continuing the Windsor meteorological work in all its departments. It is proposed to continue at this observatory observations of the daily rainfall by the two gauges, and to secure the monthly maximum and minimum air temperatures." We hope that the Government will not be long in seeing that due attention must be paid to the question of meteorology in New South Wales, and that, after private enterprise has carried on the work for so many years, it becomes a duty to see that a breach in the continuity of the observations is not made through lack of funds.

SOME NEW STUDIES IN KATHODE AND RÖNTGEN RADIATIONS.[1]

THE researches of Crookes, Lenard, and Röntgen have given to man a new eye; they have, perhaps, also given to nature a new light; they have certainly given to science more than one new problem. A vacuum tube may appear but a simple piece of apparatus; but were we acquainted in their entirety with the secrets that it contains, we should know much at present utterly unknown, not only as regards electrical action, but also in reference to the fundamental constitution of matter, and the

[1] Abstract of Friday evening discourse delivered at the Royal Institution on February 4, by Alan A. Campbell Swinton.

true mechanism of energy. It is, in fact, for the reason that within the Crookes' radiant matter tube it is possible to deal, not as in every-day life with aggregates of matter, but perhaps individually with single molecules and single atoms floating apart in space, that so much attention is at present being devoted to this particular branch of physics.

Every one is now acquainted with what has become the quite ordinary phenomenon of the kathode rays. These excite luminescence in the glass upon which they fall, and cast a sharp shadow of any obstacle interposed in their path. When the tube is suitably placed in a magnetic field the shadow rotates and becomes at the same time smaller, the magnetic field having thus the property of concentrating the rays, and at the same time giving them a twist. This concentration of the kathode rays by means of a magnetic field, which has been studied by Birkeland and by Fleming, can be employed to show the intensely heating effect and erosive properties of the rays. Indeed, by suspending a tube over one pole of a straight electro-magnet, and thus concentrating the rays to a point, it is possible by moving the tube or the magnet to actually engrave on the interior surface of the glass a figure of any desired form.

The more ordinary method of producing a concentrated kathode discharge is by employing as kathode a spherical aluminium cup, from the concave side of which the rays are given off normally to the surface. By employing two such cups, connected to the two secondary terminals of an induction coil supplied with alternating electric current, and giving at the secondary terminals a pressure of about 20,000 volts, the intense heating effect of the kathode rays can readily be shown by allowing them to fall upon a small fragment of quicklime. In this manner a brilliant and beautiful light is produced, and it is not at all improbable that it may eventually be found possible to obtain in this way, commercially and practically, high voltage electric lamps of much higher efficiency than the ordinary incandescent filament lamps, and possibly even rivalling arc lamps. In both these latter it is necessary that the incandescent substance should be a fairly good electrical conductor; whereas in the kathode ray lamp there is no such limitation, and consequently there is a much wider range of available refractory substances. It is also quite conceivable that in the future an electric furnace of this nature may be found of service in some of the more delicate of chemical investigations, where it is necessary to obtain in isolated substances exceedingly high temperatures. Indeed, already, Crookes and Moissan have employed this means for turning into graphite the surface of diamonds.

It is now becoming more and more generally believed that Sir William Crookes' original theory as to the nature of these kathode rays is correct. According to this theory they consist of material particles of residual gas, which, being similarly electrified by contact with the kathode, are violently repelled by the latter. This has been the view held for a long time by most English physicists, and the chief point of difference now appears to be whether these material particles are single atoms, single molecules, or larger aggregations of matter. This theory is supported by the erosive action of the rays, which are found after a short time to bore straight and very minute holes right through the block of quicklime in the kathode ray lamp. A model, consisting of a gilded pith ball suspended between two metal plates connected to a Wimshurst machine, may be used to roughly illustrate what is supposed to occur. The ball obtains an electrical charge from whichever plate it starts in contact with, and is violently repelled into contact with the other plate, and so on backwards and forwards. In a Crookes' tube, however, the velocity of the negative stream is undoubtedly much higher than that of the positive stream. This may be connected with the fact that the positive discharge is much more dispersive than the negative. Indeed, a tube while in action appears to be filled almost entirely with positively electrified atoms, while it is only behind the kathode and in the kathode stream itself that any negatively electrified atoms are to be found. It is, however, possible to show experimentally that something, at any rate, producing the same effect as a positive stream does exist at very high exhaustions. For this purpose a radiometer tube, as shown in Fig. 1, containing a small mill wheel with mica vanes, similar to those employed by Crookes, may be used. The wheel is mounted upon a sliding carrier, so that it can be moved bodily either out into the centre of the tube, when the kathode stream impinges directly upon the vanes, or back into an annex, when the vanes are quite outside the kathode line of fire. In the former position, as discovered by Crookes, the wheel rotates with great rapidity in a direction indicating an atomic stream from the kathode to the anode. In the latter position, with sufficiently high exhaustion, the wheel is found by the author always to rotate in an opposite direction, indicating a returning stream of atoms from the anode to the kathode, the anode stream passing outside of the kathode stream. As suggested by Prof. G. F. Fitzgerald, some action of this nature will perhaps explain the curious effects obtained by the author, and already noticed in NATURE for April 15, 1897, from which it appears that both the convergent and divergent cones of kathode rays in a focus tube are usually hollow, it seeming likely that if the supply of atoms to the active kathode surface is from all round the edge of the latter, the atoms may be all shot off again from the kathode in the form of a hollow cone, before they get further than a certain distance towards the centre.

Birkeland has shown that if a thin kathode stream, obtained by passing the rays from a flat kathode disc through a narrow slit in a piece of platinum serving as the anode, is deflected by a suitable magnetic field, it is split up into bundles of rays; and if allowed to fall upon the glass walls of the tube, it gives fluor-

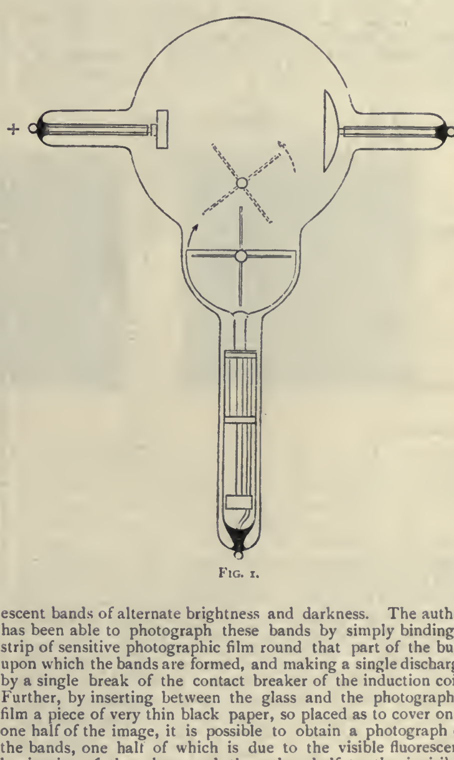

Fig. 1.

escent bands of alternate brightness and darkness. The author has been able to photograph these bands by simply binding a strip of sensitive photographic film round that part of the bulb upon which the bands are formed, and making a single discharge by a single break of the contact breaker of the induction coil. Further, by inserting between the glass and the photographic film a piece of very thin black paper, so placed as to cover only one half of the image, it is possible to obtain a photograph of the bands, one half of which is due to the visible fluorescent luminosity of the glass, and the other half to the invisible Röntgen rays. Photographs produced in this manner show that the Röntgen rays are also under these conditions given off in bands, which are co-terminous with the fluorescent bands, though photographically fainter than the latter. It is important to note that in the Röntgen ray photograph the greatest effect is always produced by the least deflected of the kathode-ray streams; that is to say, by that stream which is presumably travelling at the greatest velocity. Here we have a probable explanation of the existence of the bands, which are most likely due to the atoms of the kathode rays having from the first different velocities imparted to them, due to the oscillatory character of the induction coil discharge, and from their gathering into groups travelling at different velocities, on the well-known principle that occasions the traffic in the street to form knots of maxima and minima, owing to the faster vehicles catching up the slower, and being impeded by them.

Passing on to the production of X-rays in tubes of the ordinary focus type, it is found that the particular material employed for the anti-kathode surface considerably affects the production of the Röntgen rays. This is a subject that was first investigated by Prof. Sylvanus Thompson, who found that the best absorbents were the best emitters of the Röntgen rays; in other words, that the best materials for the anti-kathode were metals of the highest atomic weight. If, as seems probable, the Röntgen rays are produced by the sudden removal of velocity from the kathode ray atoms by collision with the anti-kathode, this is in accordance with what would be expected, as substances of high atomic weight would obviously be the most efficient by reason of the greater inertia of their atoms. The author has made numerous experiments with various metals for the anti-kathode, comparing them in a tube in which the anti-kathode, made half of one metal and half of another, was movable. By jerking the tube, either half could be brought opposite the kathode, and put into use; so that under exactly similar conditions it was possible to accurately compare the efficiency of the two substances. Of available substances, platinum was found to be much the best.

The usual method adopted for varying the resistance of a Röntgen ray tube, and thus modifying the character of the

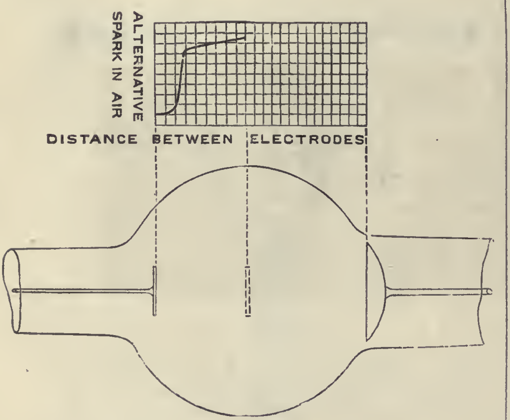

FIG. 2

Röntgen rays it produces, so as to obtain the exact penetrative quality that is desired, is by varying the vacuum. The higher the exhaustion the greater is the resistance in the passage of the discharge, the greater appears to be the velocity of the kathode stream, and the more penetrative are the Röntgen rays. This variation of the vacuum is usually effected by heating the tube, which has the effect of driving out into the interior molecules of the residual gas condensed or occluded upon the glass. Apart from this, however, it is suggested that very possibly the temperature of the contents of the tube and the consequent kinetic energy of the molecules, which is greater the higher the temperature, may in itself assist the passage of the discharge. The author has found other means of varying the resistance of the tube, and altering the character of the Röntgen rays that it generates, which do not depend upon either the degree of exhaustion or upon the temperature. According to one method the tube is fitted with two or more kathodes of different sizes, but all focussing upon the same anti-kathode. With such a tube it is found that the smaller the kathode the greater is the E.M.F. required to cause the electric discharge to pass through the tube, and the more penetrative are the Röntgen rays generated. Another method of effecting regulation consists in making the anti-kathode, which is also the anode, movable, and altering the distance between it and the kathode. Still another, in making the kathode movable, and altering its position relative to the glass walls of the tube. Some of the author's experiments in these directions have already been described in NATURE for April 29 and May 27, 1897. He has, however, now further studied the cause of these effects by means of a tube in which the positions of both anode and kathode can be altered independently by means of a magnetic adjustment. Fig. 2 shows a portion of this tube, and above it is drawn a curve representing, in terms of the alternative spark in air, the difference of potential required to cause a discharge to pass through the tube with varying positions of the anode. In the diagram the abscissæ represent the distance between anode (which also formed the anti-kathode) and the kathode, divided in tenths of an inch, while the ordinates represent also in tenths of an inch the length of the alternative sparks in air between two brass balls ¾ inch in diameter. Starting with the anode in its furthest position from the kathode, and moving it gradually towards the latter, it will be observed that at first there is a slight gradual increase in the length of the alternative spark. Then for the next small movement there is a very sudden increase, and after that a further gradual increase till the point marked in dotted lines is reached, which denotes the limit of travel that the anode was allowed. Similarly, Fig. 3 represents the effect of moving the kathode in the same tube, the anode being stationary in the position shown. Here, as will be seen, the less the distance between the kathode and anode the less is the length of the alternative spark. This distance in this case

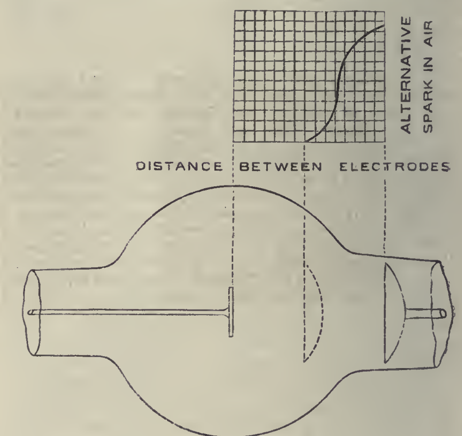

FIG. 3.

does not appear to be the determining factor, as it is more than counterbalanced by the more important factor of the position of the kathode relatively to the glass walls of the tube. Starting with the kathode as far away as possible from the anode, and moving it towards the latter, there is a gradual decrease in the length of the alternative spark to commence with, then a further, much more rapid decrease, as the kathode emerges from the annex, and a still further, but less sudden decrease, as the kathode is moved away from the glass walls out into the bulb. Now as to the effect upon the Röntgen rays, as it has been before remarked, the greater the resistance of the tube and the greater the E.M.F. necessary to cause a discharge to pass, the greater is the velocity of the atoms that form the kathode stream, and the more penetrative are the Röntgen rays produced. Further, so far as the movable kathode is concerned, the supply of atoms appears to be of great importance. If penetrative Röntgen rays are desired, the access of atoms to the kathode must be restricted. If only a few atoms can get to the kathode, these are projected at great velocity; if there is too ready access, the atoms crowd in upon the kathode, and the electrical charge of the latter is unable to throw them off with much speed. It is possible to restrict the supply of atoms to the kathode either by bringing the latter back into a recess or annex, as in the tube just shown, or by using a tube in which both kathode and anti-kathode are fixed, but in which there is a movable conical glass shield which can be brought up from behind the kathode so as to impede the access of the atoms which, as we have seen, come in round the edges of the kathode, to any desired extent. This tube regulates just as did the adjustable kathode tube.

In order to produce sharply-defined Röntgen photographs, it is of course of the utmost importance that the rays should be given off from a very small area. The sharpness of definition varies considerably with different tubes, and a ready means of judging as to their quality in this respect is very useful.

The best and most accurate method is by means of pin-hole photography. Seeing that the Röntgen rays are not refracted, photography with a lens is, of course, out of the question; but with a pin-hole, very accurate and distinct images can be obtained. It is only necessary to place a sheet of lead, pierced by a pin-hole, near the tube, and then to examine the rays coming through the hole with a fluorescent screen, placed some way behind the lead sheet, in order to see exactly the size and shape of the active area of the anti-kathode; or, instead of the screen, a photographic plate may be employed and the effect recorded. Fig. 4 shows three pin-hole photographs of the anti-kathode taken in this way, giving the effect produced with three different distances between the kathode and anti-kathode. The largest figure is produced with the greatest distance, and *vice versâ*. It will be observed that, owing to the anti-kathode being placed obliquely to the kathode, the figures are all oblique, though somewhat imperfect, conic sections; further, that when the distance between kathode and anti-kathode is great, we have a section of the divergent cone giving a hollow ring with a central spot. The ring gets smaller and smaller, and finally disappears as the distance between the electrodes is reduced, and the focus approaches the anti-kathode. It will also be noticed that where in the ring portion of the figures the kathode rays strike most normally—that is to say, at one of the two points of greatest curvature of each ellipse—the Röntgen rays are produced more actively than in the remaining portion where the kathode rays impinge on the anti-kathode more on the slant.

FIG. 4.

By some it is imagined that because the Röntgen rays are so very penetrating, therefore they are of the nature of an invisible light of great intensity, which, though not affecting the human retina, acts upon photographic plates very powerfully. This is quite erroneous, and, as a matter of fact, the photographic effect of Röntgen rays is relatively very feeble. The author has investigated this by exposing two photographic plates, respectively, to a very powerfully excited Röntgen-ray tube, screened by black paper to remove the visible luminosity, and to the light of a single standard candle. By adjusting the distances and exposures so as to obtain a precisely equal effect in both cases, he has found that the photographic power of the particular Röntgen-ray tube investigated was about one-sixtieth of one standard candle.

With regard to the true nature of the Röntgen rays, there have been many theories. There is the original suggestion of Röntgen himself, that they may possibly consist of longitudinal waves in the ether. Others have thought that they were possibly ether streams or vortices. There is a theory that they consist of moving material particles similar to the kathode rays. There is the more generally received doctrine, that they are simply exceedingly short transverse ether waves, similar in all respects to the waves of light, only so much shorter than the most ultra-violet waves hitherto known that they pass between the molecules of matter, and are consequently neither refracted nor easily absorbed or reflected by any media. Lastly, there is the theory, first suggested to the writer early in 1896 by Prof. George Forbes, and recently independently enunciated and elaborated by Sir George Stokes, which imagines them to be frequently but irregularly repeated, isolated, and independent disturbances or pulses of the ether, each pulse being similar, perhaps, to a single wave of light, and consisting of a single transverse wave or ripple, but the pulses following one another in no regular order, or at any regular frequency, as do the trains of vibration of ordinary light.

Then, again, there is the question of the mechanism by means of which the Röntgen rays are produced. They are generated by the impact of the kathode stream upon the anti-kathode, and it is now becoming more and more certain that the kathode stream consists of negatively charged atoms travelling at enormous velocity. If we accept this view, there are obviously several methods by which we may imagine the Röntgen rays being generated by the impact of the travelling atoms upon the anti-kathode. Each kathode-ray atom carries a negative charge, while the anti-kathode is positively charged, so that when the two come into contact an electrical discharge will take place between them. An electrical oscillation will thus take place in the atom just as in the brass balls of a Hertz oscillator, and transverse electromagnetic waves will be propagated through the ether in all available directions. As the electrostatic capacity of the atom must be exceedingly small, the periodicity of oscillation and the wave frequently will be enormous, while at the same time the oscillation will probably die out with sufficient rapidity to admit of only one or two complete periods. At the same time the greater the difference of potential between atom and anti-kathode at the moment of impact the greater will be the amplitude of oscillation, and the more vigorous and far-reaching the etheric disturbances.

Or we may imagine a more purely mechanical origin for the Röntgen rays. It is believed that the velocity of the kathode rays is enormous, being, as recently measured by J. J. Thomson, over 10,000 kilometres per second; and though Lodge, in his well-known endeavours to detect a movement of the ether by dragging a material body through it obtained only negative results, of course he could not possibly obtain any velocity at all comparable to this. Assuming that at the velocity of the kathode-ray atoms these do appreciably drag the ether with them, there may be some other effect produced, analogous to the atmospheric effect that is noted as the crack of a whip or a clap of the hands, as each atom hits the anti-kathode and rebounds.

Since this paper was written, the author's attention has been called to Prof. J. J. Thomson's suggestion in the *Philosophical Magazine* for February, that the Rontgen rays consist of very thin and intense electromagnetic pulses produced in the ether by the sudden stoppage by the anti-kathode of the electrified particles of the kathode stream.

Or, again, it is conceivable that the phenomenon is merely one of heating, and that the kathode stream atoms are, by impact with the anti-cathode, raised to such an enormous temperature, that they give off for a short space of time super-ultra-violet light. Taking a velocity for the atoms of 10^9 centimetres per second, as found by J. J. Thomson to be the minimum velocity of the kathode stream, and calculating the temperature to which a nitrogen atom would be raised if, when travelling at this speed, it were instantly brought to rest and the whole of its energy converted into heat in the atom itself, we have the result that the rise in temperature is no less than the stupendous figure of approximately 50,000,000,000 degrees Centigrade. This is upon the assumption that the specific heat remains constant; but allowing for this, and even allowing for the merest fraction of the energy being converted into heat in the atom itself, there is obviously an ample margin to admit of a temperature being actually obtained enormously transcending anything of which man has any knowledge. Perhaps it may be objected that it is only when we come to deal with aggregations of atoms that we can speak of heat, and that a hot atom is a physical absurdity. If, however, we look upon heat as a rhythmic dance of the atoms, perhaps we may also contemplate the possibility of a single atom executing a *pas seul*, and giving pulses to the ether at each of its movements. In any case, this difficulty disappears if we imagine the travelling particles each to consist of an aggregation of atoms. The fact that substances of high atomic weight form the most efficient anti-kathodes, lends force to the suggestion that the Röntgen rays are produced in some way by the sudden removal of velocity from the atoms that form the kathode stream, owing to the collision of these latter with the comparatively stationary atoms of which the anti-kathode is composed; while the effect observed with the pin-hole photographs of the anti-kathode, in which, as has been seen, the kathode rays that strike the anti-kathode most normally are the most effective in producing Röntgen rays, is also in accordance with this view. At the same time, the fact that in Röntgen ray photographs of Birkeland's kathode ray spectrum it is always the least deflected ray that produced the greatest photographic action, goes to show that the higher the velocity of the kathode ray atoms the more effective these latter are in generating the Röntgen rays.

More than two years have now elapsed since the date of Röntgen's discovery, and nearly twenty years since the commencement of the researches of Crookes. Here, as always, we find that "Art is long, opportunity fleeting, experiment uncertain, judgment difficult." Thus wrote the Greek Hippocrates some twenty-three centuries ago, and time has not impaired the truth of the ancient aphorism.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Junior Scientific Club met at the Museum on Wednesday, May 18. After private business, Rev. G. D. Allen exhibited his collection of European Cicindelidæ and Carabidæ. Mr. N. V. Sidgwick (Ch. Ch.) read a paper on "Tautomerism," which gave rise to a short discussion, and Dr. Gustav Mann gave an account of Miss L. Huie's further researches on changes produced in Drosera by feeding. The foods recently investigated include peptone, milk, globulin, and urea. The results previously obtained with egg albumin are confirmed by the three former foods, with important modifications. Urea acts as a poison.

CAMBRIDGE.—On June 15, honorary degrees are to be conferred on General Ferrero (Italian Ambassador), the Master of the Rolls, Mr. Leonard Courtney, Mr. James Bryce, Prof. Dicey, Sir Edward Poynter, Sir William Turner, F.R.S., the Master of Balliol, Mr. F. C. Penrose, F.R.S., Prof. S. R. Gardiner, Sir Henry Irving, and Mr. Charles Booth, author of the valuable inquiry into East-end life and poverty.

The honorary degree of M.A. is to be conferred also on Dr. Arthur Willey, Balfour student, for his excellent researches on *Nautilus*.

The General Board of Studies recommend the establishment of a University Lectureship in Chemical Physiology, but in view of the present state of the University finances the post will be without stipend from the Chest.

Dr. Joseph Griffiths has been appointed to the new Readership in Surgery, which takes the place of the suspended Professorship.

THE Report of the Council of the City and Guilds of London Institute upon the work of the Institute during last year has just been published. Before referring in detail to the several branches of the Institute's work, the Council point out that the percentage of expenditure on the teaching staff is 61·9 per cent. at the Central Technical College, and 58·2 per cent. at the Finsbury Technical College, while the average of fourteen University Colleges is 64·9 per cent. The comparison relieves the Council of any suspicion of excessive expenditure. The Research Fellowship at the Central Technical College, founded by the Leathersellers' Company during the mastership of Dr. W. H. Perkin, F.R.S., was awarded at the commencement of the summer term, with the sanction of the Company, to Mr. W. S. Gilles and Mr. F. F. Renwick, who were together engaged in investigating the oxidation products of the so-called artificial camphor. Dr. Williamson, the holder of the Salters' Company's Fellowship, has continued his investigations at the College on the actual composition of the wheat grain grown on Sir John B. Lawes's experimental farm at Rothamsted, and that of the Royal Agricultural Society at Woburn. A number of other investigations have been carried out in the engineering, physics, and chemical laboratories, and the results in many cases have been published in the technical and scientific journals. Prof. Ayrton rightly points out that the assignment of space for an electro-chemical laboratory merits attention in consequence of the rapidly growing importance of the electro-chemical industry. It is certainly time that a well-equipped laboratory was established to provide facilities for investigations in electro-chemistry.

SCIENTIFIC SERIALS.

American Journal of Science, April.—On the temperature coefficients of certain seasoned hard steel magnets, by Arthur Durward. The author examined the temperature coefficients of a large number of stout magnets seasoned according to the method of Barus and Strouhal. If the temperatures are plotted as abscissæ, and the percentage losses of magnetic moment as ordinates, the curves obtained show a slight concavity upwards in most cases, which implies that the loss of moment becomes accelerated at the higher temperatures. Some specimens show an anomalous behaviour, which can be traced to local softening of the steel, and a temperature coefficient considerably augmented in consequence.—The skull of Amphictis, by E. S. Riggs. Describes an almost complete skull in the Princeton collection from the phosphorites. It is unusually small, the length from the incisors to the condyles being ·074 m. The cranium is well expanded, showing a large and well-convoluted brain. The nasals are narrow and slender as in the civets. The genus forms a connecting link between the Mustelidæ and the Vineridæ, and supports Schlosser's theory as to their common origin.—New form of make and break, by C. T. Knipp. The ordinary form of make and break for a seconds pendulum consists of a platinum tip brushing through a mercury drop. This is subject to oxidation and other troubles. The author uses a simple spring device which is always in order, and gives a sharply defined tick for transmission. A T-shaped lever of thin sheet brass is attached to the pendulum. As it swings, each end alternately comes into contact with a fine steel spring. In the middle position, the springs are both in contact, and the circuit is established and transmits the signal.—Rhodolite, a new variety of garnet, by W. E. Hidden. During the past fifteen years there has been found from time to time, over a very limited area in western North Carolina, a variety of garnet called rose garnet. It is distinguished by the variety of its tints, by its transparency, and by its freedom from inclusions and other imperfections. Its specific gravity is 3·838. The ratio of MgO to FeO is almost exactly 2 : 1. The detailed formula is $2Mg_3Al_2(SiO_4)_3.Fe_3Al_2(SiO_4)_3$.

Bulletin of the American Mathematical Society, April.—The February meeting, in accordance with the rule lately set up by the Society, was an all-day one. This arrangement gives opportunity for not only scientific, but also social intercourse. There was a good attendance of members, and many papers were read.—The theorems of oscillation of Sturm and Klein (first paper), by Prof. Bôcher. The author states that Sturm's work (*Liouville's Journal*, 1836) has been regarded by some writers as not sufficiently rigorous, and that other methods must be substituted for his; for instance, the method of successive approximations recently employed by Picard for establishing some of the theorems. Prof. Bôcher considers that Sturm's work can be made perfectly rigorous without serious trouble and with no real modification of method. This is what he proposes to do in the present paper; in a subsequent paper he hopes to discuss the cases in which certain functions are discontinuous either within or at an extremity of the intervals within which they are considered. The paper was read at the December meeting, and within its limits appears to be a thorough discussion of the matter.—Another paper read at the December meeting is by C. L. Bouton, on some examples of differential invariants. It is founded on Lie's methods. The invariants are those occurring in projective transformations, and the treatment for the plane is given in full; the method for the corresponding solid problem is sketched in, and the results given. In the author's opinion all the invariants are new.—Papers read at the February meeting are on an extension of Sylow's theorem, by Dr. G. A. Miller.—Note on the tetrahedroid, by Dr. J. L. Hutchinson. The writer points out the connection between a certain quartic surface, discussed by him in the *Annals of Mathematics* (vol. ii. p. 158), and the above-named surface.—Note on integrating factors, by P. Sarel.—Early history of Galois' theory of equations, by Prof. J. Pierpont. This is a very interesting bibliographical paper, which treats of (1) Galois' relations to Lagrange, and (2) how Galois' algebraic theories became public. Galois' estimate of his discoveries is thus stated: "J'ai fait des recherches qui arrêteront bien des savants dans les leurs."—Reviews follow of Love's theoretical mechanics, of Schell's tortuous curves, and of Page's differential equations.—There are a few slight notes, and the useful list of mathematical publications.

Wiedemann's Annalen der Physik und Chemie, No. 3.—Conductivities of electrolytes, by F. Kohlrausch, L. Holborn, and H. Diesselhorst. The authors point out that the modern advances in the measurement of temperatures and resistances have made it necessary to redetermine the conductivities of electrolytes in terms of the units now adopted. As standard electrolytes they take solutions of sulphuric acid of density 1·223, magnesium sulphate of density 1·190, and sodium chloride saturated at 18°. The resistance of 1 cc. as a cube is 0·7398, 0·04922, and 0·21605 in the three cases, which represent the maximum conductivities of those salts at the temperature mentioned.—The foundations of the electric unit of resistance, by W. Jaeger and K. Kahle. The authors describe the methods adopted in the Physikalisch-Technische Reichsanstalt for purifying the mercury and calibrating the tubes of standard resistances. The tubes must be filled in a vacuum. The resistances show a secular diminution of about 0·00003 ohms in five years.—Absorption and emission of steam and carbonic acid in the infra-red spectrum, by H. Rubens and E. Aschkinass. The infra-red rays separated out by five successive reflections at fluospar surfaces are absorbed by carbonic acid and water vapour in thick layers. Their wave-length is about $24\,\mu$. Their absorption by the atmosphere accounts for their absence in the solar spectrum.—On the transparency of some liquids for rays of great wave-length, by the same authors. Water shows considerable absorption, but benzol is more transparent even than silver chloride.—On light nodes in a kathode ray bundle under the influence of a magnetic field, by E. Wiedemann and A. Wehnelt. When the lines of force are parallel to the axis of the tube, the kathode rays are twisted into a bundle having successive nodes. The phenomenon is completely in accordance with the projected-particle theory of kathode rays.—Visibility of Röntgen rays, by E. Dorn. Proves that the light effects seen are not due to an accommodation-strain or to electrical discharges in the neighbourhood of the observer's head.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 5.—"Observations on the Action of Anæsthetics on Vegetable and Animal Protoplasm." By J. B. Farmer, M.A., and A. D. Waller, M.D., F.R.S. Received March 9.

The object of the investigation was to observe simultaneously and comparatively the effects of certain anæsthetics (carbon dioxide, ether, and chloroform) upon vegetable and upon animal protoplasm.

Two gas chambers in series, through which anæsthetic and other vapours can be passed, contain: the first, a leaf of *Elodea Canadensis* under the microscope (× 300); the second, a sciatic nerve of *Rana temporaria* connected with an inductorium and galvanometer (or upon occasion a galvanograph).

The actual movements of chlorophyll bodies in a cell of the leaf were observed and measured by one observer, while the other took readings of the galvanometric deflections in response to excitation of the nerve. To establish comparison between the two classes of effects we took as measures:—the number of chlorophyll bodies that crossed a cobweb in the eye-piece during each successive minute, and the magnitude of galvanometric deflections at intervals of one minute, before, during, and after the action of the vapour. The number of bodies passing per minute gives measure of the rate of movement in the vegetable protoplasm, while the magnitude of successive galvanometric deflections gives measure of the mobility of the animal protoplasm.

The results obtained from a study of *Chara*, *Elodea*, and plasmodium of *Badhamia* were quite consistent, but owing to the greater ease in making a quantitative determination, *Elodea* was used for the more exact comparative experiments.

The action of carbon dioxide was to produce an initial slight acceleration, followed speedily by a complete cessation of movement. On disconnecting the CO_2 apparatus and aspirating air through the chamber the protoplasm, after the lapse of two or three minutes, began to show signs of recovery. Fitful movements of the granules first occurred, and then they soon resumed their processional motion around the cell; at first very slowly. The movement rapidly became accelerated and considerably exceeded the normal rate. This acceleration was not of long duration, and was followed by a slowing down to the ordinary speed.

The results of experiments with chloroform and ether were also given.

May 12.—"On the Connection of Algebraic Functions with Automorphic Functions." By E. T. Whittaker, B.A., Fellow of Trinity College, Cambridge. Communicated by Prof. A. R. Forsyth, Sc.D., F.R.S.

If u and z are variables connected by an algebraic equation, they are, in general, multiform functions of each other; the multiformity can be represented by a Riemann surface, to each point of which corresponds a pair of values of u and z.

Poincaré and Klein have proved that a variable t exists, of which u and z are uniform automorphic functions; the existence-theorem, however, does not connect t analytically with u and z. When the genus (*genre*, *Geschlecht*) of the algebraic relation is zero or unity, t can be found by known methods; the automorphic functions required are rational functions, and doubly periodic functions, in the two cases respectively. But no class of automorphic functions with simply connected fundamental polygons has been known hitherto, which is applicable to the uniformisation of algebraic functions whose genus is greater than unity.

The present memoir discusses a new class of groups of projective substitutions, such that the functions rational on a Riemann surface of any genus can be expressed as uniform automorphic functions of a group of this class. Groups are first considered which can be generated by a number of real substitutions of period two, whose double points are not on the real axis, and whose product in a definite order is the identical substitution. A method is given for dividing the plane into curvilinear polygons corresponding to such a group; these polygons are simply-connected, and cover completely the half of the plane which is above the real axis. Sub-groups of these groups are found, whose genus is greater than unity, and which are appropriate for the uniformisation of any algebraic curves.

The sides of the polygons, into which the half-plane is divided, are formed of arcs of circles orthogonal to the real axis.

The analytical connection between the variables of the algebraic form and the uniformising variables is given by a differential equation of the third order. A certain number of the constants in this equation have to be determined by the condition that the group of substitutions associated with the equation leaves unchanged a certain circle. When any arbitrary values are given to these constants the solution of the differential equation is termed a quasi-uniformising variable. The properties of quasi-uniformising variables, and their relation to the uniformising variable, are discussed in the last section of the paper.

Physical Society, May 13.—Mr. Shelford Bidwell, President, in the chair.—A paper by Prof. W. E. Ayrton and Mr. T. Mather, on galvanometers, was read by Prof. Ayrton. It is a sequel to *Proc. Physical Soc.*, vol. x. p. 393, and to *Phil. Mag.*, vol. xxx. p. 58. The authors suggest that in future the comparative sensitiveness of galvanometers should be expressed in terms of the number of millimetre scale-divisions per micro-ampere, when the observed image or "spot" is one metre from the mirror. Unit angular deflection is therefore 1/2000 of a radian. Further, for the periodic time, *i.e.* the time between two transits of the "spot" across some fixed point on the scale, in the *same* direction, the standard should be ten seconds. It is also proposed to reduce the factor of sensitiveness, as regards resistance, to the common basis of one ohm. The assumption is that, for a given galvanometer, the deflection per micro-ampere is proportional to the 2/5 power of the resistance of the windings. Tables accompanying the paper give complete data for a large number of galvanometers constructed during the past ten years, and it is possible to trace the improvements in sensitiveness throughout that time. The most sensitive galvanometers are the oscillographs, they have very short periods; the moving parts are small, the controlling fields very strong. They are designed to indicate the character of rapidly-varying currents. An oscillograph, as improved by Mr. Duddell, was exhibited; its period is 0·0001 sec., and its factor of sensitiveness, according to the authors' classification, is greater than any yet obtained. A distinction is drawn as to the use of the term "dead-beat." Maxwell applies it to galvanometers in which the motion is "aperiodic," *i.e.* to those in which the suspended system, before coming to rest, passes only *once* through the position of equilibrium. This meaning is retained; it is not to be confused with "quick-moving" or "short-period." A pendulum illustrating these distinctions was exhibited. As regards insulation of galvanometers and shunt-boxes, the authors now apply the "guard-wire" principle of Mr. W. A. Price. The instrument to be insulated is enclosed in a metal case provided with a terminal, to which one end of the windings is connected. The second end of the windings passes out through an ebonite bush-piece. This arrangement is said to nullify leakage and to prevent electro-static disturbance of the suspended system. In the second section of the paper, the authors calculate the limiting sensitiveness of galvanometers of the "Thomson" type. The investigation is based upon Prof. Schuster's B.A., 1894, paper; it takes into account the period of the suspended system, and the specific magnetisation of the needle. Lastly, the authors discuss the relative merits of long and short periods, *i.e.* the best "control," for galvanometers intended to indicate zero points in potentiometer operations. They conclude that if the control can be readily altered, and if the sensitiveness can be adjusted for the test, then, for rapidity of working, the "control" should be so adjusted that the sensitiveness is approximately two or three times greater than is absolutely needed for the desired accuracy. Prof. Threlfall thought the authors' method of comparing galvanometers very misleading. The results obtained in their comparison of the oscillograph (3,310,000), and the suspended-coil galvanometer (27) might be regarded as the *reductio ad absurdum* of the proposed system. The absurdity arose from the dissimilarity of the two instruments. Moreover, the proposed system ignored the fact that sensitiveness may be obtained by optical as well as by electro-magnetic means. Optical sensitiveness, owing to its greater stability, was to be preferred to electro-magnetic sensitiveness. The fundamental problem in the construction of galvanometers is an optical one; it is necessary to decide the mass and dimensions of the suspended parts so as to ensure (1) optical accuracy, and (2) electro-magnetic sensitiveness. Thus, to some extent, the weight of the mirror determines the thickness of the suspension. As an instance of what might be done by optical methods Prof. Threlfall referred to work done by himself and Mr. Brearley. (*Phil. Mag.*, 1896), in which it was possible to measure to $1{\cdot}48 \times 10^{-13}$ amperes, and, with special refinements, to 3×10^{-14} amperes. He had found that the best diameter for glass mirrors was 1·1 cms., with a weight just under 0·5 grammes. These were used with a scale at 276 cms., read by a microscope to 0·04 m.m. The course of the light was: lamp, large lens, small scale, mirror, eye-piece. The period was 25 secs., and the resistance 50,000 ohms. Even better results could be obtained by using mirrors of quartz or of blood-stone. Quartz is incomparably to be preferred to glass. Such figures indicated what could be done by optical sensitiveness, the sensitiveness that the authors ignored. It was pointed out by Prof. Threlfall that the controlling field for galvanometers of the "Thomson" type should be straight and uniform. This was best secured by using two magnets, one above and one below the needles. Prof. Perry said the authors had not asserted that a galvanometer with higher figure of merit, according to their classification, was *superior* to another of lower figure. It must be agreed that the figure they obtain is a very valuable datum for the comparison of instruments designed for similar purposes; for instance, in classifying those used by Prof. Threlfall. Mr. Duddell was to be congratulated on the extreme sensitiveness and small period of his oscillograph. Prof. Ayrton, referring to Prof. Threlfall's *reductio ad absurdum*, admitted that the criticism would carry some conviction if the two instruments were of different kinds; if, for instance, one possessed a suspended needle and the other a suspended coil. But the argument failed, because both instruments were of the suspended-coil type. In one of them Mr. Duddell had developed the advantages to be gained by reducing the air-gap. To form an opinion of electro-magnetic improvements in galvanometers it was necessary to reduce the results of all instruments to some system of classification. There was no objection, after that, to adding a good mirror, and reading by a good microscope.—The President proposed votes of thanks to the authors, and the meeting adjourned until May 27.

Chemical Society, May 5.—Prof. Dewar, President, in the chair.—The following papers were read:—The action of hydrogen peroxide on carbohydrates in the presence of iron, by C. F. Cross, E. J. Bevan, and C. Smith. The authors show that the presence of iron salts is necessary to cause the oxidation of hexoses and cane-sugar by hydrogen peroxide; the hydrogen peroxide causes a constitutional change in the hexose molecule yielding products containing the group C(OH) : C(OH). Dicarboxylic acids are produced as the result of secondary reactions.—Note on the oxidation of certain acids in presence of iron, by H. J. H. Fenton.—Properties and relationships of dihydroxytartaric acid. Part ii. Metallic salts, by H. J. H. Fenton. The salts of dihydroxytartaric acid with the alkali metals are now described.—The affinity-constants of dihydroxymaleic, dihydroxyfumaric, dihydroxytartaric and tartronic acids, by S. Skinner. On comparing the affinity constants of maleic, malonic, succinic, fumaric, tartaric, dihydroxymaleic, dihydroxyfumaric, dihydroxytartaric and tartronic acids, it appears that the affinity constant increases on introducing hydroxyl groups, and is greater for the lower members of the series of dibasic acids; the unsaturated acids have larger affinity constants than their saturated isologues.—Note on the enolic and ketonic forms of ethylic acetoacetate, by R. S. Morrell and J. M. Crofts.—The resolution of tetrahydropapaverine into its optically active components, by W. J. Pope and S. J. Peachey. The constitution which Goldschmeidt has attributed to papaverine indicates that tetrahydropapaverine has the constitution

$$\begin{array}{llllll} (OMe)C.CH : & C.CH_2. & CH. & CH_2. & CH : & CH.C(OMe) \\ \quad\quad \| & | & | & & | & \quad \| \\ (OMe)C.CH : & C.CH_2. & NH & & CH : & CH.C(OMe) \end{array}$$

The authors confirm Goldschmeidt's constitution for papaverine by showing that the tetrahydro-derivative is racemic, and have isolated the dextro- and lævo-isomerides by means of their salts with dextrobromocamphorsulphonic acid.—Molecular weights of permanganates, perchlorates, and periodates in solution, by J. M. Crofts. Molecular weight determinations of permanganates, perchlorates and periodates in fused Glauber's salt indicates that these salts have the molecular composition $M'MnO_4$, $M'ClO_4$ and $M'IO_4$.—The action of chlorine on pyridine, by W. J. Sell and F. W. Dootson. Amongst other products an addition compound of pyridine and chlorine is formed during the action of the latter upon the former.—The oxidation of paranitrotoluenesulphonic acid to dinitrostilbenedisulphonic acid and to paranitrobenzaldehydorthosulphonic acid, by R. Herz and W. H. Bentley.—Determination of molecular weights: modification of Landsberger's boiling-point method, by J. Walker and J. S. Lumsden.

Royal Microscopical Society, April 20.—Mr. E. M. Nelson, President, in the chair.—Mr. Rousselet exhibited and described a metal lamp chimney made by Mr. Pillischer, and having two openings to carry white and tinted glass.—The President exhibited and described a new monochromatic light screen trough of American invention.—Mr. H. G. Madan read a paper "On some organic substances of high refractivity available for mounting specimens for examination under the microscope." Mr. White asked if these media were suitable for histological work. Mr. Madan said piperine and quinodine had been found harmless, monobromonaphthaline and phenylthiocarbimide were not likely to injure even delicate tissues, but he thought the mixture of metacinnamene and phenylthiocarbimide approached most nearly to balsam in permanency and neutrality. Dr. Dallinger said he had specimens mounted in nearly every medium which had been mentioned, but at the present time only one of these slides was in good condition; nevertheless, it was most important that such media should be available. The President referred to a table of coefficients which he had worked out to show the comparison of the refractive indices and dispersive powers of these new media with those of some well-known glasses.—Mr. Morland exhibited about three dozen slides of diatoms.—Mr. J. J. Vezey read a short note by Mr. E. B. Stringer, supplementary to his paper on photomicrography which was read at the meeting of the Society in December last.

Mathematical Society, May 12.—Prof. Elliott, F.R.S., President, in the chair.—Mr. A. E. H. Love, F.R.S., gave an account of some fundamental properties of manifolds.—Lieut.-Colonel Cunningham, R.E., communicated a description of "the 77 squares puzzle," by Major Turton, R.E., and exhibited a cardboard specimen of the puzzle. He also reported that the *complete* factorisation of the numbers $N = 3^n + 1$, where $n = 6\nu + 3$, had now been effected by the joint work of Mr. C. E. Bickmore and himself for the following values of n (51, 57, 69, 75, 81, 93 in part, 99, 105), thus *completing* the factorisation of these numbers up to $n = 105$ (except 93 in part), those from $n = 3$ to 45, 63, 87 being previously known. These numbers include several high primes of 9, 10, 11 figures.—The President communicated a paper, by Mr. H. G. Dawson, on the numerical values of $\int_0^h e^{x^2}dx$; and one by Prof. H. Lamb, F.R.S., on the reflection and transmission of electric waves by a metallic grating. Impromptu remarks were made by the President (in connection with the figure of Pascal's theorem) and by Mr. F. S. Macaulay.

Zoological Society, May 17.—W. T. Blanford, F.R.S., Vice-President, in the chair.—Mr. Oldfield Thomas read a paper on a small collection of Mammals from Nyasaland that had been presented to the British Museum by Mr. Alfred Sharpe, C.B. Sixteen species were enumerated, mostly from North Nyasaland. Among them was a new antelope from Urori, coloured like *Cephalophus æquatorialis*, but with horns in the female, as in *C. monticola*.—A communication was read from Dr. A. G. Butler on a collection of Lepidoptera lately made in British East Africa by Mr. C. S. Betton. It contained examples of 123 species of butterflies and of 111 species of moths. Among the moths were forms which were referred to five new genera, viz. *Bettonia*, *Aclonophlebia*, *Trotonotus*, *Hameopis*, *Lembopteris*, and *Metaculasta*. Besides these new genera thirty new species were characterised in this paper.—Mr. F. E. Beddard, F.R.S., communicated a paper by Miss Sophie M. Fedarb on some earthworms from India. Four species were treated of in this paper, of which the following three were described as new:—*Perichæta cupulifera*, *P. crescentica*, and *Dichogaster parvus*.—Mr. W. E. de Winton described a new rodent of the family Anomaluridæ from the Benito River, French Congo, which was referred to a new genus *Aëthurus*, differing from both *Anomalurus* and *Idiurus* in not having any expanded flying-membranes, but resembling the former in the formation of the tail, and being more like the latter in the form of the skull. The species, proposed to be named *Aëthurus glirinus* was of the same size as *Anomalurus batesi*, grey in colour, with a black bushy tail and a thickening of the skin of the lower leg, in which are set jet-black, club-shaped hairs forming anklets.—A communication was read from Mr. Stanley S. Flower, in which he pointed out that the gecko from Penang described by Stoliczka as *Cyrtodactylus affinis* and that described by himself under the name of *Gonatodes penangensis* were identical, and that the proper appellation of the species would be *Gonatodes affinis*.

Royal Meteorological Society, May 19.—F. C. Bayard, President, in the chair.—Mr. R. H. Scott, F.R.S., read a paper on the frequency of rainy days in the British Islands. He had taken the number of rainy days in each month at forty stations for the twenty years 1876-95, and then divided that number by the total number of days in the month, and so ascertained the resulting percentage. The greatest excess of frequency is always on the extreme north and west coasts. June is the month with the least number of rainy days, but in July the summer maximum of rain occurs, bringing the well-known Lammas floods. In October the weather becomes decidedly showery, and the distribution begins to assume its winter type. November is the month with the greatest frequency of rainy days.—Mr. F. J. Brodie read a paper on the abnormal weather of January last, which was one of the most remarkable winter months on record. The month was singularly dry, with an absence of snow or sleet—a somewhat unusual feature in January even for any individual station, but far more remarkable as applying to the country as a whole. The special feature, however, was the striking absence of severe frost, the frequent prevalence of unusually mild weather, and as a result the abnormal warmth of the month, especially in the more northern parts of the kingdom. The mean temperature was generally over the whole country about 5° above the average, while at many places situated in the more northern parts of the kingdom it was more than 6° above the average. The atmospheric pressure throughout the month was also very high, the mean being from two to three tenths of an inch above the average.

CAMBRIDGE.

Philosophical Society, May 2.—Mr. F. Darwin, President, in the chair.—On the theory of order, by Mr. E. T. Dixon. All the theorems of non-metrical (projective) geometry depend solely on the conception of "order" so defined as to be independent of the idea of "before or after," which belongs only to time. It follows from this definition that no "order" can be ascribed to less than four units in any uniform group: and this is why less than four points have no "projective relation" or an harmonic ratio. The paper further discusses the way in which numbers (or coordinates) may be assigned to the units of a group for purposes of analysis, with or without a system of "unique" lines having already been determined.—On the representation of a function, by Mr. H. F. Baker.—On the total eclipse of the sun, January 22, 1898, by Mr. H. F. Newall. A general account was given of the observations made during the recent eclipse, and photographs were exhibited, showing: (1) the general appearance of the corona; (2) the spectrum of the sun's limb as photographed with prismatic cameras by Sir Norman Lockyer's party, and by Mr. Evershed; (3) the spectrum of the sun's limb as photographed with a slit spectroscope.—Captain E. H. Hills, R.E., exhibited and described the photographs obtained by him of the spectrum of the corona, and also the two series of photographs of the spectrum of the sun's limb at the beginning and end of totality.

PARIS.

Academy of Sciences, May 16.—M. Wolf in the chair.—The Secretary announced to the Academy the loss it had sustained by the death of M. Souillart, Correspondant in the Section of Astronomy.—On the impossibility of certain series of groups of points on an algebraic surface, by M. Émile Picard.—On some causes of uncertainty in the exact estimation of carbonic acid and of water vapour, diluted with large volumes of air or inert gases, by M. Armand Gautier. It is shown that potash, even when spread over long columns of glass beads, is incapable of removing the last traces of carbon dioxide from air. This, however, is readily accomplished by the use of a U-tube containing moistened baryta. The increase of weight of a phosphoric anhydride tube after passing through it large volumes of air dried over sulphuric acid was also determined, the amount being of the order of 0·4 mgr. for 100 litres of air. An attempt was made to estimate the maximum amount of sulphuric acid vapour carried away by 100 litres of air, and the conclusion drawn that at ordinary temperatures the vapour pressure of sulphuric acid in air must be less than one twenty-millionth.—On an absolute actinometer, by M. A. Crova. The instrument described is a modification of those proposed by M. Knut-Angström and M. Chwolson, consisting of a thin disc of pure copper, suitably protected from accidental radiations, and placed normally to the sun's rays, the temperature being measured by the resistance of a thin constantin wire.—Agglutination of the bacillus of true tuberculosis, by M. S. Arloing. Certain serums have the power of causing the bacilli of true human tuberculosis to cohere. An attempt will be made to see whether this property can be applied to the diagnosis of tuberculosis in man, analogous to the method now used for typhoid fever.—On the development of the disturbance function, by M. Adrien Féraud.—On the quadratic and rational correspondence of two plane figures, and on a remarkable substitution, by M. Ernest

Duporcq.—On the Hamiltonian groups, by M. G. A. Miller.—On the liquefaction of hydrogen and of helium, by M. James Dewar (see NATURE, p. 55.) On a Crookes' tube which can be revivified by osmosis, by M. P. Villard. A platinum tube is fixed to one end of the glass part of a Crookes' tube. When after repeated use the resistance of the tube becomes too high, the platinum tube is heated with a Bunsen burner, the hydrogen of the flame penetrates the tube, and in two or three seconds the tube is fit for use again.—On a property of fluorescent screens, by M. P. Villard. If an object is placed between the Crookes' tube and the screen, the latter illuminated for some time, and then the object removed, it is found that those parts of the screen previously protected by the interposed object are more luminous than the others.—On the molecular weights of the easily liquefiable gases, by M. Daniel Berthelot. Starting with the theorem that the molecular weights of gases are proportional to their limiting densities when the pressure is infinitely small, from the experiments of M. Leduc, the true density ratios of oxygen, carbon droxide, nitrous oxide, hydrochloric acid, acetylene, phosphoretted hydrogen, and sulphur dioxide are determined, the precision being, in the opinion of the author, equal to that obtained by the best chemical methods.—On the preparation and properties of anhydrous beryllium fluoride, and the oxyfluoride of beryllium, by M. P. Lebeau. The product obtained by drying in air the substance given by the solution of beryllium hydrate in hydrofluoric acid is an oxyfluoride, $5BeF_2.2BeO$, and the anhydrous fluoride cannot be obtained in this way. The latter, however, can be obtained in the pure state if the drying be conducted in a stream of gaseous hydrogen fluoride.—On a method of preparing potassium carbonyl-ferrocyanide synthetically, by M. J. A. Muller. Potassium ferrocyanide, heating in closed vessels with carbonic oxide at 130°, gives in less than forty-eight hours 90 per cent. of the theoretical yield of $K_3Fe(CN)_5CO$.—On a new unsaturated tertiary alcohol, dimethylheptenol, by M. Ph. Barbier.—Ethanepyrocatechol and its derivatives, by M. Ch. Moureu.—On the presence of the common eel in the open sea, by M. Léon Vaillant. The eel was found in the stomach of a sperm whale, and is of interest in furnishing an undoubted proof that the eel descends to the sea.—On the development of *Alpheus minor*, by M. H. Coutière.—Origin of the structure of lenticels, by M. Henri Devaux. The observations given show that the lenticel is a small region continually accommodating itself to the conditions of external moisture.—On the origin of the thallus of the Cutleriaceæ, by M. C. Sauvageau.—On the *Septoria graminum*, destroying the leaves of wheat, by M. L. Mangin.—Insertion of the base of the nerve fibre on the limiting margin of an adult nerve axis, in the form of a continuous epithelial sheet, by M. J. Renaut.—Some micro-organisms of soured wines, by MM. F. Bordas, Joulin and de Raczkowski.—Some periscopic glasses, by M. Ostwalt.—Variations in the pressure and horizontal components of the wind governed by the moon. Discussion of the formulæ: generation of depressions, by M. A. Poincaré.—Earthquakes of May 6, 1898, documents by M. Jullien of Chambéry, M. Guerby of Annecy, M. André of Saint-Genis-Laval, and M. Soret of Geneva, communicated by M. Mascart.

DIARY OF SOCIETIES.

THURSDAY, May 26.

Royal Society, at 4.30.—On the Cytological Features of Fertilisation and Related Phenomena in *Pinus silvestris L.*: V. H. Blackman.—The Skeleton and Classification of the Calcareous Sponges: G. P. Bidder.—On Surfusion in Metals and Alloys: Prof. Roberts-Austen, F.R.S.—Note on the Complete Scheme of Electrodynamic Equations of a Moving Material Medium, and on Electrostriction: Dr. J. Larmor, F.R.S.—Aluminium as an Electrode in Cells for Direct and Alternate Currents: E. Wilson.—Contributions to the Study of "Flicker": T. C. Porter.—On the Kathode Fall in Gases: Dr. Capstick.

Royal Institution, at 3.—Heat: Lord Rayleigh.

Institution of Electrical Engineers, at 8.—The Design of Electric Railway Motors for Rapid Acceleration: Prof. Charles A. Carus-Wilson.

FRIDAY, May 27.

Royal Institution, at 9.—Sir Stamford Raffles and the Malay States: Lieut.-General the Hon. Sir Andrew Clarke.

Physical Society, at 5.—A Simple Interference Method of Reducing Prismatic Spectra: Mr. Edser and Mr. Butler.—Some further Experiments on the Circulation of the Residual Gaseous Matter in Crookes' Tubes Campbell Swinton.

SATURDAY, May 28.

Royal Institution, at 3.—The Biology of Spring: J. Arthur Thomson.

Geologists' Association (Liverpool Street Station, G.E.R.), at 11 45.—Long Excursion to Aldeburgh and Westleton. Directors: W. Whitaker, F.R.S., F. W. Harmer, and E. P. Ridley.

WEDNESDAY, June 1.

Entomological Society, at 8.—The Lepidoptera Heterocera of China and Japan: J. H. Leech.—The Moths of the Lesser Antilles; Sir Geo. F. Hampson, Bart.

THURSDAY, June 2.

Royal Institution, at 3.—Modern Methods and their Achievements in Bacteriology: Dr. E. E. Klein.

Linnean Society, at 8.—Notes on some Lories: Prof. St. George Mivart, F.R.S.—A Revision of the Genus Symblepharis: E. J. Salmon.—On the Food of the Uropoda: Surgeon-Captain H. A. Cummins.

Chemical Society, at 8.—The Action of Ether on Organic Acids and on Carbohydrates in Presence of Hydrogen Bromide: H. J. H. Fenton and Mildred Gostling.

FRIDAY, June 3.

Royal Institution, at 9.—The Development of the Tomb in Egypt: Prof. W. M. Flinders Petrie.

Geologists' Association, at 8.—Fossil Sharks and Skates, with special reference to those of the Eocene Period: A. Smith Woodward.

SATURDAY, June 4.

Royal Institution, at 3.—The Temples and Ritual of Asklepios at Epidaurus and Athens: Dr. R. Caton.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Electro-Dynamics: Prof. C. A. Carus-Wilson (Longmans).—Bulletin of Miscellaneous Information, 1897 (Darling).—The Scientific Memoirs of Thomas Henry Huxley, edited by Profs. M. Foster and E. Ray Lankester, Vol. 1 (Macmillan).—Creation Records discovered in Egypt: G. St. Clair (Nutt).—Catalogue of the African Plants collected by Dr. F. Welwitsch in 1853–61: W. P. Hiern, Part 2 (British Museum).—List of the Types and Figured Specimens of Fossil Cephalopoda in the British Museum (Natural History): G. C. Crick (British Museum).—Elements of Descriptive Astronomy: Prof. H. A. Howe (Philip).—Manual Training: Woodwork: G. Ricks (Macmillan).—A Simplified Euclid Book I.: W. W. Cheriton (Rivingtons).—Syllabus der Pflanzenfamilien: Dr. A. Engler, Zweite, umgearbeitete Ausgabe (Berlin, Borntraeger).—Die Vegetation der Erde, II. Grundzüge der Pflanzenverbreitung in der Karpethen: F. Pax, I. Band (Leipzig, Engelmann).

Pamphlets.—Per la Storia della Meteorologia in Italia: P. G. Boffito (Torino).—Essai sur la Théorie des Machines Electriques a Influence: Prof. V. Schaffers (Paris, Gauthier-Villars).—Versuch einer Darstellung der Empfindungen: W. Przibram (Wien, Hölder).

Serials.—Journal of the Chemical Society, May (Gurney).—Zoologist, May (West).—Himmel und Erde, Mai (Berlin).—History of Mankind: F. Ratzel, translated, Part 26 (Macmillan).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1898, No. 4 (Bruxelles).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. 42, Part 2 (Manchester).—L'Anthropologie, Tome ix. No. 2 (Paris).—Monthly Weather Review, February, (Washington).

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THURSDAY, JUNE 2, 1898.

SYSTEMATIC BACTERIOLOGY.

System der Bakterien. Handbuch der Morphologie, Entwickelungsgeschichte und Systematik der Bakterien. Allgemeiner Theil. By W. Migula. Vol. i. Pp. 368; 6 plates. (Jena: Gustav Fischer, 1897.)

APPLIED or technical bacteriology in recent years has developed so rapidly, that in the rush after new discoveries the study of systematic bacteriology has been almost entirely neglected. With the introduction of Koch's methods the separation of bacteria was made an easy matter, and when it became evident that a large number of pathological lesions are caused by micro-organisms, bacteriology was introduced into the medical laboratories, and undoubtedly the pathological bacteriologist has greatly advanced our knowledge of the action of bacteria in health and in disease. Until Pasteur appeared, those lowly organisms had been unobtrusively studied in botanical laboratories, but the discoveries of this immortal genius revealed to all how great a share the bacteria have in the preservation of health and the causation of disease, in the sorrows and pleasures of life. Discovery after discovery in the causation of disease has led to triumph after triumph in prevention and cure; the study of fermentation has led to the perfection of important industries, and even now an appeal is made to the bacteria to keep our surroundings in a good sanitary condition. Bacteriology was so keenly studied by medical men that at one time there was almost a danger lest all micro-organisms were regarded as our foes, and yet their friendly acts greatly outweigh the harm that they do to us. Now, however, this is fully recognised, and just as at one time disease-producing bacteria were searched for, so at present the tendency is to seek after useful micro-organisms and to sing their praises. In this country, as usual, we are slow to encourage the study of applied bacteriology; in our midst it is yet fighting its way into medicine, and there is still an appalling ignorance of bacteriology even amongst the youngest physicians and surgeons; the British brewers are just beginning to see what Denmark and Germany saw years ago, and in agriculture we pin our faith on lectures and feeble examinations instead of opening research laboratories for the study of bacteriology as applied to the dairy and the soil. However, the records of other countries show us what practical bacteriology has achieved in a short time.

The never-ceasing discovery of new bacterial forms by men who have no knowledge or sympathy with systematic botany has led to serious confusion, especially in medical circles. It is their practice to describe an organism, at once to give it a name, often derived from the lesion it produces, and to claim for it a specific place in nature, without attempting to define its proper position in a systematic classification. The confusion about the choleraic vibrio is not yet entirely cleared away; thirty and more varieties have been described as different species, and now in the case of the diphtheria bacillus the number of pseudo-forms increases rapidly. The medical bacteriologist is too much influenced by simple staining reactions, and morphological appearances or biological and chemical phenomena, and he distinguishes species by most inadequate tests. It is therefore a matter of congratulation to be able to welcome two works on bacteriology, founded upon botanical principles, such as Prof. Migula and Prof. A. Fischer have offered. Here we shall speak only of Prof. Migula's "System of Bacteriology."

The author begins with a concise critical account of the historical development of systematic bacteriology from Leeuwenhoek to our present time. It must be a relief to many that Prof. Migula considers it almost useless waste of thought to ponder over the question whether bacteria are plants or animals; since they must be placed somewhere, we may without hesitation classify them among the plants, not because they possess a vegetable nature, but because their nearest living allies are found among the plants. The different systems proposed by Cohn, Zopf, Flügge, de Bary, Hüppe, Eisenberg, Miquel, Fischer and others are discussed and criticised. A classification on the principle of fructification is impossible, because we cannot honestly accept the existence of arthrospores, and thus there is no *fundamentum divisionis*; nor can we classify bacteria according to their chemical, physical and physiological properties, as proposed by Eisenberg. Prof. Migula justly repudiates the extraordinary artificial and unnatural system of Miquel, which was founded upon the constancy of physiological properties. As it is a habit of medical bacteriologists, even at the present time, to distinguish species or varieties on such a principle, which has also been ably criticised by Prof. Marshall Ward, we advise them to glance at pp. 42 and 43, which should convince them of their error. Prof. Migula's system is as follows:—

BACTERIA.

Family I.—Coccaceæ.

Species 1. Streptococcus = division in one plane.
2. Micrococcus = division in two planes.[1]
3. Sarcina = division in three planes.
4. Planococcus = division in two planes; flagella.
5. Planosarcina = division in three planes; flagella.

Family II.—Bacteriaceæ.

Species 1. Bacterium = no flagella.
2. Bacillus = completely surrounded by flagella.
3. Pseudomonas = polar flagella.

Family III.—Spirillaceæ.

Species 1. Spirosoma = no flagella; rigid.
2. Microspira = 1, or 2–3 polar flagella; rigid.
3. Spirillum = 5–20 polar flagella; rigid.
4. Spirochæte = no flagella; flexible.

Family IV.—Chlamydobacteriaceæ.

Species 1. Streptothrix.
2. Cladothrix.
3. Crenothrix.
4. Phragmidiothrix.
5. Thiothrix.

Family V.—Beggiatoaceæ.

Species Beggiatoa.

The morphology of the bacterial cell is carefully described, and considerable attention is paid to the cell-membrane, which, according to Prof. Migula, is directly

1 It is pleasing to note that the term "staphylococcus" does not occur this system.

continuous with the flagella where they exist. The latter cannot be traced into the substance proper of the cell, a statement which the writer of this review, from his own studies, especially on the bacillus of tetanus, is not prepared to accept. The question whether bacteria possess a nucleus is discussed at length, and the author concludes that true nuclei have not been detected, and it is improbable that they exist. All the granules or structures hitherto described as nuclei, cannot possibly be regarded as such; this is clearly shown by Fischer's researches on bacterial plasmolysis. In studying the minute details of the bacterial cell, Prof. Migula rightly insists upon the absolute necessity of starting from the normal living micro-organism. Extremely interesting is the masterly discussion of the nature of the granules and vacuoles observed in the substance of the bacterial cell, of the origin of polar staining and segmentation. In this section the subject of plasmolysis is carefully considered. The granules so frequently observed he regards as the rudimentary nucleus of the bacterial cell, but he frankly admits that this view is based entirely on personal opinion. One of the best portions of the book is the section on the flagella, which recently have been diligently studied also by Fischer, who has proved that these fascinating structures are the motor-organs of the mobile micro-organisms, and who has attempted to classify the bacteria according to the arrangement and distribution of their flagella. Prof. Migula concludes that all flagellate schizophytes, excepting Spirochæta and Beggiatoa, are bacteria, and that different species belonging to the same family can be distinguished by their flagella; and herein all who have experience of flagella staining will agree with him: the number of flagella, their mode of insertion, and their shape and curves—all these points must be noted.

The growth and division of the bacterial cell is described with eloquent fulness. The mode of division is a generic character in the coccaceæ; it is constant, and a coccus dividing in one plane by no manner of means can be made to divide in two or three planes. But, furthermore, it is a fundamental distinctive feature between the coccaceæ and the other bacteria; for the latter divide only in one plane, and the division is always preceded by an elongation of the cell in a direction at right angles to the plane of division. Until recently it was stated that cocci are as long as they are broad, and that by such measurements they can be distinguished from the bacteria; but Prof. Migula insists that we must abandon this unsatisfactory distinction in favour of the one just enunciated. The bacteriaceæ always divide at right angles to their long axes, and we must therefore take exception to the statements, recently made in certain quarters, that the diphtheria bacillus divides parallel to its long axis. Of the branching of streptococcus chains he gives two satisfactory explanations: (1) occasionally in a long chain a coccus becomes twisted so that its plane of division is turned in a different direction; (2) a few links in the chain die, and are overgrown by the survivors. This branching therefore does not signify a mycelial ancestry. After division has taken place, the organisms may be arranged as diplo-cocci, strepto-cocci, tetra-cocci, or as sarcinæ; but it is absurd to use the terms diplo- and tetracoccus as generic ones, for many organisms belonging to different genera may present all these forms. The chapter on spore formation occupies fifty-three pages, and is a masterly account of the subject, from which a few points may be quoted. The so-called arthrospores cannot be distinguished from ordinary vegetative cells, and cannot therefore be regarded as spores, so that the endospore is the only recognised spore. Physiological properties, such as resistance against heat, desiccation, or antiseptics cannot decide the nature of a spore; the only true criterion is germination, a process differing in essence and in principle from ordinary vegetative proliferation by division. The formation and structure of the spore are described with a wealth of detail which omits no important fact. Broadly speaking, germination may occur in three ways: (*a*) the membrane of the spore remains unruptured, either persisting as the membrane of the young bacterium, or being dissolved during the process of germination; (*b*) the spore-membrane is ruptured at one or other pole, allowing the young bacterium to glide out; or (*c*) it is ruptured equatorially; but in each case there are numerous minor variations and deviations from the type, depending partly upon the conditions under which the germination is observed. A nucleus so far has not been demonstrated in the spore, although recently Hegler claimed to have done this. We must fully agree with Prof. Migula when he expresses the opinion that so long as we are ignorant of the natural conditions of bacterial growth, we are not in a position to use the faculty of spore formation for the purpose of systematic classification, for many bacteria which at present are described as asporogenous under more natural conditions than the gelatine or agar-agar tubes can supply, may actually form spores.

Everybody will turn with interest to the chapter on Pleomorphism and Variability, which opens with a historical account of the views held since Nägeli's time. Nägeli in almost unpardonable and unintelligible manner ignored all morphological and physiological characters of the bacteria, and became the master of the reckless apostles of pleomorphism. Their creed led the philosophic Buchner into the almost amusing error of proclaiming the identity of the hay bacillus and the anthrax bacillus, and caused the illustrious Billroth to blunder with his *Coccobacteria septica*. Prof. Migula insists that species must be determined by identity in development and growth and constancy of morphological characters; but as yet our microscopes are not perfect enough to detect the minutest morphological differences, and therefore for the present, in many cases, we must fall back upon biological characters. Varieties are by no means constant, and widely different forms may constitute a species. It is impossible here to discuss the question more fully; those who take an interest in such matters must consult the original.

In the last 100 pages the biological characters of the bacteria are discussed; the different nutrient media and the methods of cultivation; the formation of pigments (which are subdivided according to their solubility in water and alcohol); the products of fermentation and of metabolic activity, and the pathogenetic properties of the bacteria. To the medical bacteriologist the chapter on infective micro-organisms is an important one. For practical purposes it is proper to distinguish between pathogenetic and non-pathogenetic organisms, but this distinction cannot be recognised in systematic bacteriology. Prof. Migula invites the botanist to follow the methods of the medical bacteriologist in the study of bacterial diseases of plants, which he regrets in most cases has been undertaken in a slipshod and careless manner. He gives a number of plant diseases, said to be due to bacteria, to expose the manner in which the subject hitherto has been approached. Anaerobiosis and phosphorescence, the thio-bacteria and ferruginous bacteria form the subjects of the next few chapters, and then we come to an interesting and concise account of the nitro-bacteria; the volume is concluded by two short chapters on the influence of heat and light on bacterial growth.

We may disagree with the author here or there, but we, and especially the medical bacteriologists, must welcome the appearance of this work. The volume is the result of Prof. Migula's own labours and studies pursued for many years with true German industry, and this enhances its value considerably. It is well written, and the language is not particularly difficult; the literary references at the end of each chapter are excellent. It is impossible to read the book without regretting that the second volume has not yet appeared. Six plates accompany the text, but, by an oversight, plates iv. and v. have been placed and numbered in wrong order, and must be transposed. A. A. KANTHACK.

THE PHYSICAL PROPERTIES OF CRYSTALS.

Die fundamentalen physikalischen Eigenschaften der Krystalle in elementarer Darstellung von Dr Woldemar Voigt, o.ö. Professor der Physik an der Universität Göttingen. (Leipzig: Veit and Co., 1898.)

PROF. VOIGT is well known for his researches into the physical properties of crystals. Not only is the mathematical theory of large parts of the subject due to him, but the experiments on which the theory is built were largely made by himself and Prof. Riecke, and many of the instruments used were invented or improved by him. His latest contribution to the science is a little book, half-way between a popular exposition and a technical treatise. Last year Prof. Voigt lectured at Göttingen on crystals to teachers in the upper classes of secondary schools, and these lectures form the basis of the book before us.

Prof. Voigt is a mathematician, and though the mathematics is here reduced to a minimum, he assumes a knowledge of the elements which his hearers doubtless possessed. A command not of facts and formulæ, but of mathematical and physical ideas and terms is required for a satisfactory study of the book. In particular, some familiarity with the use and transformation of coordinates is essential. In England, where the knowledge of elementary mathematics is widely spread, this little volume ought to find many readers, and a good translation is to be desired.

We have before us no mere text-book, but a book with an idea and a plan. Round the idea the facts are grouped, and one is carried on naturally from one set of properties to another. After a preliminary chapter on the symmetry of crystal forms, the leading idea is developed in the second chapter. Prof. Voigt points out that, in investigating the relation between cause and effect, it is allowable to treat not only effects but causes as states of matter. For instance, electric phenomena produced by heat may be regarded as the relation between the temperature and the electrical state of a body. Temperature is determined by a scalar quantity, and the electrical state of any particle by a vector. This vector is, moreover, a so-called polar vector, *i.e.* one, like a translation, whose components change sign when the sense of all the coordinate axes is changed, in contradistinction to a so-called axial vector, whose components retain their signs. Temperature involving no direction, the direction of the vector can only be determined by the crystalline structure, and we should expect such a relation to be possible in acentric crystals possessing one single polar axis of symmetry, such as tourmaline. In fact, the pyro-electric properties of tourmaline have been known for 200 years.

Besides scalars and vectors there is a third kind of quantity, by which a state of tension or dilatation is characterised. It is determined by a magnitude and a straight line, undetermined in sense. Prof. Voigt calls such a quantity a *tensor*, and three mutually perpendicular tensors a *tensor-tripel*, giving in the preface his reasons for the adoption of a new term, and pointing out that in doing so he is merely extending the use of the word in quaternions. By means of these three kinds of quantities and their mutual relations, he is able to classify, in the manner indicated, the different phenomena. In every case we have two effects due to the same cause, and the primary effect is taken to represent the cause in its relation to the secondary effect. Each chapter after the second exhibits such a relation. We have an example of the relation between a scalar and a tensor-tripel in that between temperature and deformation, between a vector and a tensor-tripel in piëzo-electricity, and numerous examples of two vectors; elasticity is treated as a relation between two tensor-tripels.

The method gives more than a mere classification, as the example shows. It enables us to say *à priori* whether a given body, isotropic or crystalline, is capable of exhibiting certain phenomena. In general the phenomena which are *à priori* possible, are *à posteriori* known to exist. In one case, however, referred to in Chapter iii., a set of phenomena represented by the relation between a scalar and an axial vector, theoretically possible in a large class of crystals, has never been observed, and it remains open to question whether the failure to observe pyromagnetic phenomena is due to an unknown point of theory or to unsuspected difficulties of observation.

In the chapter on the symmetry of crystals, Prof. Voigt takes three typical forms—Iceland spar (rhombohedron), tourmaline, and quartz—and he derives the two latter from the former by the simple process of joining together two "half rhombohedra." In spite of three excellent figures, the explanation would not be comprehensible without previous knowledge of the way in which the rhombohedra are to be divided. Even the simplest crystal forms are hard to understand without a model, and one could wish, in addition to the figures, for diagrams of models to be made in folded paper.

One purely external fact may be noted about the book: unlike most foreign publications, it can be bought neatly bound in buckram.

W. H. AND G. CHISHOLM YOUNG.

MODERN DEVELOPMENT OF THE ATOMIC THEORY.

The Arrangement of Atoms in Space. By J. H. Van 't Hoff. Second revised and enlarged edition, with a preface by Johannes Wislicenus, &c.; translated and edited by Arnold Eiloart. Pp. xi + 211. (London: Longmans, Green, and Co., 1898.)

THE history of the development of that department of science which it is now usual to call stereo-chemistry is extremely interesting. While it shows that great results often spring from small beginnings, it also shows that although genius may discern in apparently trivial phenomena the basis of very far-reaching ideas, it requires the united efforts of a large number of workers both to extend the applications of the idea and to render its foundation firm and secure. In 1848 Pasteur discovered that racemic acid, itself possessing no action on a ray of polarised light, is resolvable into two acids, each of which rotates the plane of polarisation in equal but opposite directions, and that this property of optical activity is associated with hemihedrism in the crystalline form. Not till more than a quarter of a century later, namely in September 1874, did Van 't Hoff give to the world his ideas on the representation of chemical structure in space. Two months afterwards similar views were put forward by Le Bel. So far as it obtained any notice at all, the new theory was received chiefly with ridicule. It is now accepted by the whole chemical world.

Nearly all the difficulties attending the new doctrine were cleared away in Van 't Hoff's "Dix Années dans l'histoire d'une théorie" (1887), and since that time a new chemical literature has sprung up devoted to the exposition of the doctrine and its application to the large number of examples now known. This little book will be useful to students looking at the subject from the theoretical point of view. And perhaps it supplies all that is really desirable, inasmuch as it provides freely references to the original papers of the numerous chemists who have worked experimentally upon the subject; and so, perhaps, the lack of detail as to methods is less likely to be felt. Dr. Eiloart, the translator of the volume, is known as an investigator of stereo-chemical problems, and he has published a useful "Guide to Stereo-chemistry," based on lectures delivered by him a few years ago in the Cornell University. The translation may be therefore trusted to represent accurately the views and intention of the author. The worst that can be said is that the exposition is in some places rather scanty, as, for example, in all that relates to the supposed configuration of the nitrogen atom, no alternative views being considered. There is an interesting appendix, containing a note by Prof. A. Werner, of Zürich, on the application of stereo-chemical ideas to the isomerism of metallic compounds, more especially to the plato-ammines and cobalt-ammines. The configuration of the groups MA_6, in which M is the metal and A the group NH_3 or some negative radicle, is represented by a regular octahedron, the metal occupying the centre, and the groups having their places at the solid angles. This accounts for the existence of two isomeric forms of these compounds, but the reader is left to find out for himself in what manner the ionisable radicles which enter into the composition of the salts are attached to this octahedral arrangement. It is interesting to find that the possibility of applying stereo-chemical ideas to elements other than carbon and nitrogen is at last beginning to be recognised by chemists. W. A. T.

OUR BOOK SHELF.

The Linacre Reports. Vol. iii. 1895–1897. Edited by E. Ray Lankester, M.A. (London: Adlard.)

THIS volume contains eighteen papers published by Prof. Lankester and his staff at Oxford since the summer of 1895, together with the reports of the teaching in the department over which he presides, and a list of the zoological additions to the Museum during the past two years.

As a record of work done in the laboratory at Oxford it compares favourably with the two volumes which preceded it, and proves that the energy and perseverance in research of the Oxford zoologists still form one of the most gratifying features of the science schools of that University. Although one-half of the papers in the volume deal with the morphology of segmented worms, the others treat of animals in widely separated classes, showing that under the guiding influence of Prof. Lankester the school is not likely to suffer from the spirit of hasty generalisation on the one hand, nor from the evils of narrow-minded specialisation on the other.

Two papers by Mr. Goodrich on the Cœlom theory and on the homologies of the Annelid prostomium can be compared with Prof. Benham's papers on certain Earthworms. The former may be taken as admirable examples of biological reasoning and clear statements of views, the latter as examples of laborious and valuable investigations of anatomical details. Prof. Lankester may be heartily congratulated upon this further proof of the stimulating influence of his teaching, and upon the skill and zeal of his friends and pupils at Oxford.

S. J. H.

Anatomia Vegetale. By Dr. F. Tognini. Pp. 274 (Milan: U. Hoepli, 1897.)

Fisiologia Vegetale. By Dr. L. Montemartini. Pp. 230. (Milan: U. Hoepli, 1898.)

THESE two handy little manuals are both apparently largely based on the "Lehrbuch der Botanik" by Strasburger, Noll, Schenck and Schimper. The vegetable anatomy, by the late Dr. Tognini, is a good account of the leading features of the science. More attention is devoted in it to the histology of plants than to their gross anatomy. The small size of the book necessitates a sketchy treatment of the subject, and the descriptions in several instances are meagre. Thus the structure and arrangement of the bast is dismissed in a few words, while scarcely anything at all is said of the changes which take place in the sieve-plates. However, much accurate information is contained in the book, and a great deal of the results of recent investigations are included in it. The illustrations are good and numerous; they are to a large extent either drawn specially for the work, or are taken from Briosi and Tognini's work on *Cannabis sativa*.

Dr. Montemartini has succeeded in getting a large quantity of sound information into his short treatise on "Plant Physiology," and he has made it more useful by citing the chief literature of each subject in a list at the end of each chapter. It is curious to note that he quotes the ringing experiment, as used by Hales, to demonstrate the ascent of water in the wood. In the "Vegetable Statics," however, this experiment is described to prove that there is no great downward motion of water in the bark. With regard to the problem of the ascent of water in trees, Dr. Montemartini accepts the hypothesis which maintains that the sap is drawn up in a tensile state. In each section the principal facts are well described, and the book is well up to date. The section on growth is perhaps the best in the book, and contains a short account of the author's own researches. The last section in the book is on reproduction, and too short to be of much use.

Glass Blowing and Working. By Thomas Bolas. Pp. 212. (London: Dawbarn and Ward, Ltd.)

CONSIDERING the practical importance of glass-blowing, not only in physical and chemical laboratories but in many manufactures, it is remarkable that so few works have been written on the subject. English students are practically restricted to Mr. Shenstone's well-known little book, and the chapters in Prof. Threlfall's "Laboratory Arts." The present work, which is based upon a course of lectures given by the author in connection with the Technical Education Committee of the Middlesex County Council, is quite distinct in character from either of these, and in some respects, perhaps, is less suitable for a beginner. The opening chapters are devoted to glass-working tools, the most important of which, of course, are the blowpipe and the bellows. The remarks on these are practical and lucid, the author showing that the ideal blowpipe and bellows differ considerably from those usually found in chemical and physical laboratories. The chapter on minor tools and appliances is very full, although many of the instruments described are but rarely used by professional glass-blowers. The chapters on glass manipulation contain nothing essentially new, the only points which seem somewhat unorthodox to one accustomed to the German style of glass-blowing being the method of making the inside seals in "traps," and the use of lead glass. The author is a strong advocate of the use of the latter, and indeed regards the blackening in a reducing flame as a positive advantage to the beginner, as compelling him to work with a flame in which the combustion is complete. The latter part of the book gives instructions for making small decorative articles at the blowpipe, with notes on the preparation of enamels and coloured glasses. Many useful recipes are given throughout the book, mostly published for the first time, of which the various inks for etching and printing on glass may be specially mentioned. If only as a collection of practical hints, the book is certain to be found on the shelves of all amateurs in this fascinating art.

Experimental Mechanics. By G. H. Wyatt, B.Sc., A.R.C.S. Handbooks of Practical Science, No iii. Pp. 54. (London: Rivingtons, 1898.)

A NUMBER of simple experiments in mechanics, most of them quantitative, are described in this book. The experiments are capable of being performed by pupils who can understand the descriptions of them, and they will train the hand, mind and eye to work together.

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 the Bugonia-Superstitions.—The Occurrence of *Eristalis Tenax* in India.

IN consequence of a notice published by Baron C. R. Osten-Sacken in NATURE (vol. xlix., p. 198, December 28, 1893), requesting the public for information about the folk-lore of the Oxen-born bees, I made to him several communications, most of which were incorporated in his subsequent works: namely, "On the Oxen-born Bees of the Ancients" (Heidelberg, 1894), and "Additional Notes in Explanation of the Bugonia-Lore," &c. (*ibid.*, 1895).[1] Continuing since in the researches, I have collected the following notes, which I trust you will allow me a space to publish, inasmuch as the latter work (p. 4) contains the author's indication that he shall thereby conclude his publications on this subject:—

(1) *The Occurrence of the Bees in a Skull.*—Besides the two instances of this incident quoted in "O. B." (pp. 64, 3) from Herodotus and from Patterson, we find another case in Purchas's "Pilgrimes." 1624, Part III., l. iii. p. 627, where Geo. Berkeley, the English merchant (*c.* 1605), narrates from his personal observations that Livonia was then so much devastated by the Russians that, her woods were "strowed with bones of the dead carcases, and himselfe did once in one of those woods, eate Honey out of a man's skull wherein a swarm of bees were, and bred as it hanged on a Tree."

(2) *Chinese Lores in Relation to the Bugonia.*—Mr. G. B. Buckton, in his "Natural History of *Eristalis tenax*," 1895, p. 79, gathering from "O. B.", includes Japan and China among the countries that "have been all more or less affected by this strange idea." Should a reader infer from this passage that the Japanese and the Chinese ever dreamt of the breeding of honey-bees from bovine carcases, gross must be his blunder. He can find in "O. B." a reproduction of my clear statements of the absence from those nations of this belief (p. 20), and of the early Japanese discrimination established between bees and drone-flies (p. 33).

However, the exposition of Mr. Buckton could excellently apply to the case of the Chinese, provided the term "Bugonia-superstition" be used in such an extensive sense as to cover all allied beliefs derivable from the confusions of bees and drone-flies. As the result of my research for three years past, I can now enumerate altogether three instances of such beliefs from Chinese source: firstly, a notice of a literatus in the beginning of the seventeenth century, who apparently mistook some *Eristalis* for honey-bees (see NATURE, vol. l. p. 30, May 10, 1894); secondly, an inveterate fallacy current among the renowned naturalists in China, that the bees use human urine for manufacturing honey[2] ("O. B.," p. 19; "A. N.," pp. 17, 19–20); and thirdly, a passage which I have lately found in "Koo-kin-tu-shu-tseih-ching" (Peking, 1726, Sec. IV., tom. lxviii, "Ki-i-pu-wei kau," i. fol. 2, *b.*), and reads thus:—"Should a hen's egg turn into bees or wasps, it would portend the town where it happens to become totally evacuated in subsequent time."

Here I may add that, although the Chinese were singularly free from the barren speculations on the artificial breeding of honey-bees from dead oxen, yet they did not escape the invasion of another enterprising illusion, which might have rivalled the Bugonia-craze in its absurdity. It is described by Chang Hwa (232–300 A.D.) in his "Poh-wuh-chi" (tom. iv. f. 7, *a*, Jap. ed., 1683):—"Tear the Turtle (*Trionyx*) into pieces about as large as stones used in the game of Ki (a sort of chess); mix them well with the juice of the Chih-hien (the red variety of *Amaranthus mangostanus*), and bury them underground in a thick envelope made of the Imperata-grass; thus, after ten days, you will find each piece of flesh changed into a turtle." Another book, named "Pi-ya Kwang-yau," is said to relate: "If a carapace of the turtle be wrapped with the Amaranth and placed

[1] For brevity's sake I shall use in this article the abbreviations "O. B." and "A. N." respectively for these works.

[2] So, Li Shi-Chin, one of the greatest naturalists China has ever produced, praises the Bees in a similar tone to Samson's riddle by saying: "Out of the fetor came forth deity; and out of the decay came forth mystery" ("Pan-tsau-Kang-muh," 1578, *sub.*, "Mih-fang")

on damp ground, it turns into another turtle: now there are men who use to divide into pieces the turtle's flesh, and by adding to them the Amaranth-juice, change them after ten days to turtles as minute as young silkworms, which they throw in ponds under the name of 'Seedling-Turtles' (*Chung Pieh*)" ("Yuen-kien-lui-han," 1701, tom. cdxli., art. "Pieh").[1] These preposterous schemes of multiplying by gemmiparone process one of the dainties dearest to the Celestial's palate, were doubtless an outcome of erroneous observations, whereby those credulous folks mistook for newly hatched turtles some insects of a turtle-like configuration with the habit of thronging about the putrid animal substances.[2]

(3) *Japanese Lores concerning Eristalis tenax.*—"In regard to the composition of honey and the confusion of the honey-bee with *E. tenax* [*cf.* (2) *supra.*], the Japanese nation was far in advance of its neighbours" ("A. N.," p. 19). Only single instance somewhat analogous to the old western stories of the Wasp and Hornet generated from dead horses, I have recited in NATURE, *ubi supra*, from a Japanese work. This is the belief in the "Horse-Hair Wasp," so-called from the popular notion of an ichneumon-fly whose ovipositors resemble horse-hairs, that it is a metamorphosis of the latter;[3] while, as Baron Osten-Sacken aptly expounds, the alleged Horse-born Wasp and Horse-born Hornet are both the issues of the ancients' confusion of *Helophilus* and *Gastrophilus*, with the hymenopters in question ("O. B.," pp. 53–55).

"The occurrence of *E. tenax* of Japan is of very long standing . . . the people did not confound it with the bee" ("O. B.," p. 33, note; *cf.* "A. N.," pp. 20–22). This Japanese immunity from the taint of such a widespread superstition, appears to be mainly due to their early ignorance of the bee-keeping.[4] Although Japan is not destitute of the indigenous bees (*cf.* Kaibara, "Yamato Hongô," 1708, tom. xiv. fol. 13), the comparative paucity in the old Japanese literature of the allusions to honey and bees, and a definite register in the national history of a failure in introducing them from Corea in 643 A.D. ("Nihongi," lib. xxiv.), together with the striking absence from the Japanese language of any native name of honey,[5] are sufficient to preclude any ideas of the original familiarity of the Japanese with apiary.

This primitive ignorance of the honey-keeping certainly gave great impulse to the early establishment by the Japanese of the demarcation between the bee and the drone-fly; which latter dipteron they have properly grouped with its allies, such as *Tabanus*, *Helophilus*, and *Gastrophilus*, under the general onomatope "Abu," which corresponds with "Mang," the Chinese appellation after their humming sounds—from the former, no doubt, descends the modern Japanese name of *E. tenax*, "Bun-bun" (*cf.* "O. B.," p. 20).

That the Japanese were early acquainted with the rat-tailed larva of *E. tenax*, is evinced in a cyclopædia compiled in 1713, wherein the imago and the larvæ of the fly are figured and described distinctly ("A. D.," p. 20). In an old vernacular leechcraft, the so-called "Long-tailed Dung-Worm" (*Onaga-Kusomushi*), the larva of the fly, was prescribed as an invaluable cure for rickets (*Kan*) (Terashima, as quoted in foot-note 4). Baron Osten-Sacken already gave from my communication to him a popular rhyme said to be efficacious in keeping this larva away from out-houses ("A. D.," p. 21). In some provincial versions of the rhyme, the larva is called "Kamisake-mushi" or "Kamisake-jorô" (*i.e.* Worm-or-Strumpet who avoids the [Shintoist] Gods).[1] "Eibian," a Japanese antiquary, understands this cursing poem to have been composed by a zealous Shintoist, who might have directed it against the Buddha Sâkyamuni, whom it represents by the loathsome larva, and whose birth took place on the day named in it (Yamazaki, "Seiji Hyakudan," 1841, chapter xli). This remark points at the remote antiquity of the Japanese acquaintance with the *ver à queue de rat*; for, according to it, the verses must have sprung in an epoch when the native and Indian creeds were yet contending greatly in Japan.

(4) *The Mithraic Association of the Bees with the Lion and the Oxen.*—Dr. Ernest Krause, in his article, "Die mythologische Periode der Entwickelungsgeschichte," in "Kosmos," Jahr. IV., B. viii. p. 350, Leipzig, 1880, ascribes the triple association of these creatures to the amalgamation of the Christian legend with the classic stories. Nevertheless, the fact that these *trio* were long in existence in Persia, before the introduction of Christianity into classic regions, is evident from the ancient cultus of Mithras, in which one who was initiated into the mystic grade of Lion had to "wash his hands with honey collected by bees who are Oxen-begotten" (Thomas Taylor, "Select Works of Porphyry," 1823, p. 181); added to which, on an ancient cylinder of recent discovery, those persons presiding on the Leontic rites, are said to be represented in the tunics and stoles covered with the design of honey-comb (F. Lajard, "Recherches sur les Cultes publics et les Mystères de Mithra," 1867, 2*e* Section, p. 240, *seqq.*).

(5) *Astronomical and Elemental Explanations of the Bugonia Myth.*—In his "A. N.," pp. 12–13, Baron Osten-Sacken names the three methods of treatments of this myth by the commentators on the classic passages that concern it. To those three, I may add as the fourth the following explanation by A. de Gubernatis, who endeavours to treat the myth astronomically: "According to Porphyrios, the moon (Selênê) was also called a bee (Melissa). Selênê was represented drawn by two white horses or two cows; the horn of these cows seems to correspond to the sting of the bee. The souls of the dead were supposed to come down from the moon upon the earth in the forms of bees. Porphyrios adds that as the moon is the culminating point of the constellation of the bull, it is believed that bees are born in the bull's carcase. Dionysos (the moon), after having been torn to pieces in the form of a bull, was born again, according to those who were initiated in the Dionysian mysteries, in the form of a bee; hence the name of Bougenês, given to Dionysos (moon). . . Sometimes, instead of the lunar bull, we find the solar lion" ("Zoological Mythology," vol ii. p. 217, London, 1872). The fifth method, as it might be, seeks in the Bugonia an "elemental" myth, as we find it in F. Lajard's work, quoted above. According to this authority, the Ox and the Lion appear to have symbolised in the creed of ancient Persians what the Chinese have designated respectively with the terms of "Yin" ("negativeness") and "Yang" ("positiveness") (*cf.* my letter in NATURE, vol. li. p. 32, November 8, 1894); and the Mithraic association of the Leontic grade with honey (compare last paragraph) is solvable by the reason that honey contains an essence extremely combustible (extremely "positive" in Chinese philosophy), which is wax (p. 242). It is highly probable that the association of the bees with the oxen existed in the same cultus of Mithras (*cf.* Taylor, *l.c.*), as we can adduce it from the Persian cosmogony, which states that, the First Bull, the first of all beings created by Armuzd, having been slain by the jealous Ahriman, his soul, the Ized Goschorum, issued from his left shoulder, and after collecting the sperm of the terrestrial bull, carried it to moon, where it became the germ of all creatures (see Lajard, p. 49; *cf.* the Dionysian story in (4) *supra*).

(6) *Bugonia-Superstitions in India.*—Once I communicated

[1] Perhaps "Hwin-nan-wan-pih-shuh," attributed to Liu Ngan (*c.* 179–122 B.C.), is the oldest work extant which mentions this sympathetic power on the turtle of the "Hien," which name comprises, besides all species of *Amaranthus*, the Purslane (*Portulaca oleracea*). Some authors who take for "Hien" the latter plant singly, tries to explain a passage in the "Book of Changes," where occurs the "Hien" with the *Phytolacca* (for the latter see my letter in NATURE, vol. liv. p. 343, August 13, 1896) as the types of diabolical plants, by conceiving as devilish the remarkable resistance to desiccation of the Purslane as well as its alleged influence on dead turtles (Chang Urh-Ki, "Hau-ngan-hien-hwa," tome i; Wu-Ki-Shun, "Shih-wohming-shih-tu-kau," ed. Ono, tome iii. fol. 19, *b*). It is a curious contingency that the word "Amaranth" is derived from Greek words—α, privative, and μαραινω, to wither (Loudon, "Encyclopædia of Plants," 1880, p. 787). Also there is a Chinese belief in a visceral disease called "parasitic turtle" (*Pieh-hia*), said to originate in eating turtle-flesh with the Hien ("Yuen-kien-lui-han," *l.c.*; Chang Urh-Ki, *ut supra*), which error has probably arisen from their confusion of some parasitic flat worms with turtles.

[2] Cf. Pliny, H. N., xi. 20: "Sicut asinorum scarabaeos mutante natura ex aliis quaedam in alia." In Chinese glossaries there are names of many beetles founded on the resemblance to the turtle. Certain aquatic Heteroptera (*e.g. Belostoma indica*) that are perhaps the origin of the "Seedling-Turtle" story, are called in Japanese "Tagame," or "turtle in rice-field" (Terashima, "Wakan Sansai-dzue, 1713, tome liii.).

[3] For the assimilation of the ichneumon-flies with the wasps, cf. Pliny, xi. 24: "Vespae quae ichneumone vocantur." "Ma-fang" (literally, horse-wasp) occurs in Chinese; here, however, the epithet "horse" signifies "large" (cf. Kaibara, *op. cit.*, tome ix. fol. 10, *b*).

[4] Even in the sixteenth century the domestication of the bees must have been unknown, at least in some western provinces: for the fact is particularly called attention to in the narration of a Japanese ambassador sent to Rome by a prince in Kyûshû: "Non hanno in quei paesi Api, ne in consequenza il nobilissimo frutto del mele . . ." ("Breve Ragguaglio dell' Isola del Giapone, Roma, 1582, Brit. Mus., 10,055. a. 1, fol. 2, *a*).

[5] Only word ever used in Japan for honey is "Mitsu" (or "Michi" in its obsolete form), bore a modification of Chinese "Mih," and that for the honey-bee is "Mitsu-bachi," composed of the heterogeneous words "Wamyô Shô," written in the tenth century, tomes xvi. and xix.).

[1] So a rustic version runs: "Since long ago auspicious is the eighth of the fourth moon; on this day punishment of worms that hate gods is their doom."

to Baron Osten-Sacken my suggestion of the possibility of finding some traces of these superstitions from an Indian source; but it met his negative remark in "A. N.," *sub fin*, chiefly grounded on the alleged lack till that time of any report firm enough for the inclusion of *E. tenax*, among the Indian fauna. In a work of N. Müller, however, we have lately found described an old silver vase made in India, which has engraved thereon Kamadeva (the Love) in the act of producing Totma (the Force). It represents the infant god riding on his quiver,[1] from which a lion is issuing forth, while the quiver rests on the back of a bee, and, as is well known, a chain of bees forms the string to the god's bow. Another mythical picture of Totma described by the same author is a lion producing out of his mouth a swarm of bees and a cow ("Glauben, Wissen, und Kunst der alten Hindus," Manzig, 1822, B.I., S. 553, *seqq.*; with Tab. I., Fig. 11 and 12). From these figures we are perhaps right in believing that the Hindus were not totally unaffected with the Bugonia-myth; and if it be so, how anciently the myth existed in India? This is the question which I should solicit assistance from any of your readers to elucidate.[2]

(7) *The Occurrence of Eristalis tenax in India.*—To supplement the last paragraph, it will be interesting to introduce here the following letter from Mr. E E. Austen, of the British Museum (Natural History), which I owe to his kindness:—

"November 16, 1897.

"*Eristalis tenax, L.* has never been recorded (at any rate, under its own name) from India. However, in a collection of Diptera from India belonging to the Bombay Natural History Society, and at present in my hands for determination, are four specimens which, in my opinion, undoubtedly belong to this species. I have not time just now to make minute examination, but so far as I can see these specimens agree perfectly with the normal European form. If there are any differences, I do not think that they can possibly be of *specific value.* Of the four specimens in question one is unlabelled; the other three are labelled respectively—'N. W. P.' (North-West Province), 'Himalayas,' and 'Musourie.' I may add that the Bombay Natural History Society's collection also contains five specimens (not labelled with precise localities) of *E. pertinax, L.*—a species which closely resembles *E. tenax*, and has identical habits. In England, at any rate, it is often the more abundant of the two.

(Signed) "E. E. AUSTEN."

In a Buddhist cyclopædia in Chinese (Tau-ngan's "Fah-yuen-chu-lin," completed 668 A.D., ed. 1827, tom. xxviii. fol. 12-13), there is a quotation from an Avadâna Sûtra, giving account of how Ananda found in a pond near Râdjagriha, which receives all sewerage of that city, a huge worm several tens of feet long, and without limbs, amusing itself among refuses, rolling, raising, and lowering The question as for the cause of so unpleasant an animal, the Buddha answers by tracing it to a long past æon, when an avaricious abbot cursed good monks with very unwholesome words, which effected the malefactor's transmigration to such a disgusting life. Here, the worm in ordures is described too briefly, but its figures, except the exaggerated size, forcibly put me in mind of a similar account of the "Long-tailed Dung-Worm" by a Japanese author (see "A. N.," p. 21); which leads to the view that the Indians took early notice of the rat-tailed larva of some *Eristalis.*

(8) *Stingless Bees besides Eristalis tenax.*—From the instances I shall give presently it will be evident that the readers must take precaution against the hasty identifications with the *Eristalis* of all so-called "stingless bees." Thus, Prof. A. Merx, of Jena, suggests the possible identity with *E. tenax* of certain stingless bees in Abyssinia, which J. Ludolf records in his "Historia Æthiopica," 1681, lib. 1, chap. 13 ("O. B.," p. 67). But it is too evident from the following words that the identity is not true:—"De hoc accipiunt Habessini Mel agreste. . . . Quia verò aculeo carent, la tenebrâ se tuentur; sub terrâ enim favos condunt, angustissimo introitu, quem viso homine quinque vel sex implent capitula sua solo æqualia ponentes, tam solerter, ut acutissimos oculos fallant." Two manners of the "stingless bees" in the Western Hemisphere are respectively described by Fernandez d'Oviedo (1478–1557) and H. Schmirdel (*c.* 1534–54): both agree in building their nests inside of trees, where they make white excellent honey (Ramusio, "Navigationi e Viaggi," Venetia, 1606, fol. 51, A; Purchas, "Pilgrimes," Part III., l. vii., chap. 4). One who reads Astley's "Collection" (1745, vol. ii. p. 355), might naturally be struck with the thought that there *E. tenax* is meant by a "Drone-Bee" that "frequents the villages [in the western coast of South Guinea] . . . but yields no honey"; on examination, however, of the original of this passage, we confirm other insect is meant thereby, as the statement has this qualification:—"[They] hurt nobody unless provoked, and then their sting causes great and dangerous inflammations" (J. Barbot's "Description of Guinea," in Churchill's "Collection," 1732, vol. i. p. 116).

KUMAGUSU MINAKATA.

7 Effie Road, Walham Green, S.W.

P.S.—It may be not amiss to note here that the Spanish Benedictine, Benito Feyjoo, in his "Théatro Critico Universal" (Madrid, 1734, tom. iv. p. 198), devotes a chapter to the Bugonia, where he refers to Sperling's failure to find any bees from dead oxen while serious pestilence was prevailing among cattle in Würtemberg (see "O. B.," p. 61). He continues: "Doctor Don Joseph Ortiz Barroso, the learned physician in the city of Utrera, experienced the same failure on two several occasions of similar epidemic that visited the territory of Sevilla. The latter observations conflict with the solution which F. Sachs seeked to apply to the case of Sperling's failure, by attributing it to the too cold climate of Würtemberg for the bees; for the same failures were experienced in Andalusia, which is a quite warm country; while such coldest countries in the north as Russia, Podolia, &c., have great abundance of the bees, causing very cheap sale of honey and wax in those parts."

K. M.

[1] In this connection it is significant that "the Italian 'carcasso' means quiver, because it is encircled and kept together with iron rings or ribs, which resemble the ribs of a human carcase" (Webster's Dictionary).

[2] About four years ago, when I followed to the British Museum my master in Mantranism, Mr. Hôryû Toki, that Yogâtchârya informed the late Sir (then Mr.) Augustus Franks of the remarkable coincidences that exist between the characters of the Brahmamist "Kamadeva" (the Hindu Eros) and of the Mantranist's "Aizen Myôwô" (the bright king who soaks mankind with love). One conspicuous figure of the latter is his crown of a lion's head (see Butsuzô Dzui," n. e., 1886, tome ii. fol. 20, *a*), whence it is very probable that some vestiges of the Leontogenes occur in the "Aizen-kyô," a Buddhist sûtra devoted to this Vadjra, but inaccessible to me in this country.

Rainfall and Earthquake Periods.

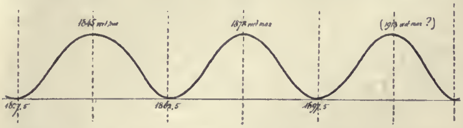
WITH reference to the remarkable letter of "A. B. M.," which appeared in your number of this week (May 19), p. 31, as to the recurrence of cold and wet periods at about thirty-five years' interval (measuring from the centre of one such period to that of the next), I beg leave to call attention to the fact that thirty-five years represents a marked period of recurrence of maximum frequency of earthquakes, as I showed in a paper which was submitted to the Royal Irish Academy in 1887, but not published. That a relation should exist between earthquakes, volcanic disturbances, and the atmospheric conditions which determine wet and dry periods, seems to me more reasonable to accept *à priori*, than to assume that these phenomena are quite independent of each other.

From Mallet's Catalogue of Earthquakes I have compiled a list between the dates 365 and 1842, showing the intimate relations between the shocks and immediate and violent atmospheric perturbations on those occasions (about 500 in all); this list could be very much extended for more recent times from Perry's and Falb's lists, and would be a valuable contribution on the subject.

But discussing simply the figures presented by your correspondent from this point of view, very interesting results can be shown. I begin by assuming (*a*) an intimate though undefined relation between most great earthquakes and intense volcanic action; (*b*) intense volcanic action in one or other of the great volcanic centres or lines of action during certain periods, giving rise to the emission of vast quantities of gases which rise into the upper atmosphere, and disturb or influence the upper currents; and (*c*) that the upper currents of the atmosphere are more and more looked on as dominating meteorological phenomena. Hence a dependency in the meteorological conditions which determine maxima of drought or wet, on maxima of volcanic action, but not concordance as to date or period. These lag upon the former. This may be roughly shown from the figures given by "A. B. M." He gives the following dates as maxima of wet periods.

The commencement of the curve corresponds to about the year 1827·5, which of itself will be found to represent a year of maximum intensity of earthquakes (it is interesting to note the record for June 3 of that year in Mallet's Catalogue "Martinique."

"At the same time the rain fell after sixty-six days' drought, no such instance of dry weather in the West Indies was remembered). The next minima (of wet) would correspond to 1862·5 (great earthquake in Greece, 26 Dec./61, and eruptions of



Vesuvius accompanied by earthquakes), and the last, to 1897·5, which fairly corresponds to the great earthquake of Assam, so fully noticed in your journal, as one of the most intense of modern times. Moreover, these figures may be presented otherwise. Taking the great earthquake of Lisbon as of date 1755, roughly we have the annexed succession of years showing at the two extremes the dates (approx.) of two of the greatest earthquakes of modern times, and to some extent showing that thirty-five years represents a period of maximum earthquake action, and agreeing roughly with the intervals of extreme drought and with periods of great volcanic activity.

1755
+ 35
1790
+ 35
1825
+ 35
1860
+ 35
1895

As regards the year 1825, it is interesting to note that Mallet's Catalogue gives for July 26 and 27 of that year, "One of the most tremendous hurricanes on record occurred in the West Indies."

Of course a great deal has to be said as to the locality of the earthquakes, and as to the volcanoes to be considered. I certainly look on those of the Andes Cordillera as of prime importance by their influence on the upper currents.

Royal College of Science, Dublin, J. P. O'Reilly.
May 21.

Ebbing and Flowing Wells.

A case somewhat resembling those previously described (Nature, May 12, p. 45, and May 19, p. 52), occurs on the dormant volcano of Barren Island in the Andaman Sea. The only (comparatively) fresh water to be found on the island reaches the surface in the form of hot springs, which gush out close to the shore at the breach through the ancient cone. The springs are due to the percolation of the drainage water beneath the most recent lava streams, which have not yet fully cooled down. The level of the springs rises and falls with the tide, and the lower part of a well, which I caused to be dug in the ash about twenty yards from the shore, filled with hot water at the flow of the tide, and ran dry at the ebb. The bottom of the well was between tide levels. The water is brackish, but rather less so at high than at low tide, the reason of which appears to be as follows. The porous volcanic materials of the island below sea level are saturated by the water of the sea, the surface of this inland subterranean water rising and falling in connection with the rise and fall of the sea tide The drainage of the amphitheatre, then, soaks downwards until it reaches the inland salt water, over which, on account of the difference in specific gravity, it flows onward to the sea. At high tide, therefore, the drainage reaches the sea through materials which have been comparatively little wetted by salt water, while at low tide it percolates through, and washes, ejecta from which the salt water has just retired. The phenomenon is, of course, complicated by the difference in time between the inland tide and that at sea.

The springs are described in some detail in *Memoirs Geol. Surv. Ind.*, vol. xxi. p. 274 (also *Records G.S.I.*, vol. xxviii. pp. 31, 34). F. R. Mallet.
May 25.

NAVIGATION.

Navigation, in its widest sense, is generally defined as the art of conducting a ship from port to port, and may conveniently be divided into coasting and guiding the path of a vessel across the trackless ocean.

Coasting is principally pilotage, assisted by a few rules based on geometry and plane trigonometry, combined with a knowledge of that oldest and most valuable of seamen's friends, the mariner's compass. A knowledge of the compass in Europe is much older than is generally supposed. It was certainly used as far back as the beginning of the thirteenth century.

The compass plays a still more important part in deep sea navigation (with which this paper is more particularly concerned), which is so closely allied to nautical astronomy that in one sense of the word it includes it, whilst in another it distinguishes the terrestrial methods of finding the position of a ship at sea, from the more accurate methods of locating her whereabouts, that the researches and labours of the astronomer have placed at the disposal of the navigator.

The earliest efforts of the seaman, when he ventured out of sight of land, were directed by the compass, which of late years has been immeasurably improved, and by a log for measuring the rate of sailing, which has become almost as obsolete as the plane sailing and the plane chart by which he estimated his position. This method, proceeding on the assumption that the earth's surface is a plane, was fairly accurate for moderate distances near the equator, or even in higher latitudes if the vessel sailed on, or near a meridian, but was quite incapable of measuring differences of longitude, and if used, for instance, on a westerly course from Cape Clear, would produce an enormous error, if the departure or westing was taken as the difference of longitude. Owing to the uncertainty and variability of the wind, sailing vessels altered their course so often that, to save the labour of working out the difference of latitude and departure for each course and distance by trigonometry, the traverse table was introduced. It is simply the tabulated values of the sides of a number of right-angled triangles, where the hypothenuse is the distance, the perpendicular the departure, the base the difference of latitude, and the course the given angle. By means of this table it was easy to get the difference of latitude made good, by taking the difference between the sum of the northings and southings, and the departure made good, by subtracting the eastings from the westings, or *vice versâ*. This was called resolving a traverse. The inability of plane sailing to afford the difference of longitude led to the introduction of parallel sailing, middle latitude sailing, and Mercator's sailing, and the inestimable chart that bears the name of the latter. It is easily demonstrated by solid geometry, that the arc of a parallel of latitude between any two meridians is equal to the corresponding arc of the equator multiplied by the cosine of the latitude; so that if a ship sails on a parallel, it is a simple operation to convert her meridian distance or departure into difference of longitude. But a ship does not always keep to a parallel; in sailing, however, from point to point, she must leave one parallel and arrive at another. Now let the portion of the rhumb line between these two parallels be conceived to be divided into infinitely small parts, which will be sensibly straight lines on each of which is a triangle representing the corresponding difference of latitude and meridian distance. Then the departure will be the sum of all these meridian distances, and must be equal to the arc of a parallel somewhere between the two extreme ones. In middle latitude sailing it is assumed to be equal to the arc of the parallel that lies midway between the one left and that arrived at, and the difference of longitude is obtained as in parallel sailing, substituting the middle latitude for the parallel.

Though the above assumption is not strictly accurate (the real parallel always lying on the polar side of the middle latitude), the results deduced from it in favourable cases are such very close approximations as to be preferable to those obtained by Mercator's sailing, which is theoretically irreproachable.

About the middle of the sixteenth century, Gerard Mercator introduced the chart which has since borne his name, in which the meridians are all parallel and the degrees of latitude increased towards the poles, and on which the rhumb line (or loxodromic curve which on the sphere is a spiral approaching nearer to one of the poles at every convolution) cuts every meridian that it crosses at the same angle. Mercator does not seem to have understood the principles on which his charts should be constructed, for he left no description of them, nor were they even accurate, and it was left to an Englishman, Wright, to demonstrate that, as in making the meridians parallel the meridian distances were being increased in proportion to the secant of the latitude the lengths of the degrees of latitude must be increased in the same ratio. This is obvious from the fundamental formula of parallel sailing. On this principle Wright proceeded to construct a table of meridional parts, by means of which we get a meridional difference of latitude which bears the same proportion to the difference of longitude as the true difference of latitude bears to the departure. We have then two similar triangles with the course as a common angle, either of which can be resolved by the rules of plain trigonometry. Now, whilst this method is in all cases theoretically accurate, in finding the difference of longitude in a low latitude corresponding to the distance run and the difference of latitude, if the course be near east or west, its tangent being large will rapidly multiply any error in the meridional difference of latitude (due to neglecting decimals, for the parts are generally given to the nearest whole number), and thus produce a large error in the difference of longitude, whereas the departure multiplied by the secant of the middle latitude would not be open to the same objection; besides, the course would approximate to a parallel, and so small would be the error from treating the middle latitude as such, that the result would be practically if not scientifically accurate For reasons of a similar nature the course and distance run from day to day, if sailing near a parallel, are better found by middle latitude sailing, especially in low latitudes, unless the ship crosses the equator, when the portions on each side of it ought to be obtained separately if this method be used. In all cases where the foregoing conditions do not obtain, recourse should be had to Mercator's sailing. In a doubtful case the course and distance might be calculated by both methods, and the results compared. For the purposes of steering, the course is only required to the nearest degree and, as a general rule, for computing the distance to the nearest minute. If, however, the course be near east or west, its secant, being large and changing rapidly, is required to the nearest second to obtain the distance accurately. As the seconds are of no use, except to get the secant exactly, they may be done without by observing that the required secant will exceed its tangent, which is in the computation already by the same amount as the nearest tangent in the tables is exceeded by its secant.

Except the ship is being navigated along the equator or a meridian, none of the foregoing methods give the shortest distance between two points on the globe, nor the courses to steer to attain it. This can only be accomplished by great circle sailing. A knowledge of great circle sailing is much older than is generally supposed, though it is only of late years that it, or a modification of it, has been at all generally practised, and even now it is not as much used as it ought to be. The earliest record that I have been able to find of the application to navigational purposes of a principle that must have been long known to mathematicians and astronomers, is in a work on navigation by Captain Samuell Sturmey, published in the middle of the seventeenth century, in which the gnomic chart is described. The gnomic chart is to great circle sailing what Mercator's chart is to the sailing of that name, and this old navigator gives rules how to convert a log slate into a chart on this projection so that the great circle courses can be read off with a protractor. Whilst great circle sailing can never have been forgotten, even if little practised, the gnomic chart seems to have dropped out of men's memories, for two centuries later it was rediscovered simultaneously by Mr. Godfray, of Cambridge, and Captain Bergen. Within the next few years Knorr, Hillarett, Jensen and Herrle all brought out gnomic charts more or less like Godfray's, of which Herrle's seems the best and most convenient for finding the distance as well as the course. Before, however, the gnomic charts were reinvented, Towson introduced a diagram and set of tables for facilitating great circle sailing. By means of the diagram the vertex of the required great circle is found, and then taking the

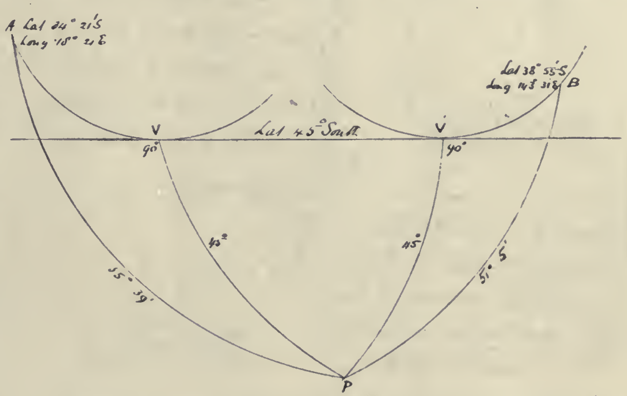


FIG. 1.—Showing the composite track from the Cape of Good Hope to Cape Otway, with 45° as maximum latitude. The composite track is from A to V, V to V′, and thence to B.
Cos AV = sin lat. A, cosec lat. V. | Cos APV = tan lat. A cot lat. V.
Cos BV′ = sin lat. B, cosec lat. V′. | Cos BPV′ = tan lat. B cot lat. V′
APB − (APV + BPV′) = VPV′ which × cos 45° = VV′.
Sin A = sec lat. A, cos lat. V and sin B = sec lat. B, cos lat. V′.

successive courses and distances out of the tables is a mere matter of inspection. A few years later Deichman endeavoured to improve on Towson's diagram, and Brevoort brought out a somewhat similar diagram to accomplish the same object. Lecky has pointed out that great circle courses, within certain limits, may be taken out by inspection from Burdwood's (and other) azimuth tables, and almost without limit from his own A, B, and C tables. Lecky, too, gives short rules for computing the first course and distance. With all these methods open to the navigator, great circle sailing ought to come to the front. One of the drawbacks to it is that in the parts of the world where it would save most distance, it leads through inclement regions and amongst ice, and not the least of Towson's merits was showing how to combine it with parallel sailing so that, without going to a higher latitude than was desired, the shortest track could be followed. He finds either by calculation or his tables the two great circles passing through the points of departure and destination whose vertices just touch the limiting parallel. The vessel is navigated along the first arc till the parallel is reached, along which she is kept till the vertex of the second circle is attained when she takes the great circle arc to her destination. This is demonstrably the shortest distance between the two places under the given conditions.

The labour of utilising great circle sailing by the rigorous method has been much magnified. It is not necessary to find the distance accurately (or even at all) every day, and the first and last courses are easily and quickly worked with the two co-latitudes and difference of longitudes (two sides and the contained angle to find the angles at the base); and for this purpose it is near enough in practice to take out the logs to three or four figures. This is the same formula as for time azimuths, which explains why great circle courses can be obtained from azimuth tables. Towson gets a right angle at the vertex, and so obtains brevity of solution. Now I will introduce a short method of my own, which I always use when the conditions are suitable. It is a very general practice to settle on the point to cross the equator according to the season of the year. Proceeding from Cape Leeuwin to Cape Guardafui, for instance, to be well to windward in the south-west monsoon, it is advisable to cross the line in about 60° E. long. Now, by working towards this point, the first course and distance may be obtained by quadrantal spherics quicker than by Mercator's sailing, because, though there are the same number of figures, the logs can be taken out in pairs, or triplets if the last course is required, to see if the ship is keeping on the same great circle. Unfortunately, it can only be used approaching the equator or in calculating a track thence to the next point of destination; but I have already shown how the courses alone can be quickly obtained in other cases, independent of the innumerable ways of getting them by inspection, and the graphic methods of Airy and Fisher, besides which there are various protractors and mechanical devices for those that favour such methods.

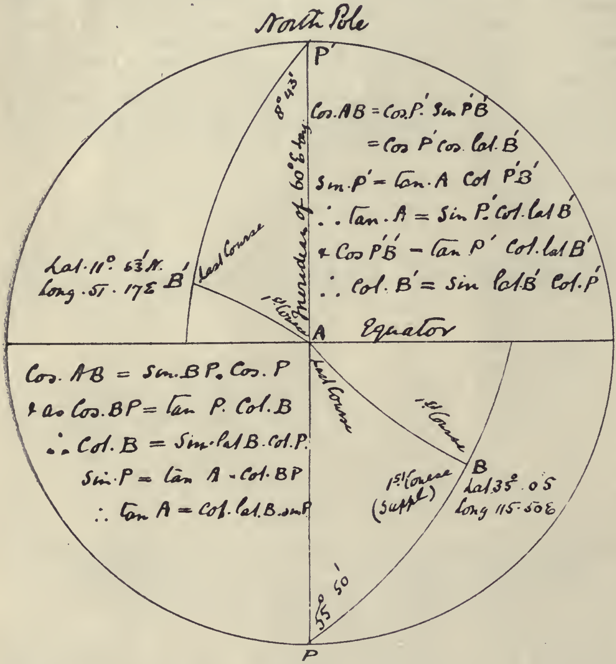


FIG. 2.

Example:

Lat. B 35° 0′	Sin 9·75859	Cos 9·91336	Cot 10·15477
D. long. 55° 50′	Cot 9·83171	Cos 9·74943	Sin 9·91772
	Cot 9·59030	Cos 9·66279	Tan 10·07249

1st course N. 68° 44′ W. AB 62° 37′ Last course N. 49° 46′ W.
60

Great circle dist. B to equator 3757 miles.

Now, whilst the foregoing methods are all sufficient to enable the navigator to obtain the bearing and distance of his port or destination, they are far from being irreproachable as a means of finding the daily position of a ship at sea, though they are always used for this purpose in case no better position is obtainable, or if it is, to compare with it. The cause of the deficiency is the uncertainty of the elements used in the calculation. When a ship on any given day leaves a well-ascertained point of departure, her position next day is obtained by the course steered and distance run. But neither can be absolutely relied on. In the finest vessels afloat with the most perfect navigating appliances, the course steered, even in fine weather, will be uncertain to 1°, which is equivalent to a deflection of $1\frac{3}{4}$ miles in every 100. This may easily be trebled or quadrupled in bad weather if compass errors cannot be checked, which, with every possible care, are liable to sudden and unlooked-for changes. In bad steering vessels, or with badly-placed compasses, or where the errors are not frequently checked, or from a combination of these causes, the error in the course may amount to 10°, which is equivalent to a deflection of $17\frac{1}{2}$ miles in every 100. The distance run, under the most favourable circumstances, is liable to an error of 3 per cent., which head winds or other causes may easily double or, in exceptional circumstances, magnify still further. Then, again, the currents of the sea are the most uncertain element with which the navigator has to deal. Half a knot to a knot per hour is quite common, whilst five knots, or over, is not unknown. Except in a few localities, the direction is almost as uncertain as the strength. Even where currents run pretty regularly, these ocean rivers are not confined and held in position by fixed limits like those of the land, but are as flexible as snakes, which is perhaps the origin of the symbol denoting them on current charts, which at best only give a general idea what to expect: they are frequently deflected, or even reversed, by distant winds, or other causes quite beyond the ken of the navigator whose ship is being affected by them. With all these elements of uncertainty in the data used, it cannot be wondered at if the position by dead reckoning be of doubtful accuracy; and it would probably be more uncertain still, but that the numerous sources of error generally tend to compensate one another. It is, none the less, of the highest importance to the navigator to keep his log account with the greatest care, in case he has nothing better to depend on. Luckily, however, there are more accurate methods generally available, by which the navigator can find the position of his vessel—methods approximating to those of the astronomer in his observatory, whose more refined instruments and abstruse calculations supply the seaman with the data necessary to combine with his own observations, and fix the position of his ship with all needful accuracy. In a subsequent paper I will explain how this is done.[1]

J. F. RUTHVEN.

ANNIVERSARY MEETING OF THE LINNEAN SOCIETY.

THE anniversary meeting of the Linnean Society of London, held at Burlington House on May 24, was the occasion of presentation, by its Fellows, to Sir Joseph Dalton Hooker, G.C.S.I., C.B., F.R.S., of a commemoration gold medal, in addition to that of the Society's annual gold medal, which was awarded to Surgeon-Major G. C. Wallich, M.D., the veteran naturalist of the cruise of H.M.S. *Bulldog*. In presenting the medal to Sir Joseph Hooker, the President, Dr. A. Günther, F.R.S., made the following remarks.

The completion of a monumental work in botany, the "Flora of British India," has been chosen by our Council as a fit occasion for the Linnean Society to pay its tribute to the recognition of the eminent services which have been rendered to biological science by Joseph Dalton Hooker. A gold medal, specially struck for the occasion, of which copies could be distributed among his numerous friends and admirers, was considered to be the most appropriate and the most enduring form to serve as a memorial of this desire of the Society.

If I attempted, or were competent, to pass in review the work by which J. D. Hooker has advanced botanical science and enriched its literature, the few words I intend to address to you would swell into a biography; for of the sixty years which have elapsed since he entered the service of science, there are but few in which he has not left his mark upon its history.

The four years which he passed with the Antarctic expedition, and the three years during which he wandered among the ranges of the Himalayas, were the period in which he saw nature in her most diversified, grandest and purest aspects, and was brought face to face with the mysteries of the distribution of life over the globe. Then and for many years afterwards he made these phenomena and their causes the object of his special study. His writings on the subject have had the most powerful influence on, and were the guide in all subsequent inquiries. His travels were of the highest importance, and that not with regard to our biological knowledge alone; his intimate acquaintance with geology, meteorology, his proficiency as a surveyor have rendered his accounts of the countries visited by him equally valuable to the geographer.

When biology entered upon that eventful period of its history, in which the doctrine of continuous evolution by natural selection was striving to replace that of distinct creations, Hooker was one of the foremost champions of the former. Many systematic workers in zoology and botany were apprehensive at the time of dangers arising to their methods from the new doctrine. Hooker dispelled such fears by his own example; he continued his systematic work, but he showed at the same time that it was not the end, but only the means to the end, of biological research.

The part which he took, during the lifetime of his father, and during the twenty years of his directorship, in raising the Royal Gardens at Kew to their importance and eminence, is known to all of you. But I cannot pass this short allusion to his official work without referring to the position which Kew has taken as the centre of advice and help for the kindred institutions in India and the Colonies. This bond had been already established by the father; but it was strengthened by the son's personal acquaintance with their capabilities, and his sympathy with their needs.

His official duties, sufficiently arduous by themselves, did not prevent him from obeying other demands of science, when he was called upon to perform the functions of President of the British Association in 1868, and of the Royal Society from 1873–1878. And since his retirement from the public service in 1885, at an age when most men seek for rest from their labours, we have seen him still prosecuting his work with that single-minded devotion to science which has been characteristic of the whole of his life.

The prosperity of the Linnean Society, of which he has been a Fellow since 1842, has always been to him an object of special interest. Some of his most remarkable memoirs appeared in our *Transactions*; Bentham, who devoted years of care to the welfare of the Society, was connected with him by ties of closest friendship. And last, but not least, we remember that in honouring the son we are doing homage to the memories of the father and grandfather, both of whom were illustrious Fellows of the Society.

Sir Joseph Hooker, in acknowledging the presentation, said:

Mr. President, I cannot express my sense of the great, the exceptionally great honour which your Council has conferred upon me in the founding and awarding of this beautiful medal. In receiving it, let me assure you that I value it as much for the evidence it bears of the friendly regard of my associates as for their all too high estimate of my endeavours towards the promotion of science. Furthermore, let me say that from no scientific body could it be received by me with more cordial welcome than from the Linnean Society, which was the first to which I have the honour of belonging to enrol me amongst its Fellows, and which especially cultivates those branches of knowledge to which I have devoted the best years of my life. To these considerations must be added what you yourself have alluded to, namely, my hereditary interest in a Society of which my father and grandfather were very early Fellows, and both of them contributors to its *Transactions*. To this latter circumstance it may perhaps be due that I was elected at a very early age, being, I believe, the youngest member of our body with no further scientific claims on the support of my electors than that I was serving as a naturalist in the Antarctic expedition under Captain Ross, where I happened to be the youngest, as I am now the only surviving officer of those then under the command of that intrepid navigator. I may mention that Captain Ross was himself a Fellow, and had a copy of our *Transactions* in his cabin, which was a godsend to me. I was in the Falkland Isles when my election took place, and nearly a year and a half elapsed before my captain and I knew that we were fellow Linneans.

In 1842 the Lord Bishop of Norwich was President. He was the first of ten under whom I have been privileged to sit. Had the Society adopted the rule of biennial presidents I should have sat under thirty at least, which, in my estimation, would have detracted greatly from the dignity which I attach to the chair, and I venture to think from its utility also. In the year 1842 there were 610 members of the Society (including fellows, foreign members and associates) with fully one-fourth of whom I soon became personally acquainted. Twenty-eight years afterwards, that is about midway between the former date and the present time, the number of my personal friends in the Society had risen to one-half of the whole body. Our numbers are now 820, but the proportion of my personal friends among them has inevitably shrunk from my having outlived so many associates of my middle age. And this leads me to ask your indulgence for one more egotistical detail. It is that I am perhaps the only Fellow who personally knew four of the 169 naturalists who, 110 years ago, formed the nucleus of our Society. Of these four I knew two during my later teens: they were the Rev. W. Kirby, the author, with Spence, of the "Immortal Introduction to Entomology"; and Dr. Heysham, of Carlisle, an excellent entomologist and ornithologist. The others were Aylmer Bourke Lambert, a former President, and the last, as I have been informed, who wore in the chair the presidential three-cornered hat; and Archibald Menzies, who as naturalist accompanied Vancouver in his voyage in the Pacific, and who introduced the *Araucaria imbricata* into England. These all died very near the year of my election.

Referring now to the progress of the Society in status and efficiency during the years that have elapsed since 1842, the record cannot but be gratifying to its Fellows. Of this the best proofs are the increment in extent and value of its publications,

[1] Throughout this paper the earth has been treated as a sphere. Of course it is really a spheroid with a compression of 1/300 in the polar axis. This hardly affects general principles, though it introduces slight modifications and corrections in detail. For these, and the rules of computation *in extenso*, the reader is referred to such standard and practical works as Riddle, Raper, Merrifield, Lecky, and others.

and the interest taken in its meetings. From its foundation up to the date referred to (fifty-four years) eighteen volumes of the *Transactions* in quarto had been published. During the succeeding fifty-four years about double that amount have been produced in the same form, besides fifty-eight volumes of the *Journal* in octavo, which latter was not commenced till 1857.

Then as regards attendance at the meetings during the first years of my fellowship, it was miserably small. If my memory does not deceive me, I recall a night in Soho Square when only five Fellows supported the President and Secretary. There was a dearth of papers too, and the discussion of such as were brought forward was discountenanced by the chair. All this is now happily a thing of the past, and I should not have alluded to those bad times had not the Society given proof of that inherent vitality which supported it under a temporary depression, and subsequently raised it to its present position.

It remains, sir, to thank you cordially for coupling my father's name with my own in this award, but for which, indeed, I could not have accepted it without a protest. I inherited from him my love of knowledge for its own sake, but this would have availed me little were it not for the guiding hand of one who had himself attained scientific eminence; who by example, precept and encouragement kept me to the paths which I should follow; launched me in the fields of exploration and research, liberally aided me during his lifetime, and paved for me the way to the position he so long held at Kew with so great credit to himself, and benefit especially to our Indian and Colonial possessions.

The gold medal of the Linnean Society was received on behalf of Surgeon-Major Wallich by his son, and, in presenting it, Dr. Günther spoke as follows:—

The gold medal of the Society is awarded this year to a zoologist, to Dr. George Charles Wallich. Although Dr. Wallich's scientific work commenced some years before, it was the year 1860 in which he entered upon the line of inquiry with which his name will be ever associated. On the recommendation of Sir Roderick Murchison and Prof. Huxley he was attached in that year as naturalist to H.M.S. *Bulldog*, on her voyage across the Atlantic to survey the sea bottom for the laying of the proposed Atlantic cable. The materials obtained by the sounding operations were slender; but in working them out, Dr. Wallich showed that he had already grasped all the principal problems of deep-sea research. To the solution of these problems he applied his wide range of knowledge, the soundness and power of his reasoning, his originality and independence of thought. His work, "The North Atlantic Sea-Bed," incomplete as it is, stands as a lasting record of the progress made by him in our knowledge of deep-sea life, and of the impetus which he gave to subsequent deep-sea exploration.

For more than twenty years he continued to work in the same line of inquiry, and in investigating collateral subjects, notably the life-history, structure and relationships of those unicellular organisms which play so important a part in pelagic and bathybial life, the lithological identity of the ancient chalk formation, and of the calcareous deposits in the oceans of the present time.

The remarkable results which he obtained in his investigations were due not only to his accuracy and keenness as an observer, but also to the ingenuity of the methods applied by him. Thus at a time when our modern micro-chemical methods were unknown, he employed the electric discharge as a means of differentiating the nucleus, and he determined the excretory function of the contractile vacuole.

Your Council were of opinion that work of such originality, advancing so many branches of biology, was peculiarly fit to be honoured by the award of the Linnean medal.

NOTES.

WE notice with deep regret the announcement that Lord Playfair died on Sunday. The funeral will take place on Saturday at St. Andrews, Fifeshire.

WE are requested to state that the Chemical Society's banquet to the past presidents on June 9, and also Dr. Mond's garden party on June 10, are postponed in consequence of the death of Lord Playfair, the senior past president and the last surviving founder of the Society.

THE Ladies Soirée of the Royal Society will take place next Wednesday, June 8.

SIR WILLIAM H. FLOWER, K.C.B., has received, from the German Emperor, the Royal Prussian order "Pour le Mérite" for Science and Art.

THE death is announced of Prof. F. Müller, distinguished for his works on ethnology and philology.

PROF. G. H. DARWIN, F.R.S., has been elected a foreign honorary member of the American Academy of Arts and Sciences, in succession to the late Prof. J. J. Sylvester.

AN exhibition of specimens of practical work of candidates at the technological examinations of the City and Guilds of London Institute will be opened at the Imperial Institute next Thursday, June 9, by the Right Hon. Lord Herschell.

THE Albert Medal of the Society of Arts for the present year has been awarded, with the approval of the Prince of Wales, the President of the Society, to Prof. Robert Wilhelm Bunsen, Foreign Member of the Royal Society, "in recognition of his numerous and most valuable applications of chemistry and physics to the arts and to manufactures."

INFORMATION of the death of Mr. W. M. Maskell, Registrar of the University of New Zealand, has been received by the *Entomologist's Monthly Magazine*. Mr. Maskell was well known for his researches in *Coccidæ*; he also published papers on *Aleurodidæ* and *Psyllidæ* amongst insects, and on Desmids in microscopic botany. The majority of his papers have appeared in the *Transactions* of the New Zealand Institute, the first having been published in 1879. At first he restricted himself to the species found in New Zealand, but later on those of Australia (especially the curious gall-making *Brachyscelidæ*), Asia, &c., came under his notice, he having become a recognised authority on the subject of *Coccidæ*. He usually published at least one paper a year in New Zealand, the later ones being lengthy, and all copiously illustrated by his own drawings.

THE Berlin correspondent of the *Times* announces that the German steamship *Helgoland* has just started on an expedition to the North Pole. The ship is built entirely of steel. She carries on board provisions for thirteen months and four boats, two of which she picks up at Tromsö. Special care has been taken in the selection of her crew, some eleven in all. The leader of the expedition, Herr Theodor Lerner, is accompanied by Dr. Brühl, Dr. Römer, and Dr. Schaudien, who are all experienced travellers and men of science. Two other expeditions—both of American origin—are about to set out with the object of reaching the North Pole. Lieut. Peary will attempt the Pole from North Greenland, while Mr. Walter Wellman will make the effort from Franz Josef Land. Mr. Wellman is now in London, and will leave in a few days for Tromsö, Norway, where his ice steamer, the *Frithyof*, is ready for him, and whence she will sail in about three weeks for the Far North. In his party are Prof. James H. Gore, of Columbia University, who will make gravity determinations in Franz Josef Land; Lieut. Evelyn B. Baldwin, of the United States Weather Bureau, who was on the Greenland ice cap with Lieut. Peary, and who is an accomplished meteorologist and geologist; Dr. Edward Hofma, of the University of Michigan, naturalist and medical officer; and Mr. Quirof Harlan, physicist from the United States Coast and Geodetic Survey, a Norwegian experienced in Arctic work.

THE Home Secretary has appointed Dr. Oliver, of Newcastle-upon-Tyne, and Dr. T. E. Thorpe, F.R.S., Government Analyst, as experts to proceed to the Potteries for the purpose of inquiring into the various kinds of glazes in use there, and as to whether any substitutes can be found for those containing lead. Not only will the work undertaken by these gentlemen have a humane bearing and be of a scientific nature; it will be helpful also to the manufacturers. This is the first instance (says the *British Medical Journal*) in which the British Government has called to its aid expert help, not only to assist it in framing regulations for the health of the workers, but also of helping on industries. As the manufacturers are sure to co-operate heartily with those to whom has been entrusted this important special inquiry, it is to be hoped that results will be arrived at which will remove from one of our prosperous and oldest industries the stain that has so long lain upon it.

DR. AGAMENNONE, who has paid considerable attention to the velocity of earthquake-waves, has recently published a valuable paper on the mean surface-velocity of the pulsations from the great Calcutta earthquake of last June 12 (*Rend. della R. Accad. dei Lincei*, vol. viii., 1898, pp. 265–271). Relying on accounts which have already appeared in NATURE, he assumes the centre of disturbance to be in 25° N. lat. and 91° E. long. At Calcutta, which is 400 km. from this point, the time of occurrence was 11h. 4·6m. a.m. (Greenwich mean time) according to Mr. La Touche; and 11h. 7m. according to Mr. Oldham. The earthquake was registered by seismographs and magnetographs at nineteen observatories in Europe, the most distant being Edinburgh, 7970 km. from the epicentre. Excluding the record on the Parc St. Maur magnetograms, which differs considerably from the others, the mean surface-velocity of the earliest vibrations was either 9 or 11 km. per second, according to the time taken for Calcutta. These first rapid vibrations lasted for about 23 minutes, and were succeeded by large long-period oscillations, the mean surface-velocity of which was either 2·61 or 2·76 km. per second. At Rome, the period of these oscillations was about 10 seconds, and their maximum amplitude 12″. Thus, as it crossed Italy, the complete wave must have been 54 km. in length, and the height of its crest about half a metre.

SENOR ANTONIO BLAZQUEZ communicates to the *Boletino* of the Madrid Geographical Society a preliminary paper on a fresh investigation as to the precise length of the Roman mile. The question has been a constant source of difficulty in connection with the determination of the sites of ancient cities, and the tracing of former inhabitants of the peninsula, and a great deal of evidence is discussed which goes to show that the Roman and the Arab miles were of the same length: 1672 metres. The length formerly accepted was 1481 metres. The detailed investigation is promised in a future paper.

DR. C. DAMMANN adds another to the already numerous monographs on German rivers in a paper on the Wupper, published in the *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande*. A careful study is made of the geology and geomorphology of the river and its basin, and of the rainfall and drainage. The fact that the basin of the Wupper consists almost entirely of impermeable rocks, gives the sudden variations in the volume of the stream some special features, especially with regard to floods. Some idea of the rapidity of these changes is given by the record of the rate of discharge on three successive days: 52·7, 182·3, and 51·7 cubic metres per second.

IN Darwin's geological observations on the volcanic islands visited during the voyage of H.M.S. *Beagle*, reference is made to a "volcanic bomb" found in the interior of Australia. The specimen was composed of green obsidian, and was found on a great sandy plain between the rivers Darling and Murray, at a distance of several hundred miles from any known volcanic region. Many similar specimens of obsidian "buttons" have since been found in Australia, and the *Proceedings* of the Royal Society of Tasmania (1897) contains two short descriptive papers on their occurrence in Tasmania. How these singular objects found their way to some of the localities in Tasmania, where their occurrence in undisturbed quartz drift far away from any known volcanic source has been reported, is unexplained. That they are volcanic products is unquestionable; and their spheroidal or discoid form points to rotation while in a fluid state. It has been suggested that the objects came from lunar volcanoes, but it is highly improbable (even if they were ejected from the moon) that they would reach our globe, and if they did they could not penetrate the atmosphere. Mr. T. Stephens, the author of one of the papers referred to, thinks the aborigines of Australia are probably largely responsible for the distribution of the obsidian buttons over the mud-plains of Victoria and Riverina, but no such explanation can be given in reference to most of the places where they have been found in Tasmania. In a paper by Messrs. W. H. Twelvetrees and W. F. Petterd in the *Proceedings* mentioned above, the suggestion is made that the objects are products of terrestrial volcanoes of an acid or sub-acid type, formerly in eruption in the southern hemisphere. The nearest known source of tertiary obsidian is New Zealand, but whether the objects have been transported through the air from that island, or from the Antarctic continent or elsewhere, it is impossible at present to decide.

WE learn from the *Meteorologische Zeitschrift* for April that Signor Boffito, librarian of the Moncalieri Observatory, near Turin, intends to publish a repertorium of Italian meteorology, which, like the valuable repertorium of German meteorology published by Dr. Hellmann in 1883, will contain a practically complete bibliography of meteorological works written in the Italian language. As the meteorological literature of Italy was especially rich in the fifteenth and sixteenth centuries, the publication of the proposed work will be very welcome. Signor Boffito will be glad to receive notice of any works published in the Italian language in other countries.

IN the U.S. *Monthly Weather Review* for February an interesting account is given of the value of a searchlight for making weather signals known in large cities or seaports at an hour of the evening when it is too late to give warning by the usual method. In the month of February 1895, the searchlight for the unfortunate battleship *Maine*, then nearing completion, was lent for temporary use at the Chicago office of the Weather Bureau, and the experiments were conducted by the present chief of the latter institution. From observers and other persons it was ascertained that the signals were clearly seen at a distance of twenty miles. At present the great cost of maintaining the apparatus in operation would preclude its adoption, but in the event of the expense being eventually reduced, the author thinks it might be used by the Weather Bureau for the purpose of immediately disseminating forecasts made from the evening observations.

THE relative merits of the weather predictions issued daily by the U.S. Weather Bureau for one or two days in advance, and those published by "farmer's almanacs" a year or more in advance, were lately made the subject of newspaper paragraphs in America, and are commented upon by Prof. Cleveland Abbe in the *Monthly Weather Review*. Of course, no true comparison can be made between the results; for while the predictions made by the Weather Bureau are based upon actual observations of atmospheric conditions, the popular weather prophets depend chiefly upon inspiration and astrological combinations, though some do go so far as compile from the records of past years a table showing what sort of weather has prevailed most frequently on the respective days of the year, and use this table for predicting the weather of future years. The art of almanac preparation, however, is in the free use of a system of general terms which will apply just as well to a thunderstorm, a hurricane, or an earthquake. The warning "look out for something very unusual about this time," is a meteorological prediction of this character.

FOR the benefit of those who make a comparison between the prophesies of the almanac-maker and the forecasts of the U.S. Weather Bureau, Prof. Abbe delivers the following homily:—In connection with meteorology in general, and especially weather predictions, there is a popular tendency to make a mistaken use of the word "science." Knowledge is science as distinguished from the world of imagination, which is fiction. Whatever is logical and true may be called scientific, but whatever is illogical or untrue is certainly not scientific. A map or a survey that gives us an exact picture of the true location of every spot on the earth's surface responds to scientific geography. A catalogue of all the plants and animals on the earth or of the stars in the sky constitutes a biological or an astronomical survey, and is truly scientific. A series of maps of the weather at 8 a.m. daily is a scientific meteorological work, and any predictions of the weather that can be logically deduced from these maps is a scientific prediction. But a lot of predictions that are said to be deduced in defiance of sound logic and with a very imperfect knowledge of the laws of nature are fanciful fictions and not scientific, because they are contrary to all sound knowledge.

IT is well known that the Kea or Mountain Parrot of New Zealand has acquired the habit of attacking sheep, and making holes by means of its sharp and powerful beak in the backs of these animals for the purpose of abstracting the kidney fat, which appears to be esteemed as a luxurious diet. It is supposed that this peculiar habit or instinct was developed by the bird getting the fat from the skins of sheep that had been slaughtered; but this solution is not very satisfactory, as there appears nothing to connect the fat on the skins of sheep with the live animals. In a note published in the *Zoologist* (May 16), Mr. F. R. Godfrey, writing from Melbourne, offers the following solution of the mystery, which seems to him to be simple and satisfactory, and more rational than the sheep-skin theory. In the hilly districts of the Middle Island of New Zealand there is a great abundance of a white moss or lichen, which exactly resembles a lump of white wool, at the roots of which are found small white fatty substances, supposed by some to be the seeds of the plant, and by others to be a grub or maggot which infest it, which is the favourite food of the Kea. Probably the bird, misled by this resemblance, commenced an exploration in sheep, and this proving satisfactory, originated the new habit. In a note to this suggestion, the editor points out that Mr. Godfrey is in agreement with Mr. F. R. Chapman (New Zealand *Journal of Science*, 1891), who, describing a valley of the Upper Waimakariri, Canterbury, says: "A very interesting *Raoulia*, or vegetable sheep, was very plentiful on steep, rocky places; but I believe a finer species is found on Mount Torlesse. . . . It is said that the Keas tear them up with their powerful beaks, and that these birds learnt to eat mutton through mistaking dead sheep for masses of *Raoulia*."

As the British Patent Law at present stands, foreign inventors can obtain patents in this country without "working" their invention, and they take the fullest advantage of this state of affairs. To give an instance: in the five years from 1891 to 1895 no less than six hundred patents were granted to foreigners for coal-tar products, not a single one of which is being worked in this country. The object of Section 22 of the Patents, Designs, and Trade Marks Act (1883) was to ensure the working in the British Isles of inventions for which the privilege of British registration has been granted, either by the patentee or by others. In order to secure this object, the Section confers upon the Board of Trade authority to order the granting of licenses on equitable terms. Unfortunately, although the Act has been in force for fifteen years, this authority has never been used, because the prosecution of a petition for the exercise of such authority involves what is practically a very costly legal contest at the expense of the petitioner. Upon the invitation of the Board of Trade, a petition has at last been carried through with the approval of the Manchester Chamber of Commerce. The facts and issue of the prosecution of it are set forth in a pamphlet prepared by the Chamber, and they need only be read to understand that British trade and industry is seriously prejudiced by the present unsatisfactory state of the Patent Law. In France, if a patent is not worked within two years (and the patentee has to prove that it *is* worked), the patent is revoked, and is declared void. In Germany the law is similar, with this exception—that the patentee, instead of two, has three years' time within which to work his invention. What is wanted is a short amending Act which will bring our Patent Law in conformity with those of Germany and France; and it is with the object of calling attention to the need of such a provision that the Manchester Chamber of Commerce has placed the whole facts before the public.

A NUMBER of examples of *Abraxas grossulariata*, in which the markings of the fore-wings, which are usually of a bright yellow, were of a deep dull ochreous colour, were exhibited at a meeting of the South London Entomological and Natural History Society at the end of last year (*Proceedings* for 1897). The specimens were sent by the Rev. J. Greene, of Clifton, Bristol, who reared them from larvæ found on the shrubs of Euonymus, which appears to be their favourite food. During the past six years Mr. Greene has bred a large number of these insects under precisely the same conditions as regards food, temperature, light and darkness. The insects were kept indoors both as larvæ and pupæ, so wet and dry weather could apparently have no effect upon them; and they were all collected within a two-mile radius, where there was no difference of soil. And yet, under these uniform conditions, Mr. Greene produced at least two hundred and fifty varieties. A remarkable variation was noticed in the "contour" of the specimens—that is, in the length, breadth, and curvature of the upper wings; but it is difficult to determine the causes which can produce such a change in the form and shape of the wings. In Mr. Greene's opinion there is one, and one only method by which entomologists may reasonably hope to obtain varieties, namely, by "crossing" the imagines, dark with light, &c. He considers this to be the true cause of the varieties of *grossulariata* obtained by him.

THE drinking habits of some butterflies and moths are briefly described by Mr. J. W. Tutt in a paper published in the *Proceedings* of the South London Entomological and Natural History Society, 1897. A number of observat ons are cited showing that the drinking of large quantities of water by certain species is beyond question. Mr. Tutt concludes as follows:—"That they drink infinitely more than is required by their tissues under any possible conditions appears certain. Baron's note (NATURE, vol. xxviii. page 55, May 17, 1883) is sufficient proof of this; whilst we have known *Polyommatus damon* to sit for more than an hour motionless, except for the slight movements of sucking up and discharging the moisture almost continuously. What this internal bath may really mean we cannot even surmise. Another important factor as to this drinking habit is a strange one; the 'thirsty souls' are, so far as my own observation goes, and so far as De Nicéville's and Bates' remarks show, almost entirely males. Why is this drinking habit confined to one sex, and why is it indulged in whilst the females are away egg-laying, or presenting the strange phenomenon of a perfectly different habit from that indulged in by their lords and masters? It is of course quite reasonable to suppose that, if a number of exact observations be made, females in small numbers do visit puddles, and pools, and streams for drinking purposes. Certain it is that females come to sugar equally with males, but this we may take it is for food, and not for drink, and it is just in this that our difficulty lies. We know that moths and butterflies that visit sugar, over-ripe fruit, and similar dainties are of both sexes. They come, it seems, for food; but males alone seem to be attracted by pure water. Does their extra activity give them a greater need in this direction? and has a habit which was at first (and still is in a measure) a necessity become so pleasurable that excessive drinking has literally become a vice?"

MESSRS. SEELEY AND CO. will shortly publish a concise popular account of wireless telegraphy, by Mr. Richard Kerr, being the substance of lectures delivered by him in the principal cities of England, Scotland, and Holland. Mr. Preece will contribute a preface to the volume.

HERREN FEIEDLÄNDER, of Berlin, have just issued their Book-Catalogue No. 430, consisting of 103 pages, entirely devoted to the anatomy, physiology, and embryology of plants.

AN earnest appeal is made by the Rev. W. Porter, "Vonmueller," Arnold Street, South Yarra, Victoria, one of the trustees, for further contributions for the erection of a granite monument over the grave of the late Baron Ferdinand von Mueller, in the cemetery of St. Kilda.

DR. ERWIN F. SMITH reprints a lecture delivered before the Massachusetts Horticultural Society on the spread of plant diseases, in which he discusses the parts played respectively by insects and by the wind in the propagation of the diseases of plants.

THE May number of the *National Geographic Magazine* is devoted to an account of the geography, resources, and political conditions of Cuba, and contains as a frontispiece the portrait of Captain Charles D. Sigsbee, the commander of the ill-fated battleship *Maine*. For several years, prior to taking command of the *Maine*, Captain Sigsbee was Hydrographer of the Navy Department, and his contributions to our knowledge of the sea bottom, and its topography, place him in the front rank of scientific hydrographers.

MESSRS. TAYLOR, TAYLOR, AND HOBSON have issued a booklet of twenty-three pages setting forth the merits of their Cooke lens. Every photographer knows how difficult it is to obtain a lens which gives a sharply-defined image all over the field of view. By increasing the number of lenses, it is possible to overcome this difficulty and secure sharp definition even at the margins of a picture. The Cooke combination satisfies this photographic desideratum by the simplest means, only three lenses being used in its construction. The superiority of the lens over the symmetrical and other old types is strikingly shown in the book by a series of reproductions from the margins of plates.

THE eleventh part of Mr. Oswin A. J. Lee's illustrated work "Among British Birds in their Nesting Haunts" has been published by Mr. David Douglas, Edinburgh. Ten plates are included in this new part, representing nests of the robin, wren, rook, marsh tit, golden eagle, spotted flycatcher, teal, and pheasant. An insertion announces that the author is desirous of taking photographs of the nests of the following birds: kite, Montagu's harrier, honey buzzard, hobby, garganey, and ruff. If any reader is able to help Mr. Lee to procure these, intimation should be sent to him at 58 Manor Place, Edinburgh.

"WE have the satisfaction of being able again to look back upon a year of general activity and extended progress, which will bear comparison with any of its predecessors." The Report of the Marlborough College Natural History Society, from which these words have been taken, show that interest in scientific subjects is well fostered by the Society. The members are encouraged to observe and to contribute papers recording the results of their observation and reading, so that the Society, like other similar societies in our public schools, is of great assistance in developing very useful faculties. For instance, the following observation, by "E. A. M.," of climbing habit in frogs is interesting:—"Some frogs have taken up their abode for the last month in two deserted blackbirds' nests, built in round thick box bushes, about two feet from the ground. One frog is generally to be seen alone sometimes on or near the edge of the nest, sometimes comfortably ensconced in the middle, only his head peeping out. In the other nest there are now always two frogs." Mr. E. Meyrick describes and figures some cinerary urns discovered during excavations in the College grounds.

THE additions to the Zoological Society's Gardens during the past week include a Collared Peccary (*Dicotyles tajaçu*) from South America, presented by Mr. Eustace Grey; a Gazelle (*Gazella dorcas*, ♂) from North Africa, presented by Mr. J. D. Lambert; a Short-headed Phalanger (*Petaurus breviceps*) from Australia, presented by Mr. Julian T. Pym; a Small Hill Mynah (*Gracula religiosa*) from India, presented by Mrs. Strather; a —— Squirrel (*Sciurus*, sp. inc.), three Schlegel's Doves (*Calopelia puella*) from West Africa, presented by Mr. W. H. Boyle; two Malabar Squirrels (*Sciurus maximus*, var. *dealbatus*) from India, presented by Mr. R. C. Wroughton; an Algerian Tortoise (*Testudo ibera*) from North Africa, presented by Mr. Albert West; a Smooth Snake (*Coronella austriaca*), British, presented by Mr. Bryan Hook; a Black-shouldered Kite (*Elanus cœruleus*), a Tachiro Goshawk (*Astur tachiro*), a Spotted Eagle Owl (*Bubo maculosus*), two Infernal Snakes (*Boodon infernalis*), two Lineated Snakes (*Boodon lineatus*), a Smooth-bellied Snake (*Homalosoma lutrix*), four Rough-keeled Snakes (*Dasypeltis scabra*), eleven Rufescent Snakes (*Leptodira hotambœia*), four Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), fifteen Crossed Snakes (*Psammophis crucifer*), a Cape Adder (*Bitis atropos*), three Puff Adders (*Bitis arietans*) from South Africa, presented by Mr. J. E. Matcham; a Gazelle (*Gazella*, sp. inc., ♂) from Senegal, two Black-striped Wallabies (*Macropus dorsalis*, ♂ ♀) from New South Wales, a Canadian Skunk (*Mephitis mephitica*), a Florida Tortoise (*Testudo polyphemus*) from North America, a Beccari's Cassowary (*Casuarius beccarii*) from New Guinea, a Sharp-nosed Crocodile (*Crocodilus acutus*) from Jamaica, deposited; two Mantchurian Cranes (*Grus japonensis*) from North China, purchased; an African Wild Ass (*Equus tæniopus*, ♂), two Barbary Wild Sheep (*Ovis tragelaphus*), two Black-necked Swans (*Cygnus nigricollis*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

SUN WORSHIP BY TUSAYAN INDIANS.—In the fifteenth annual report of the U.S. Bureau of Ethnology, and in recent numbers of the *American Anthropologist*, Dr. J. Walter Fewkes gives a detailed account of a group of the ceremonials which form the ritual practised by the Tusayan Indians. It has been known for some years that the aborigines of the semi-deserts in the south-western portion of the United States possess a remarkably elaborate system of belief and ceremonial, and Dr. Fewkes has devoted a considerable amount of attention to them in order to determine the significance of the various parts of the ritual followed. In the course of his investigations he has made a number of interesting observations on the astronomical means used for determining the time for ceremonials. He has found that among the Hopi Indians there are priests skilled in the lore of the sun, who determine, by observation of the points on the horizon where the sun rises or sets, the time of the year proper for their religious observances. An important ceremony is performed at the winter solstice, and in December 1897 Dr. Fewkes made a special journey to Arizona to study the ritual on the spot. This is not the place to refer to the ethnological aspects of the ceremonials witnessed by him, but the following extract from the Report of the U.S. Bureau of Ethnology will interest students of primitive astronomy.

"We are justified in accepting the theory that sun and moon worship is usual among primitive men. Whether that of the sun or of our satellite was the earlier, it is not in the province of this article to discuss, but it is doubtless true that sun worship is a very ancient cult among most primitive peoples. The Pueblos are not exceptions, and while we cannot say that their adoration is limited to the sun, it forms an essential element of their ritual, while their anhydrous environment has led them into a rain-cloud worship and other complexities. I think we can safely say, however, that the germ of their astronomy sprang from observations of the sun; and while yet in a most primitive condition they noticed the fact that this celestial body did not always rise or set at the same points on the horizon. The connection between these facts and the seasons of the year must have been noted early in their history and have led to orientation, which plays such an important part in all their rituals. Thus the approach of the sun to a more vertical position in the sky in summer and its recession in winter led to the association of time when the earth yielded them their crops with its approach, and the time when the earth was barren with its recession. These epochs were noticed, however, not by the position of the sun at midday, but at risings and settings, or the horizon points. The two great epochs, summer and winter, were, it is believed, connected with solstitial amplitudes, and the equinoctial, horizontal points, unconnected with important times to agriculturists, were not considered as of much worth. There is every evidence, however, that the time of day was early indicated by the altitude of the sun, although the connection of the altitude at midday with the time of year was subordinated to observations on the horizon."

STELLAR RADIATIONS.—Referring again to the problem of the measurement of stellar radiations, mentioned in our issue of May 12 (p. 39), the recent improvement in galvanometers ought to help the matter towards solution. At the meeting of the Physical Society on May 13, Prof. Ayrton said that the sensitiveness of these instruments had increased during the last few years in the ratio of 27 to 3,310,000. Of course it must be remembered that these figures apply to a particular class of instrument, and that they are based upon a somewhat empirical definition of the factor of sensitiveness. Nevertheless, they do indicate advance in the refinements of current-measurement.

It is to be hoped that similar attention may now be given to perfecting an electrometer for extremely small potential-differences; such an instrument is required for the development of photo-electricity generally. The sensitive plates of the cells used by Prof. Minchin for stellar measurement are only a few square millimetres in area; the advantage of this is that several of them can be placed together at the focus of a telescope. Their function is, not to give current, but potential differences when exposed to light. They respond chiefly to yellow radiations, and each plate, irrespective of its size, gives from one-third to one-half a volt, for daylight. If electrometers could be improved in the ratio 27 to 3,310,000, the experiments made by Pouillet, just fifty years ago, might be extended almost to the circumjovial planets.

THE LATE PROF. SOUILLART.—At the meeting of the Paris Academy of Sciences on May 23, M. Callandreau gave a short account of the late Prof. Souillart, whose death we have already announced. Prof. Souillart was elected a Correspondant of the Academy in succession to M. Gyldén, the Academy thus showing its esteem for the astronomer who during thirty years devoted his leisure to the study of the theory of the satellites of Jupiter, and succeeded in bringing out important complements of the chief work of Laplace. It was while studying under M. Puiseux, at the Normal School, that M. Souillart had his inclination turned to celestial mechanics. In 1865 his "Essai sur la théorie analytique des satellites de Jupiter" appeared in the *Annals* of the School, and formed the basis of two later memoirs—one, published by the Royal Astronomical Society, devoted to the analytical theory of the movements of the satellites; while the other, dealing with the reduction of the formulæ to numbers, appeared in the thirtieth volume of the "Mémoires des Savants étrangers." In addition to these publications, a series of notes appeared in the tenth, eleventh, and twelfth volumes of the *Bulletin astronomique*. The whole of these works formed the basis of the treatment of the satellites of Jupiter given by M. Tisserand in his "Traité de Mécanique céleste."

When M. Souillart left the Normal School he was appointed professor of mathematics in the Saint-Omer High School, and at the same time was attached to the Faculty of Sciences at Nancy. In 1873 he became professor of mécanique rationelle at Lille University, and, some years later, professor of astronomy, which post he occupied at the time of his death.

THE INDUSTRIAL APPLICATIONS OF ELECTRO-CHEMISTRY.

THAT electricity is able to bring about chemical change appears to have been observed for the first time about the middle of last century. With Volta's discovery of the principle of his pile, in 1792, it became possible to set larger quantities of electricity in motion, and in 1800, the year in which Volta described his first large battery, the study of the chemical effects of the electric current may be said to have commenced with the observations of Nicholson and Carlisle on the electrolysis of water. They were the first to notice the separate evolution of the products of the decomposition at opposite poles; so that our knowledge of electrolysis, upon which the majority of the applications of electro-chemistry depend, may be said to have been acquired in the nineteenth century.

In the early 'thirties it was repeatedly proposed to deposit metals by immersing the object to be coated in a solution of the metal, placing it in contact with a more oxidisable metal. An external source of current was applied to electrotyping in 1839 by Jakobi, Spencer and Jordan independently of each other; the first-named also describes the employment of electrolytic gas in producing lime-light. The use of a current generated by magneto-electric machines was patented in 1842, and, according to Mr. Swan, current generated in this way was employed by Messrs. Elkington at Birmingham in that year. It was not, however, until 1864-5 that the more perfect machines of Pacinotti and Wilde made it possible to produce the electric current at a sufficiently economical rate to permit of its employment in a chemical process on the manufacturing scale. The electrolytic refining of copper was patented by Mr. J. Elkington in 1865 and 1869, and in the latter year the first electrolytic copper refinery was erected at Pembrey, near Swansea. The progress of electro-chemical industry was at first slow, but the improvements in dynamos and steam-engines, stimulated by the rapid extension of the applications of electricity to lighting and other purposes, the development of water powers, and last, but not least, the impetus given to the study of electro-chemistry by the theories of Van 't Hoff and Arrhenius, have contributed to make this progress during the past decade extraordinarily rapid. A circumstance, the effect of which on the future development of the applications of electro-chemistry is not to be underrated, is the evolution of a new type of chemist—one, namely, who adds to his knowledge of chemistry a competent knowledge of physics and especially of electricity; there can be no doubt that the country in which the facilities for obtaining training of this kind are defective will be heavily handicapped in the future. With special electro-chemical laboratories being founded at almost every university and polytechnic in Germany, it is depressing to see so little being done in our own country (more especially since it is apparently becoming increasingly difficult for foreigners to obtain admission to the German laboratories).

The present position of technical electro-chemistry has not been attained without many failures; instructive and interesting as many of these are, it is impossible to refer to them within the limits of this article, which must, therefore be confined to a general description of processes actually employed.

The oldest and most important of these is the electrolytic copper-refining process. The copper containing 0·3 to 2 per cent., or sometimes more, impurity is cast into plates which are suspended, some 3 or 4 inches apart, in large, lead-lined wooden boxes. Between each pair of plates a thin sheet of pure copper is suspended, and the solution, containing 15 to 20 per cent. of crystallised copper sulphate and 5 to 6 per cent. of sulphuric acid, run in. The impure copper plates, of course, form the soluble anodes, the thin sheets receiving the deposit of pure copper. A current of from 100 to 200 amperes per square metre is usually employed, the E.M.F. being 0·2 to 0·4 volt. The electrical energy needed is, therefore, 0·1 to 0·2 electrical horse-power hour per pound of copper deposited. Considerable variations in the details of working are found in different works, owing to the varying local conditions. When a larger current density is employed the amount of electric energy required to deposit a pound of copper is greater, but, on the other hand, the copper is deposited more quickly, and therefore, for a given output, less copper is locked up in the baths, less labour is required, and a smaller plant is sufficient. In order to obtain a homogeneous deposit of copper the solution must be kept in circulation, otherwise a deficiency of copper near the kathode surface would arise, which would lead to the formation of a non-coherent impure deposit. Of the impurities in the anodes, gold, silver, and part of the arsenic and antimony remain undissolved, whilst iron, nickel, and the remainder of the arsenic and antimony pass into solution. The two latter metals are deposited along with the copper if they are allowed to accumulate too largely in the solution, especially if the amount of free acid present is small. The solutions must therefore be purified from time to time, and this forms the main difficulty of the process. By blowing air through the solution, after neutralising it with cupric oxide, ferric arsenate and basic antimony sulphate are deposited; but large quantities of copper sulphate are thus accumulated, which are difficult to dispose of. Where cheap power is available, the impure solutions may be electrolysed with insoluble anodes of lead and the copper, arsenic and antimony deposited; otherwise evaporation and recrystallisation must be resorted to.

The anode slimes which contain Au, Ag, Se, Te, Bi, Sb, and As, are worked up to recover the precious metals. In 1896, 137,000 tons of electrolytic copper were obtained, of which the United States produced more than all other countries together. The greater part of this pure copper is employed for electrical purposes, where its high conductivity is of paramount importance. The electrolytic copper is obtained in a coarsely crystalline condition, and is fused before use. Mr. Elmore aims at depositing the copper directly in the form in which it is to be employed; copper tubes, for example, are made by depositing the metal upon a rotating cylinder, the surface of the deposit being constantly polished by a prismatic piece of agate which moves backwards and forwards parallel to the axis of the cylinder. This produces a very dense and tough deposit, and at the same time permits of the employment of a current density as high as 600 amperes per square metre. The removal of the cylinder from the tube is very simple when it is made of some easily fusible alloy.

The electrolytic process for making aluminium has entirely superseded the chemical process, the superiority of the former (from a commercial point of view) being demonstrated by the diminution in the price of aluminium from over 20*s.* per lb. in 1888 to about 1*s.* 4*d.* to-day. The electrolyte employed is a solution of alumina in a fused mixture of the fluorides of aluminium and of the alkali or earth-alkali metals. Minet has used a mixture of common salt and aluminium fluoride, but it would appear that the solvent usually employed is cryolite from which iron and silicon have been removed by a preliminary electrolysis. The baths consist of large iron, carbon-lined boxes, the lining forming the kathode. The anode consists of massive blocks of carbon suspended above the bath, and dipping under the fused electrolyte almost to the bottom of the bath. The electrolyte is maintained in the fused state by the heat generated by the passage of the current, and the aluminium collecting on the bottom of the bath is run off from time to time. The alumina alone undergoes decomposition, the oxygen combining with the carbon anode and escaping as carbonic anhydride. Anhydrous alumina is shovelled on to the surface of the bath as required, and serves to protect the fused mass below from loss of heat by radiation. Although attempts have been made to refine aluminium containing iron and silicon, they do not appear to have met with success, and it is therefore necessary to exclude these impurities from the materials used. The pure alumina used in the process is prepared from bauxite. A current of 7000 amperes is passed through each bath (the current density being probably about 2·5 amperes per sq. cm. of kathode), an E.M.F. of about 5 volts being required. The current efficiency is considerably less than the theoretical amount, owing to some secondary action, so that from 14 to 18 electrical horse-power hours are required to produce a pound of metal. The annual production of aluminium is rapidly increasing, and is at present considerably over 2000 tons. Notwithstanding the very large consumption of electrical energy in this manufacture, it is interesting to note that the cost of the pure alumina is the largest individual item in the total cost of production.

The problem of utilising aluminium presents as great difficulties as that of its economical production. Mr. A. E. Hunt, of the Pittsburg Reduction Company, has recently given an interesting account of the applications of aluminium, from which it appears that these difficulties are being overcome.

The energetic reducing action of aluminium is utilised in many ways, the most important being the production of steel castings; two to five ounces of aluminium per ton suffices to remove oxygen from the steel, and so to obviate to a great extent the formation of blow-holes in the castings. A little aluminium added from time to time to the baths of molten zinc used in galvanising, removes the oxide and keeps the baths fluid. The addition of a little aluminium in making brass castings increases their soundness and strength in a similar way.

Aluminium is also used instead of brass for a multitude of small cast and stamped objects which do not require to be soldered; there would still appear to be no trustworthy method of permanently soldering aluminium. Aluminium may possibly be used as a conductor of electricity, though at present the advantage in price lies with copper; the specific conductivity of aluminium is 63 to 64 per cent. of that of copper, whilst copper is 3·3 times as heavy.

The history of the electro-metallurgy of zinc is mainly a record of failures. Zinc is readily deposited from neutral or slightly acid aqueous solutions or from the fused chloride, but, from the former, is very prone to separate in a spongy form. Mylius and Fromm show that this is probably due to the formation of traces of oxide, and is prevented by the presence of reducing agents. Vigorous circulation of the solution is also advantageous. The presence of metals more electro-negative than zinc, which deposit on it and promote its oxidation, also produces the spongy deposit. The difficulty of insuring the absence of such metals from solutions obtained from zinc ores, as well as the low price of the metal, which precludes any elaborate purification, probably account for the slow progress of this industry. Progress is, however, being made. Dieffenbach's process is in successful operation at Duisberg in Germany. In this a solution of zinc chloride, obtained by leaching a zinciferous iron pyrites after submitting it to chlorinating roasting, is electrolysed; but further details are wanting.

The Ashcroft process obtains coherent zinc by employing a somewhat basic solution of zinc sulphate or chloride in the kathode compartments of the electrolytic cells, whilst the Siemens and Halske process employs somewhat acid zinc sulphate solution. Both these processes are at work on the large scale, but their ultimate success does not seem to be yet quite assured; so that a more lengthy description may be dispensed with.

At Tarnowitz an alloy of zinc and silver with a little lead and copper, obtained by desilverising lead with zinc containing about 0·5 per cent. of aluminium, was refined electrolytically, using a slightly basic concentrated solution of zinc and magnesium chlorides as electrolyte, and rotating zinc plates as kathode. The insoluble anode mud thus obtained contained about 75 per cent. of silver, and the zinc deposited was almost chemically pure.

Electro-galvanising is also now somewhat largely employed, the electrolyte being a solution of zinc sulphate. Here again close attention to the current density and composition of the solutions is required to secure a smooth and adherent deposit.

Nickel.—Whilst it is perfectly easy to deposit a very thin film of nickel by electrolysis, the metal peels off if a thicker deposit is attempted. According to Foerster, however, tough, homogeneous plates of nickel of any thickness may be deposited from aqueous solutions of the sulphate or chloride if they are heated to from 50° to 90° C. The nickel obtained is, however, not so pure as is the case with copper, cobalt and iron being found in the refined metal in about the same quantities present in the unrefined. Electrolytic nickel is now a commercial article, part of it being obtained from alloys of copper and nickel containing a considerable amount of sulphur, which are used as anodes, the copper being first deposited, whilst the nickel goes into solution, from which it is subsequently deposited.

The electrolytic removal of tin from tin-plate is said to be carried on to a considerable extent. The tinned scrap is suspended in iron baskets which form the anode, and the tin deposited in the spongy form on sheet-iron kathodes, the electrolyte being a solution containing 12 to 15 per cent. of sodium chloride, to which a little caustic soda is added from time to time to prevent the precipitation of stannous oxide. The solution is warmed to 40° or 50° C., and since tin dissolves under these circumstances independently of the electric current, it is necessary occasionally to evaporate the solution and work up the residue for sodium stannate. Sodium is now made exclusively by the electrolysis of fused caustic soda. In Mr. Castner's process the heat generated by the passage of the current is utilised to keep the bath in the fused state. Magnesium is also a product of electrolysis. The small quantity produced is made at Hemelingen, near Bremen, by the electrolysis of perfectly dry, fused carnalite (magnesium potassium chloride). The iron crucible in which the salt is melted serves as kathode, the central carbon anode being surrounded by a perforated porcelain or stoneware cylinder which retains the chlorine.

The application of electrolysis to the precipitation of gold from cyanide liquors, marks an advance of some importance in the metallurgy of gold. Gold is not completely precipitated in a reasonable time by zinc from solutions containing less than 0·1 or 0·2 per cent. of free potassium cyanide, whereas with the electrolytic process the concentration of the solution is a matter of indifference. It thus becomes possible, by the employment of very dilute cyanide solutions, to extract economically the small quantities of gold contained in slimes and tailings which would otherwise have been thrown away. A further advantage of the electrolytic precipitation is that the gold obtained contains some 89 per cent. of gold, instead of the 70 per cent. contained in the zinc bullion. The solutions to be electrolysed contain from 0·01 to 0·05 per cent. of potassium cyanide, according to the nature of the ore treated, together with from 1 to 4 dwts. of gold per ton of solution, in the form of potassium aurocyanide. They have, therefore, a very high resistance. Owing to the very small quantity of gold to be deposited, however, a very small current is sufficient (0·6 ampere per square metre), and the baths can be worked with the moderate E.M.F. of 4 volts. The quantity of electric energy required is thus small, and its cost is almost negligible compared with that of the rest of the process. The solution flows into the electrolytic tank at one end, and passes alternately over and under the electrodes until it flows out of the tank deprived of 80 to 90 per cent. of its gold. The kathodes consist of thin sheets of lead, and the anodes of iron enclosed in canvas bags to retain the precipitate of prussian blue which forms on them. They are placed about 1½ inches apart. The gold remaining in the liquors flowing from the electrolytic tanks is not lost, these liquors being made up to strength with fresh cyanide and used again. After remaining in the tanks some months the lead kathodes are sufficiently rich in gold to be removed and submitted to cupellation. Owing to the important advantages already mentioned, the employment of this process is rapidly extending; in 1896, two years after the first installation of the process, over 46,000 ounces of gold were obtained in the Transvaal by means of it, and at present it is much more extensively used.

Turning, now, to the application of electrolysis to the production of substances other than metals, there is an important group of industries engaged in the electrolysis of potassium and sodium chlorides, producing, according to the conditions employed, caustic alkalis and chlorine, hypochlorites or chlorates.

In the first case it is necessary to keep the primary products of the decomposition separate, and this is accomplished in two ways: (1) by the use of a porous diaphragm; (2) by means of mercury. The manufacture of a diaphragm which shall be sufficiently durable with a solution of caustic soda on one side of it, and of chlorine on the other, is by no means easy. The fact that diaphragms are being successfully used proves, however, that the difficulties are not insuperable. A more serious drawback is the impossibility of separating the caustic alkali from the chloride. As soon as the solution at the kathode contains hydroxyl ions, these begin to migrate, under the influence of the current, toward the anode, in time passing into the anode compartment and giving rise to the formation of hypochlorites and chlorates and to the evolution of oxygen, and so diminishing the efficiency of the cell. It is therefore necessary to draw off the solution from the kathode compartment of the cell while it still contains much undecomposed chloride, and to separate this from the caustic alkali as far as possible during the process of concentration.

The process of Hargreaves and Bird avoids this to a great extent in a very ingenious way. The kathode in this process consists of a sheet of copper gauze, upon which the diaphragm is built up of asbestos mixed with some cementing material. The diaphragm, with the copper gauze outside, forms the outer wall of the cell which contains the solution of salt and the carbon anode. The caustic soda is thus formed outside the cell, and is washed down and converted into carbonate by a mixture of steam and carbon dioxide. The diaphragm is made so impervious that, when in good condition, no liquid will run out of the cell, and only three molecules of salt to 100 molecules of sodium carbonate are obtained. The diaphragms last about thirty days, but, according to Kershaw, yield less favourable results toward the end of the time. Hulin's process is somewhat similar to that of Hargreaves and Bird, the diaphragm-kathode consisting of a sheet of porous carbon through which the caustic soda solution is forced as quickly as it is formed by hydrostatic pressure inside the cell.

When mercury is employed as the kathode, the diaphragm becomes unnecessary, the mercury taking up sodium in contact with the salt solution and giving it up to pure water in another vessel. A great many devices have been contrived for causing the mercury to alternately perform these functions. The simplest and most effective is undoubtedly the rocking cell of Mr. Castner. This consists of a shallow oblong tank divided into three compartments by means of partitions which do not quite reach the bottom. A thin layer of mercury lying on the bottom of the cell lutes the spaces below the partitions, thus dividing the cell into three separate compartments. The two end ones contain strong brine and carbon anodes, the central one pure water and an iron kathode which is connected electrically with the mercury. The cell is tilted slightly from side to side, so that the mercury flows from one end compartment to the other, always covering the floor of the central compartment, however. In this way the sodium taken up at the ends is conveyed to the water in the centre. The central compartment forms really a galvanic element, consisting of sodium amalgam and iron in a solution of caustic soda; the connection of the iron to the mercury short circuits this cell, and therefore hastens the dissolution of the sodium. The caustic soda obtained in this way is practically pure, and the current efficiency over 90 per cent. of the theoretical value; whilst the electromotive force required is 4 volts for each cell.

If instead of keeping the products of the electrolysis of a salt solution separate they are mixed together in the cold, a solution of hypochlorite is formed. A limit to the concentration attainable is, however, quickly reached, partly owing to the electrolysis of the hypochlorite, partly to its reduction by the hydrogen evolved. Hermite employs rotating zinc kathodes, between each pair of which a platinum gauze anode is fixed, the electrolyte, consisting of a solution of salt and magnesium chloride, flows through the apparatus, yielding a weak bleaching liquor suitable for bleaching paper pulp or for deodorising sewage, in which latter case sea water may be used. Kellner attains the same result by using a long tank in which a large number of carbon plates are fixed in such a way that the solution flowing in at one end of the tank must circulate between each pair of plates before passing out of it. Only the two end plates are attached to the terminals of the dynamo, so that each intermediate plate acts on one side as anode, on the other as kathode.

The electrolytic preparation of potassium chlorate was patented by Charles Watt as early as 1851, but the idea was not put into practice until 1889, when Gall and Montlaur started the first electrolytic potassium chlorate plant at Villers-sur-Hermes in Switzerland. They employ thin platinum-iridium anodes and iron kathodes, and maintain the solution at a temperature of 50° to 60° C. by the heat evolved by the passage of the current. The electrolytic cell is divided by a diaphragm of porous earthenware into a smaller kathode, and a larger anode compartment, in order to prevent as far as possible the reduction of the chlorate by the hydrogen evolved at the kathode. A current of 10 amperes per sq. dcm., and an E.M.F. of 5 volts are used, and the caustic potash formed at the kathode transferred to the anode compartment sufficiently fast to absorb all the chlorine evolved. The potassium chlorate crystallises out in the anode compartment, its solubility being diminished by the employment of a saturated solution of potassium chloride as electrolyte. The diaphragm may be dispensed with, according to Oettel, if the solution is alkaline, because in that case potassium chlorate is not reduced, to any appreciable extent, by nascent hydrogen. High current density at the kathode, and low current density at the anode, promote the formation of chlorate, the best results being obtained when a quantity of oxygen is evolved, corresponding to some 30 or 40 per cent. of the current passed. The current efficiency is reported to be from 65 to 70 per cent., and there is no doubt that the electrolytic process will eventually displace the older chemical one, about one half of the world's consumption of chlorates being already supplied by it.

Of other electrolytic processes there is not very much to be said. In Mr. A. B. Brown's process for the manufacture of whitelead a 10 per cent. solution of sodium nitrate is electrolysed in order to obtain caustic soda and nitric acid, which are subsequently used for the preparation of lead nitrate and its precipitation as lead hydroxide, the latter being finally converted into lead carbonate by means of a solution of sodium bicarbonate.

Applications of electrolysis to tanning and to the purification of sugar have been frequently proposed, but nothing very definite is known as to their success.

Among organic compounds iodoform has long been prepared by the electrolysis of an alkaline solution of potassium iodide containing alcohol. According to Elbs and Hertz good results are obtained by electrolysing a solution containing 5 to 6 grams of sodium carbonate, 10 grams of potassium iodide and 20 cc. of alcohol in 100 cc. of water at a temperature of 60° C. with a current density not exceeding 1 ampere per square decimetre. Under these circumstances the current efficiency is over 97 per cent. and the iodoform produced perfectly pure.

It has been proposed to apply ozone to a great variety of purposes, but here again a lack of trustworthy information about the results is found. According to Mr. Swan, however, it is used in making vanilin and heliotropin. When used as a bleaching agent it is necessary to use it in conjunction with other substances, such as hypochlorites or hydrogen peroxide. Mr. Andreoli has devised an ozone producer in which the electrodes are furnished with numerous points and separated by a glass plate. In order to prevent the heating of the gas it is caused to pass rapidly throught the apparatus, and the electrodes are made hollow and cooled by internal circulation of water. The silent discharge is obtained by means of an alternating current dynamo and high tension transformer yielding a rapidly alternating current at a pressure of 10,000 volts or more. By this means 30, or under favourable conditions 40 grams of ozone are obtained for a horse-power hour.

Electro-thermal Processes.—The electric current possesses two considerable advantages as a heating agent; in the first place temperatures otherwise unattainable may be reached by its aid, and secondly the heat may be applied directly and economically to the substances which are to be caused to react. The three most important products of the electric furnace are carborundum, phosphorus, and calcium carbide.

Carborundum, a compound of carbon and silicon in equal atomic proportions, was prepared by Acheson in 1891, in the course of experiments on the artificial production of the diamond. It is remarkable for its extreme hardness, which is only inferior to that of the diamond. It is prepared by heating a mixture of powdered coke and sand, to which a little sawdust and salt are added in order to make the mass more porous, in a furnace 16 feet long, 5 feet wide and 5 feet deep, which is built up of loose fire-bricks. Through the end walls of the furnace bundles of 60 carbon rods, each 3 inches in diameter pass, which are connected inside the furnace by a cylindrical core of small pieces of coke. This core is surrounded on all sides by the mixture of sand and coke. The passage of the current through the core gives rise to a cascade of small arcs between the pieces of coke, which soon raises the whole core to a very high temperature which is communicated to the surrounding charge. A current of 6000 amperes at 125 volts pressure is passed for 36 hours, after which the furnace is allowed to cool and the hollow cylinder of crystalline carborundum surrounding the core removed. About 5·3 electrical horse-power hours are expended in producing a pound of the crystalline product, a considerable quantity of valueless, amorphous carbide of silicon being also formed at a greater distance from the core, where the temperature is lower. The carborundum is obtained in the form of steel grey to brownish green crystals, the coloration being due to iron; it is a valuable abrasive, cutting the hardest steel without destroying its temper; and is being largely used in place of emery. The production has increased from 15,000 pounds in 1893, when it was first made on a manufacturing scale, to about one and a half million pounds in 1897.

The manufacture of phosphorus in the electric furnace has been carried on for some years by means of the process of Readmann and Parker and Robinson. Wöhler found, as long ago as 1830, that phosphorus may be obtained from calcium phosphate by heating it to a high temperature with sand and carbon, calcium silicate and carbon monoxide being produced. The employment of the electric furnace has made it possible to use this process for the manufacture of phosphorus. Naturally occurring phosphates are used and siliceous material added, which will furnish a readily fusible slag. The finely-powdered mixture of these substances with carbon is fed in through a hopper at the top of a brick-lined trough, 18 inches square and 36 inches deep, through opposite sides of which the carbon electrodes are introduced. The fused slag collects at the bottom of the furnace, whence it is run off from time to time in the same way as in a blast furnace, whilst the mixture of phosphorus vapour and carbonic oxide pass to the condensing apparatus through an opening placed near the top of the furnace. More than 80 per cent. of the phosphorus contained in the materials used is obtained, the loss being largely due to the presence of iron which combines with phosphorus to form a phosphide which remains in the slag. The heat is concentrated mainly between the electrodes, so that the walls of the furnace do not suffer.

Calcium carbide was prepared by electrically heating together carbon and lime, in 1892 by Moissan in France, and by Willson in America; its manufacture is now carried out on a very considerable scale, both in America and in Europe. The production is said to be about 20,000 tons yearly. The furnaces employed vary considerably in details of construction and in magnitude. Those employed at Niagara consist of a square brickwork shaft in which a bundle of carbon rods, which forms one electrode, is suspended. The bottom of the shaft is closed by an iron rectangular box, running on rails, the bottom of which has a thick lining of carbon, which serves as the other electrode. The finely-powdered mixture of coke and lime is fed into the space round the upper electrode through channels in the brickwork sides of the shaft. The arc having been established between the electrodes, the mixture of coke and lime is shaken down into it, and converted into calcium carbide, which remains in a semi-fluid condition upon the lower carbon plate. The calcium carbide, being a fairly good conductor of electricity, now serves as the lower electrode, fresh material being constantly added to its upper surface until the iron box is full, when it is run out and a fresh one substituted for it. The current employed is 1700 to 2000 amperes, and the electromotive force 100 volts, a pound of the carbide being obtained for an expenditure of 2·25 electrical horse-power hours. When sufficient carbon is employed in the mixture, the electrodes are very little acted upon; the excess of carbon which is required depends very much on the kind of apparatus employed. A pound of well-made carbide yields 5 cubic feet of acetylene gas, the employment of which for lighting appears to be making some progress.

In concluding this brief sketch of the applications of electrochemistry, it is perhaps worth pointing out that, important and interesting as are the applications which have been made, those which yet remain are still more so. For example, it is possible, by compressing sulphur dioxide and air into separate carbon tubes dipping in dilute sulphuric acid, to cause the two gases to combine to form sulphuric acid, and at the same time furnish an electric current. The alluring prospect of obtaining electric energy as a bye-product in a chemical works, should be a sufficient incentive to efforts to overcome the numerous difficulties in the way.

THOS. EWAN.

THE STRANGLING OF AN ELEPHANT.

ONE of the elephants in Barnum and Bailey's Show, which has been visiting Liverpool during the past two weeks, having recently shown signs of insubordination, Mr. Bailey determined, in order to perfectly safeguard his visitors, to sacrifice the animal. He has had during his life occasion to destroy many elephants, which, as a rule, he has handed over to experienced veterinary and other surgeons, who have tried various methods, such as poisoning, shooting and bleeding. All have proved, however, unsatisfactory, because uncertain, tedious, and not seldom dangerous to those engaged in conducting the operations. On this occasion it was determined, after consultation with several experts and with the Secretary of the Royal Society for the Prevention of Cruelty to Animals, to kill the elephant by strangulation, which had once before been adopted with success by Mr. Bailey. Accordingly it was arranged that on a recent Sunday morning—the day most suitable to the Show people and that freest from intrusion by the public—Don, as the doomed elephant, who was supposed to be about twenty-two years of age and nearly 4½ tons in weight, was named, should be strangled.

At the appointed hour those specially invited—among whom were several veterinary surgeons, Dr. Forbes, Director of the Liverpool Museums (to whom the body was generously to be handed over as a gift from Mr. Bailey to the Museum), Dr. Roberts, and Mr. Burnham, of the Society for Prevention of Cruelty to Animals—found the elephant standing quietly in one of the large tents in line with some twenty to thirty others. A new Manilla rope was loosely wound three times around its neck, and its legs, fully stridden, were securely chained each to a post firmly driven into the ground alongside each limb. The animal was intentionally not isolated from its fellows, as it was feared that if separated by itself it would become restive and ill-tempered. The rope surrounding the beast's neck had one end secured to three strong pillars in the ground, some distance away and slightly in advance of the fore-feet; and the other, which terminated in a loop, was hooked to a double series of pulleys, to the tackle of which ninety men were attached. When all was ready, the slack was gently, quietly, and without any apparent annoyance to the elephant, which kept on eating hay, taken in till the coils round its neck were just taut. The word was then given, "Walk away with the rope." Amid perfect silence the well-disciplined company walked away with it without the least effort. So noiselessly and easily did everything work that, unless with foreknowledge of what was going to take place, one might have been present without realising what the march of these men meant. The elephant gave no sign of discomfort, either by trunk or tail; its fellows standing close by looked on in pachydermatous unconcern, and at the end of exactly thirty seconds it slowly collapsed, and lay down as if of its own accord. There was absolutely no struggle, and no motion, violent or otherwise, in any part of the body, nor the slightest indication of pain. In a few seconds more there was no response to the touch of its eyelashes or other parts of the eye, and this condition remained for a few minutes; but through, perhaps, the leakage into the chest of a small quantity of air, some slight sensitiveness returned to the eye, seen on touching its inner angle, though not the cornea. On slightly tightening up the rope, the chest gave one or two short throbs, and after six and a half minutes all movement ceased, and sensation was entirely lost; while at the end of thirteen minutes from the order "to walk away," the eye had become rigid and dim.

That no more humane, painless and rapid method of taking the life of a large mammal could be devised, was the opinion of all the experts who witnessed the execution of this elephant.

The skin and skeleton have been preserved for exhibition in the Municipal Museums, and all the important viscera have been placed in Formal, for future study by the Director and his staff. Prof. Paterson and Dr. Dunn, of University College, who very kindly aided in the dissection, have made a full study of certain parts of the nervous system, which they had not completed in the dissection made by them (on which they have recently contributed a valuable paper to the *Journal of Anatomy and Physiology*) of the "rogue" elephant poisoned last year in Liverpool. These points, and others which may turn out to be of interest on the fuller dissection of the present specimen, will be published in the *Bulletin* of the Liverpool Museums.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—On Tuesday evening, May 24, the Oxford University Junior Scientific Club held a very successful conversazione at the University Museum, which was tastefully decorated and lighted for the occasion. Over 1000 persons attended, and were received by the President, Mr. W. E. Moss (Trinity), and the other officers of the club. For the entertainment of the guests numerous exhibits and demonstrations of the most varied description were on view in the central court and the adjacent departments; and in the large lecture theatre two lectures were given: the first, by Prof. H. B. Dixon, F.R.S., of Owens College, Manchester, on "Climbing in the Rocky Mountains"; and the second, by Dr. Gustav Mann (New Coll.), on "Microphotography," both being well illustrated by lantern slides. A short lecture was also given in the geological lecture theatre by Mr. G. J. Burch, on "Artificial Colour-Blindness," in which evidence was brought forward to show that, instead of three, there are really four colour-sensations—red, green, *blue*, and violet. The reason so many experimenters have only detected three, is that a large number of people are colour-blind to either blue or violet. The lecturer's experiments consisted in fatiguing the optic nerve by exposure to special parts of the spectrum, and it was thus shown that the pure blue of the spectrum between violet and green could be eliminated. The Radcliffe Library was open during the evening, by kind permission of the librarian (Sir Henry W. Acland, Bart., K.C.B., F.R.S.), as was also the Pitt-Rivers' Collection, by permission of Mr. H. Balfour, the curator. The band of the Royal Artillery, with Sergt.-Major W. Sugg as conductor, gave an excellent selection of music.

IN view of the importance of ascertaining, with such accuracy as the conditions allow, the number of pupils receiving instruction in public and private secondary schools in England, the Lords of the Committee of Council on Education are repeating the inquiry first made in May 1897. Forms of inquiry have been sent to all those schools which are understood to be giving secondary education, and if one has not been received by the principal teacher an application to the Secretary of the Education Department will ensure the papers being sent.

VOTING by means of ballot papers through the post, Convocation of the University of London have placed Mr. J. Fletcher Moulton, who opposes the scheme for a teaching University, first on the list of those from whom Her Majesty will select a member of the Senate in succession to the late Sir Richard Quain. The two other candidates were Dr. J. B. Benson and Mr. P. Daphne. Mr. Moulton headed the poll by more than two hundred votes. It is not anticipated that the result of this election will influence the Government's intention to introduce the London University Bill at an early date.

THE London County Council has decided to lay out plots of ground in Battersea, Ravenscourt, and Victoria Parks in such manner as will afford assistance to scholars at elementary and secondary schools in the study of practical botany. Hardy typical plants belonging to twenty natural orders will be arranged in beds near the paths, one bed being devoted to each order. Each specimen will be labelled with its common name and its Latin or systematic name. Labels giving the names and natural orders will also be attached to the more important trees, shrubs and plants throughout the parks mentioned. Teachers holding printed orders issued by the Technical Education Board will be able to obtain from the superintendent in each park such specimens as may be required for botanical study. It is hoped that later on the arrangements may be extended to the cultivation of important types of the lower orders of plants, such as fungi, mosses, ferns, liverworts, &c., and facilities afforded for the study of aquatic plants.

A REPORT on the International Congress on Commercial Education, recently held at Antwerp, is given in the *London Technical Education Gazette*. The following items from the report are of interest:—The view of the majority of delegates present at the Congress was that *specialised* commercial education should not be commenced in primary and secondary schools, but that there was ample room for the development of higher commercial teaching. It is a significant fact that the city of Antwerp spends 2½ millions of francs on education out of a total revenue of 4 millions of francs. In connection with the discussion of the question as to what extent special commercial instruction should be given in secondary schools Dr. Stegemann, official German delegate, gave a long account of the German schools, more particularly of the "Realschulen" and of the "Fortbildungsschulen" (continuation schools). He said that the latter were principally supported by leading merchants and members of mercantile corporations, because they fully recognised the importance of giving to their clerks a theoretical education as the complement to their office training. Dr. Stegemann said that commercial instruction could be given in the secondary schools, without any specialisation whatever. "We in Germany do not care to know anything about a river unless it will float a ship, and new countries interest us only when they afford an outlet for our industry." Speaking afterwards upon the past and present of commercial education in Germany, Dr. Stegemann pointed out the solidarity which existed between the professors of their schools and the commercial men of the country, a union which led to the happiest results, inasmuch as the latter had given to the former the benefit of their practical business experience. In conclusion, he said that he ventured to counsel English educationists not to lose sight of the fact that, even in Great Britain, they must give to their young men a more extended and practical course of study if they wished to maintain the commercial prestige of their country. As to the aim of the continental higher commercial institutes, M. Heinzmann Savigno (Antwerp) said the object pursued at the Antwerp Institute, and at the other establishments modelled upon it, was not to furnish "clerks" in the ordinary acceptation of the word, but "merchants," who would be able to transact their business on a scientific basis, and give to their commercial transactions an impetus which would materially extend their country's home and foreign trade. They also aimed at the creation of men who would be properly prepared to be themselves professors of the higher commercial sciences, or to go forth into the world and effectively undertake the duties of the consular service. The speaker added that, in order to keep pace with the growing extension of colonial enterprise, he would strongly advocate the formation of a special class of men competent by their knowledge to take the lead in colonial development.

SCIENTIFIC SERIALS.

American Journal of Science, May.—On the properties of seasoned magnets of self-hardening steel, by B. O. Peirce. In searching for a material of which to make a set of standard measuring magnets which should be as permanent as possible and have small temperature and induction coefficients, the author tested a number of magnets made of some of the brands of "self-hardening" tool steel now in common use for lathe tools. He found that the temperature coefficient could be reduced almost indefinitely by cutting the rods long and thin.—Some lava flows of California, by F. L. Ransome. This paper deals with a strip of the middle, western slope of the Sierra Nevada. The volcanic eruptions began during the Miocene period and continued to the end of the Pliocene. The deposition of auriferous gravels both preceded and accompanied the deposition of volcanic material. The author distinguishes three separate flows of lava, which were eventually brought to an end by fresh andesitic eruptions. During Pleistocene time the present streams have dissected the Neocene lavas and tuffs, and have deeply cut into the Jurassic and older rocks.—Some new Jurassic vertebrates from Wyoming, by W. C. Knight. The University of Wyoming has in its collection of Jurassic vertebrates partial remains of four swimming saurians that in a general way resemble Plesiosaurs. The discovery of these remains is of considerable value to American Mesozoic geologists for correlating the American and European Jurassic. The largest of the four species surpasses in size the European Pliosaur, and it is described under a new genus, *Megalneusaurus*. The description given is founded upon a cervical, dorsal, and caudal vertebra; one fore-limb nearly complete; ribs, and the greater portion of the pectoral girdle. The genus represents the largest known animals of the order Sauropterygia.—On the estimation of manganese separated as the carbonate, by Martha Austin. The carbonate precipitated by means of alkaline carbonates is very uncertain. An improvement in the quantitative analysis may be effected by converting the carbonate first into oxide and then into sulphate by heating with a few drops of concentrated sulphuric acid.

Symons's Monthly Meteorological Magazine, May.—The climate of Algeria, by Dr. A. Thevenet, director of the Algerian Meteorological Service. The first subject dealt with is temperature. The absolute maximum in the shade is 122° at Orléansville (lat. 36° 40′ N., long. 1° 19′ E.), and the absolute minimum is given as 6°·8, at El-Aricha (lat. 34° 16′ N., long. 1° 23′ W., altitude 4364 feet). Sharp frost is not infrequent on the Sahara, but on the Mediterranean coast frost is rare. The air is not so dry as might have been expected; monthly means below 40 per cent. are very rare, except on the high plateaux and on the Sahara. The mean annual rainfall at Algiers, as recorded at four stations between 1838 and 1895, is 30·16 inches, but there is considerable divergence between the different records.—Results of meteorological observations at Camden Square (London) for April for forty years, 1858–97. The mean of all the highest maximum temperatures was 70°·7, and the mean of all the lowest minima was 29°·8. The average monthly rainfall was 1·66 inches, while in April of this year it was only 1·01 inches.—The gloomy summers of 1860 and 1879, and the nineteen years' cycle, by H. A. Boys. The author points out that there has been so obvious a parallel between most of the last few years and those years that preceded them by 19 and 38 years respectively, that ground has been given for watching whether the summer of 1898 will not prove gloomy and rainy like those of 1860 and 1879, at least in the midland counties.

Wiedemann's Annalen der Physik und Chemie, No. 4.—Some modifications in the quadrant electrometer, by J. Elster and H. Geitel. The drying apparatus is a wide side tube off the chamber containing the quadrants. It contains a wire attached to the movable end cover, and the point of the wire carries a piece of sodium, wiped or scraped to remove adhering petroleum or oxide. Below the sodium is a glass bulb, which catches the dripping moisture. The sodium is surrounded by a wire net to prevent its dropping bodily into the liquid.—Duration of electric oscillations of large periods, by J. Bergmann. Describes an improved apparatus for measuring oscillations with periods over one-millionth of a second.—Fluorescence and actino-electricity, by G. C. Schmidt. E. Wiedemann and the author have propounded the theory that the molecules, split up into ions by the action of light, give rise to fluorescence on recombination. This would lead to the conclusion that fluorescent bodies could not easily lose negative ions on exposure to light, *i.e.* would not be photo-electrically or "actino-electrically" sensitive. This conclusion is, however, not borne out by experiment, as no connection between the two phenomena can be established. It is found, on the other hand, that bodies which exhibit the strongest thermo-luminescence show also the strongest photo-electric action.—A new method of measuring dip and horizontal intensity, by G. Meyer. The dip may be measured without a magnet and without a galvanometer by means of a continually revolving inductor coil and a telephone. The axis of the coil is adjusted to the telephone minimum. The measurements are correct to within 3′ of arc. To measure the horizontal intensity, the earth's field is compensated by the field due to a current of known strength. Complete compensation is indicated by silence in the telephone.—An instrument for measuring astigmatism, by R. Straubel. This consists of two cylindrical lenses which rotate with respect to each other about a common axis. Artificial astigmatisn of any given amount may thus be produced.

FROM the articles in the *Journal of Botany* for March–May, we may select the following as of the most general interest:—The fifty years' limit in nomenclature, by the editor; in which he shows how impossible it would be to work such a rule in practice. Notes on Mycetozoa; and Mycetozoa of Antigua and Dominica, by Mr. A. Lister. Experiments in cross-fertilisation of *Salices*, by Mr. G. F. Linton. Some species of willow cross with great readiness, others with reluctance, and others obstinately resist all attempts at hybridisation. Wayfaring notes in Rhodesia, by Mr. R. F. Rand. The work of cross-fertilisation of the native flowers of Rhodesia appears to be effected largely by butterflies; but by far the most active agents are beetles.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 5—"On certain Structures formed in the drying of a Fluid with Particles in Suspension." By Catherine A. Raisin, B.Sc. Communicated by Prof. T. G. Bonney, D.Sc., LL.D., F.R.S.

Experiments have been made with various muddy fluids, which were allowed to dry under certain conditions, in order to study the forms assumed by the dried material. It seemed possible that these forms might throw some light on the origin of certain minor structures in rocks. Various pigments or powdered rocks (mostly very fine grained) were mixed with water and placed on microscope slides or larger pieces of glass, generally beneath a cover-glass.

In materials not of the very finest grain (*e.g.* prussian blue), the forms shown by the dried powder consist usually of two sets of elements, coarser and finer. The former tend to develop as branching stems, which are either bent and winding, forming a kind of maze, or somewhat rectilinear with terminal knobs. The finer material forms a feathery or fan-shaped pattern, generally at the margin of the deposit, and in the intervals between the coarser stems. It consists of successive curving lines, or of radial streaks and furrows. The different structures are combined in various patterns, of which one illustration is reproduced (Fig. 1). In addition, vesicular structures, cracks, and joints are developed in the dried mud, some of the cracks bearing even a certain resemblance to the appearance in frozen gelatin described by Prof. Sollas (*Trans. Roy. Ir. Acad.*, 1890). The mode of formation was studied by watching the films in the process of drying, and by comparing different examples. As the edge of the film gradually retreats, coarser stems begin to form, while fine material, remaining for a time in moist condition, afterwards dries as the fine pattern.

These various forms seem to illustrate, more or less closely, structures which occur in nature. Thus, dendritic deposits along joint-planes, or on other surfaces in rocks, although undoubtedly they often are the effects of crystallisation, may be sometimes formed by mechanical drying, or both conditions may co-operate. It is possible that some of the "pseudorganic" structures described in rocks, might really be the casts or replacements of dried streaks. Similar principles to those shown in these films may govern the formation of structures in

FIG. 1.—This shows near one edge a fine pattern with concentric lines and radial furrows; then coarser bent stems, which become smaller and reduced towards the further margin, while the fine material forms rather feathery tufts. Prussian blue. (Natural size.)

the mass of a rock, as, for example, the development of Landscape Marble (as explained by Mr. B. Thompson), or the growth of some agates and chalcedonic deposits. Even the solidification of certain igneous rocks, or the processes of secondary silicification, may be somewhat analogous. Further, the similarity shown in cracks and vesicles to those in some pyromerides seems to give support to the hypothesis that these nodules at an early stage were often in a semi-solidified condition with an external crust.

In conclusion, the forms resulting from the processes of crystallisation, which have been described in numerous papers by different authors, may be shortly compared; and some additional experiments have been made, especially as to the effects produced by the admixture of material in suspension (or of a colloid) with the solution of a crystallising salt. Spherulitic and dendritic forms, as described by Lehmann and other observers, may be developed, or even an imitation of micropegmatitic structure. Certain interesting forms of ice crystals (shortly described in NATURE, 1892, by Prof. Meldola, Prof. Bonney, and others) are shown, in a note by Prof. Bonney, to have been developed under somewhat similar conditions.

"The Relations between the Hybrid and Parent Forms of Echinoid Larvæ." By H. M. Vernon, M.A., M.B. Communicated by Prof. Ray Lankester, F.R.S.

The object of this research was to determine systematically, during a period of several months' duration, the exact relationships of structure and size existing between certain hybrid and parent Echinoid larval forms. The method of procedure was similar to that described in a former paper (*Phil. Trans.* B., 1895, p. 577).

Upon the cross *Sphærechinus* ♀-*Strongylocentrotus* ♂, twenty-two experiments were made. As a rule only 10 per cent. of the ova were fertilised, and only 1 per cent. of them reached the eight days pluteus stage. The hybrids were most easily obtained in the summer months, few or none of the ova being cross-fertilised in the winter. The hybrids obtained in May, June, and July were of an almost pure *Sphærechinus* type, only a third or less of them being of an intermediate or *Strongylocentrotus* type. In November, on the other hand, only about a sixth were of the maternal, and five-sixths of a semi-paternal type. Finally, in December and January all the hybrid larvæ were of this paternal type.

On the reciprocal cross of *Strongylocentrotus* ♀ and *Sphærechinus* ♂ eighteen experiments were made. During April, May, and June a fair number of the ova were cross-fertilised, but no plutei were obtained. In July and August some 47 per cent. of the ova were fertilised, and 29 per cent. of them survived to the eight days' pluteus stage. In November and December, on the other hand, not only were no plutei obtained, but as a rule not a single ovum was cross-fertilised. The hybrid larvæ themselves were of the pure *Strongylocentrotus* type.

These extraordinary variations in the capacity for cross-fertilisation seem to be due to the variations in maturity which the sexual products undergo with change of season. Thus in July and August most of the *Strongylocentrotus* individuals contain but very small quantities of ripe sexual products, or none at all; and the larvæ obtained may be as much as 30 per cent. smaller than those obtained in the winter and spring. At intermediate times of the year the larvæ are of intermediate size. It appears, therefore, that the *Strongylocentrotus* ♀-*Sphærechinus* ♂ hybrid is only formed at the time when the *Strongylocentrotus* ova have reached their minimum of maturity; whilst in the case of the reciprocal hybrid, it follows that as the maturity of the *Strongylocentrotus* sperm increases, it is able to transform first a portion and then the whole of the hybrid larvæ from the *Sphærechinus* to its own type. In other words, the characteristics of the hybrid offspring depend directly on the relative degrees of maturity of the sexual products.

As a result of the ten experiments made on the cross *Echinus* ♀-*Strongylocentrotus* ♂, it was found that the hybrid larvæ were on an average about 8 per cent. *larger* than the pure parental larval forms, and, moreover, that even more of the cross-fertilised ova developed to plutei than of the directly fertilised ones. In the reciprocal cross, only about 1 per cent. of the ova reached the pluteus stage, and these plutei were about 13 per cent. smaller than the pure maternal larvæ.

Various crosses, in several instances reciprocal ones, were also effected between *Strongylocentrotus*, *Sphærechinus*, *Echinus microtuberculatus*, *Echinus acutus*, *Arbacia*, *Echinocardium cordatum*, *Echinocardium mediterraneum* and *Dorocidaris*.

On performing cross-fertilisations with the colour varieties of *Sphærechinus*, there was found to be a distinct diminution of fertility. Series of experiments were made in June, July, November and December, the differential fertility seeming to gradually diminish with the progress of the season. Nevertheless, it was always most distinctly present. There was little or no infertility between the less definitely marked colour varieties of *Strongylocentrotus*.

April 28.—"A Compensated Interference Dilatometer." By A. E. Tutton, Assoc. R.C.S. Communicated by Captain Abney, C.B., F.R.S.

The author describes a form of Fizeau interference dilatometer which he considers combines the best features of the apparatus described by Benoit, and belonging to the Bureau International des Poids et Mesures, in Paris, and that described by Pulfrich, constructed according to the modifications introduced into the method by Abbe. Moreover, besides other improvements, a new principle, that of compensation for the expansion of the screws of the Fizeau tripod which supports the object, is introduced, which enhances the sensitiveness of the method so highly as to render it applicable to the determination of the expansion of crystals in general, including those of chemical preparations. Hitherto the application of the Fizeau method has been confined to such crystals as could be obtained large enough to furnish a homogeneous block at least a centimetre thick. A block only 5 mm. thick is ample for use with the author's compensated dilatometer. The principle of the compensation depends upon the fact that aluminium expands 2·6 times as much as platinum-iridium for the same increment of temperature. The author therefore employs, like Fizeau and Benoit, a tripod of platinum-iridium, and places upon its transverse table, through which pass the three screws, a disc of aluminium whose thickness is 1/2·6ths of the length of the screws. The space between the lower surface of the glass plate which is laid upon the upper ends of the screws to assist in producing the interference, and the upper surface of the aluminium, then remains constant for all temperatures under observation, and if a crystal is laid upon the aluminium compensator the whole amount of its expansion by rise of temperature is available for measurement by the interference method. Hence the method is no longer a merely relative one, affording the difference of expansion between the tripod and the substance investigated, but affords directly absolute measurements of the expansion.

The results of numerous determinations of the expansion of the platinum-iridium of the tripod are given, carried out with the surface of the tripod table and the cover-wedge separated at the long interval of 12 mm., by the aid of green mercury light. The mean value is very similar to that of Benoit, and is

$$\alpha = 10^{-9}(8600 + 4{\cdot}56t).$$

The result of several determinations in red hydrogen light of the expansion of the pure aluminium used for the series of compensators, carried out by the Fizeau relative method with a block 12 mm. thick, is

$$\alpha = 10^{-8}(2204 + 2{\cdot}12t).$$

Similar determinations for the black glass of the crystal-covering plates afford the value:

$$\alpha = 10^{-9}(7257 + 10{\cdot}4t).$$

In a subsequent memoir the author intends to present the results of determinations of the expansion of the sulphates and selenates of potassium, rubidium, and cæsium.

Physical Society, May 27.—Mr. Shelford Bidwell, President, in the chair.—A paper by Messrs. Edwin Edser and C. P. Butler, on a simple method of reducing prismatic spectra, was read by Mr. Edser. The production of interference-bands in a continuous spectrum is capable of furnishing a reference-spectrum, which can be employed to determine the wave-lengths corresponding to the bright lines in a spectrum of a metal or of a gas. The authors discuss various methods by which such bands can be formed. In their final experiments, an air-film between two plane parallel glass plates is inserted in front of the slit of the spectrometer, in the path of the incident light. Owing to the interference of the direct ray with that twice internally reflected, bright bands separated by dark intervals are observed in the spectrum; these bright bands correspond to a series of different waves, whose lengths are easily determined for the whole series, when two of them are known. The bands are much improved by partial silvering of the two internal surfaces of the glass. It has been found that ordinary plate-glass, if well chosen, is good enough for all these experiments. In order to adjust for parallelism, a spot of light, or the filament of a glow-lamp, is viewed through the silvered surfaces. A long train of images is generally visible; these must be brought into coincidence. If now a sodium flame is looked at through the film, interference bands are seen. These bands must be adjusted by pressure, to be as broad as possible. An arc-lamp is used for illuminating the collimator slit. The authors exhibited the apparatus, and showed photographs of spectra-scales with the appropriate wave-lengths, calibrated upon them by this method. The results there obtained were read from the spectrometer to 0·4 of a tenth-metre, with an ordinary pocket-lens. A simple graphic method enables wave-lengths, corresponding to a great number of spectral lines, easily to be determined by inspection. The phase-changes introduced by the silver do not affect the final result. Prof. Threlfall congratulated the authors on their discovery of a method that would greatly reduce the labour of calibrating spectra, and at the same time give such accurate results. Prof. Boys said the simplicity of the apparatus added greatly to the value of the method. It would seem to him better if the slit were somehow contrived within the film-space. All want of definition due to rays falling at different angles upon the collimator object-glass would thus be avoided, and only a small part of the glass plates, *i.e.* the slit, would require to be strictly parallel planes. The limit of accuracy in the authors' method depended upon the collimator, not upon the optical perfection of the silvering of the plates. Mr. Butler pointed out that previous methods had always required experienced spectroscopists for mapping-out results. In the new method that work could easily be done by an assistant. Mr. Edser said that by putting the two plates immediately in front of the slit only a very small part of the glass is concerned in the action, light coming through at an angle would not reach the lens in the collimator.—Prof. Boys, Vice-President, then took the chair, and Mr. Campbell Swinton read a paper on some further experiments on the circulation of the residual gaseous matter in Crookes' tubes. In the discussion that followed the former paper on this subject, at the Physical Society on March 25, 1898, Mr. Appleyard had suggested that, in tracing the cause of the rotation of the exploring mill, it would lead to simpler results if the vanes were made of some light conducting substance, for it was probable that mica introduced complications by retaining the charges. Prof. Boys then pointed out that the mica might be gilded. Such a tube has now been made by Mr. Wolff. With the gilded mica vanes so placed as to be outside the kathode stream, the mill behaves in a manner similar to the non-conducting insulated mill. It shows a greater tendency to assume a position of stability, due to electrostatic induction; this renders it somewhat troublesome in starting, but, when once under way, the mill rotates always when excited. Occasionally, when starting, a few reverse revolutions are observed; these are probably due to electrostatic influence and momentum, and also possibly to eddy currents in the residual gaseous matter. But it is found, in all cases, that rotation in the direction that indicates a stream of residual gaseous matter from anode to kathode, follows the reversal immediately after one or two oscillations. An electrometer connected to the mill through the pivot and needle-point, shows the vanes to be always electrified positively. The results are confirmed by a second tube with oblique vanes. The author concludes that at very high exhaustions there exists a molecular or atomic stream from anode to kathode, which carries a positive charge, and travels at high velocity outside the opposite kathode stream. Mr. J. Quick asked what was the minimum degree of exhaustion required to produce these results. Prof. Boys said that the experiment gave some amount of probability to the truth of Mr. Campbell Swinton's hypothesis, but it did not altogether prove the mechanical theory of rotation to be correct. He was glad that the chance suggestion at the last discussion had led to such interesting experiments being continued. Prof. Threlfall mentioned that Boettger had devised a method for gilding mica, by a chemical process, that was much to be preferred to ordinary gilding. Mr. Campbell Swinton said it was necessary to exhaust the tubes as completely as possible to a point where it was only just possible for any discharge at all to pass through them. If the rotation was due to electrification, there must still be some mechanical process whereby the charges get to the vanes—a stream of residual gas satisfied that condition.—The Vice-President proposed votes of thanks, and the meeting adjourned until June 10.

PARIS.

Academy of Sciences, May 23.—M. Wolf in the chair.—Notice on the late M. Souillart, Correspondant in the Section of Astronomy, by M. O. Callandreau.—Some remarks on the periods of double integrals, and on cycles of two dimensions in algebraic surfaces, by M. Émile Picard.—New researches on the reaction between pyrogallol and oxygen in presence of alkalies, by M. Berthelot. The reaction depends upon the nature of the alkali employed. The amounts of oxygen absorbed, and carbon monoxide evolved, were measured and the oxidation products studied.—Chronophotography applied to the study of muscular action in locomotion, by M. Marey. The paper is accompanied by four plates, illustrating the methods used. After a set of photographs of the living animal has been obtained, its skeleton is prepared, and these photographed upon the same scale. From these the curves of change of length of each muscle can be deduced.—The origin of the vertebrates, by M. Edmond Perrier.—On minimum surfaces, by M. C. Guichard.—On systems of differential equations which satisfy quadruply periodic functions of the second species, by M. Martin Krause.—On the determination of the terminal curves of spirals, by MM. C. E. Guillaume and J. Pettavel. A mechanical method for determining Phillips' curve for spiral balance springs.—On a new method of determining the mechanical equivalent of heat, by MM. J. B. Baille and C. Féry. A cylinder of copper is fixed in a rotating magnetic field, and the heating effect measured. The moment of the couple required to keep the sphere at rest and the velocity of the field can be exactly measured. The correction for cooling must be measured with great exactness. In the preliminary results quoted the values of J lie between 422 and 426.—On some experiments in submarine acoustic telegraphy with the aid of a microphone, by M. E. Hardy.—On the osmosis of liquids through a membrane of vulcanised rubber, by M. G. Flusin. Since the measurement of the limiting osmotic pressure could not be carried out with this membrane, the velocity of the osmotic current was determined from the liquid into ethyl alcohol. The amounts of liquid absorbed by the rubber were also determined, but these figures are not proportional to the velocities of osmosis.—Improvement of over-exposed negatives, by M. Mercier. The plate is immersed for two minutes in a solution of tartar emetic, dried and developed as usual with hydroquinone.—On an apparatus for aërating boiled or distilled water, by M. Maillet.—Recapitulation of the atomic weights calculated by the method of limited densities, by M. Daniel Berthelot. By the methods given in preceding notes the atomic weights of carbon, sulphur, nitrogen, and chlorine are calculated. The agreement between the numbers so obtained, and those obtained by chemical methods is so close that the original assumption may be regarded as proved, Avogadro's law being strictly true only at extremely small pressures.—On the determination of the molecular weights of gases; reply of M. Marqfoy to M. Daniel Berthelot.—On reaction zones, by M. Albert Colson.—On the phosphorescent mixtures formed by strontium sulphide, by M. J. R. Mourelo.—On the limits of inflammability of combustible vapours, by MM. H. Le Chatelier and O. Boudouard.—Spectrum analysis of some non-conducting minerals by fused salts, by M. A. de Gramont.—Synthesis of safranine, by M. Georges F. Jaubert.—Action of aluminium chloride and of chlorine in presence of aluminium chloride upon anhydrous chloral, by M. A. Mouneyrat. By the action of $AlCl_3$ upon chloral at 100°, besides the products already discovered by Combes, pentachlorethane, $CCl_3.CHCl_2$ is obtained, and the tetrachlorethylene which forms the main product of the reaction is formed from this by further heating with $AlCl_3$. With chlorine, under similar conditions, a good yield of hexachlorethane is obtained.—Estimation of phosphoric acid in superphosphates, by M. Léo Vignon.—New observations on *Peripatus*, by M. E. L. Bouvier.—On the carbon monoxide normally contained in the blood, by M. Maurice Nicloux. The amounts of gas given by the blood of animals from the country is sensibly the same as in that of animals in towns (Paris). The carbon monoxide would appear to be produced within the organism itself.—On fungi intermediate between *Tricophytons* and *Achorions*, by M. E. Bodin.—On the minerals of the basaltic fumerolles of Royat (Puy-de-Dôme), by MM. A. Lacroix and P. Gautier.—On the apatite from certain granulitic enclosures from Chuquet-Genestoux, by MM. A. Gonnard and Adelphe.—Urinary acidity and its determination, by M. Charles Lapierre.—Earthquake of May 6, 1898, communicated by M. Michel Lévy.

DIARY OF SOCIETIES.

THURSDAY, June 2.

Royal Institution, at 3.—Modern Methods and their Achievements in Bacteriology: Dr. E. E. Klein.
Linnean Society, at 8.—Notes on some Lories: Prof. St. George Mivart, F.R.S.—A Revision of the Genus Symblepharis: E. J. Salmon.—On the Food of the Uropoda: Surgeon-Captain H. A. Cummins.
Chemical Society, at 8.—The Action of Ether on Organic Acids and on Carbohydrates in Presence of Hydrogen Bromide: H. J. H. Fenton and Mildred Gostling.

FRIDAY, June 3.

Royal Institution, at 9.—The Development of the Tomb in Egypt: Prof. W. M. Flinders Petrie.
Geologists' Association, at 8.—Fossil Sharks and Skates, with special reference to those of the Eocene Period: A. Smith Woodward.

SATURDAY, June 4.

Royal Institution, at 3.—The Temples and Ritual of Asklepios at Epidaurus and Athens: Dr. R. Caton.

MONDAY, June 6.

Royal Geographical Society, at 8.30.—Circumnavigation of Lake Bangweulu: Poulett Weatherley.
Society of Chemical Industry, at 8.—The Conditions existing in Acetylene Generators: Prof. V. B. Lewes.
Institute of Actuaries, at 5.—Annual General Meeting.

TUESDAY, June 7.

Zoological Society, at 8.30.—On some Crustaceans from the South Pacific. Part II. *Macrura anomala*: L. A. Borradaile.—Report on the Gephyrea collected by Mr. J. Stanley Gardiner at Rotuma and Funafuti: Arthur E. Shipley.—Fourth Report on Additions to the Batrachian Collection in the Natural History Museum: G. A. Boulenger, F.R.S.

WEDNESDAY, June 8.

Geological Society, at 8.—On the Discovery of Natural Gas in East Sussex: C. Dawson.—Note on Natural Gas at Heathfield Station (Sussex): Dr. J. T. Hewitt.—On some High-Level Gravels in Berkshire and Oxfordshire: O. A. Shrubsole.—The *Globigerina*-Marls of Barbados: G. F. Franks and Prof. J. B. Harrison. With an Appendix on the Foraminifera, by F. Chapman.

THURSDAY, June 9.

Royal Society, at 4.30.—*Probable Papers*: Experiments on Aneroid Barometers at Kew Observatory and their Discussion: Dr. C. Chree, F.R.S.—The Nature of the Antagonism between Toxins and Anti-Toxins: Dr. C. J. Martin and Dr. T. Cherry.—Some Differences in the Behaviour of the Real Fluids from that of the Mathematical Perfect Fluid: A. Mallock.—On the Heat Dissipated by a Platinum Surface at High Temperatures: J. E. Petavel.
Royal Institution, at 3.—Modern Methods and their Achievements in Bacteriology: Dr. E. E. Klein.
Mathematical Society, at 8.—On the General Theory of Anharmonics: Prof. E. O. Lovett.—Point-Groups in a Plane, and their Effect in determining Algebraic Curves: F. S. Macaulay.—On a Regular Rectangular Configuration of Ten Lines: Prof. F. Morley.—On the Calculus of Equivalent Statements (eighth paper): H. MacColl.

FRIDAY, June 10.

Royal Institution, at 9.—Some Experiments with the Telephone: Lord Rayleigh.
Royal Astronomical Society, at 8.
Malacological Society, at 8.

SATURDAY, June 11.

Royal Institution, at 3.—The Temples and Ritual of Asklepios at Epidaurus and Athens: Dr. R. Caton.
Geologists' Association (Waterloo Station, S.W.R.), at 1.50.—Excursion to Godalming. Director: T. Leighton.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

Books.—City and Guilds of London Institute. Report of the Governors, March 1898 (Gresham College).—A Text-Book of Entomology: Prof. A. S. Packard (Macmillan).—Britain's Naval Power: H. Williams, Part 2 (Macmillan).—The Pruning Book: L. H. Bailey (Macmillan).—A Primer of Psychology: E. B. Titchener (Macmillan).—Weather Lore: R. Inwards, 3rd edition (E. Stock).—Ackworth Birds: Major W. B. Arundel (Gurney).—Elementary Practical Zoology: F. E. Beddard (Longmans).—Outlines of Sociology: L. F. Ward (Macmillan).—A System of Medicine: edited by Prof. T. Clifford Allbutt, Vol. v. (Macmillan).—Through Unknown Thibet: Captain M. S. Wellby (Unwin).

Pamphlet.—Remarkable Eclipses: W. T. Lynn, 3rd edition (Stanford).

Serials.—Psychological Review Monograph Supplements, Vol. 2, No. 3 (Macmillan).—Longman's Magazine, June (Longmans).—Sunday Magazine, June (Isbister).—Good Words, June (Isbister).—Chambers's Journal, June (Chambers).—Publications of the British Fire Prevention Committee, Nos. 1 to 7 (1 Waterloo Place).—Humanitarian, June (Hutchinson).—Sitzungsberichte der Physikalisch-Medicinischen Societät in Erlangen, 29 Heft, 1897 (Erlangen).—Natural Science, June (Dent).—Century Magazine, June (Macmillan).—Notes from the Leyden Museum, July and August, 1897 (Leiden, Brill).—National Geographic Magazine, May (Washington).

CONTENTS.

THURSDAY, JUNE 9, 1898.

LORD RAYLEIGH'S "SOUND."

The Theory of Sound. By J. W. Strutt, Baron Rayleigh, Sc.D., F.R.S. Second edition, revised and enlarged. Two volumes. Pp. xiv + 480, and xvi + 504. (London: Macmillan and Co., 1894 and 1896.)

IT was neither to be expected nor to be desired that any alteration of the general plan of Lord Rayleigh's "Sound" should be introduced in a new edition. A few errors have been detected and corrected (they are very few indeed), and the book has been considerably enlarged; but the characteristic features of the new portions are those of the old, and our admiration is again aroused by the skilful interweaving of theory and experiment, each supporting and adorning the other.

We are grateful, too, that there is a continuance of the help which we have received from the author in "clearing our minds of cant," or rather of that unquestioning employment of conventional explanations which is its equivalent in physical science. For example, many would even now be contentedly repeating the ordinary text-book theory of the maintenance of vibrations in an electric bell had he not awakened them to the knowledge that it was wholly beside the mark; and the statement that "a simple vibration involves *infinite* continuance, and does not admit of variations of phase or amplitude" should be very useful to many more.

The first important addition is an investigation of the resultant of a large number of vibrations whose phases are accidentally distributed. An expression is found for the probability of a resultant intensity of any specified magnitude, and the mean intensity is shown to be the sum of the intensities of the components.

Under the head of intermittent vibrations, the difference between intermittence artificially imposed upon a simple vibration and the intermittence of beats is pointed out and employed to explain some experimental results obtained by Prof. A. M. Mayer.

A section is added dealing with unstable systems with one degree of freedom, and we are reminded that the possibility of periodic motion under the operation of impressed periodic force is no proof of stability.

The maintenance of vibrations is then discussed, and it is shown that if impulses are given to a vibrating system whenever it passes through its equilibrium position their effect is mainly upon the amplitude and the period is sensibly unaltered; while if they are given at the moments when the system is at rest the effect is mainly upon the period, the vibrations being neither encouraged nor discouraged. An investigation is also given of the theory of the maintenance of vibrations by a periodic force whose frequency is double that of the maintained system, as in one form of Melde's well-known experiment and in the crispations of a liquid observed by Faraday.

Next we come to a description of some of the principal methods for the accurate determination of absolute pitch, including, of course, the author's excellent comparison of a fork with a clock pendulum by the use of the phonic wheel. An account of this instrument has been given earlier in the book, and its use with a counting apparatus certainly brings a fairly good determination within the reach of experimentalists of very moderate skill. Another interesting method which is described is that of counting the two sets of beats of overtones which are heard when two notes whose interval is an equal temperament-whole tone are sounded on a harmonium. The method depends, of course, on the fact that in *maintained* vibrations the frequencies of overtones must be accurately multiples of that of the fundamental. The necessity of this correspondence is proved later, but a hint of it might have been given here with advantage to the student; for in acoustics, as in other matters, the progress of the human mind is from the vulgar credulity of accepting all overtones as accurately harmonic through the vulgar incredulity of doubting whether any can be so.

In the general treatment of vibrating systems an investigation of the effects of imposed constraints upon the periods is given, also the theorems of Routh relating to the roots of the equation defining the periods, with an extension to unstable systems; a section dealing with the reaction upon the driving-point of a system thrown into forced vibration is also added. Under the head of transverse vibrations of strings the propagation of progressive waves along a string whose mass is supposed to be concentrated at equidistant points is considered, and it is shown that there will be no such propagation if the frequency is above a certain critical value. The reflection of waves at the junction of two strings is treated, also reflection produced by gradual change of density, and it is shown how the analogue of dispersion in optics is introduced if the string is considered to possess finite stiffness, and that in this case the ordinary formula for the intensity of the reflection must be modified. Reflection at a junction is also discussed in the case of longitudinal vibrations of bars, and the weakness of the transmitted intensity when the change of velocity at the junction is considerable is pointed out.

A summary is given of the experiments of Elsas on forced vibrations of membranes, and the march of the nodal lines with varying frequency is described. In the chapter on vibrations of plates an account is given of the author's interesting observations on the notes of bells, and his ingenious method of obtaining the nodal lines corresponding to each note by utilising the beats produced by asymmetry.

The first volume ends with two new chapters, one on the vibrations of thin cylindrical and spherical shells, and one on electrical vibrations. In the latter the theory of oscillatory currents in circuits with capacity and induction is given, and applications to Hughes' induction balance and Wheatstone's bridge are discussed. The concentration of currents of high frequency on the outside of a conductor is also worked out, and the propagation of current waves along cables is treated, justice being done to Heaviside's work on the effect of inductance in diminishing distortion in telephony. The mode of action of the telephone is also discussed, and the author's results as to the minimum audible current are given.

In the chapter on aerial vibrations, which opens the second volume, some interesting phenomena depending upon the second order of small quantities are explained,

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the best known being the striations which are always seen in a Kundt's tube, and which are shown to be due to the tendency of solid particles to arrange themselves in chains perpendicular to the lines of alternating flow. An investigation of reflection at a corrugated surface follows, next comes a description of some experiments on diffraction of sound.

A general account of the mode of maintenance of the vibrations of a flute organ-pipe is then given, and attention is called to the fact that the note of the pipe when sounded is higher than the note to which it would resound, and that the difference increases with the wind pressure. The mutual influence of organ-pipes mounted side by side is considered; it has been shown how this influence militates against the successful application to pipes of Scheibler's method of determining absolute pitch. The maintenance of vibrations by increasing the pressure at a node at a time of maximum pressure and decreasing it at a time of minimum pressure by the introduction and removal of air or of heat is considered. (The student will find it a profitable mental exercise to satisfy himself that this mode of maintenance is consistent with the general principle that the force should be applied when the system passes through its equilibrium position; he may also note the analogy to the maintenance of the oscillations of a galvanometer needle by a small current suitably controlled by a reversing key). If, on the other hand, the moments of the most rapid addition and subtraction of heat are those of most rapid change of pressure, it is shown that the vibration is neither maintained nor damped, the effect being concentrated upon the period. It may be remarked that the passage from Newton's theory of sound to Laplace's, or *vice versâ*, in calculating the pitch of a pipe is a case exactly in point. Among the more important applications of maintenance by heat, singing flames and Rijke's sounding tubes are treated, also the sounds sometimes heard when a bulb has just been blown at the end of a glass tube. The maintained vibration of mercury contained in a U-tube, one end of which is connected with a heated bulb, is a visible example of the latter phenomenon, and the principle has been successfully applied to small hot-air motors. A short account of the conditions of maintenance in reed instruments is also given.

Under the head of fluid friction, Kirchoff's investigation of the effects of viscosity and heat-conduction upon the propagation of sound finds a place, and the behaviour of very narrow tubes towards sound is applied to the question of reflection at a porous wall. The theory of the vortices observed by Dvŏrák in Kundt's tubes is also investigated.

Four new chapters complete the book. The first deals with liquid waves under gravity and cohesion; in it are treated, among other matters, the determinations of surface tension by the measurement of ripples and by observations on the vibrations of a liquid cylinder, the importance of the latter method in permitting the examination of a newly-formed surface being pointed out. The instability of a liquid jet, the behaviour of drops in collision, and the vibrations of detached drops are also considered. The next chapter, on vortex motion, gives an investigation of the instability of stratified motion in a fluid, and its application to the theory of sensitive flames and smoke-jets. Bird-calls and aeolian tones are also shortly treated, some considerations as to pitch being deduced from the principle of dynamical similarity. A brief account of the propagation of vibrations in elastic solids follows, and the last chapter deals with facts and theories of audition. In it the author's experiments on the minimum amplitude of sound waves consistent with audibility are described, a discussion of Ohm's law and its exceptions is given, and, by the application of dynamical principles to the internal vibrators which on Helmholtz's theory form the analysing mechanism of the ear, the bearing of the degree of damping in these vibrators on the origin of dissonance, on the possibility of accurately judging pitch, and on the remarkable results of Kohlrausch as to the exceedingly small total number of vibrations requisite for the appreciation of a definite pitch, is explained. Finally, the conflicting views which have been held as to combinational tones, the perception by the ear of the phase relationship of two tones, and the characteristics of vowel sounds are discussed.

In NATURE of December 12, 1878, Prof. Helmholtz, after suggesting some of the above problems, wrote of the first edition of this book; "Lord Rayleigh certainly deserves the thanks of all physicists and students of physics; he has rendered them a great service by what he has done hitherto. But I believe I am speaking in the name of all of them if I express the hope, that the difficulties of that which yet remains will incite him to crown his work by completing it." This has now been done, but the only voice which could without impertinence utter praise is, alas, silent. L. R. W.

HAWKS AND HAWKING.

Hints on the Management of Hawks (Second Edition); *to which is added Practical Falconry Chapters, Historical and Descriptive.* By J. E. Harting. 8vo. Pp. viii + 268, illustrated. (London: H. Cox, 1898.)

MR. HARTING is such an authority on the art of hawking, and is, furthermore, such an excellent field naturalist, that it was only to be expected his volume on this branch of sport would reach a second edition. But, as the author states in his preface, the additions to the new edition, both as regards letter-press and illustrations, are so extensive as almost to give it a claim to rank as a new work.

From all points of view, management, rearing, training, and use in the field, as well as regards their natural history, Mr. Harting appears to have furnished all that there is to be told concerning hawks and hawking; and if the votaries of this sport are not satisfied with his efforts, they must indeed be hard to please. Some of the most interesting chapters in the volume are those relating to the now obsolete kite-hawking and heron-hawking; the one of which has ceased to exist from the practical extinction of the quarry, and the other from the altered physical conditions of the country. In all portions of his subject the author owes much to the artist, some of the illustrations being really exquisite, especially those from the pencil and brush of Mr. Lodge. What, for instance, can be more striking than the contrast between the figure of the heron sailing gracefully at ease on p. 153, and the same bird after being stricken by the peregrine two pages later? It is, of course, a drawback that so many of the illustrations depict birds and other animals in postures of pain, but this is inseparable from the subject. While commending the illustrations as a whole, a few, like the one of the hobby, appear to have been printed from somewhat worn blocks.

To those not conversant with the sport, it may come as a matter of surprise that so many species of the *Falconidæ* are trained in various countries for hawking; these ranging in size from the merlin and the hobby to the golden eagle, and their quarry from the snipe and the lark to the roe-deer, or even the wolf. As hawking with eagles is unknown in western Europe, the portion of Mr. Harting's work relating to that branch of the sport cannot fail to prove generally interesting. It would, of course, have been mere waste of space if the author had attempted to give full descriptions of all the various hawks and falcons employed in the sport; but as there is some considerable degree of confusion in regard to the species of eagles trained for hawking in Turkestan and other parts of the Russian empire, he has done well in giving a full discussion on the question. And here Mr. Harting, as usual, displays an intimate acquaintanceship with the zoology of the subject and the literature relating thereto. It appears from these observations that the bird commonly employed in Turkestan, where it is known as the berkut, is the golden eagle, but that other species, such as the Imperial eagle, are likewise trained; while it is stated that occasionally sea-eagles of two species are made use of.

Although it is by no means meant to displace the older and more bulky treatises, Mr. Harting's little volume ought to give the beginner all the information he requires for setting up a hawking establishment, either on a large or a small scale, and it will doubtless aid in maintaining interest in an ancient and exciting sport which ought by no means to be allowed to fall into neglect. R. L.

THE RUDIMENTS OF PHYSICS AND CHEMISTRY.

General Elementary Science. Edited by William Briggs, M.A., F.C.S., F.R.A.S. Pp. viii + 390. (London: W. B. Clive.)

Elementary General Science. By A. T. Simmons, B.Sc., and Lionel M. Jones, B.Sc. Pp. viii + 328. (London: Macmillan and Co., Ltd., 1898.)

THE new regulations for the matriculation examination of the University of London provide that on and after next January all candidates must present themselves for examination in the rudiments of physics and chemistry included in a syllabus under the head of "General Elementary Science." Following the "stream of tendency" of science teaching at the present time, the examiners announce in a note prefixed to their syllabus that the subjects "will be treated wherever possible from an experimental point of view. Candidates will be expected to have performed or witnessed simple experiments in illustration of the subjects mentioned in this syllabus." By making this announcement, the University of London has shown its intention to encourage the introduction and extension of practical methods of science teaching into our secondary schools; and there can be no doubt that if the examiners insist upon the possession of knowledge gained by demonstration and experience, instead of the transient information acquired by reading, their action will be the means of greatly improving the character of the scientific instruction given in the smaller secondary schools. Hitherto, many schools of this character have trained candidates for matriculation without showing them a single scientific experiment; the new curriculum will, however, make this state of things impossible, and will therefore be the means of increasing the efficiency of secondary schools.

The two volumes under notice have both been prepared to meet the new requirements of the London University, and they exemplify the old saying that "there is a right and a wrong way to do everything." In the volume edited by Mr. Briggs little attempt has been made to produce a book in the spirit of the new syllabus. Neither the first section of the book dealing with mechanics, nor the second section dealing with heat, light and electricity, can be regarded in any way as likely to lead to a practical acquaintance with scientific facts; they both contain a large amount of information concisely expressed, but the information is of precisely the same kind as appears in books prepared for students working under the old matriculation regulations. In other words, more attention is paid to arithmetical gymnastics in the regions of mechanics and physics than to experiment. The section on chemistry is better done, nearly one hundred experiments being described in it; but it is unequal in treatment, and contains too many equations and formulæ for a beginner in chemistry to understand. As a whole, the book is unsatisfactory; it contains information to be read and learnt by the student instead of descriptions of experiments to be performed, and though it may be useful as a training in providing exercises in physical arithmetic, it has no educational value.

The book by Messrs. Simmons and Jones is of quite a different character from that compiled under Mr. Briggs's direction. It contains an admirable course of practical work covering all the principles of mechanics, physics, and chemistry included in the new subject for London matriculation. No less than 310 experiments are described, and they are not only practicable, but can also be performed with simple apparatus. Many of the experiments, such as the pin-methods of proving the laws of reflection and refraction of light, the simple experiments on voltaic cells, and the method for heating a solid in a closed volume of gas (p. 258), are distinctly good, while most of them furnish evidence that the authors are describing matters of personal experience, and not hypothetical arrangements. The experiments alone provide a valuable set of practical exercises in elementary physics and chemistry, and if the descriptive text is read in connection with them, the student will be given a sound basis of scientific knowledge. The volume contains an instructive course of work which will be of real assistance to both teachers and pupils in schools where elementary science is taught.

OUR BOOK SHELF.

The Flora of Perthshire. By F. Buchanan White, M.D. Edited by James W. H. Trail, A.M. Pp. lxi + 407; with a portrait of the author, and a map of the county. (Edinburgh: W. Blackwood and Sons, 1898.)

IT had long been known that the late Dr. Buchanan White was preparing a "Flora of Perthshire," when his death in 1894 arrested the progress of the work. The manuscript was then put into the hands of Prof. J. W. H. Trail, who has edited it.

The book is well arranged; clear, perhaps at the expense of detail of secondary value. For such we must consider the long strings of exact localities, common in such works, in this one usually summed up into short general statements. There is no doubt that the book has been carefully planned, that its aims are broad, and that all matter not of real concern has been excluded. Here and there we find critical remarks, or statements of the variability of the species. These are interesting; but the great feature of the book is in the new data relating to the altitudes reached by plants. It will be noticed that the upper limits of species usually are in excess of those given more than half a century ago by H. C. Watson for the Eastern Grampians; also that they differ in different parts of the county. So many of the glens of Perthshire run east and west, and gather from this cause heat in a way which glens open to north winds do not. Perhaps this accounts for the difference. The subject is one yet wanting many observations.

The manuscript appears to have been less complete when it changed hands than was thought. As a result we see a slight want of uniformity. One, who, like Dr. Buchanan White, united into a single species *Viola tricolor* and *arvensis*, would not be likely to follow the division of the genus *Hieracium* to the extreme. It is, indeed, a cause for regret that the author left no outline of the introduction, which he could so well have written. The essay reprinted in its place only deals with one question; and for others, which would have found a place, we must seek in his published papers. A list of these papers is incorporated in the book with a memoir of the author.

I. H. B.

Manual Training: Woodwork. A Handbook for Teachers. By George Ricks, B.Sc. Lond. Pp. 187. (London: Macmillan and Co., 1898.)

WORKING in wood with carpenter's tools is now provided for in the curriculum of many public elementary schools, as well as in technical schools, with the object of training the manual and visual faculties to act in connection with the mental. Used with care, this manual work becomes a valuable educational agent, but unless it is carried out on an orderly system it degenerates into mere tinkering. Mr. Ricks has kept the true aims of manual training well in mind in the preparation of his work. "Our aims," he says, "must be wholly educational. We must arouse interest and quicken intelligence. We must develop and strengthen habits of attention, industry, and perseverance. We must train the eye to accurate observation, and the hand to dexterity in execution." The aspirations are commendable, and the author's experience has enabled him to develop a practicable scheme of work in which it is shown how they can be carried into effect. Beginning with a chapter on drawing as a factor in manual training in wood, this is shown to be the fundamental basis of the work. The necessity of exact measurement in all work, and the use of working drawings, is insisted upon; and rightly, for without drawings to scale, exact and intelligent handiwork is scarcely possible. An instructive chapter is given on the various woods used as timber, their structure, growth, preparation and properties. We notice that in explaining specific gravity with reference to timber, Mr. Ricks adopts as his standard the weight of a gallon of water (10 lbs.), the specific gravity of oak thus being 8, of beech 7, and so on. This is convenient for some reasons, but it is apt to create confusion; and if the child afterwards learns that the specific gravity of iron is 7, he will wonder whether the metal or the wood is the heavier.

After the preliminary chapters and exercises come systematic work on the use of carpenters' cutting tools, simple workshop operations, and bench work from working drawings. The book shows evidence of thought and experience, and should prove of service to teachers of manual training.

A Description of Minerals of Commercial Value. By D. M. Barringer, A.M., LL.B. Pp. 168. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1897.)

A SET of tables for the identification of minerals is very useful to mineralogists and others; and as this note-book contains such tables and little else, it is welcome. The information is conveniently arranged so that it can be quickly referred to, nevertheless there are so many omissions that the book cannot be used to the exclusion of other books on mineralogy, and consequently its chief claim to consideration, that of saving time, falls to the ground. For example, under the heading of lead ores, only galena and cerussite are mentioned, although six compounds of bismuth and five of antimony are described. It may be hoped that Mr. Barringer will see his way to making his book more complete in future editions.

Ludwig Otto Hesse's Gesammelte Werke, herausgegeben von der Mathematisch-Physikalischen Classe der Königlich Bayeirschen Akademie der Wissenschaften. (München, 1897.)

COLLECTED into one large quarto volume of over 700 pages, ranging in date from 1838 to 1874, we find here the mathematical articles in which Hesse laid the foundations of the modern analytical theory of Solid Geometry, with the details of which we are familiar in the treatise of Dr. Salmon.

The subjects discussed are all of geometrical interest, even where the title may indicate an algebraical flavour, as the analytical developments are such as arise from the investigations of geometrical properties. We may instance the researches on the Functional Determinant, called after the inventor the Hessian, which has played so important a part in the hands of Sylvester and Cayley. A biography, based on a memorial lecture by Prof. G. Bauer, completes the volume; in it a characteristic remark of Sylvester is embodied. It is interesting to learn that Jacobi utilised Hesse as a collaborator in developing the theory of the Attraction of Ellipsoids.

G.

Krōmskōp Colour Photography. By Frederic Ives. Pp. xvi + 80. (The Photochromoscope Syndicate, Ltd., 1898.)

MOST of our readers have either seen or heard of Mr. Ives' process of colour photography, known now under the name of the Krōmskōp System. In the small book we have before us, Mr. Ives gives the reader a concise account of the principles involved in this method of producing coloured pictures, describing and explaining at the same time the construction and action of the various krōmskōpes which are now being manufactured. This information will be found very serviceable to any one who wishes to attain the maximum of efficiency in this branch of photography. In addition to the above instructions, reference is made to the literature on the subject, and various extracts relating to the nature, theory, &c., of colour from writings of well-known men are inserted.

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.*]

Liquid Hydrogen.

THE letter of W. Hampson, which appears in your issue of May 26, can only mean by implication to charge me with having utilised without acknowledgment an idea of his, conveyed through a third party, in my paper on the liquid hydrogen jet, published in 1895. Such a suggestion is absolutely without any foundation in fact. My results would have been attained had Dr. Hampson never existed, just as they have been developed. He certainly in no way contributed directly or indirectly to the success of those hydrogen experiments. Had Mr. Hampson attempted to consult me as to his plans, I should have declined to entertain them, just as I had treated, under similar circumstances, distinguished colleagues engaged in low temperature research; for no other reason than to avoid the possibility of controversy. Further, I never would have allowed my assistant either to consider or advise on the projected scheme of some other person about to engage in the same field of investigation, simply because such a position would be quite unprecedented, and certain to result in misunderstandings. W. Hampson is the only inventor or investigator who has not in a straightforward way approached me directly in such matters, and it is no excuse for his dubious course of action to say he had an "introduction." My assistant has explained his position in the matter in letters addressed to "*Engineering*" within the last few weeks. The paper of 1895, on gas jets containing liquid, has been a fruitful source of recrimination. No less than three patentees of low temperature apparatus—viz. Solvay, Linde and Hampson—have each recognised in its contents part of the essential subject-matter of their respective patents. It will be for these gentlemen to fight the matter out. Suffice it to say, that the statements made in my paper of 1895 remain a correct record of facts. Further remarks on the subject can be found in the Society of Arts *Journal* for March 1898; made during the course of a discussion on the Linde process.

The Hampson patent was not published before April 1896, and the first exhibition of the working apparatus took place towards the end of March of the same year; or some three months subsequent to my Chemical Society paper. Mr. Hampson declares in his letter that he "*was afterwards the first in this country to liquefy air and oxygen without employing other refrigerants.*" Now, in my paper of 1895 the following passages occur:—"With such a simple apparatus and an air supply at 200 atmospheres, *with no previous cooling*, liquid air begins to collect in about five minutes, but the liquid jet can be seen in between two and three minutes." "In the above experiments air is taken *at the ordinary temperature*, which is a little above twice its critical temperature, and is partially transformed in a period of time, which in my experiments has never exceeded ten minutes, simply and expeditiously into the liquid state at its boiling-point—194°, or a fall of more than 200° has been effected in this short period of time." J. DEWAR.

May 30.

Printed Matter and Photographic Plates.

IN connection with this subject it does not appear to be generally known that photographic negatives, after they have been developed and fixed, and especially if they have been intensified by means of the bi-chloride of mercury and ammonia process, are often strongly impressed by prolonged contact with printed matter. I first observed this many years ago, and have a large number of negatives in my possession which show the effect very strongly, I enclose a photographic negative taken by myself in 1882, which has remained since 1886 wrapped up in the accompanying advertisement sheet of the *Electrician*. As will be observed, the greater portion of the print in contact with the film is clearly legible. It is, however, worthy of note that it does not appear to be the printer's ink in this case that has produced the chemical action, but rather the paper itself, or some ingredient therein. Those portions of the film protected from contact with the paper by the ink have retained their original colour, while the other portions not so protected have become very considerably bleached. The printing on the side of the paper removed from the film does not seem to have had any effect.

It has probably been noticed by others that ordinary albumenised and sensitised photographic paper is also strongly affected in the course of time by contact with printed matter. In this case, also, the printing comes out as white lettering upon a darker ground. A. A. C. SWINTON.

The Transport of Live Fish.

YOUR readers may be interested to know of an experiment with the transport of live fish I am making, and so far successfully. I left Brisbane on April 16, taking with me four specimens of Ceratodus. This remarkable fish is doubtless sufficiently well known to your subscribers to render a description on my part unnecessary. D. O'CONNOR.

S.S. *Duke of Devonshire*, Colombo, May 16.

CEREMONIAL DANCES OF THE AMERICAN INDIANS.

READERS of NATURE do not need to be reminded of the important work being done by the Bureau of American Ethnology, which is conducted under Act of Congress "for continuing ethnologic researches among the American Indians under the direction of the Smithsonian Institution." The value of the researches that are being carried on, and the results of which are issued in the form of annual reports and bulletins, cannot be over-estimated; for the Indian customs and beliefs, which form the subject of the majority of the papers, are not destined to survive for many years. The Indian reserves are gradually being curtailed, the Indians themselves are slowly becoming civilised, and this process is naturally attended with change and decay of their primitive ceremonial and belief. It must be admitted that the Indian nature is slow to change, and retains its tribal instincts under a veneer of civilisation. In fact, the case of a young Arapaho Indian, who, though speaking good English and employed as a clerk in a store, thought it but natural that he should join his tribe in dancing the sun-dance for three days and nights without food, drink or sleep, is far from exceptional. But the change, though gradual, is constant, and at no distant period the American Indian will have ceased to furnish the anthropologist with opportunities for the study of primitive man. When that time arrives the value of these reports, compiled by trained observers in accordance with a scientifically organised plan, will be unique.

The present article is concerned with three of the papers published in the fourteenth, fifteenth and sixteenth annual reports of the Bureau. These papers may be classed and considered together, as they deal with certain ceremonial dances still practised by many of the Indian tribes. The longest of the papers is that entitled "The Ghost-dance Religion and the Sioux Outbreak of 1890," which is contributed by Mr. James Mooney, and is published in a volume by itself as Part ii. of the fourteenth annual report. The underlying principle of the ghost-dance is the doctrine that at some future time the whole Indian race, whether living or dead, will be reunited in a life upon earth untroubled by the fear of death, hunger, or disease. Most Indians hold that this change will be brought about by spiritual powers who will require no assistance from men, but at times of discontent medicine-men have sought to anticipate the Indian millennium by preaching a crusade against the further encroachments of the white population, and persuading their fellow tribesmen that in this resistance they will have the active support of their dead ancestors and relatives. Such a revival took place in 1890 among the Sioux, the largest and strongest Indian tribe in the United States. The cause of the outbreak may be traced to irritation at the encroachments made on their reserve and to the neglect of the Government to carry into effect their promises of furnishing supplies. As the area of their hunting-grounds was diminished, they had to depend for subsistence on their cattle and crops and on the rations allowed them by Government. In 1888 their cattle suffered from disease, in the two following years their crops were a failure, and their rations of beef were diminished by half. In 1890 they were on the brink of starvation, and ready to listen to the words of a messiah. In fact there is no doubt that hunger was the real cause of the rebellion, and not the ghost-dance itself, though this ceremonial was adopted as the means of propagating the crusade. That resistance to the whites had no part in the original doctrine of the dance is proved by the fact that in many other tribes which practise it no outbreak has occurred. The Sioux rebellion was put down after a short though costly war, and Mr. Mooney has given a detailed account of the campaign which was brought to a close by the battle at Wounded Knee. We are not here concerned with this somewhat melancholy chapter of Indian history, but will confine ourselves to the interesting account he has given of the ghost-dance with which the rebellion is generally connected.

No one is better qualified to give an account of this ceremony than Mr. Mooney, for he has had exceptional opportunities for studying it. From 1890, when the ghost-dance was beginning to attract attention, to the early part of 1894, he has studied it on several expeditions, his actual investigations among the Indians extending over a period of twenty-two months and entailing some 32,000 miles of travel. Not only has he frequently seen the dance performed, but he has taken part in it himself among the Arapaho and Cheyenne, and by means of his kodak and camera has obtained some valuable photographs. He also visited Wovoka, the messiah who inaugurated the recent revival, and by gaining the confidence of the Indians obtained from a Cheyenne Indian, Black Short Nose, a copy of the messiah's message, embodying the doctrine of the ghost-dance, which he had previously sent to the Cheyenne and Arapaho tribes. Mr. Mooney has given a very full and interesting account of the ceremony of the ghost-dance, but here we have not space for more than a sketch of its most striking features.

The place chosen for the dance is frequently consecrated by the sprinkling of sacred powder. Seven priests lead the dance, and seven women are sometimes added as leaders, the number seven being sacred with most Indian tribes. Those selected as leaders receive two feathers of the crow, the sacred bird of the ghost-dance, or one of the eagle, which is sacred with all Indians; and these feathers they thrust in their hair. Nearly all the dancers wear feathers, the painting and ornamenting of which is attended with great ceremony; while the faces of the dancers are painted with elaborate designs in red, yellow, green and blue. The dance generally begins in the middle of the afternoon, the leaders walking to the spot selected, where they form a small circle facing inwards and joining hands. Then without moving they sing the opening song in a soft undertone, and, having sung it once, repeat it, raising their voices to their full strength, and slowly circling round from right to left. This process is repeated with different songs. Gradually the people of the tribe gather round, and one after another joins the circle until any number, from fifty to five hundred, men, women and children, are in the dance. The object aimed at by all the dancers is to fall into a sleep or trance in which they will see their dead relatives and converse with them. Sometimes a dancer will work himself into the trance-state solely by the influence of the movements of the dance and the singing, but the dancers are generally helped by the medicine-men standing within the circle, who, in Mr. Mooney's opinion, unconsciously exercise hypnotic influence. The first symptom of the trance-state is a slight muscular tremor, and, as soon as a medicine-man perceives this he fixes his eyes on the dancer, uttering sharp exclamations and twirling a feather or small cloth rapidly in his face. Soon the dancer loses control of himself, staggers and breaks away from the ring, which closes up again. The medicine-man continues his passes, generally keeping the sun full in the face of the dancer, who becomes rigid and finally falls to the ground unconscious. The trance lasts sometimes ten minutes, sometimes for hours; for those who continue dancing are careful not to disturb any dancer in the trance. As Mr. Mooney has taken part in the dance himself, he has observed the various stages in the hypnotic trance, as will be seen from the following quotation:

"From the outside hardly anything can be seen of what goes on within the circle, but being a part of the circle myself I was able to see all that occurred inside, and by fixing attention on one subject at a time I was able to note all the stages of the phenomenon from the time the subject first attracted the notice of the medicine-man, through the staggering, the rigidity, the unconsciousness, and back again to wakefulness. On two occasions my partner in the dance, each time a woman, came under the influence, and I was thus enabled to note the very first tremor of her hand and mark it as it increased in violence until she broke away and staggered toward the medicine-man within the circle."

In addition to his observations of the actual ceremony of the ghost-dance, Mr. Mooney has made very careful studies of the songs employed by the dancers. As with church choirs in civilised countries, the leaders of the dance hold numerous rehearsals of the songs which are to be employed at the next dance; for though each tribe has certain songs which form a regular part of the ceremony, new ones are constantly being added by those who have experienced the trance. Mr. Mooney was often present at these rehearsals, and was thus enabled to take down many of the songs, and some of the airs he has put to music. In fact Mr. Mooney has treated his subject exhaustively, and has prefaced it with a discussion of the various Indian revivals due to prophets who preceded Wovoka. His paper, which runs into some 500 quarto pages, is full of material which will be of the greatest value to the anthropologist and student of religion.

Two somewhat shorter papers on certain ceremonial dances among the Indians are contributed by Mr. J. W. Fewkes to the fifteenth and sixteenth annual reports of the Bureau, which were issued during the course of last year. Like Mr. Mooney's memoir, Mr. Fewkes' papers also are of great value, as they are based on personal observations; he does not, however, enter at any great length into the doctrines which underlie the ceremonials he describes. His paper in the fifteenth annual report is entitled "Tusayan Katcinas," and in it he has given a careful record of the Katcina ceremonials as he saw them performed in the Hopi village of Walpi in Tusayan; his paper is the result of observations made by himself and by the late Mr. A. M. Stephen during the years 1890 to 1894. The word *Katcina* has a twofold meaning. It is used as a name for certain supernatural beings, subordinate to the greater gods, who are impersonated in Hopi ceremonials by men wearing masks; it is also employed as a name for the dances in which these men take part. The Katcina dances are carried on at fixed times during the period between the winter and the summer solstices, and their chief point of difference from the ceremonies performed by the Hopi during the rest of the year consists in the presence of the Tcukúwympkiyas, or masked figures; the men who wear the masks or helmets are supposed to be transformed for the time into the deities they represent. The times for the ceremonies are determined by the priests of the tribe by observing the points on the horizon where the sun rises and sets (see p. 111). Of the Katcina ceremonials the most elaborate is that termed Powámû. Extensive preparations are made before the dance, the old paint left from previous occasions being scraped off the masks, which are then carefully redecorated and ornamented with clusters of feathers. The dancers also decorate themselves, using iron oxide for painting their legs, knees and waists a pale red. On the occasion Mr. Fewkes describes, preliminary ceremonies took place at Walpi for a week before the first ceremonial day of the Powámû, in which masked men from the neighbouring villages of Tewa and Hano took part. We have not space here to enter into any detailed account of the elaborate ceremonials performed on this and the succeeding days, including songs, a kind of primitive drama, dances, ceremonial smoking, flagellations, sprinkling of liquids, casting of meal and pollen into liquids, the making of small dolls or images, &c. Mr. Fewkes has not attempted to explain the theoretical significance of the ceremonies, but has contented himself with accurately describing them as they were performed. We may note, however, that in his subsequent paper on the snake-dance he throws out the suggestion that these Katcina ceremonies are to be traced to a totemic origin.

Mr. Fewkes' paper contributed to the sixteenth annual report is entitled "Tusayan Snake Ceremonies," and is based on a comparative study of the snake-dance, which is now known to be performed at five Tusayan villages. At Walpi it is celebrated in its most elaborate form, and lasts for twenty days, though only on nine days do ceremonies actually take place. Sixteen days before the snake-dance occurs it is formally announced at sunrise, the chiefs of the village having been engaged in ceremonial smoking during the previous night. For the next seven days no ceremonies are performed, but on the eighth day the assembly takes place, and for nine days secret ceremonies continue, which close at sunset on the ninth day with a dance, in which snakes are carried in the mouths of the dancers; the four following days are days of purification. Mr. Fewkes admits that the meaning of the snake-dance is obscure, but inclines to the belief that the elaborate ritual is performed for two main objects—the making of rain and the growth of corn. He does not consider that the dance is in any way connected with actual snake-worship.

We have said enough to indicate the great interest of these papers, not only to the student of Indian ritual, but to anthropologists generally. If we may make one criticism, it is that in places they would, perhaps, have gained a little by compression.

ON A NEW CONSTITUENT OF ATMOSPHERIC AIR.[1]

THIS preliminary note is intended to give a very brief account of experiments which have been carried out during the past year to ascertain whether, in addition to nitrogen, oxygen, and argon, there are any gases in air which have escaped observation owing to their being present in very minute quantity. In collaboration with Miss Emily Aston we have found that the nitride of magnesium, resulting from the absorption of nitrogen from atmospheric air, on treatment with water yields only a trace of gas; that gas is hydrogen, and arises from a small quantity of metallic magnesium unconverted into nitride. That the ammonia produced on treatment with water is pure has already been proved by the fact that Lord Rayleigh found that the nitrogen produced from it had the normal density. The magnesia, resulting from the nitride, yields only a trace of soluble matter to water, and that consists wholly of hydroxide and carbonate. So far, then, the results have been negative.

[1] Paper to be read before the Royal Society on June 9 by Prof. William Ramsay, F.R.S., and Morris W. Travers. Received by the Society June 3.

Recently, however, owing to the kindness of Dr. Hampson, we have been furnished with about 750 cubic centimetres of liquid air, and, on allowing all but 10 cubic centimetres to evaporate away slowly, and collecting the gas from that small residue in a gas-holder, we obtained, after removal of oxygen with metallic copper and nitrogen with a mixture of pure lime and magnesium dust, followed by exposure to electric sparks in presence of oxygen and caustic soda, 26·2 cubic centimetres of a gas, showing the argon spectrum feebly, and, in addition, a spectrum which has, we believe, not been seen before.

We have not yet succeeded in disentangling the new spectrum completely from the argon spectrum, but it is characterised by two very brilliant lines, one almost identical in position with D_3, and almost rivalling it in brilliancy. Measurements made with a grating of 14,438 lines to the inch, kindly placed at our disposal by Mr. E. C. C. Baly, gave the following numbers, *all four lines being in the field at once*:—

D_1	5895·0
D_2	5889·0
D_3	5875·9
D_4	5866·65 + 1·7 to correct to vacuum.

There is also a green line, comparable with the green helium line in intensity, of wave-length 5566·3, and a somewhat weaker green, the wave-length of which is 5557·3.

In order to determine as far as possible which lines belong to the argon spectrum, and which to the new gas, both spectra were examined at the same time with the grating, the first order being employed. The lines which were absent, or very feeble, in argon, have been ascribed to the new gas. Owing to their feeble intensity, the measurements of the wave-lengths which follow must not be credited with the same degree of accuracy as the three already given, but the first three digits may be taken as substantially correct:—

Violet	4317	Blue	4834
,, ...	4387	,, ...	4909
,, ...	4461	Green	5557·3
,, ...	4671	,, ...	5566·3
Blue	4736	Yellow	5829
,, ...	4807	,, ...	5866·5
,, ...	4830	Orange... ...	6011

Mr. Baly has kindly undertaken to make a study of the spectrum, which will be published when complete. The figures already given, however, suffice to characterise the gas as a new one.

The approximate density of the gas was determined by weighing it in a bulb of 32·321 cubic centimetres capacity, under a pressure of 521·85 millimetres, and at a temperature of 15·95°. The weight of this quantity was 0·04213 gram. This implies a density of 22·47, that of oxygen being taken as 16. A second determination, after sparking for four hours with oxygen in presence of soda, was made in the same bulb; the pressure was 523·7 millimetres, and the temperature was 16·45°. The weight was 0·04228 gram, which implies the density 22·51.

The wave-length of sound was determined in the gas by the method described in the "Argon" paper. The data are:—

	i.	ii.	iii.
Wave length in air	34·17	34·30	34·57
,, ,, gas	29·87	30·13	

Calculating by the formula

$$\lambda^2_{air} \times \text{density}_{air} : \lambda^2_{gas} \times \text{density}_{gas} :: \gamma_{air} : \gamma_{gas}$$
$$(34{\cdot}33)^2 \times 14{\cdot}479 : (30)^2 \times 22{\cdot}47 :: 1{\cdot}408 : 1{\cdot}666,$$

it is seen that, like argon and helium, the new gas is monatomic and therefore an element.

From what has preceded, it may be concluded that the atmosphere contains a hitherto undiscovered gas with a characteristic spectrum, heavier than argon, and less volatile than nitrogen, oxygen, and argon; the ratio of its specific heats would lead to the inference that it is monatomic, and therefore an element. If this conclusion turns out to be well substantiated, we propose to call it "krypton," or "concealed." Its symbol would then be Kr.

It is, of course, impossible to state positively what position in the periodic table this new constituent of our atmosphere will occupy. The number 22·51 must be taken as a minimum density. If we may hazard a conjecture, it is that krypton will turn out to have the density 40, with a corresponding atomic weight 80, and will be found to belong to the helium series, as is, indeed rendered probable by its withstanding the action of red-hot magnesium and calcium on the one hand, and on the other of oxygen in presence of caustic soda, under the influence of electric sparks. We shall procure a larger supply of the gas, and endeavour to separate it more completely from argon by fractional distillation.

It may be remarked in passing that Messrs. Kayser and Friedlander, who supposed that they had observed D_3 in the argon of the atmosphere, have probably been misled by the close proximity of the brilliant yellow line of krypton to the helium line.

On the assumption of the truth of Dr. Johnstone Stoney's hypothesis that gases of a higher density than ammonia will be found in our atmosphere, it is by no means improbable that a gas lighter than nitrogen will also be found in air. We have already spent several months in preparation for a search for it, and will be able to state ere long whether the supposition is well founded.

LYON PLAYFAIR.

IT is now fifty-three years since I first met Playfair. He was President of the Chemical Section of the British Association in 1855 at Glasgow. Frankland and I were the Secretaries. Liebig attended the meeting, and stayed with his friend Walter Crum, and it was appropriate that Playfair, who was one of Liebig's most promising English pupils, should preside over a meeting of chemists at which his German master was present. Playfair then was in the height of his activity. His addresses in 1855, and again thirty years later, when he was President of the Association, although not containing much of striking originality, were clear, luminous expositions, as indeed were his speeches in the House of Commons, and latterly in the House of Lords.

In the year 1834, when he was fifteen years of age, he began to study chemistry under Graham, who was then professor at the Andersonian at Glasgow. After a short visit to his parents in India, where his father was Chief Inspector-General of Hospitals in Bengal, he followed Graham to London, and in 1838 went to Giessen to study under Liebig, then the rising star in the chemical firmament. There he became not only Liebig's pupil, but his friend; he worked at organic chemistry, publishing in 1841 his first paper on a new fatty acid contained in the butter of nutmegs, and in the following year he published an abstract of Liebig's report on organic chemistry as applied to chemistry and pathology. On his return to England, through Liebig's influence with James Thomson, a man who even in those early days saw the value of science as applied to industry, Playfair was appointed as chemist to the well-known calico printworks at Clitheroe. After a few years he exchanged this position for a more suitable one in the Royal Institution, Manchester, where he found more congenial society in the friendship of Dalton and Joule. It was whilst he was in Manchester that Playfair induced Bunsen, who had just perfected his process of gas analysis, to come over to Alfreton to collect the gases of the blast furnace. The results of this visit furnished the first evidence concerning the chemical changes occurring in the blast furnace, and were published in the British Association Reports for 1845.

It was in conjunction with Joule that Playfair's name is best known as an investigator, several memoirs on atomic volume and specific gravity appearing in their joint names in the Chemical Society's *Journal*, the most important result of which was the discovery of the well-known laws relating to the disappearance of the volume of the acid and of the base of crystals of hydrated salts. If Playfair had remained under the influence of Dalton and Joule, his record of original work would probably have been much longer than it is, but his activity was destined to be turned into other channels. Sir Robert Peel, who had heard of Playfair and formed a high opinion of his powers, appointed him on a Commission to inquire into the sanitary condition of large towns, and such matters he found more to his taste than purely scientific research. In recognition of the services which he performed on this Commission, he was appointed chemist to the Museum of Practical Geology. It was here that he carried out his best-known research, namely that on the nitro-prussides, a new class of salts characterised by giving a splendid purple colour with alkaline sulphides. A year or two later preparations were being made for the first great exhibition of 1851, and Lyon Playfair was chosen as a competent man to visit the manufacturing districts to secure the co-operation of persons interested in manufactures and commerce. This somewhat difficult task he accomplished with tact and success, and later on he took a leading part in the classification and arrangement of the exhibits, and the appointment of the juries was mainly left in his hands. A good story is told of his *savoir faire* at the opening of the exhibition, where it was of course desirable to have all nations represented. A very gaily-dressed Chinaman found himself in the procession side by side with the Archbishop of Canterbury, and was about to be removed to some less conspicuous position when the Prince Consort desired he might be left where he was. Playfair's efforts had been successful in obtaining the recognition of China, for, in the absence of any yellow-jacketed mandarin as ambassador, Playfair had got hold of a Chinese ticket-collector of a junk then being exhibited in the docks. Not only during the existence of the exhibition, but even up to the present time, Playfair left his mark on the results of that exhibition, for he was the guiding hand in the numerous and complicated transactions which have taken place since the purchase of the South Kensington Estate by the Royal Commissioners. The foundation of the Science Scholarships, which are now proving such a boon to the aspirants to scientific fame, was entirely Playfair's idea. Working in connection with the exhibition of 1851 brought him into personal contact with the late Prince Consort, in whose household he accepted a post, and it was to Playfair that the Prince was much indebted in his various schemes of land improvement and other scientific matters. A few years later, when the Science and Art Department was put upon a new footing, Playfair was appointed joint secretary with Sir Henry Cole; this partnership, as might be foreseen from the character of the two men, did not last long, and Playfair became Inspector-General of Government Museums and Schools of Science. A more permanent and satisfactory position was, however, now open to him. In 1856 he succeeded Gregory as Professor of Chemistry in the University of Edinburgh, and in this position he remained for thirteen years, and the wags said that he was the only Scotchman who, having tasted the flesh-pots of Egypt, was ever known to return to the land of cakes not plum—but oats.

As Davy's greatest discovery was Faraday, so it may be said that Playfair's was Dewar, who acted for some time as his assistant. The five months' duties of the Edinburgh chair did not by any means exhaust his energies. On the occasion of the second great exhibition of 1862, his services were again called for, and in 1868 he was returned to Parliament in the Liberal interest as representing the Universities of Edinburgh and St. Andrews, a seat which he held for seventeen years. His Parliamentary labours were arduous and important, and his name will go down as representing the reorganisation of the Civil Service. He also presided over many important Committees and Royal Commissions; indeed, it may be said that for many years no official inquiry was considered satisfactory without the advice of Playfair, whose clear head and common sense were always readily placed at the service of the nation. He was Postmaster-General in Gladstone's ministry of 1873, and on the return of the Liberals to power in 1880 he was elected Chairman of Ways and Means, a post which in those stormy days was no sinecure. At the election of 1885, finding his Liberal views did not coincide with those of the University constituencies, he offered himself as a candidate for South Leeds, and was returned also in 1886 and 1892. He was Vice-President of the Council during Mr. Gladstone's short administration of 1886, but was not offered office in 1892, but received the honour of a peerage, which was given him more for his political than his scientific eminence. Playfair was the last remaining original member of the Chemical Society. The banquet which was to have been given in his honour and in that of the other past presidents of fifty years' standing has had to be postponed owing to his somewhat sudden death.

It is to him that we owe the first movement with regard to technical instruction, and his name will go down to posterity as one "who loved his fellow men."

He was laid to rest at St. Andrews, the city from which his family sprang. His merit was recognised by representatives of the Queen and of the Prince of Wales, and numerous friends and admirers, both scientific and political, as well as by the citizens of St. Andrews.

H. E. R.

OSBERT SALVIN, F.R.S.

ORNITHOLOGY and entomology have sustained a great loss by the death of Mr. Osbert Salvin, which occurred on the 1st inst. at his beautiful residence Hawksfold, near Haslemere. The second and only surviving son of the late Mr. Anthony Salvin, the well-known architect, he was born in 1835, and received his education at Westminster and Trinity Hall, Cambridge, where he graduated as a Senior Optime in the Natural Science Tripos of 1857. Immediately after taking his degree he, together with Mr. W. H. Hudleston (then Simpson), joined Mr. (now Canon) Tristram in his natural history exploration of Tunis and Eastern Algeria, where they passed five months. In the autumn of the same year Mr. Salvin proceeded to Guatemala, where, chiefly in company with the late Mr. G. U. Skinner, the celebrated collector of orchids, he stayed till the middle of 1858, returning to Central America (henceforth always to be associated with his name) about twelve months later. He again went out in 1861, accompanied by Mr. Frederick Godman, and continued the explorations he had already begun, but was home again in 1863. In 1865 he married Caroline, the daughter of W. W. Maitland, Esq., of Loughton in Essex, and with her subsequently undertook another voyage to Central America. In 1874, on the foundation of the Strickland Curatorship in the University of Cambridge, he accepted that office, which he filled until 1883, when, on his father's death, he succeeded to the property at Hawksfold, and removed thither, though there was scarcely a week in which he did not pass some days in London; for with Mr. Godman he had conceived the idea of bringing out a "Biologia Centrali Americana," being a complete natural history of the countries lying between Mexico and the Isthmus of Panama. This gigantic task, by far the greatest work of the kind ever attempted, taxed all their united efforts, and those of the many contributors they enlisted, and is still in progress. Before beginning this, Mr. Salvin had edited the third series of the *Ibis*, of which he was one of the founders, and had brought out a "Catalogue of the Strickland Collection" in the Cambridge Museum. He contributed also the *Trochilidæ* (Humming-birds) and *Procellariidæ* (Petrels)—on which he was the acknowledged authority—to the British Museum "Catalogue of Birds," and almost his latest labour was that of completing and arranging the late Lord Lilford's "Coloured Figures of British Birds"; while the Royal Society's "Catalogue of Scientific Papers" enumerates forty-seven published by Mr. Salvin alone, twenty-three by him and Mr. Godman jointly, and fifty-four by him and Mr. Sclater—all before 1884.

Mr. Salvin was a Fellow of the Royal, Linnean, Zoological and Entomological Societies, on the Councils of each of which he frequently served; and it may be truly said that there were few naturalists whose opinion was more often sought, for his advice was generally sound. His figure was well known at the Athenæum Club, and last year he was elected an Honorary Fellow of his old College. He will be greatly missed by a large circle of friends, to whom his quiet and unassuming manners greatly endeared him.

N.

NOTES.

THE freedom of the city of Edinburgh is to be conferred on Lord Lister on June 15.

THE annual ladies' conversazione of the Royal Society was held yesterday, as we went to press.

THE Prince of Wales will open the new buildings of the University Extension College, Reading, on Saturday next, June 11.

A FLORAL fête and children's floral parade will be held in the gardens of the Royal Botanic Society, Regent's Park, from 2 to 7 o'clock to-morrow (Friday).

THE city of Como, the birthplace of Alexander Volta, is preparing to worthily celebrate in 1899 the hundredth anniversary of the invention of the Voltaic or Electric Pile. To commemorate this important event, which has led to some of the greatest discoveries of the present century, there will be held at Como, from May 15 to October 15, an International Electrical Exhibition, to which will be annexed a national exhibition of the manufacture of silk—a branch of trade much developed in Como—and an international exhibition of the machinery, preparation, and process of working the same. Italian and foreign electricians are invited to a Congress, which will be held for the purpose of discussing the progress and applications of electricity. Como is a flourishing city on the main line of St. Gothard, and forty kilometres from Milan. It is pleasantly situated at the foot of the Rhaetian Alps, and on the shores of the most beautiful lake of Lombardy, to which it gives its name. An electrical exhibition ought to succeed in Italy, where the abundant hydraulic power greatly facilitates electric works. The application of electricity to the manufacture of silk must be of interest in Como, where the silk-works are of ancient date, and rapid progress is being made, though the industry is indebted to foreign countries for the machinery and implements. We are informed that foreign inventions will be greatly valued at the exhibition, and will be well placed. For the encouragement of exhibitors, the city of Como has decided to give a sum of 10,000 francs in prizes for new inventions in the field of electricity.

The title of the evening lecture which Prof. W. J. Sollas, F.R.S., will deliver at Bristol on September 9, at the meeting of the British Association, will be "Funafuti, the Study of a Coral Island." Mr. Herbert Jackson has chosen "Phosphorescence" as the subject of his evening discourse on September 12. Mr. W. Whitaker, F.R.S., will be the chairman of the conference of delegates of corresponding societies. Subscriptions to the local fund being raised for the expenses of the meeting now amount to 3665*l.*, and it is hoped that this will be increased to at least 4000*l.*

Our Paris contemporary, the *Revue Générale des Sciences*, has arranged with the Orient Steam Navigation Company, Limited, for the *Lusitania* to make a special cruise to Norway and the North Cape from July 15 to August 10. The boat will leave Dunkerque on the former date and proceed to Bergen, from which place it will go up the coast to the North Cape, calling at Trondhjem, Tromsoe, Hammerfest, and other places of interest. After viewing the midnight sun, the party will leave the North Cape on July 25, and will be taken down to Christiania, visiting many places on the way. Prof. J. Thoulet, professor of mineralogy and oceanography at the University of Nancy, and Baron Jules de Guerne, general secretary of the Société Nationale d'Acclimatation de France, will accompany the tourists, and will give short lectures, with lantern illustrations, on the various features of interest in the places visited. The programme is an attractive one, and provides a pleasant and instructive means of spending a holiday.

A valuable circular (No. 18), dealing with the physics of timber, has just been issued by Prof. B. E. Fernow, Chief of the Division of Forestry of the U.S. Department of Agriculture. The paper is given exceptional importance by the development of a formula worked out by Mr. S. T. Neely, showing how the strength of beams can be determined from the compression strength. In testing timber to obtain its various coefficients of strength, the test which is at once the simplest, most expedient, satisfactory and trustworthy is the "compression endwise test," which is made by crushing a specimen parallel to the fibres. All other tests are either mechanically less easily performed, or else, as in the case of cross-bending, the stresses are complex, and the unit coefficient can be expressed only by depending upon a doubtful theoretical formula. It is, therefore, of great practical value to have a relation between the cross-bending strength—the most important coefficient for the engineer—and the compression strength, and this is what Mr. Neely has found. His discovery is expressed in the following conclusion:—"The strength of beams at elastic limit is equal to the strength of the material in compression, and the strength of beams at rupture can be directly calculated from the compression strength; the relation of compression strength to the breaking load of a beam is capable of mathematical expression." This enunciation is of far-reaching importance, and a comparison of calculated with observed results given in the circular is convincing as to the efficiency of the formula. It is to be hoped that other and similarly successful scientific investigations into the physics of timber will be made in the U.S. Division of Forestry.

The mysterious phenomenon known as "Barisal Guns" or "Mist-poeffers" forms the subject of a useful paper by Dr. A. Cancani in the last *Bollettino* (vol. iii. No. 9) of the Italian Seismological Society. The observations on which his discussion is founded are collected from places in or near the inland province of Umbria, where the noises are known as "marina," it being the popular belief that they come from the sea. The sound is quite distinct and easily recognised; it is longer than that of a cannon-shot, and, though more prolonged and dull, it is not unlike distant thunder. It invariably seems to come from a distance and from the neighbourhood of the horizon, sometimes apparently from the ground, but generally through the air. The weather when the "marina" is heard is calm as a rule, but that it often precedes bad weather is shown by the common saying, "Quando tuona la marina o acqua o vento o strina." The interval between successive detonations is very variable, sometimes being only a few minutes, or even seconds. They appear to be heard at all times of the day and year, the experience of observers differing widely as to the epochs when they are heard most frequently. With regard to the origin of the "marina," Dr. Cancani concludes that they cannot be due to a stormy sea, because "mist-poeffers" are frequently observed when the sea is calm; nor to gusts of wind in mountain gorges, for they are heard on mountain summits and in open plains. If their origin were atmospheric, they would not be confined to certain special regions. Nor can they be connected with artificial noises, for they are heard by night as well as by day, and in countries where the use of explosives is unknown. There remains thus the hypothesis which Dr. Cancani considers the most probable, that of an endogenous origin. To the obvious objections that there should always be a centre of maximum intensity (which is never to be found), and that they are so rarely accompanied by any perceptible tremor, he replies that, in a seismic series, noises are frequently heard without any shock being felt, and of which we are unable to determine the centre.

The American Academy of Arts and Sciences have decided to award the Rumford Medal to Prof. James E. Keeler, director of the Lick Observatory, "for his application of the spectroscope to astronomical problems, and especially for his investigations of the proper motions of the nebulæ, and the physical constitution of the rings of the planet Saturn, by the use of that instrument."

The honour of Knight of the Order of the Polar Star has been conferred upon Dr. J. Scott Keltie by the King of Sweden and Norway.

Dr. R. Koch has been consulted by the East African Protectorate as to preventive measures against rinderpest, which is again rampant in the interior. Dr. Macdonald, the principal medical officer, and Veterinary-Captain Haslam, M.D., have visited Zanzibar to represent the Protectorate on this and other infectious diseases. Dr. Haslam will proceed to the seat of the disease, and direct preventive measures.

We learn from the *British Medical Journal* that the monument to Pasteur, which is to be erected in Paris in the space in front of the Pantheon, is now almost completed. M. Falguière, the sculptor, has introduced certain modifications into his original design, in which Pasteur was simply represented as overcoming Death, which was in the act of flight. Now a group of a mother with her child, thanking Pasteur, has been added on the right, while behind the central figure Fame is shown crowning him with laurels. The international subscription to the memorial now amounts to nearly 13,000*l.*

The Local Government Board, acting under the recommendations of recent Commissions as to the cultivation in glycerine of vaccine lymph before such is applied to the human body, has (says the *Times*) leased a large laboratory and several office rooms at the British Institute of Preventive Medicine, on the Thames Embankment, for the purpose of cultivating the lymph. The bacteriological expert who has been appointed to take chief control of the new laboratory is Dr. F. Blaxall, lecturer on bacteriology at Westminster Hospital. He will have an assistant, who has already been nominated, and an efficient staff. The calves from which the vaccine lymph is taken will be kept for the present at the Government calf establishment near the Foundling Hospital, and the lymph will be taken thence to the Thames Embankment in its pure state to be prepared and stored in glycerine.

WE regret to announce that Mr. Henry Perigal, the treasurer of the Royal Meteorological Society, died on Monday at the advanced age of ninety-seven years. Mr. Perigal was the author of various works on astronomy, bicycloidal and other curves, kinematics and the laws of motion, probable mode of constructing the Pyramids, &c. He was a constant attendant at the meetings of various London scientific societies until within two years of his death. He was a Fellow of the Royal Astronomical, Royal Microscopical, and Royal Meteorological Societies, as well as a member of several other scientific associations.

THE *Times* announces the death of the Rev. Percival Frost, F.R.S., on Sunday last, in his eighty-first year. Born at Hull, he was educated at Beverley, Oakham and Cambridge, where he was second wrangler and first Smith's prizeman in 1839, Fellow of St. John's College from that year until 1841, mathematical lecturer at Jesus College from 1847 to 1859, mathematical lecturer at King's College, Cambridge, from 1859 to 1889. He had been a Fellow of King's College since 1882, and was elected a Fellow of the Royal Society in 1883. Dr. Frost was the author of treatises on "Curve Tracing," "Solid Geometry," "The First Three Sections of 'Newton's Principles,'" as also of numerous papers published in various mathematical journals.

SIR ROBERT RAWLINSON, K.C.B., eminent by his works in civil and sanitary engineering, died on Tuesday, May 31, at the age of eighty-eight. He was a vice-president of the Society of Arts, and from 1849 to 1888 was chief engineering inspector of the Local Government Board. He took a foremost part in the development of sanitary science, and as a member of the Army Sanitary Commission in the Crimea was able to vindicate the soundness of his sanitary teaching. The beneficial results obtained by the Commission led to increased attention being paid to sanitary requirements, and thus brought about a very great reduction in the annual mortality of the British Army. Sir Robert Rawlinson acted as chairman of the Royal Commission on the Pollution of Rivers in 1866, and also served on the Commission which inquired into the sanitary condition of Dublin in 1879. He became a member of the Institution of Civil Engineers in 1866, and president in 1894. At one period he took a considerable part in the proceedings of that body, discussing mostly questions connected with drainage and water supply, of which his official position gave him a wide experience.

IT has already been announced that the autumn meeting of the Iron and Steel Institute will take place at Stockholm on Friday and Saturday, August 26 and 27 next. Particulars of the special transport arrangements, which have been made for the convenience of members attending the meeting, have now been issued. A special steamer, of over 3000 tons, chartered by Dr. H. S. Lunn and Mr. Woolrich Perowne, will leave Newcastle-on-Tyne on Wednesday, August 17, and will proceed by way of the Baltic Canal, Kiel and Wisby to Stockholm, where she will lie, and serve as a floating hotel, from Thursday, August 25, to Sunday, August 28. The return journey will be by way of Copenhagen, Gothenburg and Christiania. Dr. Lunn and Mr. Perowne have also arranged for the S.S. *St. Sunniva*, a one-thousand ton boat, to leave Leith on Saturday, August 20, proceeding by way of Christiania to Stockholm, where she will lie on Friday, Saturday and Sunday, August 26, 27 and 28, proceeding from Stockholm to St. Petersburg, and returning by way of Copenhagen and the Baltic Canal. The Orient Steam Navigation Company, Limited, have re-arranged the itinerary of their pleasure cruise No. 3 to the Baltic, so as to bring their S.S. *Lusitania* (3912 tons) to Stockholm on Thursday, August 25, and to keep her there until Sunday, August 28. The itinerary includes visits to Copenhagen, Wisby, Stockholm, Kronstadt, St. Petersburg, Kiel, and the Baltic Canal. The Great Eastern Railway Company has promised to afford special facilities to members travelling by the Continental route. The arrangements which are being made by the Local Reception Committee for the instruction and pleasure of the members, and the ladies accompanying them, are making satisfactory progress, and the detailed programme will be issued in due course.

IN view of the forthcoming conference of representatives of Sea Fishery Committees convened by the Board of Trade, a preliminary meeting of the representatives was held on Tuesday at the Guildhall, Westminster, to obtain a consensus of opinion on the subjects which are to be considered. It was resolved that a deputation should urge on the Government the need of legislation to protect immature sea fish and the enlargement of the powers of Sea Fishery Committees. A resolution was also carried in favour of the formation of an association of Fishery Committees.

THE Belgian Government having decided to offer a premium of 50,000 francs to the inventor of a paste for matches which will be free from white phosphorus and which will ignite on cloth or any other surface, a Ministerial decree has been issued determining the conditions. The competition will be international in character, and will remain open until January 1, 1899. Communications on the subject are to be addressed to M. Woeste, the president of the Commission appointed to adjudicate, at 2 Rue Laterale, Brussels.

HERR N. A. MÖLLER, in Eberswalde, has sent us a communication in which he states that he has undertaken a labour of love which will not be easy unless he is helped by many who are in the position to assist him. Fritz Müller, the naturalist, an old friend of his, died in Brazil, and Herr Möller wishes to raise a monument to his name by publishing a work which will contain an account of his life, character, method of work, his most important letters, and if possible his most valuable scientific writings. With this intention Herr Möller requests all those of our readers who possess any manuscripts, letters, &c., which may be found useful in such a biography, to forward them to him in Eberswalde, where they will be taken the greatest care of and returned when finished with.

A SYLLABUS prepared by Mr. R. De C. Ward, containing an outline of requirements in meteorology, intended for use in preparing students for admission to Harvard College and the Lawrence Scientific School, affords evidence that careful and systematic work in meteorology is given more encouragement in the United States than it receives here. The scheme of work indicated in the syllabus will train the student to scientific methods of investigation, and will make him to some extent a thinker and investigator on his own account.

IN our issue of April 8, 1897 (vol. lv. p. 542), we drew attention to an important investigation by Dr. O. Pettersson, with the object of showing that certain relations existed between the behaviour of the Gulf Stream and the subsequent general character of the weather over Europe, the results of which were based upon observations made during about twenty years at three stations on the Norwegian coast. In the *Meteorologische Zeitschrift* for March last, Dr. W. Meinhardus, of Berlin, continues the investigation in an article entitled, "On some

Meteorological Relations between the North Atlantic Ocean and Europe during the Winter Half-year," based upon a much longer series of observations. The results confirm those of Dr. Pettersson in a very satisfactory way, and show that a good idea of the temperature over a large area may be predicted with a considerable probability of success, and that, generally speaking, a high (or low) temperature of the Gulf Stream on the Norwegian coast in the first part of the winter (November to January) is usually followed by a high (or low) air-temperature in Central Europe in the latter part of the winter (February to March) and the early spring (March and April). It will be seen that the investigation refers entirely to the winter months.

MR. H. PARKER gives, in the *Ceylon Observer* of May 12, a detailed account of the abnormal rainfall of 31·72 inches in twenty-four hours, experienced at Nedunkeni, in the Northern Province of Ceylon, last December, and already briefly described by a correspondent in these columns (p. 78). Nedunkeni, eleven miles down the southern road to Mullaittivu, and 122 feet above sea-level, is a small village a little to the east of the dividing ridge of North-Central Ceylon, and though itself in the catchment area of the eastern Per Aru, which flows through Tannir Murippu Tank, it is only a little to the south-west of the point where three separate drainages meet. Forest, containing a thick growth of high trees, extends over the neighbourhood, and more especially for many miles from the south to the east. For about three years a rain-gauge has been established in the grounds of the dispensary in the village, and its records are regularly transmitted to the Public Works Office, and are published among the rainfall returns. Although the mean annual rainfall at Nedunkeni is probably little more than 50 inches, the fall for last December was 67·07 inches, and of this amount 31·72 inches were measured at 9.30 a.m. on December 16 as the rainfall of the preceding twenty-four hours. From an examination of the position of the rain-gauge, and the testimonies of the observers, Mr. Parker concludes that most probably the actual rainfall was in excess of the recorded amount.

WEATHER influences on farm and garden crops are discussed in an interesting address by Mr. Edward Mawley, published in the *Quarterly Journal* of the Royal Meteorological Society (April). After giving a short sketch of the climate of the British Isles as a whole, Mr. Mawley considers separately some of the effects produced on vegetation in this country by varying temperatures, by scanty and heavy rains, by sunshine and by wind; and afterwards treats of the leading farm and garden crops, and their special requirements with regard to atmospheric conditions. The paper should be of service in showing how intimate the connection is between meteorology, agriculture and horticulture.

MR. T. MELLARD READE informs us that a very large boulder of gypsum has been uncovered by the excavations in the brickworks of Mr. Ed. Peters, Cooks Lane, Great Crosby, near Liverpool. It is embedded in and completely surrounded by a thick bed of brown boulder clay, the bottom of the boulder being about 17 feet below the surface of the ground. The boulder measures 11 feet by 6 feet by 6 feet extreme dimensions, and weighs about 13 tons. "Small pieces of gypsum and plates of selenite are," adds Mr. Reade, "not uncommon in our boulder clays; but this individual boulder not only far surpasses in size any drift fragments of gypsum hitherto found, but is actually the largest boulder of any sort that I have seen taken out of the boulder clay, or recorded from it in the neighbourhood of Liverpool."

IT is known that a function of two variables x and y may have a maximum or minimum value along every straight line passing through a certain point O without the function necessarily being itself a maximum or minimum at that point. A simple proof that the same cannot be the case if the function is a maximum at O, not only for all *straight* lines, but also for all continuous lines through O, is given by Signor G. Vivanti in the *Atti de Lincei*, vii. 8.

THE Royal Academy of Sciences of Naples has hitherto been supposed to have originated about the year 1732, but from a communication published in its *Rendiconto*, by Prof. Federico Amodeo, we learn that the foundation of the Academy has been traced back thirty-four years earlier. In 1698, under the Viceroy, Luigi della Cerda, Duke of Medinacoeli, there was founded, in Naples, a literary and scientific society called the Palatine Academy; this society appears to have been overlooked by historians, owing to the fact that no published writings of its members had come before their notice. Prof. Amodeo has now succeeded in discovering a number of printed papers, notably two scientific works of the mathematician Antonio Monforte, affording abundant proof of the existence and activity of this, the parent of the present Academy, which thus dates from the year 1698.

PROF. P. DE HEEN continues his researches on so-called "infra-electric" radiations in the current number of the *Bulletin de l'Académie royale de Belgique*. The author is led to the conclusions that every source of disturbance in the ether gives rise not only to known radiations, but also to other rays vibrating in a different manner. These rays have the same properties as Röntgen rays in the matter of their action on dielectrics, charged conductors and electric fields, and differ from them in the matter of wave-length. They are absorbed so much more readily than ordinary light waves, that any such rays which emanate from the sun are completely sifted out by our atmosphere. In accordance with M. Perrin's views, the discharge of a conductor by these rays is chiefly due to their action on the lines of force. Lastly, an electric field is found to behave towards infra-electric rays as an opaque medium.

AN extremely simple commutator for converting an alternating current into a direct one is investigated by Signor A. Dina (of Zürich) in the *Rendiconti del R. Istituto Lombardo*, xxxi. 9. From the experiments of Prof. Grätz (of Munich) and Herr Pollak (of Frankfort), it appears that an aluminium element capable of evolving oxygen at the anode produces a remarkable weakening of the current, and if the electromotive force is less than 22 volts, practically no current flows; but if the pole in question is made the kathode, no perceptible change in the current takes place, the electromotive force of the element being less than 1 volt. Hence it is easy, by arranging such elements in series, to obtain a combination which will only allow currents to pass in one direction, and which will resist any required electromotive force in the opposite direction. From experiments now described, the present writer concludes that the action of the elements is similar to that of a condenser, the aluminium becoming coated with a film of oxide which plays the part of dielectric. Signor Dina has not succeeded so far in putting the method to any practical use, though Herr Pollak claims to have done so.

A SERIES of experiments on the action of opaque tubes on Röntgen rays passing down them is described by Prof. Villari (*Atti dei Lincei*, vii. 8, and *Rendiconto dell' Accademia di Napoli*, iv. 3, 4). In a series of previous experiments, Prof. Villari found that in traversing a long tube opaque to them, these rays lose a large part of their power of discharging an electrified conductor at the end of the tube. This effect the author now attributes to the action of the tube in cutting off lateral rays, which, by their action on the surrounding air, would accelerate the discharge. In the matter of photographic action, Prof. Villari finds no difference between rays which have passed through a tube and those which have not, and he concludes that Röntgen rays are neither reflected nor diffused by the walls of the tube, and that the transmitted rays are probably in no way modified by its presence.

MR. ERNEST HOSE communicates to the *Sarawak Gazette* for May some observations on an encounter between a python and wild pigs in the jungle at Tambak. A young pig had been seized by a large python, and the cries of distress summoned about twenty of the herd to an attack. They gored the python savagely with their tusks, and so harassed and lacerated it as to force it to relinquish its prey. The python was ultimately killed by Mr. Hose.

AN interesting note on Chinese antiquities is given in the consular report on Shashih (C. 8648–108 of 1898), just issued. Shashih contains a pagoda dating, it is said, from the ninth century, and there are other remains. There are distinct traces of the town having been at one time fortified, the earth nucleus of a wall and six brick gateways being still visible. The place is one of considerable interest to the archæologist and student of ethnography. All round Chingchou, which is about two miles from the north-west extremity of Shashih, are mounds, earthworks, look-out terraces, &c., the remains of ancient cities and fortresses, which mark the sites of successive capitals and strongholds of the ancient kings of Ch'u and their local successors from the very dawn of authentic history. These remains are not described in the report, but it is stated that the traditions attached to them cluster round the capture of the capital of Ch'u by the Prince of Ch'in in 278 B.C., its destruction as an independent kingdom half a century later, the part it played in the wars of the second and third centuries A.D., and the momentary revival of independence in the tenth century as the principality of Nan P'ing.

ANOTHER report on China, very important for commercial purposes, "Trade of Central and Southern China" (C. 8649–29 of 1898), contains some geographical and other notes of interest, together with maps. K'uei Fu is interesting as one of the oldest sites of Chinese occupation in these parts, dating from the beginning of our era. Geographically it marks the point of junction of the limestone mountains, athwart which the Yang-tze has forced a way in 100 miles of rapids and gorges, and the red sandstone formation of Ssŭ-ch'uan. A mile beyond Tzŭ-t'ung-chen there is a once-renowned Buddhist temple, and still noteworthy for its gigantic figure of Buddha, about 80 feet high, 5 feet across the toes of one foot, cut in high relief out of the solid rock and overlooking a bad rapid in the river, over which it is thought to have a sort of divine superintendence. Though cut in A.D. 1126, it is still in excellent preservation, and evidently much respected. The temple on the bluff behind the image was once on a grand scale, but it has been allowed to fall into utter ruin. In the region beyond this is the plain of Sui-ning, composed of solid alluvium 30 feet deep. There are frequent little temples to the god of the soil, usually of solid stone, the image being enclosed by open fretwork, so that the god cannot see out. The city of Ch'êng-tu is defended by huge walls and gates. The first wall was built in the third century B.C., shortly after the Chinese reduced the old aboriginal state of Shu, and began to colonise this country; the present wall was built in 1784, and is really a magnificent structure, and in almost perfect preservation. Opposite the city of Chia-ting has been cut in high relief a huge figure of Maitreya Buddha, no less than 380 feet high. Between Hêng-chiang and Lao-wa-t'an is the territory of the independent people Lolo, a race akin to the Thibetans, and perhaps the Burmese, who peopled these parts before the Chinese, and whom the latter have never subdued, although they have been attempting the enterprise for nearly 2000 years. The eastern part of the Red Basin was early peopled by the Chinese race, and in the third century A.D. Ch'êng-tu was the capital of the western of the three kingdoms into which China was then divided. At the end of the Ming dynasty (1640) the inhabitants were destroyed in one of those social cataclysms that have occurred with much regularity every few hundred years in Chinese history. When order was restored by the present dynasty, the province was colonised chiefly from Hupei and Hunan on the east. Altogether this is a most interesting report; and though intended for trade, the ethnographer and geographer will obtain many useful notes therefrom.

UNDER the title of "The Adulteration of Dairy Produce," Mr. R. Hedger Wallace has brought together a mass of statistics relative to the quality of the articles which come under the above head. The author's original paper was read before the Royal Scottish Society of Arts in Edinburgh, and it constitutes a formidable indictment against the conduct of dairying both at home and abroad. The butter we import is apparently frequently shamefully adulterated. The reputed pure Normandy and Brittany butters, we are told, for example, have been found to contain as much as from 30 to 40 per cent. of margarine; and not only is this latter material employed to swell the volume of first-class butter exported to this country from these districts, but butter of inferior quality is imported from Central France, Italy, and even Australia, to be *blended* and forwarded to us as the best Normandy and Brittany butter. Another plan consists in importing Belgian butter, which enjoys a by no means high reputation, and then shipping it from Calais to England as Normandy butter, whilst Australian butter is also *worked up* to sell in London under the Isigny mark, a noted brand of Normandy butter. In the space of a little over two years it appears that of the samples of butter taken at port of entry into this country and analysed, 10½ per cent. of the Dutch samples were adulterated, 2 per cent. of the Danish, 19 per cent. of the German, 5½ per cent. of the Norwegian, and 7 per cent. of the Russian. Unfortunately such adulteration is not confined to our friends across the Channel, and the practice of working up butters, as it is called, is carried on at home as well. It is clear that such extensive adulteration, as Mr. Wallace assures us goes on in the butter trade, ought to be energetically dealt with by our public authorities. Another important matter discussed by the author is the use of antiseptics or preservatives to milk, technically known as "drugging" the milk. We know that the addition of chemicals to milk as preservatives is prohibited in France on the grounds of unwholesomeness; cannot we induce responsible officials in this country to bring this matter to the notice of the Government, and have such treatment of milk included under the head of adulterants? The New York law on dairy products, passed in 1893, enacts, among other things, "that milk is adulterated to which has been added, or into which has been introduced any foreign substance whatever." Surely it is time steps were initiated, if not by authorities responsible for the purity of our food supplies, then by the public themselves, to put a stop to so reprehensible a practice.

As contributions to our knowledge of the Flora of India, we have received reprints of the tenth portion of the materials for a Flora of the Malayan Peninsula by Dr. George King, and of a paper on some new Malayan orchids by Dr. G. King and Mr. R. Pantling.

IN the *Kew Bulletin* No. 132, Mr. George Massee has a note on the obscure disease which is often very destructive to young fruit trees, known as "slime-flux." Mr. Massee attributes the injury to the combined attacks of a Schizomycete, *Micrococcus dendroporthes*, and of the aquatic condition of a fungus *Torula monilioides*. The *Micrococcus* is the active agent in producing fermentation, but can enter the tissues of the plant only through injuries in the bark.

THE additions to the Zoological Society's Gardens during the past week include a Servaline Cat (*Felis servalina*), a Serval (*Felis serval*) from Uganda, presented by Mr. Francis G. Hall; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. P. G. Dupuch; two Golden Eagles (*Aquila chrysætus*), European, presented by Edgar Baxter; a Yellow-billed Sheathbill (*Chionis alba*), captured at sea, presented by Captain H. W. Schlemann; a Bean Goose (*Anser secetum*), European, presented by Mr. W. H. St. Quintin; two Egyptian Kites (*Milvus ægyptius*) from Congoland, presented by the Rev. R. H. C. Graham; a Common Viper (*Vipera berus*) from Cornwall, presented by the Rev. John Harris; a Burchell's Zebra (*Equus burchelli*, ♂) from South Africa, deposited; two Black Hornbills (*Lophoceros nasutus*) from West Africa, a Yarrell's Curassow (*Crax carunculata*) from South-east Brazil, a Guan Ortalida from South America, a Double-ringed Turtle Dove (*Turtur bitorquatus*) from Java, purchased; an English Bull (*Bos taurus*) born in the Gardens.

Erratum.—In the classification of Bacteria given in the review of Prof. Migula's work on "Systematic Bacteriology," which appeared in last week's NATURE, the term "genus" should be substituted for "species."

OUR ASTRONOMICAL COLUMN.

THE COMPANION TO PROCYON.—As is well known Prof. Schaeberle discovered in November 1896 a companion to Procyon, which he suggested would prove the theoretical companion predicted by Bessel. This difficult object—difficult on account of its nearness to Procyon, not by reason of its faintness—has been satisfactorily observed at the Yerkes Observatory, thus confirming Prof. Schaeberle's measures, the motion of the object, and its suggested identity with Bessel's companion. We have now the following measures:

1896, November ...	P = 318°·8 ...	D = 4″·59
1897, October ...	P = 324·1 ...	D = 4·70
1898, March ...	P = 326·0 ...	D = 4·83

Prof. Barnard, who reports the observation, says that when the seeing is good, the companion star is a very conspicuous object and easy to measure with the bright star in the field unobscured. It was estimated to be one magnitude fainter than the old companion, which is of about the twelfth magnitude. This description, however, scarcely agrees with that of Prof. Schaeberle, who states that he made a measure of the star in November 1897, ten minutes before sunrise, and when looking along the outside of the telescope Procyon was no longer visible in the sky. This would imply that the comes was brighter than the thirteenth magnitude, and therefore more observations may be anticipated.

THE LIVERPOOL OBSERVATORY.—We have received the annual report of the director of the Liverpool Observatory, and are glad to see that he is making some attempt to break away from the mere meteorological observations, which have so long held sway at this observatory. The present attempt is a very small one, consisting merely in the observation of the Right Ascension of some of the circumpolar stars that Prof. Auwers has suggested should be continuously observed, with the view of affording more frequent opportunities, and more accurate determinations of the azimuthal error of transit instruments. Cometary observations have always formed a part of the routine work of this observatory, since the appointment of the present director. These are still being actively prosecuted, when the brightness of the comet permits. We notice also that the observatory is taking some part in the inquiries that are now going on in seismometry and the physics of the earth's crust.

SUNSPOT PERIODS AND NATURAL PHENOMENA.—In an article entitled "Le Soleil et la Nature" in the *Bulletin de la Société Astronomique de France* for June, M. Camille Flammarion brings together some very interesting data concerning the connection between the sunspot period and the yearly return of swallows, cuckoos and nightingales, and the flowering of chestnuts and lilacs. The observations have been extended over several years. In the case of the chestnuts and lilacs, M. Flammarion himself commenced the series in the year 1871, and not only observed the same trees every year when they began to bud, but employed the same scale of observation from the first; the observations are thus homogeneous throughout. In the remarkable series of figures accompanying the article, M. Flammarion has grouped together the observations of three years, and plotted curves which undoubtedly suggest a connection between one another, and with that representing the number of spots on the sun. Further, when spots are most numerous migratory birds return to any one place earlier in the year than usual, and when spots are at a minimum they do not come back until a much later date. In the case of swallows this is very remarkable, as observations of their time of return have been made since 1853, a period of forty-five years. The curve has a period of about eleven years, and the times of the maxima and minima correspond well with those of the sunspot curve.

Another curious fact M. Flammarion points out is that the curves showing the temperature of the months of March and April and the mean temperature of the year are nearly identical for the period covered by the years 1876–97.

DOUBLE AND MULTIPLE SOUTHERN STARS.—On April 28 of this year we noted in this column that Dr. T. J. J. See had published in the *Astronomical Journal*, Nos. 431–432, some details of his plan of double and multiple southern stars, and the first part of a catalogue of new double stars. In the current numbers of the *Astro. Nachr.* (Nos. 3495–6) he publishes a further catalogue containing the measures of those systems made at the Lowell Observatory during the past year and four months. In many instances these measures are the first that have ever been made, and on that account a great part of the accompanying results possess a degree of interest equal to that of the first measures of new double stars. Messrs. W. A. Cogshall and S. L. Boothroyd have ably assisted Dr. See in this work.

THE ROYAL OBSERVATORY, GREENWICH.

ON Saturday last (June 4) the Astronomer Royal presented his annual report to the Board of Visitors of the Royal Observatory, Greenwich. As usual the numerous guests numbered among them many astronomers and other men of science; and the weather, though at times threatening, proved sufficiently fine to allow the buildings and instruments to be comfortably inspected. The following brief *résumé* is taken from the report:—

Buildings.

The buildings on the south side of the grounds, which form part of the new physical observatory, are now approaching completion, having been delayed somewhat by a failure in the supply of terra-cotta. Up to the present time the construction of the magnetic pavilion has not been commenced, although provision has been made for it and a good site selected. It is hoped that this will no longer be delayed, for the amount of iron recently used in the construction of the new physical observatory has a very decided effect on all the magnetic instruments in the old buildings. For some months past we have noticed a scaffolding outside the dome of the 28-inch. This we read was put up in February last in preparation for erecting a balcony round the building, but the plans were subsequently reconsidered and modified, and the work in consequence delayed. The electric light and telephone communication has been extended to the new buildings, and a new accumulator house is being constructed in the basement on the north-east side of the physical observatory to replace the shed in which they are now located.

Transit Circle.

A diagram on the wall of the transit room showed a curve which had been plotted, the points in the curve representing the number of R.A. observations and circle readings for each year from 1877. A glance at this curve showed that the number of transit observations during the more recent years has increased by leaps and bounds, and where in place of the usual 4000 observations per year in 1877–80, the number now has reached the figure 11,000. This year the transits, counting separate limbs as one observation, amount to 11,441, excluding determinations of collimation error 297 and level error 651. The circle readings were 10,626. The correction for the R.D. discordance for 1897 has been found to be very small, amounting to $+0''.068 + 0''.104$ sin L.D. The colatitude of the transit circle obtained from 800 stars in 1897 was 38° 31′ 21″·69, differing by $-0''.21$ from the adopted value.

The mean error of the moon's tabular place (computed from Hansen's lunar tables with Newcomb's corrections) is $-0^s.142$ in R.A. and $+0''.27$ in N.P.D. deduced from 95 observations. These are equivalent to an error of $-1''.97$ in longitude and $+0''.16$ in ecliptic north polar distance.

The New Altazimuth.

The axis of this instrument has been considerably stiffened, and modifications in the friction rollers have been made to relieve the weight of the instrument on its bearings. Changes have also been made in the illumination of the field and microscopes. In December last the instrument was brought into working order; but regular observations have only recently been commenced, as the determination of division errors, and other observations necessary to test the stability of the instrument, occupied several months' work.

The observations on the whole show satisfactory stability in the instrument, the collimation, level, and azimuth being steady. Long series of observations of the nadir point have been made to test the stability of the microscopes and of the instrument generally for zenith-distance observations. Discordances were found in the results given by the two circles, which, after a considerable time had been spent, were traced to the wheel carrying one of the sets of microscopes, which was found to have worked loose. This was remedied recently, and the accordance in the results from the two circles appears now to be satisfactory. But large changes in the readings of the individual microscopes are found on turning the instrument into different azimuths, which, however, would not affect the observations, as the microscopes come back to sensibly the same readings for the same azimuth. As, however, this implies a displacement of the microscopes relatively to the circles when the instrument is turned, Mr. Simms is considering whether the supports of the microscopes and pivots can be stiffened.

Thompson Equatorial.

Photographic tests with the 26-inch object-glass, varying the distance between the two lenses, show that the images were never good when away from the centre of the field. The glasses were, therefore, sent back to Sir Howard Grubb for alteration, and have only just been returned. A few trial photographs show that the "coma" is now corrected, but that a slight refiguring is still required. This, we are told, is being now done by Sir Howard Grubb at the observatory.

The 30-inch Cassegrain, mounted on the other end of the declination axis, has been employed for obtaining photographs of the moon, star clusters, and star fields. These have all been obtained at the secondary focus, the focal length of the mirror being somewhat longer than that for which the tube was designed, making it impracticable to take photographs with it at the primary focus. Dr. Common proposes to supply another mirror of the correct focal length, 11 feet 3 inches.

The photographic spectroscope has been completed, and is mounted at the back of the cell of the 30-inch mirror, but the diagonal prism to reflect the rays from the Cassegrain telescope into the collimator has not yet been mounted and adjusted.

The 28-inch Refractor.

This instrument was in use for micrometric measurements from 1897 May 11 to 1898 May 10, with the exception of about seven weeks, from August 5 to September 23, when it was used for photography, the crown lens being reversed. During the year 273 double stars have been measured, each star being measured on the average on two nights; the distance between the components of these stars is less than 1″·0 in 156 cases, and in 63 less than 0″·5.

From August 5 to September 25, 1897, the instrument was used with the crown lens in the photographic position. During this period 110 measurable images of 17 double stars were obtained on dry collodion plates. The closest of these pairs were:—

	Magnitudes.	Distance.
		″
Σ 2881	7·7 and 8·2	1·6
Σ 2723	6·4 ,, 8·2	1·5
Σ 2900	6·0 ,, 9·2	1·5
Σ 2799	6·6 ,, 6·6	1·3

Astrographic Equatorial.

The following statement shows the progress made with the photo-mapping of the heavens:—

	For the Chart. (Exposure 40m.)	For the Catalogue (Exposures 6m., 3m., and 20s.)
Number of photographs taken	363	147
,, successful plates	285	118
,, field photographed successfully	283	110
Total number of successful fields reported 1897 May 10	551	814
Number of photographs, previously considered successful, rejected during the year ...	6	15
Total number of successful fields obtained to 1898 May 10 ...	828	909
Number still to be taken	321	240

An important but unsatisfactory discovery has been made by an examination of all the plates on the shelves. This has shown that 166 catalogue plates out of 909—that is, nearly one-fifth of the total number—and 90 chart plates out of 828 have deteriorated owing, probably, to the effect of damp in the building in which they have to be stored pending the completion of the new physical observatory. There is difficulty in warming this building adequately, and the books, as well as the photographs stored there, have suffered from damp. The film has, in some cases, left the glass, and in the others shows signs of doing so. Of the 166 damaged catalogue plates, 57 have been completely measured, 23 partially measured, and 86 are not measured.

The importance of making duplicates as soon as possible of all negatives in such a work as this cannot be underrated. Positives on glass of all the 90 damaged chart plates were taken, and these are uninjured.

Of the fields still required, 197 are within 10° of the Pole, and no photographs of this part of the sky have yet been taken, the work being purposely deferred till near the epoch 1900. It is proposed to begin taking these now, and the settings of the scales for the guiding stars are partly computed.

Spectroscopic and Heliographic Observations.

No spectroscopic observations have been made during the last twelve months.

With the Dallmeyer photo-heliograph photographs of the sun have been secured on 191 days, 355 of these being selected for preservation, besides nine photographs with double images of the sun for the determination of zero of position. With the Thompson 9-inch photo-heliograph twenty-two photographs were taken on twelve days. Photographs to supplement the Greenwich series have been received from India and Mauritius up to 1898 February 22.

For the year 1897 Greenwich photographs have been selected for measurement on 183 days, and photographs from India and Mauritius (filling up the gaps in the series) on 181 days, making a total of 364 days out of 365 on which photographs are available. The importance of utilising the clear sky of India and Mauritius for obtaining the photographs can hardly be better demonstrated than by the figures given above, which show that on only one day out of the whole year a photograph record of the sun's disc was not secured.

There has been but little change in the mean daily spotted area of the sun for the period covered by the report as compared with the preceding one. The progress towards minimum has shown itself rather in the increase of days when the sun was wholly free from spots, than in the poverty of the displays of spots on the days when the sun's surface was disturbed.

It will be remembered that about the time of the recent eclipse in January there were several, comparatively speaking, large spots on the solar disc, considering that the minimum period was so near at hand.

The remark made regarding the deterioration of the astrographic plates applies also to many of the solar photographs, an examination having shown that some of those stored in the new library and in the museum of the physical observatory, both gelatine and wet collodion, have suffered from damp, spots of mildew being found on the film, though much more frequently the mildew is confined to the uncoated side of the glass.

Magnetic Observations.

Fortunately for the magnetic records secured at the observatory, the proposed electric tram-line in the neighbourhood of the Deptford Cattle Market has been successfully opposed. That this would have seriously damaged the records there can be absolutely no doubt, since it would have been only 1¼ miles from the observatory: even now small agitations, due to the running of trains on the South London Electric Railway, 4½ miles from the observatory, can be clearly traced from the year 1890 on the horizontal and vertical force sheets, synchronising with the disturbances in the earth current registers.

The principal results for the magnetic elements for 1897 are as follows:—

Mean declination	16° 50′·4 West.
Mean horizontal force by the Gibson instrument in the library ...	3·9877 (in British units). 1·8387 (in metric units).
Mean dip	67° 5′·5 (by 9-inch needles). 67° 6′·8 (by 6-inch needles). 67° 7′·1 (by 3-inch needles).

These results are to a certain extent affected by the iron in the new physical observatory and in the new altazimuth pavilion. To eliminate this effect as far as circumstances would allow, observations have been made during the past year on the site selected for the new magnetic pavilion in Greenwich Park, which is presumably free from any disturbing effect of iron. The horizontal force has been observed monthly on this site with the two deflection instruments (Gibson and Elliott), the declination occasionally with the Elliott instrument, and a dip with a Kew dip circle (Dover 74).

It appears from these observations that the declination at the observatory has been increased by 3′ to 4′ through the introduction of iron.

The mean horizontal force obtained with the Gibson instrument in the park is 1·8366 in metric units. In the same units we have also the following differences:—

Gibson in library—Gibson in park ...	+ 0·0021
Elliott in library—Elliott in park	+ 0·0084
Elliott in its usual position in library—Elliott on Gibson pier	+ 0·0060
Gibson in park—Elliott in park	+ 0·0010

All the magnetic disturbances during 1897 were of a comparatively trifling nature.

Meteorological Observations.

The mean temperature of the year 1897 was 50°·3, being 0°·9 above the average for the fifty years 1841–1890.

During the twelve months ending 1898 April 30, the highest daily temperature in the shade recorded on the open stand was 90°·2 on June 24. The highest reading recorded in the Stevenson screen was 87°·4 on the same day. The monthly mean temperatures were in excess of their corresponding averages in every month with the exception of May, September, and March. In January the excess amounted to 5°, the mean temperature for that month being 43°·6. In the preceding fifty-seven years there is one instance only of a higher mean temperature occurring in January, viz. in 1884, when it was 43°·9. A mean value equal to the present January value (43°·6) was also recorded in two other years (1875 and 1890). The winter of 1897–1898 was remarkably mild throughout, and the temperature of the air fell to freezing point (or below) on twenty-nine days only—ten of these occurring in March and seven in December. The lowest temperature recorded during the winter was 23°·3 on December 24. [The lowest temperature recorded in January was 30°·0.] The mean temperature for the five months 1897 October to 1898 February, was 44°·6, being 2°·4 in excess of the average value. During the whole period of fifty-seven years (1841 to 1897) this value has only been exceeded three times, viz. in the winter of 1876–1877, when the mean for the five months was 45°·8, in the winter of 1845–1846, when it was 44°·8, and in the winter of 1865–1866, when it was 44°·7. A mean value of 44°·6 (the same as that for the present year) was also recorded in the winter of 1848–1849, and in that of 1868–1869.

The number of hours of bright sunshine recorded during the twelve months ending 1898 April 30, by the Campbell-Stokes instrument, was 1529 out of the 4454 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0·343, constant sunshine being represented by 1.

An interesting comparison is made between the results as given by the new and the old ball of the sunshine recorder for 1897. With the former 1542·6 hours were registered throughout the year, while with the latter only 1268·4 hours, the excess with the new ball amounting to 274·2 hours during the twelve months.

The rainfall for the year ending 1898 April 30 was 17·33 inches, being 7·21 inches less than the fifty years' average. The number of rainy days was only 149. This is a very small annual rainfall; the three smallest falls during the preceding fifty years being 16·38 inches in 1864, 17·61 inches in 1867, and 17·70 inches in 1858.

Personnel.

No change of any importance has been made with regard to the staff during the past twelve months, Mr. Dyson continuing to take special charge of the astronomical department, and Mr. Cowell the astro-physical department, in which is included the magnetic and meteorological branch.

GUTTA PERCHA.

In a recent course of three lectures[1] delivered before the Society of Arts, and subsequently revised and reprinted from the *Journal* of the Society, with additional illustrations and appendices in the form of a bulky pamphlet, Dr. Obach dealt very fully with the history, origin, treatment and properties of gutta percha.

In the first lecture the early history, botanical derivation and geographical distribution of this substance were related, and the analyses of various commercial "brands," as well as exhaustive statistics of the annual imports and exports of the material were given.

In the second lecture the mechanical cleaning processes and chemical washing and hardening processes were described and illustrated, and also the different methods of extraction of gutta percha from removable parts of the trees, such as twigs and leaves, explained. This lecture concluded with an enumeration of the various *natural* substitutes for gutta percha which have been proposed at various times, including the interesting material known as *balata*.

The third lecture dealt with the mechanical and electrical properties of gutta percha and its application for various technical purposes, also its behaviour towards water, oxygen and ozone. In conclusion the *artificial* substitutes for gutta percha were briefly discussed.

The following is a short report on those parts of the third lecture which we think may be more especially interesting to the readers of Nature.

In order to simplify matters, Dr. Obach selected from the numerous sorts of gutta percha which make their appearance on the Singapore market twelve different "brands," which may be considered as typical; they are distinguished by the name of the locality whence they are derived. For direct comparison and easy reference these twelve materials were divided into four groups, each group comprising materials more particularly related to each other. The groups were designated as "Genuine," "Soondie," "White," and "Mixed."

It was explained that cleaned gutta percha consists essentially of two constituents, viz. a hydrocarbon termed pure gutta (G) having the composition $C_{10}H_{16}$, and being therefore isomeric with oil of turpentine, and a resin (R) containing more or less oxygen, and consisting principally of two substances named Albane $C_{10}H_{16}O$, and Fluavile $C_{20}H_{32}O$. Besides these proximate components there is also a variable amount of extraneous matter present in every commercial gutta percha, even after the most scrupulous cleaning, which consists of finely-ground bark, wood fibres, vegetable colouring matter, grit, &c., summarily termed dirt (D), and of water (W).

Dr. Obach has found that the physical and mechanical properties of the various sorts of gutta percha depend almost exclusively on the relative proportion of gutta and resin, *i.e.* the ratio $\frac{G}{R}$, whereas the electrical properties depend chiefly on the nature of the gutta and, to a lesser extent, upon that of the

1 "Cantor Lectures on Gutta Percha," by Dr. Eugene F. A. Obach, F.I.C., F.C.S., M.I.E.E.

resins, but also very largely upon the amount and the character of the impurities contained in the material.

The specific gravity of cleaned gutta percha of average composition is very nearly the same as that of water, but that of individual brands deviates considerably from it, some being about 3 per cent. lighter, and others about 2 per cent. heavier, as will be seen from Table I., which gives the specific gravities for eleven definite brands and an average material obtained by mixing a number of different cleaned materials in the masticator. The table also gives for comparison the specific gravities of balata, of gutta percha extracted from leaves with petroleum spirit by Dr. Obach's patent process, and also of pure Para-caoutchouc.

The exceptionally low specific gravity of the gutta percha from leaves is to be attributed to the fact that it consists almost entirely of pure gutta.

TABLE I.—*Specific Gravity of Cleaned Gutta Percha.* (2·2 mm. sheet.)

Group	Name of brand	Spec. grav. at 15° C.	Ratio G/R
I. Genuine	Pahang	0·9858	3·9
	Banjer red	0·9868	4·0
	Bulongan red ...	0·9911	3·4
II. Soondie	Bagan	0·9709	1·44
	Kotaringin	0·9729	1·30
	Serapong	0·9767	1·38
III. White	Bulongan	1·0093	1·57
	Mixed	1·0186	1·14
	Padang	0·9911	1·40
IV. Mixed	Padang reboiled ...	0·9960	1·18
	Sarawak mixed ...	0·9912	1·20
	Mixed after cleaning	1·0022	1·75
V. Various	Balata	0·9731	1·16
	G.P. from leaves ...	0·9625	51·90*
	Para-caoutchouc ...	0·9275	—

* Not 5·19, as erroneously stated in the *Journal* and Reprint.

The absorption of water by gutta percha was ascertained by immersing strips of the cleaned material in water and weighing them at regular intervals for about eighteen weeks. The results of these tests made on representative materials of the four groups which have been mentioned, and on gutta obtained from leaves, on balata and caoutchouc, are graphically shown in Fig. 1.

The curves shown on the left of the diagram (Fig. 1) represent the average results obtained for the different brands composing the various groups or "classes," as well as the results for gutta percha extracted from leaves, for balata, and also for pure Para-caoutchouc; but the curves on the right of the diagram were indirectly obtained by calculation and represent the absorption, which would have taken place if each specimen tested had entirely consisted of the kind of gutta which is characteristic of it. The reason for this reduction of the results to "pure gutta" is that the water is exclusively absorbed by this component and not by the resin, which has been found impervious to it.

It will be seen from the diagram, that it is the group of "genuine" materials which absorbed the most water, both before and after the reduction to "pure gutta"; whereas of the materials as such, it is the "white" sorts which are the least permeable to water, and of the "pure guttas" that of the material extracted from leaves.

Pure Para-caoutchouc, as is generally known, has a considerably greater absorptive power for water than even the most permeable kind of gutta percha.

The temperature at which gutta percha becomes plastic, a physical property of practical importance, depends almost entirely upon the relative proportion of gutta and resin. The great difference existing in that respect between the different sorts was demonstrated in the lecture by an experiment illustrated in diagram (Fig. 2).

The apparatus consists of a frame, *f*, holding three strips of gutta percha, 1, 2, 3, under the tension of springs S_1 S_2 S_3, the frame is lowered into a beaker of water, V, and the latter slowly heated, the arrangement being such that an electric current is established, and an alarum, A, sounded as soon as a strip becomes sufficiently soft to allow the spring to pull it apart. The three materials employed contained 2½, 38 and 60 per cent. of resin, and the temperatures at which they softened were found to be 55°, 48° and 42° C. respectively.

Another physical property, viz. the time required by gutta percha to harden or set again on cooling, after having previously been softened by heat, also depends mainly on the relative percentage of gutta and resin, as was pointed out by the lecturer.

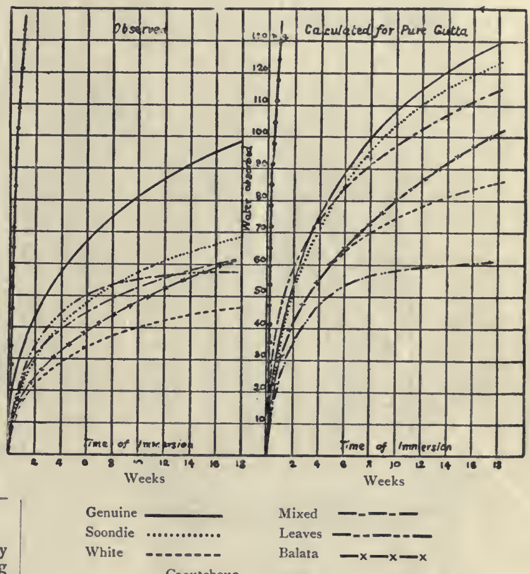


FIG. 1.—Absorption of water by different "classes" of gutta percha. (Thickness of sheet 2·2 mm.; area, 1 sq. dm.; weight, 10 g.)

The mechanical properties of gutta percha, of which the tensile strength is the principal one, are in their turn also greatly affected by the percentage of resin.

The important electrical properties of gutta percha chiefly depend on the nature of the gutta, and, to a lesser extent, on that of the resin, but only slightly on the relative proportion of these two components.

The insulating property of gutta percha was stated to have been first observed by Dr. Werner von Siemens in 1846. Faraday also noticed it shortly afterwards, and called attention to it in March 1848.

Dr. Obach showed the two principal electrical properties by means of an electroscope arranged as shown in Fig. 3. The instrument was provided with a flat brass disc, P, at the top, and below it two pith rods, *p*, *p*, were suspended on either side of a fixed strip of brass, *m*. When a piece of gutta percha tissue was spread over the brass disc and the electroscope charged by means of the brass knob, *k*, at the side, the pith rods diverged and remained stationary. If the fingers were now placed on the covered disc, the rods slightly converged and then again remained stationary. On withdrawing the hand, the rods took up their former diverged position.

This simple experiment demonstrated at once the excellent insulating property of gutta percha and its inductive capacity. Its insulating power was shown by the fact, that the tissue formed an efficient screen between the hand and the brass disc of the electroscope, to prevent the latter from being discharged. Its inductive capacity was shown by the temporary fall of the pith rods, indicating the "binding" of the charge on them when the tissue was touched by the hand.

Per se the insulation of gutta percha should be as high as possible, and the inductive capacity as low as possible; but whereas the latter property is mostly associated with other good qualities of the material, such is not always the case with a high insulation.

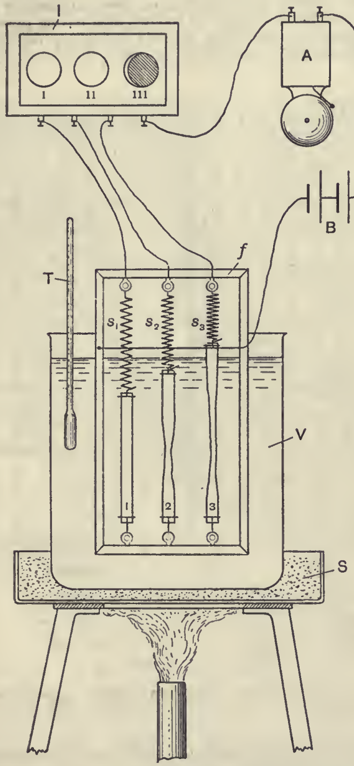


Fig. 2.—Softening temperature of gutta percha.

Faraday apparently had some difficulty in 1848 in obtaining gutta percha having a sufficiently good insulation. He found that this was due to an excessive amount of water contained in the commercial material. This is an important matter, and experiments were shown by Dr. Obach to demonstrate the effect of different percentages of water on the insulating power of gutta percha. The electroscope was charged until the rods fully diverged. Strips of gutta percha, containing approximately 15, 10, 5 and 2½ per cent. of water, were then successively brought into contact with the brass knob, the finger being held against the other side of the strip. When the strip containing 15 per cent. of water was brought into contact with the knob, the pith rods slowly converged, and did not regain their former position on removing the strip, which showed that the charge had been dissipated. On repeating the experiment with the next strip, containing 10 per cent., the charge disappeared much more slowly; the strip containing 5 per cent. of water was next tried, and this was found to be an almost perfect insulator and practically equal to the best strip with 2½ per cent. of water. It must be mentioned however, that different sorts of gutta percha behave differently in this respect. The specific insulation and inductive capacity of various specimens of gutta percha are given in a table in comparison with other materials, such as paraffin wax, colophony, ebonite, &c., but space does not permit us to reproduce this interesting table here. The figures show how greatly the electrical data vary for different kinds of gutta percha. For instance, the insulation resistance per cube knot was only 382 megohms for an otherwise excellent specimen of gutta percha, and 139,300 megohms for a specimen of considerably inferior description. Gutta percha extracted from leaves has usually a comparatively high insulation, exceeding that of paraffin wax, colophony and ebonite, but the insulation resistance of pure vulcanised caoutchouc is higher still, approaching the maximum obtained with ordinary gutta percha. The specific inductive capacity also varies greatly, the lowest values per cube knot

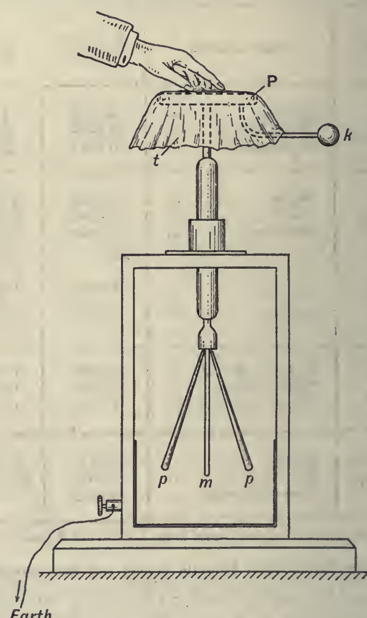


Fig. 3.—Insulation and electrostatic capacity of gutta percha.

being ·0466 and the highest ·0801 microfarad. In this respect the gutta obtained from leaves by Dr. Obach's process compares favourably with any ordinary gutta percha. Pure Para-caoutchouc also has a very low inductive capacity, viz. ·0446 mfd., which is lower than that of the best gutta percha, but paraffin wax is lower still, viz. only ·0411 mfd. Water, on the other hand, has the highest known inductive capacity of any substance, *i.e.* 1·348 microfarad per cube knot. The significance of this will be seen on comparing the values in Table II., which gives the insulation and inductive capacity of several "brands" of gutta percha, each with a high and low percentage of water.

The dielectric strength of insulating materials is another property, which is daily becoming more important. From tests made on gutta percha-covered cores of submarine cables, it has been found that a thickness of $\frac{1}{8}$ inch of this dielectric is pierced by about 40,000 volts, and one of $\frac{1}{16}$ inch by about 28,000 volts.

The next table (III.), which is abstracted from a large table in the *Journal*, contains the chemical composition and the physical, mechanical and electrical properties of the first grades of the twelve principal brands of gutta percha.

The figures show how largely the physical and mechanical properties depend on the relative proportion of gutta and resin, *i.e.* the ratio $\frac{G}{R}$. The temperatures given as those at which the material softens and at which it becomes pliable, have only a relative value, as they apply to the particular method of testing here employed, but for comparative purposes they are most valuable.

The softening temperature is determined as follows:—A thin sheet of the gutta percha to be tested is very slowly heated in a water bath, and a small stud from time to time brought to bear upon it with a definite pressure. As soon as the stud leaves a permanent impression on the surface of the sheet, the temperature of the water is noted and recorded as the "softening temperature."

The temperature at which the material becomes pliable is thus determined:—A strip of the material of definite dimensions is held vertically in a bath of water; the upper end of the strip is attached to a cord, passing over a pulley and carrying a known weight, the strip being thus subjected to a constant tension. The temperature of the water at the moment when the weight is able to pull the strip asunder, is taken as that of "pliability."

The "time of hardening" is that taken by the material, heated to the temperature of pliability, to become sufficiently rigid to resist the pressure of the stud in the apparatus used for determining the softening temperature, the water surrounding the strip being maintained at 75° F.

With a view to investigating the action of oxygen on cleaned gutta percha more thoroughly than had hitherto been done, Dr. Obach conducted an exhaustive series of experiments having for their special object a direct comparison of the avidity with which the different "brands" of gutta percha absorbed oxygen under similar conditions. For this purpose small spheres, of 2 cub. cm. contents and 8 sq. cm. superficial area, were enclosed in glass tubes filled with oxygen and inverted over mercury troughs. The tubes had a capacity of about 30 cub. cm., and each contained two spheres. They were refilled as soon as the composition of the residual gas approached that of the air, the oxygen used containing about 7 per cent. of nitrogen. The mercury troughs were placed outside a window on the south front of the laboratory exposed to full sunshine. The experiment extended over twenty-four weeks, and during that period the total amount of bright sunshine amounted to 680 hours.

The smoothed curves, given in Fig. 4, show the average amount of oxygen in cub. cm. absorbed by each of the four different groups of materials and for comparison, also that absorbed by gutta percha obtained from leaves and by balata. As in the case of the experiments on the absorption of water, two sets of curves

TABLE II.—*Insulation and Induction per Cube Knot with Low and High Percentage of Water.*

(Abstracted from larger table.)

Percentage of water.	I. Genuine. (Pahang.)			II. Soondie. (Bagan.)			III. White. (Banjer.)			IV. Mixed. (Sarawak.)		
	Water p.c.	Insul. megs.	Induct. mfds.	Water. p.c.	Insul. megs.	Induct. mfds.	Water. p.c.	Insul. megs.	Induct. mfds.	Water. p.c.	Insul. megs.	Induct. mfds.
Low	1·5	6,173	·0523	1·7	7,950	·0521	0·6	10,410	·0555	1·1	24,250	·0564
High	6·3	5,480	·0675	7·3	4,350	·0682	7·1	6,454	·0898	7·0	24,250	·0718

TABLE III.—*Chemical Composition, Physical, Mechanical and Electrical Properties of the First Grades of Twelve Different "Brands" of Gutta Percha.*

(Abstracted from larger table.)

	Name of brand	Percentage composition					Temperat. (° C.) when G.P. becomes		Time of hardening in mins.	Tensile strength. Lbs. per sq. inch.	Elongation during breaking test per cent.	Insul. resist. per cube knot at 75° F. after 2nd min. in megohms	Induct. capac. per cube knot in microfarads
		G	R	D	W	$\frac{G}{R}$	Soft	Plastic					
I. Genuine	Pahang	80·0	17·7	1·4	0·9	4·52	48·8	66·1	2¾	5,067	444	1,077	·0511
	Banjer red	70·5	26·9	1·4	1·2	2·62	45·0	67·2	5	4,123	417	3,723	·0542
	Bulong red	73·4	24·2	1·4	1·0	3·03	46·1	64·4	4	4,200	440	4,511	·0537
II. Soondei	Bagan	57·7	40·6	1·0	0·7	1·42	40·0	61·6	9	2,528	383	10,800	·0523
	Kotaringin	57·8	40·3	1·2	0·7	1·43	40·0	61·1	12	2,443	383	3,284	·0541
	Serapong	57·5	41·0	1·0	0·5	1·40	41·1	60·5	12	2,466	390	35,180	·0536
III. White	Bulongan	52·5	45·0	1·5	1·0	1·16	41·6	70·0	18	2,537	420	46,380	·0581
	Mixed	52·0	46·0	1·2	0·8	1·13	42·7	78·8	19	3,180	418	86,550	·0541
	Banjer	53·6	42·9	1·7	1·8	1·25	43·3	75·0	24	3,026	406	45,780	·0612
IV. Mixed and Rebd.	Saraw. mix.	61·3	35·1	2·0	1·6	1·75	42·7	65·0	12	2,572	397	12,330	·0602
	Pad. rebd.	50·3	45·7	1·5	2·5	1·10	36·6	61·6	63	1,465	475	16,840	·0649
	Banca rebd.	47·1	50·5	1·3	1·1	0·93	38·8	63·3	54	1,552	371	71,380	·0577

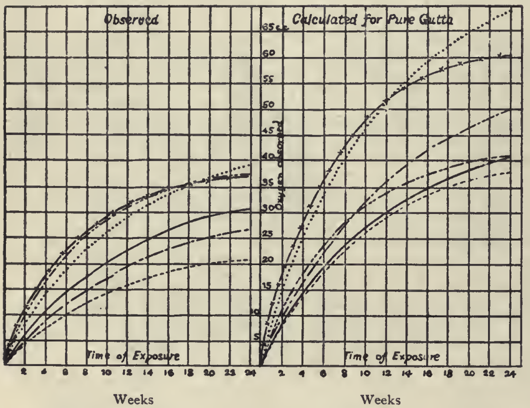
Note.—Each series of figures in this table represents the average result obtained with a number of individual lots of the particular brand.

are given—one representing the absorption of oxygen by the materials as tested, and the other the absorption calculated for "pure gutta," since here also it is mainly this constituent by which the absorption takes place.

The appendix to the lectures, given in the reprint, contains the results of a complete chemical analysis of the identical specimens of gutta percha used for the determination of the specific gravity and the experiments on the absorption of water and oxygen.

Experiments were also shown to demonstrate the remarkable difference in the behaviour of gutta percha and caoutchouc towards ozone, thin tissue of the former resisting the action of strongly ozonised oxygen for a considerable time, whereas a caoutchouc membrane was pierced by a jet of this gas impinging on it in a few moments. The lecturer also spoke of the applications of gutta percha hardened by extraction of the resin according to his process, proposing it for the use of boats for the arctic regions, on account of its considerably greater strength than that of ordinary gutta percha at very low temperatures, which was demonstrated by experiments.

He also showed that the elasticity of golf balls, as shown by the height of rebound when allowed to drop on a stone slab, depended almost entirely on the percentage of resin in the gutta



Genuine ———— Mixed —-—-—
Soondie ············ Leaves --—--—--
White -------- Balata —x—x—x

FIG. 4.—Absorption of oxygen by different "classes" of gutta percha. (Two spheres, each 16 mm. diam.)

percha of which they are made; and consequently the treatment by the hardening process is now invariably resorted to, except in the case of gutta percha obtained from leaves by chemical precipitation processes, which consists almost entirely of pure gutta, as has been already mentioned.

HORN-FEEDING LARVÆ.

SOME few months ago I received a consignment of skulls of antelopes from West Africa, the specimens having been shot by the late Lieut. R. H. McCorquodale, 3rd Dragoon Guards, and on opening the cases I was much struck by the appearance of the horns; all, without exception, were infested by singular thin finger-like protuberances which seemed to grow from the horn, leading me at a first impression to the immediate conclusion that they were some species of fungi; on a nearer inspection I found them to be cocoons, and not having seen anything like them before I looked into what literature I could find on the subject.

As it is, generally speaking, only travellers, or those in touch with travellers, who have the opportunity of seeing the actual cocoons on the horns, a sketch and a few salient points will doubtless be of interest. The skull, that of a Hartebeest, was exhibited at the Linnean Society on January 20 last, and is the original of the sketch; the cocoons are cylindrical and closed at the outer end like the fingers of a glove, extremely tough and composed of a dark grey felt substance, evidently the comminuted fibres of horn, the largest being about three inches in length; these cocoons are formed by the horn-feeding larvæ of the moth known as the *Tinea vastella*, and the following is a description of the insect:—Very pale gilded ochraceous shining. Head ochraceous and tufted above, palpi porrect, pubescent, extending a little beyond the front, much shorter than the breadth of the head, third joint lanceolate, much shorter than the second. Abdomen extending much beyond the hind wings. Legs rather long, hind tibiæ thinly fringed. Wings long, narrow, fringe rather long, fore wings slightly acute, exterior border very oblique, under side and hind wings purplish cinereous, excepting the fringe. Length of the body seven lines, of the wings sixteen lines.

A very interesting point with regard to the habits of this insect, which has not yet been cleared up, but upon which I hope to be able to throw some light, through the observations of

Cocoons ½ natural size. Skull and horns ⅓ natural size.

officers now serving in Africa, is, that it has been asserted to feed on the horns of living animals; and in support of this I will quote the following:—"Dr. Fitzgibbon many years ago while in Gambia stated he was surprised at finding grubs enclosed in cases, which projected from the horns of animals freshly killed, the blood not being yet dry, the carcases of the animals being exhibited in the market place." This statement is recorded in vol. i. of the *Proceedings* of the Dublin Zool. Soc. "In contradiction, Lieut.-Colonel Wenman Coke said he had shot large numbers of various species of horned animals in South Africa, but that he had never seen the horn of a living animal perforated by one of these larvæ, although he had seen many dead horns infested with them. Colonel Coke is most confident that the larvæ never attacks a living animal; he says that had this been the case it could not have escaped his observation; Mr. Truman concurs in expressing great doubt as to the correctness of the theory that the larvæ feed on the horns of living animals." We have the strong evidence of Dr. Fitzgibbon, and might argue that, as the fibrous substance of the horn undergoes little or no change at the death of the animal, there seems no reason why the moth should not deposit its eggs when the living animal is at rest, nor why the larvæ should not penetrate the horn. I venture to assert as my own opinion, and that of many sportsmen from whom I have made inquiries, that the larvæ does not feed on the horns of living animals; had this been the case, it would not have escaped the observation of some of our "mighty African hunters." Thus Dr. Fitzgibbon's statement stands alone; the question must, however, remain *sub judice*.

The habitat of the moth was generally supposed to be Africa, but Sir George Hampson showed me some specimens which he had collected in various districts in India.

I am indebted to Lord Walsingham, who kindly gave me some very useful notes, he having himself written a few years ago on the subject; also to Mr. P. H. Miller for a very faithful sketch.

W. H. McCORQUODALE.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—In connection with the Congress of Physiology and the Congress of Zoology to be held in Cambridge towards the end of August, the University proposes to confer the honorary degree of Doctor of Science on the following distinguished foreign representatives. For Physiology: Prof. Bowditch, Harvard; Prof. Golgi, Pavia; Prof. Kronecker, Berne; Prof. Kühne, Heildeberg; and Prof. Marey, Paris. For Zoology: Dr. Anton Dohrn, Naples; Prof. Milne-Edwards, Paris; Prof. Haeckel, Jena; Prof. Hubrecht, Utrecht; and Prof. Kowalevsky, St. Petersburg.

The annual report of the Museums Syndicate testifies to the great activity of the science departments and the ever-growing importance and value of the collections acquired by the University. Numerous expeditions have left Cambridge to prosecute researches in far distant lands, and have returned with important and extensive trophies of their work. South America, through Mr. Graham Kerr and Mr. Budgett, has yielded some fine zoological series. The South Pacific fauna has been illustrated by the spoils of Mr. Stanley Gardiner of the Funafuti expedition. Dr. Willey has brought unique contributions from New Britain; and both he and Prof. Flinders Petrie have greatly enriched the magnificent collection of crania under the charge of Prof. Macalister. Other additions are due to Dr. Haddon (Torres Straits), Sir W. L. Buller (Macquarrie Island), Prof. Wiltshire and Mr. H. H. W. Pearson (Ceylon), and many other workers and benefactors.

Mr. Frank Morley, of King's College, the author of numerous works and memoirs in pure mathematics, has been approved for the degree of Sc.D.

The complete list of matriculations for the year has now been published. It appears that 931 students have joined the University in 1898, as compared with 887 in the preceding year.

Dr. Alex. Hill has been re-elected Vice-Chancellor for the ensuing academical year.

Mr. R. Pendlebury, and Mr. A. E. H. Love, F.R.S., Fellows and Lecturers of St. John's College, have been appointed University Lecturers in Mathematics.

A University Lectureship in Chemical Physiology is to be established in connection with Prof. Foster's department, but the University is unable to assign any stipend to the post at present. The lecturer will be remunerated from the students' fees.

Hitherto the same persons have acted as examiners in Anatomy and in Physiology respectively for the Natural Sciences Tripos, Parts i. and ii., and for the Medical examinations. The number of candidates has increased so largely (it is now 310 in physiology, and 252 in anatomy) that the work involved is too much for one pair of examiners. It is accordingly proposed to divide the duty by appointing separate examiners for the Tripos and for the M.B. examinations.

PROF. E. B. FROST, of Dartmouth College, has been elected professor of astrophysics at Yerkes Observatory; and Prof. E. F. Nichols has been appointed professor of physics in Dartmouth College.

MR. WILLIAM BUTLER DUNCAN, of New York City, has presented to Yale University the Hotel Majestic at New Haven, to be used as a dormitory, and to be called the Duncan Dormitory.

IN replying to questions referring to the Government measures which it is intended to bring forward shortly, Mr. Balfour informed the House of Commons on Monday that the Lord President of the Council would introduce, "in another place," a Bill dealing with the organisation of secondary education, and he hoped the London University Bill would be passed.

ABOUT a year ago the Lords of the Committee of Council on Education decided to make inquiries as to the number of pupils in public and private secondary and other schools (not being public elementary or technical schools) in England, and the teaching staff in such schools. These schools are very various in character, in constitution, and in size; but, broadly speaking, they furnish to the country what is known as secondary or intermediate education in its different grades, and fill the gap between the public elementary schools and the universities or university colleges. They include schools in which educational efficiency is at a minimum, and schools (unfortunately but a small proportion) where rational methods of instruction are followed. The results of the inquiries made through the Education Department have just been published in a Blue Book. The Return represents the first attempt which has been made in this country to give a statistical survey of the schools in the great province of national education which is intermediate between the public elementary schools and institutions of academic rank or for technical training. It shows the various forms of control and ownership under which these schools are carried on, but, as they do not come under any comprehensive system of inspection, no pronouncement can be made as to their educational efficiency or inefficiency. The number of pupils in the 6209 schools comprised in the Return are 291,544; of these 158,502 are boys, and 133,042 are girls. Only 9 per cent. of the boys are more than sixteen years of age, and 11 per cent. of the girls. As to the staff, 32 per cent. of the boys' schools are without graduates on the attached staff, 73·8 per cent. of the girls' schools, and 81·3 per cent. of the mixed schools. From this it will be seen that 61·6 per cent. of all the schools on the Return have only non-graduates on the exclusively attached staff. Of course, this division into schools with graduates and without graduates on the staff only affords a rough criterion as to the character of the instruction, for graduates are not necessarily good teachers, nor are good teachers necessarily graduates. It is, however, time that steps were taken to insist upon all private schools giving public guarantees of their educational efficiency.

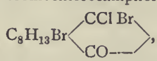
SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, May 5.—Dr. A. Günther, F.R.S., President, in the chair.—Dr. Bernard Renault and Prof. Max Carl Wilhelm von Weber were elected Foreign Members of the Society.—A paper was read by Sir John Lubbock, Bart, M.P., F.R.S., on some Spitsbergen Collembola. Owing to the well-known tolerance of cold by insects belonging to this order, it was, he thought, not surprising that several species should occur in Spitsbergen. Eleven species of *Collembola* had been found in Greenland, as recorded by Meinert (Vidensk. Meddel., 1896, pp. 167–173), and five species were already known from Spitsbergen. He was now able to add two more, one of which was new. This he proposed to call *Isotoma spitsbergenensis*. The second species, *Isotoma quadrioculata*, had been previously met with in Greenland. Both of these were obtained by Mr. Trevor Battye during Sir Martin Conway's expedition to Spitsbergen in 1896.—Miss Ethel Barton, by permission of the President and Council, read a paper on the structure and development of *Soranthera*, a genus of brown Algæ (*Phæophyceæ*) containing a single species, *S. alvoidea*.—Mr. J. T. Cunningham read a paper dealing with the evolution of animal structure, and entitled "The Species, the Sex, and the Individual." The general conclusion arrived at by the author was that adaptation was not produced indirectly by selection from indefinite variations, but directly by the influence of stimulation in modifying the growth of the parts or organs of the body.

Geological Society, May 18.—W. Whitaker, F.R.S., President, in the chair.—The garnet-actinolite schists on the southern side of the St. Gothard Pass, by Prof. T. G. Bonney, F.R.S. The author described the field relations and the microscopic structures of a group of schists or gneisses characterised by the frequent presence of conspicuous garnets and actinolites which are exposed on the southern slopes of the St. Gothard Pass and for some distance west and east, on the northern side of the Val Bedretto. These rocks in the field might be regarded as highly-altered sedimentary strata (as the author once thought) or as a group of igneous rocks (originating possibly in magmatic differentiation) affected by fluxion-movements anterior to consolidation. To the latter view he now inclined, but considered the schistosity and the peculiar minor structures to be the results of crushing (generally without marked shearing) followed by very considerable mineral reconstruction.—On the metamorphism of a series of grits and shales in Northern Anglesey, by Dr. C. Callaway. While mechanical force has been concerned in producing the more intense metamorphism of the lower part of the series, the author was not disposed to advance this as the sole cause of the changes produced.—On a volcanic series in the Malvern Hills, near the Herefordshire Beacon, by H. D. Acland. It is suggested that the rocks may be the volcanic equivalents of the plutonic rocks of the Malvern axis, faulted down and protected by the bend in the axis which occurs in the neighbourhood of the Herefordshire Beacon.

Chemical Society, May 19.—Prof. Dewar, President, in the chair.—The following papers were read:—The liquefaction of hydrogen and helium, by J. Dewar. Hydrogen was liquefied by allowing the gas cooled to $-205°$, and under 180 atmos. pressure, to expand; about 1 per cent. of the gas liquefied. Helium was liquefied by cooling in liquid hydrogen.—The action of formaldehyde on amines of the naphthalene series, Part 1, by G. T. Morgan. Formaldehyde acts on β-naphthylamine in alcoholic solution containing hydrochloric acid yielding naphthacridine, and bases of the composition $C_{21}H_{13}N$, $C_{22}H_{16}N_2$, and $C_{23}H_{18}N_2$.—On the constitution of oleic acid and its derivatives, Part 1, by F. G. Edmed. Pelargonic and azelaic acids, as well as two hydroxystearic acids, are formed on oxidising oleic and elaidic acids; the author therefore assigns the constitution $CH_3(CH_2)_7CH : CH(CH_2)_7 CO_2H$ to the two latter acids.—Stereoisomeric derivatives of camphor, by T. M. Lowry. On recrystallising dibromochlorocamphor,



its rotatory power changes, indicating the existence of stereoisomerism.

Cambridge.

Philosophical Society, May 16.—Mr. F. Darwin, President, in the chair.—On the figures produced on photographic plates by electric discharges, by Mr. J. A. McClelland. When an electric discharge has passed to the surface of a photographic plate a distinct figure is produced when the plate is developed, and the form of the figure is dependent on the sign of the discharge. The object of the paper is to determine whether these figures are produced by some direct electrical action on the film, or by the light which accompanies the discharge. Figures were taken with the plates in air at various pressures, and as the pressure was diminished the branching lines in the figures became broader and less distinct, as they would if produced by the light of the discharge in the air close to the film. The transparency of various substances was tested, and while no effect was produced through thin slips of ebonite, the effect through glass and mica was quite distinct. The experiments seemed to show that the light of the discharge was chiefly instrumental in producing the figures. The difference in the positive and negative figures is due to the difference in the discharge in air in the two cases.—On a method of facilitating the measurement of temperature by platinum thermometry, by Mr. E. B. H. Wade. Attention is drawn to the inconvenience arising from the fact that equal increments of the resistance of platinum wire do not represent equal increments of the temperature. A form of Wheatstone's Bridge is then described in which the inconvenience disappears. The resistance of the platinum is balanced by that of two resistance boxes in parallel, plugs being transferred from one box to the corresponding places in the other till the balance is obtained. It is shown that when this is done, equal increments of the resistance in one box may be made to represent equal increments in the temperature of the platinum wire. Accuracy is not sacrificed in obtaining the simplification resulting from this method.—The development of *Peripatus novæ-britanniæ*, by Dr. A. Willey. The ova are without yolk, and the nutrition of the embryo is effected by the development of a large trophic vesicle, which occupies the entire dorsum of the embryo, and projects far in front of the embryo as a head-fold and behind as a tail-fold. The trophic vesicle is thus a hollow closed cylinder lined internally by endoderm and externally by ectoderm, the cells of the latter being adapted for absorption of nutriment. The trophic folds were compared with the amniotic folds of insects. The trophic cavity becomes the gastral cavity of the adult, and in the transformation from one to the other the endoderm undergoes certain changes. It secretes a basal membrane and a cuticular membrane simultaneously with a great increase in thickness; and between the two membranes the endoderm contains numerous small and large yolk-like globules, which are probably to be regarded as reserve nutrient matter to tide the embryo over the first few days of its independent life. This late deposition of reserve nutrient matter derived ultimately from the maternal organism, as opposed to foreign ingested matter, is probably of some significance with regard to the question of the lecithality of the ovum. The embryo lies outside on the ventral surface of the trophic vesicle just as an insect embryo lies upon the yolk.—On Röntgen rays and ordinary light, by Mr. C. Godfrey. Prof. J. J. Thomson has shown that the sudden stoppage of an electron gives rise to a thin electric pulse which is propagated through the medium; these pulses he identifies with Röntgen rays. The application of Fourier analysis shows that the assemblage of these pulses is equivalent to a mixture of simple harmonic waves of all wave-lengths; a peculiar feature is that these waves are absent whose lengths are sub-multiples of the thickness of the pulse. Most of the energy is resident in the short waves; but about 1/1000 of the whole energy will be visible light. The pulses suggested by Sir George Stokes as affording an explanation of Röntgen rays differ from Prof. Thomson's in one respect; the integrated displacement through the thickness of the pulse is zero. On this property Sir G. Stokes bases his proof that there will be no diffraction; and it may be seen that these pulses (taken to be of the same thickness as Prof. Thomson's) will have only 10^{-9} of this energy in the visible spectrum.—On the possibility of deducing magneto-optic phenomena from a direct modification of an electro-dynamic energy function, by Mr. J. G. Leathem. The method initiated by Maxwell for the explanation of the Faraday effect depended on the direct insertion of a magneto-optic term in the energy. This method was extended by Fitzgerald and others to the explanation of Kerr's effect, namely the modification introduced in the circumstances of optical reflexion by magnetisation of the reflector. A difficulty occurred, however, in satisfying all the interfacial conditions, which virtually showed that such a scheme was not formally self-consistent. The origin of the discrepancy has been traced by Mr. Larmor ("Report on the Action of Magnetism on Light," Brit. Assoc., 1893) to omission to secure what may for shortness be called the electromotive incompressibility of the medium: in the ordinary problem of optical reflexion there is no tendency for this to be disturbed, but when Maxwell's magneto-optic energy terms are included, the reaction against compression introduces what may be termed an electric pressure, which must appear in the equations. It was necessary to compare the modified scheme thus obtained with experimental knowledge: and the calculations given in this paper show that in fact it does not represent the phenomena. The paper is only a summary of the actual calculations, because since they were completed the author has shown ("On the Magneto-optic Phenomena of Iron, Nickel and Cobalt," *Phil. Trans.* 1897), that the other rigorous theory formulated as an alternative by Mr. Larmor (*loc. cit.*), which leads to an analytical scheme practically the same as those advanced on various hypotheses by Fitzgerald, Goldhammer, Basset, Drude, and others, is in much more satisfactory agreement with experiment. This brief history of the subject shows the desirability of the examination of the consequences involved in the former method of explanation; the result is, however, what was to be expected by those who adhere to the more recent formulation (Larmor: "A Dynamical Theory of the Electric and Luminiferous Medium," Part 3, *Phil. Trans.*, 1898) of optical theory, which treats a material medium as free æther pervaded by discrete molecules involving in their constitution electrons considered as nuclei of intrinsic æthereal strain. On such a view a continuous energy function is not the starting-point, and the influence of these discrete nuclei could hardly be conceived to modify the propagation in the intervening æther in so fundamental a manner as an electromotive pressure would demand.—On the solutions of the equation $(\nabla^2+\kappa^2)\psi=0$ in elliptic coordinates and their physical applications, by Mr. R. C.

Maclaurin.—On the interpretation of divergent solutions of the hypergeometric equation, by Mr. W. McF. Orr. The author obtains divergent series satisfying a general hypergeometric equation, and estimates the error involved in choosing a finite number of terms of such a series as a solution of the equation.

EDINBURGH.

Royal Society, May 16.—Lord Maclaren in the chair.—Prof. Crum Brown read a paper on the origin of certain of the Phœnician alphabet characters. The idea was to ascertain whether any of them can plausibly be regarded as modifications of others. It was suggested, for example, that *Aleph* was deduced from *Argin* by the addition of a central vertical stroke, *Heth* from *He* and *Tsade* from *Zain* by the addition of a vertical stroke at the left side, *Caph* from *Gimel* and *Samesh* from *Zain* by the addition of a horizontal stroke, *Pe* from *Beth* by opening the loop (or *vice versâ*), *Daleth* from *Tau* by the addition of a diagonal stroke, &c. Attention was called to the risks of being misled by accidental resemblances and to the bearing of such guesses on de Rougé's hypothesis.—Mr. T. C. Baillie read a paper on the thermal conductivity of nickel. The value he obtained by use of Forbes' method was ·117. What was believed to be a better value, namely ·103, was obtained by a new method, which had the great merit of giving an experimental value of the thermal conductivity directly without requiring the specific heat to be known. A short bar had its one end kept at a steady high temperature as in the Forbes' experiment. To the other end a small cap was attached, through which a steady stream of water was passed. The temperature of the water was taken just as it entered the cap, and just as it left it. The quantity of water passed in a given time being known, the amount of heat lost from the end of the bar to the water was calculated in terms of the specific heat of water. By means of thermometers set at intervals along the bar, the gradient of temperature was indicated, and a good approximation to the value of the gradient at the position occupied by the cap could be calculated. These measured quantities, the gradient and the heat lost, give at once the conductivity. The paper also contained an account of a simple method for determining the thermometer corrections.—Prof. D'Arcy Thompson, in a paper on the crab in mythology, drew attention to the fact that in old coins the crab is always found associated with those deities which are astrologically connected with the zodiac sign *Cancer*, and with animals that give names to constellations which are astronomically related to the constellation Cancer.

PARIS.

Academy of Sciences, May 31.—M. Wolf in the chair.—Photographic studies on some parts of the surface of the moon, by MM. Lœwy and Puiseux.—Remarks on the third part of the photographic atlas of the moon, published by the Paris Observatory.—On the preparation and properties of the di-alkylamido-anthraquinones, by MM. A. Haller and A. Guyot. Dimethyl-amido-benzoylbenzoic acid heated at 180° with strong sulphuric acid gives about one-third of the theoretical yield of dimethyl-amido-anthraquinone. The yield is more than doubled by starting with the reduction product, dimethylamido-benzoyl-benzoic acid, condensing this with sulphuric acid, and oxidising the product with ferric chloride. The corresponding ethyl derivatives were prepared in a similar manner.—On the creation of new articulations between bones normally independent, in the case where the old articulations cannot be reconstituted owing to their having been completely destroyed, by M. Ollier.—Formation in blood serum, under the action of chemical substances, of a material capable of coagulating the bacilli of true tuberculosis, by M. S. Arloing. It has been shown in a previous paper that the blood serum of tuberculised goats contains a substance which is capable of coagulating the tubercle bacilli from a homogeneous culture. It is now shown under that prolonged treatment, by injection of such substances as eucalyptol, guiacol, creosote, and solution of corrosive sublimate, the blood serum acquires the same property, the last-named substance giving the most active serum. The author points out that all these chemical substances have been proposed for the treatment of tuberculosis in man.—On a flying apparatus, by M. Ader. The apparatus described does not belong to the class of aeroplanes, but attempts to reproduce the curves of the wings of birds in flying.—On surfaces of total constant curvature, by M. C. Guichard.—On the form which by the suppression of certain terms becomes a development in complete series, by M. Riquier.—On a method of determining the order of a fringe of high order, by MM. Ch. Fabry and A. Perot. The fringes produced by the interference of the reflections from two parallel silvered plates some three or four centimetres apart are of a very high order. By throwing simultaneously rays of two different known wave-lengths (say red and green), and noting the positions of exact coincidence of a red and green ring, the order can be determined.—On the kathode rays, by M. P. Villard. If the antikathodic wall of a Crookes' tube is covered with cupric oxide glass, cuprous oxide is formed by the action of the rays. This reduction is attributed to hydrogen, furnished by the traces of water given up by the glass. In a tube with mercury electrodes, in which the vacuum was formed by boiling out with mercury, no kathode rays could be formed.—Action of some carbonates upon chromous acetate, by M. G. Baugé.—On the states of equilibrium of a ternary system, lead-tin-bismuth, by M. Georges Charpy. The results are expressed in the form of a curve, Thurston's triangular diagram.—On dimethylpiperazine and some phenolic combinations of this base, by MM. P. Cazeneuve and Moreau.—Heats of neutralisation of phenyl-phosphoric acid, by M. G. Belugou.—On some halogen derivatives of ethyl-phenyl-ketone, by M. A. Collet. The ketones described were prepared from propionyl and bromo-propionyl chlorides, and the halogen benzene derivative by Friedel and Craft's reaction, and include ethyl-*p*-chlorphenyl-ketone, ethyl-*p*-bromophenyl-ketone, bromoethyl-*p*-chlorophenyl-ketone and bromoethyl-*p*-bromophenyl-ketone, together with their oximes, and phenylhydrazones.—On the solipedisation of the Equidæ during recent times, by M. G. Joly. A comparison of the osteology of the horse of the quaternary period with that of the present day shows that the alterations of structure corresponding to increased speed can be readily traced, and are probably still going on.—On *Acinetospora pusilla* and the sexuality of the Tilopteridæ, by M. C. Sauvageau.—On the growth of a green plant, in absolute darkness, by M. R. Bouilhac. The algæ nostoch can be grown in complete absence of light, and has a green colour, although less intense than when grown in sunlight. It is essential that glucose be present in the culture fluid.—On polymorphism, by M. Fred. Wallerant.—Examination of a combustible material by means of the X-rays, by M. H. Couriot. The method affords a ready means of determining the amount ot mineral impurity present in a coal.—The artesian basin of the "Oued Rir," and the best means of utilising its irrigation waters, by M. Georges Rolland.—On the distribution of gluten and its immediate principles in the farinaceous nucleus of the wheat grain, by M. E. Fleurent.—Influence of asphyxia upon the amount of carbonic oxide in the blood.—Production of carbon monoxide in the organism, by M. Maurice Nicloux. The carbonic oxide found in the blood would appear not to be derived from the air, but to be a substance formed normally by the organism.—Researches on the ostioles of the cerebro-spinal system, by M. J. J. Andeer.

AMSTERDAM.

Royal Academy of Sciences, April 23.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Hamburger on the result of experiments showing that venous propulsive pressure promotes in a high degree the destruction of bacilli anthraces and their spores, which have been introduced under the skin.—Prof. Pekelharing presented a paper by Dr. G. C. J. Vosmaer and himself, entitled "Observations on Sponges," which will be published in the *Transactions* of the Academy.—Prof. Franchimont presented on behalf of Dr. P. van Romburgh a paper for publication in the report of the meeting, entitled "On the occurrence of cinnamic methyl ether in *Alpinia Malaccensis*, Rosc." On distillation with water the rootstocks of this plant yielded about 0·2 per cent. of ethereal oil, specific gravity 1·039 at 27°, exerting a right-handed rotation of 1°·5 in a tube 200 mm. in length. On the temperature being lowered, cinnamic methyl ether crystallised out—the liquid residue seemed to contain terpenes—which substance was not only detected by vapour density and analysis, its melting-point, 36°, and its boiling-point, 159°, but it also saponified, after which the two components, into which it was split up, were detected, cinnamic acid by its melting-point, 133°, and its other properties; methyl alcohol *e.g.* by the formation of the addition product with nitro-trimethylphenylenediamine, which crystallised in orange-coloured needles. Cinnamic methyl ether in chloroform, on being treated with bromine, yielded a dibromic addition product, melting at

116°, consequently phenyl $\alpha\beta$-dibromic propionic methyl ether. The leaves of this plant, too, are rich in methyl cinnamite. This is the first instance of cinnamic methyl ether being found in the vegetable kingdom.—Prof. van Bemmelen made on behalf of Dr. E. A. Klobbie a communication entitled "Qualitative-analytic determination of osmic tetroxide," which will be inserted in the report of the meeting.—Prof. H. A. Lorentz on optical phenomena, depending on the mass and the charge of the ions (II.). The author discussed the question whether the density of the absorbing gas itself and of other gases, with which it is mixed, has any influence on the position of the absorption lines in the spectrum. The formulæ show no appreciable influence, if the absorption is small in a layer of the thickness of one wave-length.

DIARY OF SOCIETIES.

THURSDAY, June 9.

Royal Society, at 4.30.—On a New Constituent of Atmospheric Air: Prof. W. Ramsay, F.R.S., and Morris H. Travers.—Experiments on Aneroid Barometers at Kew Observatory and their Discussion: Dr. C. Chree, F.R.S.—The Nature of the Antagonism between Toxins and Anti-Toxins: Dr. C. J. Martin and Dr. T. Cherry.—Some Differences in the Behaviour of Real Fluids from that of the Mathematical Perfect Fluid: A. Mallock.—On the Heat Dissipated by a Platinum Surface at High Temperatures: J. E. Petavel.

Royal Institution, at 3.—Modern Methods and their Achievements in Bacteriology: Dr. E. E. Klein.

Mathematical Society, at 8.—On the General Theory of Anharmonics: Prof. E. O. Lovett.—Point-Groups in a Plane, and their Effect in determining Algebraic Curves: F. S. Macaulay.—On a Regular Rectangular Configuration of Ten Lines: Prof. F. Morley.—On the Calculus of Equivalent Statements (eighth paper): H. MacColl.—On the Conformal Representation of a Pentagon on a Half Plane: Miss M. E. Barwell.—On a Continuous Group defined by any Given Group of Finite Order (second paper): Prof. Burnside, F.R.S.

FRIDAY, June 10.

Royal Institution, at 9.—Some Experiments with the Telephone: Lord Rayleigh.

Royal Astronomical Society, at 8.—Observations of Phenomena of Jupiter's Satellites in the Year 1897: John Tebbutt.—Occultations of Ceres and Venus: Cambridge Observatory.—Reply to Dr. Rambaut's Note on the Effect of Chromatic Dispersion: David Gill.—Right Ascensions and Declinations of Eight Stars in Aquarius, and their Probable Proper Motions: C. J. Merfield.—Further Researches on the Orbit of γ Lupi: T. J. J. See.—On the Actinic Qualities of Light as affected by different Conditions of Atmosphere]: Rev. J. M. Bacon.

Physical Society, at 5.—Exhibition of a Model illustrating Dr. Max. Meyer's New Theory of Audition: Prof. S. P. Thompson, F.R.S.—Attenuation of Electric Waves along a Line of Negligible Leakage: Dr. E. H. Barton.—Diffusion Convection: A. Griffiths.

Malacological Society, at 8.—On the Land Shells of Curaçoa and the Neighbouring Islands: Edgar A. Smith.—On the Anatomy and Synonymy of the Genus of *Mariaella* (Gray): W. M. Webb.—A Note on a New Form of Arionidæ from the Alps in Austria: J. F. Babor.—Descriptions of New Land Shells from Ceylon: E. R. Sykes.—List of the Land and Freshwater Mollusca of South Africa: J. C. Melvill and J. H. Ponsonby.

SATURDAY, June 11.

Royal Institution, at 3.—The Temples and Ritual of Asklepios at Epidaurus and Athens: Dr. R. Caton.

Geologists' Association (Waterloo Station, S.W.R.), at 1.50.—Excursion to Godalming. Director: T. Leighton.

TUESDAY, June 14.

Royal Horticultural Society.—Lecture on Hybrid Orchids.

Anthropological Institute, at 8.30.—Evidence of Lake Dwellings on the Banks of the Costa, near Pickering, North-east Yorkshire, with Illustrative Specimens: Captain the Hon. Cecil Duncombe.—Exhibition of a Large Collection of Stone Implements from Illinois and Ontario, with Descriptive Remarks: Rev. James Oliver Bevan.—On Marriage Laws and Customs of the Cymri: R. B. Holt.

WEDNESDAY, June 15.

Royal Meteorological Society, at 4.30.—Frequency of Non-Instrumental Meteorological Phenomena in London with Different Winds from 1763 to 1897: R. C. Mossman.—Progress of the Exploration of the Air by means of Kites at Blue Hill Observatory, Mass., U.S.A.: A. Lawrence Rotch.

Royal Microscopical Society, at 7.30.—Exhibition of Sponges: B. W. Priest.——At 8.—Report on the Foraminifera of the Malay Archipelago (continuation): F. W. Millett.

THURSDAY, June 16.

Royal Society, at 4.30.

Linnean Society, at 8.—Observations on the Seasonal Variations of Elevation in a Branch of Horse-Chestnut Tree: Miller Christy.—On Pantopoda collected by Mr. W. S. Bruce in the Neighbourhood of Franz-Josef Land: G. H. Carpenter.—Morphological Relationships of the Actiniaria and Madreporaria: J. E. Duerden.—On some Fossil Leporines: Dr. C. I. Forsyth Major.

Chemical Society, at 8.—Ballot for the Election of Fellows.—Preparation of a Standard Acid Solution by Direct Absorption of Hydrogen Chloride: Dr. G. T. Moody.—Researches on the Terpenes. III. Halogen Derivatives of Fenchene and their Reactions. IV. On the Oxidation of Fenchene: J. A. Gardner and G. B. Cockburn.

SATURDAY, June 18.

Geologists' Association (London Bridge, L.B.S.C.), at 12.25.—Excursion to Crowborough. Directors: G. Abbott and R. S. Herries.

BOOKS, PAMPHLET, SERIALS &c., RECEIVED.

Books.—Dante's Ten Heavens: E. G. Gardner (Constable).—Die Zelle und die Gewebe: Prof. Dr. O. Hertwig, II. (Jena, Fischer).—Lehrbuch der Botanik für Hochschulen: Prof. Strasburger and others, Dritte Verbesserte Auflage (Jena, Fischer).—Th. Thoroddsen, Geschichte der Isländischen Geographie, Autorisierte Übersetzung von A. Gebhardt, Zweiter Band (Leipzig, Teubner).—Angling Days: J. Dale (E. Stock).—Essai sur la Classification des Sciences: Prof. E. Goblot (Paris, Alcan).—Automobiles sur Rails: J. Dumont (Paris, Gauthier-Villars).—Ostwald's Klassiker der Exakten Wissenschaften, Nos. 93 to 96 (Leipzig, Engelmann).—Practical Plant Physiology: Prof. W. Detmer, translated by S. A. Moor (Sonnenschein).—Year-Book of the Scientific and Learned Societies of Great Britain and Ireland, 15th Annual Issue (Griffin).—The Heat Efficiency of Steam Boilers: B. Donkin (Griffin).—Introduction to Algebra: Prof. G. Chrystal (Black).

Pamphlet.—Summary Survey of the Geological Survey Department for the Year 1897 (Ottawa).

Serials.—Berichte der Naturforschenden Gesellschaft zu Freiburg i.B., Zehnter Band, 1, 2, 3 Heft (Freiburg i.B.).—Bulletin of the American Mathematical Society, May (N.Y., Macmillan).—Astrophysical Journal, May (Chicago).—Zeitschrift für Physikalische Chemie, xxvi. Band, 1 Heft (Leipzig).—Bulletins de la Société d'Anthropologie de Paris, Tome viii. No. 6 (Paris, Masson).—National Review, June (Arnold).—Scribner's Magazine, June (S. Low).—Strand Magazine. June (Newnes).—Fortnightly Review, June (Chapman).—Engineering Magazine, June (222 Strand).—Transactions of the Royal Society of Edinburgh, Vol. xxxviii. Parts 3 and 4; Vol. xxxix. Part 1 (Edinburgh, Grant).—Proceedings of ditto, Vol. xxii, No. 1 (Edinburgh, Grant).—Meteorological Record, Vol. xvii. No. 67 (Stanford).—Quarterly Journal of the Royal Meteorological Society, April (Stanford).—Geographical Journal, June (Stanford).—Journal of Botany, June (West).—Observatory, June (Taylor).—Atlantic Monthly, June (Gay).

Geological Model of London and Suburbs: J. B. Jordan (Stanford).

CONTENTS.

THURSDAY, JUNE 16, 1898.

ON LABORATORY ARTS.

On Laboratory Arts. By Richard Threlfall, M.A., Professor of Physics in the University of Sydney. Pp. xii + 338. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1898.)

THERE are certain passages in the preface of Prof. Threlfall's valuable contribution which it may be useful to quote before dealing with the book itself.

"It often happens that young physicists are to be found whose mathematical attainments are adequate, whose observational powers are perfectly trained, and whose general capacity is unquestioned, but who are quite unable to design or construct the simplest apparatus with due regard to the facility with which it ought to be constructed. That ultimate knowledge of materials and of processes which by long experience becomes intuitive in the mind of a great inventor of course cannot be acquired from books or from any set course of instruction. There are, however, many steps between absolute ignorance and consummate knowledge of the mechanical arts, and it is the object of the following pages to assist the young physicist in making his first steps towards acquiring a working knowledge of 'laboratory art.' . . . Before all things the means indicated must be definite and reliable. It is for this reason that the writer has practically confined himself to matters lying within his own immediate experience, and has never recommended any process (with one or two minor exceptions, which he has noted) which he himself has not actually and personally carried through to a successful issue. . . . With regard to the question as to what matters might be included and what omitted, the general rule has been to include information which the author has obtained with difficulty, and to leave on one side that which he has more easily attained. . . . Though no doubt a great deal can be done with inferior appliances where great economy of money and none of time is an object, the writer has long felt very strongly that English physical laboratory practice has gone too far in the direction of starving the workshop, and he does not wish, even indirectly, to give any countenance to such a mistaken policy."

The writer of this notice feels so strongly the importance of the subject of the first and last of these extracts that it is only with an effort that he can forego the opportunity which they offer of airing views, and confine himself to the more prosaic duty of review.

The second extract is one which shows that the first essential in a work of this kind is complied with. A mere collection of recipes for making and doing all sorts of things which have been collected from anywhere and everywhere, while not absolutely useless, is necessarily untrustworthy. Without the personal certificate of a man who is both a physicist and a mechanician, no description of a process for making or doing anything will necessarily be the most appropriate or even serviceable at all. With such a certificate, however, any one with but little experience of any particular laboratory art may set to work upon it with reasonable confidence.

The first chapter, of ninety pages, is upon the manipulation of glass and on glass-blowing for laboratory purposes. Of all laboratory arts probably glass-blowing and working, not including the work of the optician, looks more easy when practised by an adept, and seems more utterly and hopelessly impossible when tried for the first time, than any other. It is one which every experimentalist must acquire in some degree, and which as a fact, with a little practice and suitable help, is one of the easiest in which to make progress. Shenstone's well-known little book has been found invaluable by many, the little work of Bolas has recently been reviewed in these columns, and now we have new advice on the same subject, differing in some points, as is to be expected, but the result of personal experience. The subject is one in which any opportunity of watching a glass-blower of skill is worth more than any written instruction, but it is one in which occasional and hurried opportunities of watching a process can be supplemented most usefully by description. Practice, however, is essential, whatever guide to procedure may be attainable.

The writer's experience of the average student is that it is not sufficient to tell him even several times that he must not begin glass-blowing operations upon dusty tubes. The very elaborate description of a really proper way of cleaning a glass tube so as to fit it for the best class of work may, perhaps, induce this individual to take the trouble at least to wash out his tubes.

Prof. Threlfall does not approve of the type of blowpipe usually furnished by the instrument maker, nor apparently does any writer on the subject. He describes a simple form of oxygen blowpipe that is suitable for working lead-glass or unusually infusible glass. For larger work with lead-glass he prefers a system of four blowpipes, the flames of which meet upon the work. The superiority of lead-glass where the nature of the experiment will admit of it is duly insisted on. It is a pity that owing to the miserable blowpipes to be found in laboratories, the beginner never gets a chance of realising how excellent lead-glass really is.

The instructions given for cracking or cutting the larger sizes of glass tubes do not quite accord with the writer's experience. The well-known point of melted glass and the flame-pencil with a very small flame are described as being suitable for leading a crack round a tube. The writer has found with tubes that are not too large, a thick copper wire mounted in a handle and bent at the end into such a form as to make a good long contact with the glass, enables one with a little practice to lead a smooth crack round the tube along any predetermined line with an accuracy and quickness not approached by any other process. It is often possible with a single heating of the wire to "cut" a tube an inch or more in diameter either square across or at an angle as great as 30°, and so nearly in a plane that five minutes' grinding on emery cloth will remove the whole of the old surface.

On p. 49 there is a figure showing an ordinary glazier's diamond mounted on a frame, so as to bear upon the exterior of a rotating tube. No doubt as this is described a tube may be cut that way, and in that case, perhaps, no exception should be taken. But since glass tubes cool from the exterior, the inner surface is ultimately in a state of stretch, while the exterior surface is in a state of compression. As a consequence, glass tubes and vessels in general are far more sensitive to even microscopic scratches inside than out. For this reason, it is preferable to mount the diamond at the side of the end of a stick or metal rod provided with a sliding stock like a marking gauge. With such an instrument, tubes may be cut with facility and accuracy. In the same way it is not easy to cut a circular hole in an ordinary glass shade; but if a glazier's diamond is used on a compass within the shade, the piece will drop out at once.

There are useful instructions on boring holes in glass. Of course, the nature of the tool and of the process depends upon the size of hole and thickness of glass. It will be news to most people, however, to read, after the process of drilling with a file is described:

"It is not, however, necessary to use a file at all, for the twist drills made by the Morse Drill Company are quite hard enough in their natural state to bore glass. The circumferential speed of the drill should not much exceed ten feet per minute. In this way the author has bored holes through glass an inch thick without any trouble, except that of keeping the lubricant sufficiently supplied."

The writer has always believed that a pyramidal end to a drill—that is, a drill of the old-fashioned flat pattern, but with the two faces meeting at the point, not joined by a cross-edge—was the best form for drilling glass, *i.e.* when a diamond drill is not available. Such a drill, made dead hard and well lubricated, certainly drills holes in thick glass with remarkable facility. The success of the Morse twist drill, where such cross-edge is always present, would seem to indicate that there is nothing essential in the pyramid theory. The application of the methods of the mechanical engineer to the work of glass is carried a step further on p. 74, where the reader is told to give up grinding glass to form in many cases where this is the usual practice, but instead to chuck it in the lathe and turn it with a steel tool ground to an edge of 80° and well lubricated. After this, any one who has not worked glass in this way would almost expect to read—the best way to start the Morse drill in glass boring is to use a dead hard and sharp centre punch, and give it a smart blow with a light hammer.

An appendix to the first chapter should be found useful, since the interest in experimenting with Röntgen tubes shows no sign of decaying. Complete and detailed instructions are given for making all the parts of these tubes, for putting them together, for making a suitable pump, and for completing by exhaustion and sealing.

The second chapter is upon glass grinding and optician's work. This is one which the great majority of experimentalists will look upon as outside their practical requirements. There is no doubt that the art of optical grinding, as distinct from mere lapidary performances, is one of the most fascinating for the very few who have laid themselves out to practise it. It, however, is one which cannot be embarked upon in five minutes. A good deal of material and apparatus has to be collected before a start can be made, and at the best the processes seem slow and tedious; they are, moreover, of a kind that cannot be hurried. On the other hand, where the practical physicist finds himself in some outlandish place, it may very well be worth his while to acquire the art of grinding and polishing plane and curved surfaces, and of attaining the skill, if he has the patience, of figuring these with the precision that optical work demands. For those within reach of the real or working optician—quite a distinct type from the shoptician—it is barely worth spending the time for the sake of the work to be done, though it may be for the sake of the pleasure that succeeding in a difficult art will bring to the worker. But this is luxury.

On the other hand, occasions arise in experimental work where it is important to be able to do on the spot and at once some operation of a kind which, taken by itself, the experimentalist would prefer to put in the hand of the instrument maker, but which it may be imperative to perform on the spot, even though the technical success may be inferior to that of a second-rate professional.

The whole series of operations required in making an achromatic object-glass of small size are described, not because any one wanting such a glass would be well advised to make one, but because such a description includes all the ordinary routine of optical work, and a beginner would find it a good training. After this the construction of small lenses and of galvanometer mirrors is described. The author tried making these mirrors of fused quartz and of crystalline quartz, as well as of glass, and has concluded that for the most perfect thin mirrors slices of the crystal are better than anything. In this conclusion the writer of this notice agrees.

The construction of large mirrors and object-glasses for telescopes is dealt with; but in the writer's opinion this, while good enough, is somewhat out of place, for it is not possible to devote enough space to the very wonderful art of testing the surface at the centre of curvature. The formula for the longitudinal aberration of the parabola at this point is not given, nor is the reader warned that the formula of Draper, which is so constantly quoted for this, only gives half the correction.

Sections 68 and 69 should be valuable to many. They are both quotations from Brashear, whose optical masterpieces are known of, if they have not been actually seen by every experimentalist in the world. The first is on the cleaning of dirty object-glasses, and the second on the working of plane surfaces on rock salt.

Some attention is given to the peculiar difficulties of producing optically plane surfaces of any size. Lord Rayleigh's beautiful method of testing the figure by interference with a free surface of water just above it is referred to rather than described. While interference methods of testing are shortly described—and they have the undoubted value that they indicate the magnitude and position of any errors—it is, perhaps, unfortunate that the very handy method of testing the goodness of a plane surface by the use of a telescope and artificial star is not properly described.

The chapter on optical work is really full of valuable information. The fact that some criticism has been offered is perhaps owing to the fact that the subject is one upon which no two people would have quite the same views. The writer must, however, here express his disappointment at not finding any indication of the value of carborundum for these processes. He has never lost an opportunity of trying to collect real experience on this material, practically without success. His own very limited experience is all in favour of the virtues which the makers so forcibly set out. It seems impossible in this country to learn anything about it directly.

The third chapter is on all sorts of things that the manipulator in materials ought to know. The first of these is on Margot's method of coating glass with aluminium and of soldering aluminium, or even glass, by means of its aluminium coat! Prof. Threlfall vouches for the practical ease and success of these processes. He gives full details of the very simple process.

The second is on Boettger's process of depositing bright gold upon glass, just as silver is deposited. This also the author has proved to be satisfactory. The question arises whether it might not be worth while, where colour is not important, to use gold in the place of silver in reflecting telescopes for the sake of the permanence that should in this way be attainable.

The third is on slitting with a disc and diamond dust and making rock sections generally. This, however, does not require particular notice except, perhaps, the curious statement that the author was surprised how difficult it was to learn anything about this art. Vol. iii. of Holtzapffel surely cannot have been in his mind when he wrote this.

A large amount of space is given to the fullest details of the different methods of making and mounting quartz fibres and of their properties. No one with this before him need have any doubt about embarking upon this laboratory art. The writer of this notice had produced the first of some articles on the subject in the *Electrician*, but on seeing Prof. Threlfall's book, felt that the ground was so well and accurately covered that it would be a mistake to go over it again. The curious property of the quartz fibre discovered by Prof. Threlfall, of becoming at ordinary temperatures very slightly *more* rigid as the temperature rises, is referred to; and the suggestion which the writer of this notice also put forward tentatively years ago is made, that chronometer balance-springs made of fused quartz might have some advantage. This curious rise in rigidity with temperature is also noticed by Mr. S. J. Barnett in a valuable paper in the *Physical Review* for February last. Another point referred to by both these writers is the extraordinarily small coefficient of expansion of melted quartz. Benoit gives the extreme coefficients for crystalline quartz as $\cdot 0^5 72$ and $\cdot 0^4 133$. Barnett found for three quartz fibres $\cdot 0^6 3$, and for a rod of fused quartz $\cdot 0^6 2$. There is one part of the description of the manipulation with quartz fibres where the writer would add to Prof. Threlfall's description. On p. 220 the method of handling the fibre, cutting it off, and mounting it so as to be of the right length is described. Instead of a board to work on, however black it may be, a piece of looking-glass lying flat on the table is infinitely superior. This was suggested years ago by some kind friend, but who it was the writer is ungrateful enough not to remember.

The writer prefers when blowing quartz fibres of extreme tenuity for suspension purposes, not to blow a maze on to some screen, but, using a finer flame, to blow out a single fibre which may often be found joining the two rods, and either thick enough to show colour or generally far too fine to do so, corresponding in fact to the black of the soap-bubble.

Soldering, brazing, silver soldering, all essential everyday arts, are next described well and fully; but whether these descriptions will make these actually easy arts ever seem so to beginners is a question. Perhaps enough is not made of the sweating process carried out without any bit, or any preliminary cleaning or preparation of any kind. On the other hand, under brazing and silver soldering, the great use of a bit made of clean iron wire in showing the melted metal where to go when it does not flash at once, might be added in a future edition.

Insulators and conductors used in the construction of apparatus are next considered. Prof. Threlfall is probably the only person who has turned to useful account the writer's discovery of the superlative insulating properties of rods of melted quartz, even in an atmosphere saturated with water. Their application to a number of electrical appliances is described and figured.

Glass, ebonite, mica, micanite, celluloid, paper, paraffin, wood, slate, and marble are all discussed from the point of view of a constructional material with insulating properties. The electrical and mechanical properties of a large number of alloys, such as platinoid, manganin, &c., close this long and most valuable chapter.

The last chapter is upon electro-plating, chiefly gold, silver, copper and nickel, and upon allied arts. The writer has often heard that the best nickel plating is really cobalt. He hoped to, but did not, find any enlightenment upon this point.

An appendix upon platinising glass concludes the book.

This notice, already too prolonged, and yet insufficient, is enough to show that the experimentalist has now a most useful guide in a large number of processes. It is not possible to describe every process. The personal certificate is what gives value to those that are chosen. It is to be hoped that with Prof. Threlfall's valuable guide, instead of despising them, some of our growing physicists may be encouraged to make themselves familiar with some, at any rate, of those arts which Newton and Faraday cultivated with such astonishing skill and success.

C. V. BOYS.

A NEW TEXT-BOOK OF ZOOLOGY.

A Student's Text-Book of Zoology. By Adam Sedgwick, M.A., F.R.S. Vol. i. Pp. 600. (London: Swan Sonnenschein and Co., Ltd., 1898.)

MR. SEDGWICK has produced the first part of what must prove to be a very useful treatise for University students, if the remaining portions of the work are as well carried out as is the present.

In this volume Mr. Sedgwick gives an account of the Protozoa, Porifera, Cœlentera, Platyhelminthes, Nemertea, Nemathelminthes, Rotifera, Mollusca, Annelida, Sipunculoidea, Priapuloidea, Phoronidea, Polyzoa, Brachiopoda, and Chætognatha. The method adopted is strictly systematic: the larger groups are described and characterised in turn, the enumeration extending as far as families, which are also briefly characterised, important illustrative genera being cited. The work is, in fact, written on the lines of the translation of the "Zoology" of Prof. Claus, which Mr. Sedgwick gave us some years ago; but instead of merely producing a new edition of that work, he has written a new book introducing his own views and his own conception as to what are important facts and useful schemes of classification.

A distinctive feature of the work is the number of excellent woodcuts which Mr. Sedgwick has culled from a very large variety of sources. The text-books of Korschelt and Heider, Perrier, Lang, Claus, Wasielewski and Bronn's Thierreich have been laid under contribution for *clichés*, and the author is to be congratulated on the admirable collection he has brought together. The book is intended to be and is as brief as is consistent with an intelligible exposition. Yet it seems hardly possible that Mr. Sedgwick will be able to complete it in another volume of the same size. He has still to treat of the Echinoderma, the entire series of Arthropoda and the Vertebrata (which he would probably call the Chordata).

There are in the book one or two noticeable and original statements and classificatory innovations which it will be interesting to mention here. Mr. Sedgwick holds, as is well known, special views on the subject of cell-structure. He accordingly defines the Protozoa as "Animals in which there is one nucleus, or, if more than one nucleus, in which the nuclei are disposed apparently irregularly and without relation to the functional tissues of the animal. Conjugating cells of the form of ova and spermatozoa are never formed." In contrast with these the Metazoa are defined as "Animals in which the ordinary (so-called adult) form of the species has more than one nucleus, and in which the nuclei are for the most part arranged regularly and with a definite relation to the functional tissues of the animal (so-called cellular arrangement). Special conjugating individuals of the form of ova and spermatozoa are always formed."

With reference to this it may be remarked that the nuclei of, say, muscular tissue in Metazoa cannot be shown to have any more definite relation to the functional contractile substance than has the nucleus of a gregarine to its functional contractile substance, and the same kind of remark is true in reference to many other active structures in the two groups compared.

It surely is not possible to maintain that conjugating cells of the form of ova and spermatozoa are never formed in the Protozoa when we include (as Mr. Sedgwick does) the Volvocinean Flagellata in that group.

The account of the Protozoa is more complete than is usual in text-books of this size and scope, and the figures of Hæmosporidia and Myxosporidia, borrowed from Wasielewski, are particularly good, though the account on p. 63 of Hæmamœba Laverani is not quite satisfactory.

Mr. Sedgwick, as might be expected from his own important share in elucidating the subject, is very clear and precise in defining the "cœlom," and in explaining its real nature. He does not, however, as one could have wished, give the actual history of the word "cœlom," and the steps by which the erroneous views of Haeckel, the Hertwigs and other German authorities have been set aside. He says, "formerly the word cœlom was used as synonymous with body-cavity or peri-visceral cavity, and no distinction was recognised between the body-cavity of the Arthropoda and the same structure in such forms as Vertebrata." I think it is worth noting that, as a matter of fact, the word cœlom was introduced by Haeckel in the year 1872, in the first volume of his "Kalkschwämme," p. 468, in the following words :

"Die wahre Liebeshöhle" (contrasted by Haeckel with the digestive cœlenteron of Cœlentera, to which the term "body-cavity" or "Leibeshöhle" was undesirably applied) "welche bei Vertebraten gewöhnlich Pleuroperitonealhöhle genannt wird, und fur welche wir, statt dieses neunsylbigen Wortes die bequemere zweisylbige Bezeichnung Cœlom (κοῖλωμα, τὸ, die Höhlung) vorschlagen, findet sich nur bei den höheren Thierstämmen bei den Würmern, Mollusken, Echinodermen, Arthropoden und Vertebraten."

For Haeckel the typical cœlom was the pleuroperitoneal cavity of the Vertebrate. At the time when he wrote, that cavity was supposed to have arisen phylogenetically by a splitting of the mesoblast; hence the failure of Haeckel to distinguish other cavities, such as the hæmocœl of Arthropoda and of Mollusca from the true cœlom. I gather from Hertwig's text-book of Embryology that I was the first to point out that the "schizocœl" (as Huxley called it) of higher Vertebrates could be and should be interpreted (in consequence of Balfour's discoveries in Selachian development) as an enterocœl—a pouch, in this case without lumen—which arises as a solid outgrowth from the enteron, the opening out of its cavity being delayed. Thus the cœlom is now characterised by Sedgwick as "a part of the enteric cavity which has lost its connection with that portion which constitutes the alimentary canal in the adult." The enteric pouches of the Actinozoa are "an incipient cœlom." Further, it is recognised by Sedgwick that "the cœlom, in addition to its mechanical relations, has two most important functions : the one of these is to bud out the reproductive cells, and the other to secrete the nitrogenous waste." The essential cells of the gonads and of the nephridia are parts of the cœlom. Mr. Sedgwick's own researches on the development of Peripatus served more than anything else to establish that the cavity of Arthropods, which I had termed "hæmocœl," is distinct from cœlom, and that there is—quite apart from hæmocœl—a true cœlom in Arthropoda reduced in the adult to nephridial and perigonadial rudiments. My own observations on the pericardium of Mollusca, and on the vascular system of both Molluscs and Arthropods, as well as the work of my pupil Gulland on the coxal glands of Limulus, had tended, before this, to show the existence of "cœlom" distinct from "hæmocœl" in both those groups. Thus the erroneous notions promulgated in the "Cœlomtheorie" of the Hertwigs were superseded. I am distinctly of the opinion that this step forward—viz. the recognition, definition and characterisation of the true "cœlom" as distinct from "hæmocœl"—has been due to English observations and English doctrine, and I think that a full account of the history would be valuable to students.

Mr. Sedgwick necessarily has something to say in this connection concerning the supposed communication of vascular system and cœlom in the Leeches. In his excellent account of those animals (in which he not only discusses Acanthobdella, but introduces Kowalewsky's recent figure of its anterior segments) Mr. Sedgwick lays great stress on Oka's recent observations upon Clepsine, and concludes that "we are bound to hold, provisionally at any rate, that in Leeches, as in other animals, the blood system and cœlom are separate from one another." I quite agree that there are probabilities in favour of Mr. Sedgwick's conclusion. Twenty years ago, and at intervals since then, I have endeavoured to put the matter out of the region of probabilities, but in spite of the careful researches made in my laboratory by A. G. Bourne and others, I have not yet succeeded in so doing. After all, it should be possible, by modern improved methods, to test this question of continuity in *Hirudo* by means of actual injection. There are "other animals," it must be remembered, in which there is free communication between the cœlom and the vascular system, to wit, the not unimportant animals known as Vertebrata.

In his classification of the Mollusca, Mr. Sedgwick has taken his own line, and refused to follow Pelseneer in the separation of the Chitons from the Gastropoda, though he places Neomenia and Chætoderma in a separate class, the Solenogastres, for very good reasons which he sets forth.

The creation of a separate phylum for each of the small groups of Sipunculoidea, Priapuloidea, and Phoronidea is perhaps legitimate in the present state of knowledge, though the questions involved are of a very difficult nature, and the facts known insufficient to give one great confidence in any of the proposed classifications affecting those animals.

Mr. Sedgwick excludes the Platyhelminthes, the Nermertea, the Nemathelminthes, and the Rotifera from the Cœlomata; but he does not argue at any length the question as to whether there are or are not cœlomic rudiments in each of these groups. The perigonadial sacs of Platyhelminthes and Nemertea and their nephridia may be interpreted as modified developments from cœlom, though it would no doubt be difficult to show that they are so. It must, however, be remembered that in such matters the assertion that A *is not* B is as positive and definite a statement, requiring just as full a proof, as the statement that A *is* B.

The chief omission which has to be noted in Mr. Sedgwick's book is that which I have recently pointed out in other works—namely, an insufficient historical account of the discoveries, hypotheses, conceptions and terms (with immediate reference to chapter and verse), the bringing together and explanation of which is the purpose of the writer's labour. Mr. Sedgwick is not so determined to omit history and the names of contemporary workers as are some other writers of text-books. He does not make a profession or virtue of this practice, and in many cases gives an immediate reference to a special memoir, or even cites a naturalist's name, after mentioning an important fact or theory. At the same time, he cannot be said to have done what could easily have been done in this respect without materially increasing the size of his book. Of course, all such references and discussions must be in proportion to the size and scope of the text-book in which they should appear, and Mr. Sedgwick not unfrequently does give a historical reference. But why should he not tell us, for instance, who invented the name Protozoa, what he meant by that term, and how it came to have its present limitations? Why should he not tell us (p. 533) who proposed the separation of Sipunculoidea and Echiuroidea which he adopts? Why should he not give credit to Dr. Hudson for his most interesting discovery of the six-legged Rotifer *Pedalion*, instead of printing Hudson's drawing of his discovery with the label "from Perrier after Gosse?" Mr. Sedgwick very properly states in a footnote that the classification of the Polychæta adopted by him is that of Dr. W. B. Benham, to whose work he refers. It would, I think, have helped many of his readers if he had given some account of the source of classification and terms used by him, in all other instances. Putting aside such suggestions for improvement, I think we must recognise that Mr. Sedgwick's book is a very good one, ably put together, and likely to be extremely useful; it is, in fact, not only the last, but the best zoological text-book—so far as the first volume goes—in the language. E. RAY LANKESTER.

THE ANALYSIS OF ORES.

Methods for the Analysis of Ores, Iron and Steel, in Use at the Laboratories of Iron and Steel Works in the Region about Pittsburg, Pa. Pp. iv + 133. (Easton, Pa.: Chemical Publishing Co., 1898.)

A COLLECTION of the methods in use in the modern laboratories of steel works must be useful if only for comparison, but the present book cannot take rank with standard works such as those by Blair and Arnold. One notes a sameness in the modes of procedure, varied, however, in some instances by questionable modifications, more especially as regards phosphorus determinations.

Sufficient attention has not, on the whole, been given to the exact relative proportions of nitric acid, molybdate, &c. Most of the operators are apparently content to assume that it is sufficient to add, in all instances, measured quantities of the reagents required. This is contrary to the writer's experience: each analysis should be conducted in accordance with the conditions observed at the time; it is not enough to merely add fixed quantities of reagents, but the operator must judge for himself, more especially as regards the use of nitric acid.

In practice the best and most accurate results are obtained by the direct weighing of the molybdate precipitate, using the magnesia method only as a check.

Volumetric methods are useful where rapid determinations are required for check purposes, but are not so trustworthy as the weight method, *i.e.* when proper precautions are taken and the necessary experience gained.

Sulphur.—The evolution method cannot be dispensed with in an ordinary steel works, but is only useful for rough determination; it is little better than a qualitative method, as has been repeatedly demonstrated.

Apparently we have no better method than with aqua regia and subsequent precipitation with barium chloride. It is well known, however, that discordant results are often obtained. At present a rapid and strictly accurate mode of determining sulphur has yet to be devised; this for various reasons well-known to analytical chemists.

As regards the estimation of manganese, nickel, copper, &c., little need be said; there is not much that is novel in the methods, which are fairly good and are such as are usually practised. The same is applicable to carbon determinations, with the exception of barium hydroxide as an absorbent (A. G. McKenna), which the author recommends; as also the complete analysis of chrome iron, which appears a mode of procedure sufficiently accurate for all practical purposes.

Analysis of Ores, &c.—Mr. James M. Camp's method for rapid analysis of blast furnace cinders apparently gives results useful to the blast furnace manager, but the determination of manganese, from Mr. Camp's own showing, cannot be neglected.

The writer has used the colorimetric method both for iron and manganese, especially iron; it is most important to make frequent iron determinations, for obviously iron in the slag is equivalent to loss of metal in the pig-bed. The colour method is rapid, good for iron in slag, and more accurate than the weight process.

Determination of Silica in Ores.—One notes that potassium sulphate or hydrofluoric acid are sparingly used, American chemists relying chiefly on the sodium carbonate method. In this country preference is given to the use of the former; chemical results are considered more accurate, with economy of time.

Determination of Iron.—The bichromate method leaves nothing to be desired as regards slags, ores or minerals in general, but is not very suitable for the accurate determination in iron or steel. Most chemists are content in iron or steel analysis to give the iron by difference, but if a method could be devised whereby the absolutely pure iron could without question be determined within ·001 per cent., such a factor would in the present state of our knowledge be invaluable. Those who have studied the recent developments of the chemistry of iron will understand this.

On the whole, American practice seems inferior to the English; some of the methods quoted are practically obsolete in this country. This applies more especially to manganese determinations—only two chemists when using the gravimetric method for manganese take note of the previous necessary removal of barium when ores are being analysed, to say nothing of other possible impurities.

Very many of the processes given seem devised merely for speedy work, regardless of accuracy; on the other hand, some needless complications have been introduced with consequent loss of valuable time.

JOHN PARRY.

OUR BOOK SHELF.

Electro-physiology. By W. Biedermann. Translated by Frances A. Welby. Vol. ii. Pp. vii + 500. (London: Macmillan and Co, Ltd., 1898.)

MISS WELBY has now completed her translation of this work. The second volume is equal to the first in scientific interest and importance, and the technical difficulties of rendering it into English have been overcome with even greater success.

Prof. Biedermann deals with the main subject of the volume, that of the "electro-physiology" of nerve, much more from a physiological than from an electrical point of view. In every branch of it he is able to give us the results of his own work, or of those of the distinguished colleague with whom he was for so many fruitful years associated at Prague; so that the student who desires to appreciate the experimental basis of Hering's doctrine cannot have a better guide than is here provided for him. It must not, however, be supposed that the work is mainly theoretical; on the contrary, on the subjects of which it treats, it is the best "reference-book" that the physiological worker has at present at his disposal.

In addition to the chapters on nerve, the volume contains a very carefully written chapter on the electrical endowments of the plant-cell, another on electric fishes, and a third on the electrical response of the retina to the stimulus of light. In discussing the first two of these special subjects, Biedermann derives his data chiefly from English sources. In the elaborate and copiously illustrated chapter on electric fishes, the reader will find a complete account of Prof. Ewart's investigations of the development and structure of the electrical organ in the rays; and of Prof. Gotch's researches on Torpedo. In like manner the chapter on the electromotive properties of excitable tissues of plants is mainly based on English researches on *Dionæa*, of which it contains a very full *résumé*. It is a satisfaction to the writer of this notice that the main results of his own investigations have been accepted by his German colleague, and particularly to observe how fully he has appreciated the evidence they afford of the essential identity of the elementary processes of plant and animal life. J. B. S.

Open-air Studies in Botany: Sketches of British Wild-flowers in their Homes. By R. Lloyd Praeger, B.A., B.E., M.R.I.A. Illustrated. (London: Charles Griffin and Co., Ltd., 1897.)

THESE open-air studies should appeal to people who live in the country, and who care about the wild plants around them. A glance through the pages recalls many a country ramble, and a good point about the treatment in the book is that an attempt is made to connect the flora of a locality with the physical conditions which prevail there. It is a pity, however, that the author should have not adopted the names in common use for his plants—*e.g. Scilla festalis* the wild hyacinth or *Volvulus* for *Convolvulus* both look and sound pedantic. Moreover the glossary, which forms a necessary appendix, is sometimes disfigured by misleading statements; thus a carpel is stated to be that part of a flower which contains an ovary. But in spite of occasional slips and blemishes, the positive merits of the book should secure for it a fair measure of success.

The Journal of the Iron and Steel Institute. Name Index. Vols. I–L (1869–96). Edited by Bennett H. Brough. (London: E. and F. N. Spon, Ltd., 1898.)

THE Iron and Steel Institute was founded in 1869, and since its establishment it has done most useful work by arranging periodical meetings for the discussion of practical and scientific subjects bearing upon the manufacture and use of iron and steel. The papers published in the Institute's *Proceedings* are here indexed, and they make a solid contribution to knowledge. The volume contains a short history of the Institute, a list of papers contained in the first fifty volumes arranged chronologically, a list of these papers arranged according to subjects, an index of the authors, and a complete index to the authors of all papers, communications, and abstracts published in the fifty volumes. The complete index will thus be of service in showing the development of the science of iron and steel.

A Simplified Euclid. Book I. By W. W. Cheriton. Preface by Elliott Kitchener. Pp. iv + 111. (London: Rivingtons, 1898.)

SO many simplified Euclids have been published during the last few years, that an addition to their number should seem superfluous. In the one before us the compiler claims that after teaching the subject for some years he thinks that the form he proposes in this book should supply a long-felt want. The method he adopts is to print the proposition exactly as it should be written out by a schoolboy, using sufficient abbreviations to save time in writing without confusing the mind of the pupil. Each proposition is printed on the left-hand side of the page, notes and exercises being printed on the right. The book has many points in its favour.

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 Origin of the Aurora Spectrum.

PROF. RAMSAY gives the wave-length of the principal line in his new gas as 5566. It will no doubt also occur to others that this is very near the wave-length of the aurora line, which Vogel has measured as 5569. It should be mentioned in connection with this line that Profs. Liveing and Dewar have observed one very near it at 557 in sparks taken in liquid oxygen. The second green line given by Prof. Ramsay as 5557, seems also to have been seen by these observers (*Phil. Mag.*, xxxviii. p. 237, 1894). ARTHUR SCHUSTER.

Manchester, June 10.

The Action of Electric Discharges on Photographic Plates.

REFERRING to the paper on this subject, read on May 16, by Mr. J. A. McClelland, at the Cambridge Philosophical Society, and reported in your issue of June 9 (p. 142), perhaps I may be allowed to mention that very similar experiments, with the deduction that the effect is chiefly due to light, and not to electrolytic or other action, were described by myself in a paper to Section A of the British Association, at its Edinburgh meeting in 1892, and will be found fully reported in the *Electrical Review* for August 26 of that year.

I do not know whether others have observed the fact that when strong sparks from an induction coil or influence machine are allowed to traverse the sensitive surface of an ordinary photographic dry plate, that a dark line, delineating the path of the spark, is immediately produced, and can clearly be seen without any necessity for photographic development. Further, that such lines, though faint to commence with, darken appreciably after a few minutes lapse of time, and still more so in the course of a few hours. This appears to indicate that whatever the precise action of the spark on the film, this action continues after it has once been started. Further, it is a curious fact that these lines, if examined with a magnifying glass, are always found to consist of two dark lines with a light space between them. This is specially noticeable immediately after the spark has passed, the space apparently filling up with lapse of time. A. A. C. SWINTON.

66 Victoria Street, London, S.W., June 10.

A High Rainbow.

ON Sunday afternoon, May 29, while sitting in my yard, my twelve-year-old son called my attention to a rainbow which he had discovered while lying on his back looking up at the sky. The local time here was 5.40 p.m., and the sun, therefore, about an hour and a half high. The bow was in the west, and about 70 degrees from the horizon, with its convex side to the sun. The colours were fairly well brought out, the red being on the convex side of the arc, and the violet on the concave side. The figure on p. 132 of Tait's "Light" shows a short arc near the zenith, which is a fair representation of what was seen here. I have not read an account of what was seen by Helvetius further than is contained in Prof. Tait's book, and do not know whether the arc seen by him near the zenith showed the rainbow colours. In this case I do not see any of the other halos seen by Helvetius. There were but few very thin clouds, and no rain at all. SIDNEY T. MORELAND.

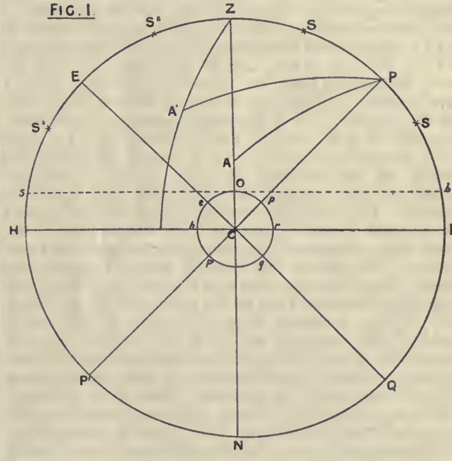
Lexington, Virginia, U.S.A., June 2.

NAUTICAL ASTRONOMY.

IF the compass is the navigator's sheet-anchor, the sextant is certainly his best bower; and just as the former was known, if not generally used in Europe, about a century before Flavio Gioia got the credit of discovering it, so the latter was invented by the transcendent genius of Sir Isaac Newton, more than half a century before it was re-invented by Hadley in 1731. Newton does not seem to have suggested its adaptability for navigational purposes, or if so, it was not sufficiently known or taken up, and I am not aware of any reason to suspect that Hadley knew of Newton's discovery.

The principal use the navigator puts the sextant to is that of measuring the altitudes of heavenly bodies—that is, the angle at his eye subtended between the object and the visible horizon. Now the *rational* horizon may be defined as the plane perpendicular to the plumb-line through the earth's centre, or the circle traced by the meeting of this plane with the celestial concave. The *sensible* horizon is generally defined as a plane parallel to the former through the eye of the observer; but this can only coincide with the *visible* horizon if the eye of the observer is at the surface of the earth—as if he were immersed in the sea, till a horizontal line from his eye would be a tangent to the sphere at that point. But the eye of the observer is always above the surface of the sea; and the more it is raised, the more the visible horizon is depressed, and a correction called "dip" has to be applied to an altitude measured to it, to reduce it to what it would have been had the eye been at the sea-level. Again, before this *apparent* altitude can be used for position-finding, it has to be still further corrected for

FIG. 1.



refraction, due to the bending of the rays of light, in passing through the earth's atmosphere, and in the case of sun, moon, or planet for parallax, to reduce it to the angle at *the centre of the earth and to the rational horizon.* Both these corrections are zero when the body is in the zenith, and a maximum at the horizon. Parallax is the angle at the observed body, subtended by the semi-diameter of the earth under the feet of the observer, which will be reduced to a point when the body is in the zenith. If the body has an appreciable semi-diameter, it has to be applied to the altitude of the limb to get that of the centre.

In the diagram (Fig. 1), let H E Z P R Q N P′ represent a meridian of the celestial concave, and the inner circle the corresponding meridian of the earth; let Z be the zenith, N the nadir, P and P′ the poles of the heavens, being the points in the celestial concave, which would be perforated by the earth's axis if indefinitely produced: then H R will represent the rational horizon, the plane of which, passing through C, is normal to the plumb-line Z O N, *s* O *b* will represent the sensible horizon (O being the position of the observer), E Q, the plane of which is normal to P P′, will be the equinoctial, whose plane coincides with that of the terrestrial equator. On a meridian from E Q towards either pole, the declination of a heavenly body (corresponding to latitude on the earth) is measured, and from the first point of Aries (the celestial meridian passing through which is the prime meridian of the heavens) right ascension is measured round eastward, instead of east and west, as longitude on the earth.

Now let the reader imagine his eye to be at C, that the earth is a transparent sphere, and that it and its atmosphere are absolutely free from refrangibility, then every point in the celestial meridian would be seen through its prototype on the surface of the earth, and any and every angle at C, measures the same arc of the celestial meridian, and of the one on the surface of the earth. Now, what is true here holds good for every other meridian—every other great circle of the celestial concave, and the one that has the same plane on the earth's surface.

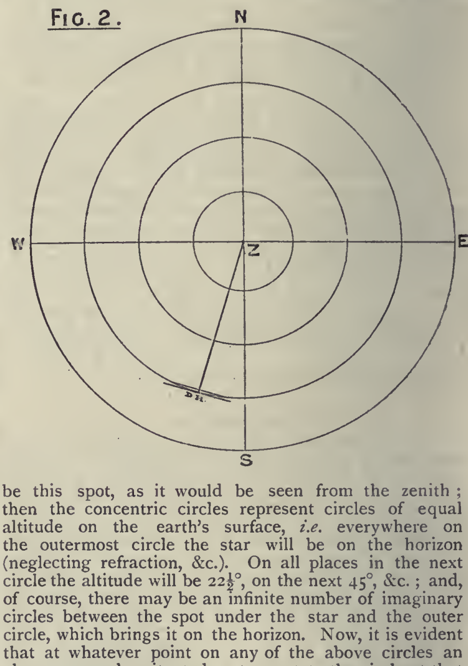
The latitude of a place is the arc of a meridian, intercepted between the place and the equator, consequently *e* O is the latitude of O; but *e* O and E Z are both measured by the angle *e* C O, and E Z = P R, each being the complement of P Z, which accounts for one of the best-known rules in nautical astronomy, viz. that the altitude of the pole = the latitude of the place; so that if there was a star at P, its altitude would give the latitude without any further computation. Let S, S′, &c., be the positions of stars on the meridian. But very little consideration will make it clear that if the observer can measure one of the arcs S R, S^1R, S^2H, or S^3H, and at the same time get the star's declination from the *Nautical Almanac*, it is a mere question of addition and subtraction of arcs to obtain the latitude. P S is the complement of the declination, and $PS + SR = ES^1 - ZS^1 = ES^2 + ZS^2 = ZS^3 - ES^3 = EZ$, the latitude of O. This is known as finding the latitude by the meridian altitude. It gives one line parallel to the equator, on which the ship must be situated. To fix her position on it, we must get another line to cross it, which passes through the position of the vessel, when, manifestly, she must be at the point of intersection. The nearer the cross is to right angles the better. To do this we must find the time, and thence by comparison with the time at the prime meridian (Greenwich is now accepted by most nations as the prime meridian), the meridian on which the ship is situated. Neglecting minor differences and irregularities, the sun appears to revolve round the earth in twenty-four hours, or at the rate of 15° in an hour. Now if we find that it is 9 a.m. at the ship, when it is noon at Greenwich, the ship must be in longitude 45° W. If, on the other hand, the chronometer showed 5 a.m. the vessel would be in longitude 60° E. The Greenwich time may be calculated from a lunar observation, which the perfection of the modern chronometer and the shortening of voyages have driven out of the field. To get the time at ship, we have recourse to spherical trigonometry, or rules and tables based on it, to calculate the hour angle. The sun's westerly hour angle is the apparent time at place (A.T.P.), which is converted into mean time (M.T.P.) by applying the equation of time, which, like declination, &c., is supplied by the *Nautical Almanac*. If the body observed is a star, we get the M.T.P. by adding to the hour angle the star's right ascension, and subtracting that of the mean sun, which is a transposition of the well-known and useful equation, ✳'s hour-angle = M.T.P. + mean ☉'s R.A. − ✳'s R.A. which we use for time azimuths, and for finding when a body will cross the meridian, for when hour angle = 0

M.T.P. = ✳'s R.A. − mean ☉'s R.A.

Now, just as the simplest way of getting the latitude is by a body on the meridian, so the best way of calculating the time for longitude is by using the altitude of the sun or a star on the prime vertical (*i.e.* the vertical circle passing through the E. and W. points of the horizon). If, by means of this altitude, or any other way, we could tell the exact instant that the body was on the prime vertical, there being a right angle in the triangle A P Z (Fig. 1), we could calculate the time by right-angled spherics from any two of the three sides, colatitude, polar distance and zenith distance, or their complements latitude, declination and altitude. But in practice, whilst it is easy to get the meridian altitude, it is impossible to be sure of getting the altitude exactly on the prime vertical. It is, however, comparatively easy to observe a body near enough to the prime vertical to be very favourably situated for finding the time by oblique spherics (or formula deduced from it), and thence the longitude; and this, combined with the meridian altitude, is perhaps the simplest and most favourable method of fixing the position at sea. However desirable, it is by no means necessary that the body be near the prime vertical, though, generally speaking, the further it is removed from it, the less favourable the conditions, till at last the triangle becomes an impossible one.

Every particular star is, at every instant of time, in the zenith of some spot on the surface of the earth. At any given instant of time, let Z, in the accompanying figure,

FIG. 2.



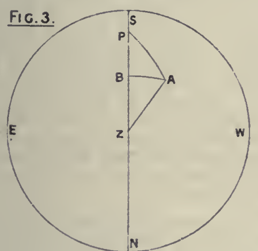
be this spot, as it would be seen from the zenith; then the concentric circles represent circles of equal altitude on the earth's surface, *i.e.* everywhere on the outermost circle the star will be on the horizon (neglecting refraction, &c.). On all places in the next circle the altitude will be 22½°, on the next 45°, &c.; and, of course, there may be an infinite number of imaginary circles between the spot under the star and the outer circle, which brings it on the horizon. Now, it is evident that at whatever point on any of the above circles an observer may be situated, a tangent to the circle at that point will be at right angles to the bearing of the body; but a small portion of the circle may be represented by a similar portion of the tangent, and it is evident that the larger the circle (which is equivalent to the smaller the altitude), the longer the portion of its circumference that may with impunity be treated as a straight line. This straight line is known as "a line of position." The line of position obtained from a meridian altitude differs from all others in this, that the ship is not only on the circle of equal altitude, but on its vertex,[1] and the tangent may be assumed as of infinite length.

[1] Compare figure in paper on "Navigation," (p. 104) illustrating composite sailing, where, however, the circles that touch the parallel are great circles.

The line of position by an altitude for time was first discovered by Captain Sumner, who, being doubtful of what latitude he was in, worked an observation with three different latitudes. On projecting these positions on the chart, he found that all three were in a straight line, which produced, led to the Smalls light, whose bearing he thus had, without knowing how far it was away. He steered along the line till he found it. He did not observe, however, that this line was at right angles to the sun's bearing, nor would it have shortened his problem if he had, because it then took as many figures to calculate one longitude and the azimuth as two longitudes with different latitudes. In these days, when azimuths can be taken out of tables by inspection, nearly half the figures are saved by using the azimuth to obtain the line of position.

Thus, no matter what the bearing of a heavenly body, if we can observe its altitude and the corresponding time at Greenwich, it will afford us some information as to the position of the ship. If it is on the meridian, with a minimum of labour we get the latitude in the simplest and most accurate way available to the navigator. If it is not too far in azimuth from the meridian, there are plenty of methods by which the observation can be reduced to the corresponding meridian altitude, and the latitude obtained. If it is on the prime vertical, the line of position will be a portion of a meridian. If it is on any intermediate bearing, the line of position will be at

FIG. 3.



right angles to the bearing of the body, through the latitude by account, and the longitude deduced from it and the observation. Any two lines of position, provided they do not cross at such an oblique angle that the intersection is ill-defined, will fix the position of the vessel. When the star is so far from the meridian, and the time too uncertain to be favourable for working as an ex-meridian, and yet too far from the prime vertical to give an accurate hour angle, the new navigation, originated by the French, and introduced into England by Captain Brent and Messrs. Williams and Walter, R.N.,[1] gives a better line of position than the older methods. By it you calculate the *altitude* for the position of the ship by dead reckoning. If this agrees with the observed altitude (corrected), the line of position is at right angles to the bearing of the star, through the position by D.R. If, however, the observed altitude is, say, 10′ greater than that calculated, the ship must be that much nearer the spot on the earth where it was in the zenith at the moment of observation; so you lay off 10 miles (1 sea mile being practically 1′ of a great circle) from the D.R. position, in the direction of the star, and through this point rule the line of position at right angles to the bearing; or the corrections for the D.R. latitude and longitude may be calculated by trigonometry (see Fig. 2).

The triangle A P Z (see Figs. 1, 3, 4 and 5) is the most important in nautical astronomy. Up to this, I have only referred to it as a means of finding hour angles (angles at P); but not only is it also used for finding azimuths (angles at Z), for if the time be accurately known, we can utilise it for finding the latitude by a star with a large hour angle. To make it clearer, and avoid complicating Fig. 1, I give figures here on the plane of the horizon. In these, let A represent three different stars, and from A let fall a perpendicular on the meridian. Then right-angled spherics can be utilised, and the latitude obtained with fewer figures than by the new navigation. Either before or after the ✱ or ✱s shown in the figure, are obtained for latitude, observe one on or near the prime vertical, for longitude and time, which will give accurately the hour angles of the latitude ✱s, allowing, of course, for any easting or westing made between the observations. Then

$$\text{Sin AB} = \sin h \sin p,\ \tan \text{PB} = \cos h \tan p \text{ and } \cos \text{ZB} = \sin a \sec. \text{AB}$$

h being the hour angle, p the polar distance, and a the true altitude. The sum or difference of PB and ZB = the colatitude. This method is even shorter than it appears at first sight (because the logs. can be taken out in pairs), and is concise and accurate when the data is trustworthy, and, even if the hour angle is doubtful, will give a good line of position.

Unfortunately, the navigator has often to work with data that are more or less doubtful. In the triangle, A P Z, he uses the three sides to find the hour angle (P). Of

FIG. 4.

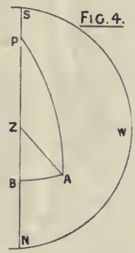
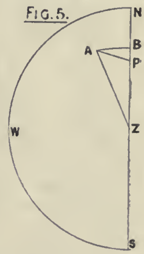


FIG. 5.



these the polar distance is accurate; the latitude is often doubtful enough to affect the hour angle, though not generally the line of position, and the altitude may be vitiated in various ways. It therefore behoves him to take his observations in a way that errors, that he can neither detect nor avoid, will neutralise each other. Few human eyes are optically perfect; the best sextants, though beautiful instruments, are not absolutely faultless, and their errors are liable to alter by a knock or jar; the sea horizon is fickle, and refraction uncertain; but the whole of these errors may be minimised, if not absolutely, eliminated, in the resulting latitude—for example, by observing (Fig. 1) the ✱'s S^1 and S^2. With about the same altitude, their refraction will probably be similarly affected; the horizon is *generally* subjected to the same influences all round; the personal and instrumental errors may be taken as constant, for the same observer and sextant, at any particular time and place when the altitudes are somewhat similar. Suppose the sum of these errors to be $-2'$, and unallowed for, the effect would be, in each case, to make S^1 and S^2 appear nearer Z than the truth; and while each resulting latitude would be 2′ wrong, the mean would be correct.

Again, in the single altitude problem (Figs. 3, 4 and 5), if the time had been calculated by two stars, one east and the other west, the time and thence the hour angles of the latitude ✱s would be less liable to the foregoing errors; and if the three stars were taken and worked for latitude, each would be a check on the others, and opposite bearings would tend to neutralise errors of

[1] "Exmeridian Altitude Tables and other Problems," by these authors, is an excellent work.

altitude. At the same time, single observations very generally give sufficient accuracy for all the purposes of navigation, though they are not to be so absolutely relied on as a systematic set.

I must not conclude without another word on the lunar method of finding the Greenwich time, which I dismissed rather summarily, further back, in favour of chronometers. For long voyages across the ocean, when a vessel is from fifty to one hundred days without sighting land, lunars may still be used, as before the days of steam, not so much for finding individual longitudes as for *rating the chronometers*, and for this purpose it is essential that a series of distances be measured on each side of the moon, and the mean of all the easterly ones, meaned with the average result of those taken to the westward, to eliminate as far as possible personal and instrumental errors. An expert lunarian, who practises regularly, may find out by experience about how much on each side, single distances, measured east or west, would place his ship; otherwise, the result of a single lunar could not be relied on to give the longitude to nearer than $\frac{1}{2}°$ or 30′, even if taken under favourable circumstances. In a steamer vibration almost precludes the observation, and the chronometers ought seldom to be 5s., and never 30s. wrong. In ports where there are not time-balls, the chronometer errors can be found accurately with the artificial horizon, observing, if possible, ✱s east and west, or the ☉ and ☽, or even by the ☉ alone. It is generally possible to verify the errors at sea by sighting land, or even to get a fair rate, by observing ✱s E. and W. of meridian to the sea horizon. An error in the chronometer does not alter the *direction* of a line of position, but moves it bodily E. or W.

As an example of the use of a single line of position, suppose a steamer to be approaching Cape Finisterre from the Channel, and only able to obtain one observation, the sun right ahead. The line of position, being at right angles to her path, will be a good check on her speed, but none whatever on the course she has made good. On the other hand, if the sun (or star) had been observed on her beam, the line of position would be no check on the speed, but would indicate the course made good, and whether, if it was continued, it would clear the land. In soundings, a line of position may be combined with the depth of water to fix the position.

The tendency of modern navigation is to become too stereotyped—to do everything by tables, which obscure the mental vision, and to relegate to the bookshelf that knowledge of theory which, combined with practical experience, is the surest guide to the navigator in deciding on the best way of utilising his observations, and which method, in any particular case, will give him the best line of position. If theory is not the only thing that will teach him, that while when the sun culminates near the zenith, he can get good observations for time within a few minutes of its passing the meridian, a Sumner line derived from such observation would be almost useless, owing to the smallness of the circle of equal altitude; it will certainly make him acquainted with the fact in a tenth of the time that unaided experience will. Some of the so-called short methods are only short because of preliminary calculations that are not counted by the authors in the work, and which may all go for nothing if some particular altitude is not obtained, that a passing cloud may render it impossible to measure; or else they involve several vexatious interpolations, which are quite as much trouble, and, if performed mentally, much more liable to error, than taking out and adding up a few lines of logarithms.[1]

[1] Every aspiring young navigator should make himself acquainted with spherical trigonometry, especially with "Napier's Analogies," which combine the brevity of short methods and special tables with the accuracy of pure mathematics. He should also accustom himself to drawing the figures for his problems till he can see the triangle in his mind's eye without a diagram.

Finally, it is better to get several observations of different bodies at (or about) the same time, than two of the same, with the requisite interval for change of bearing, because one of these observations has to be reduced to what it would have been if taken at the same place as the other, and the reduction may be vitiated by errors of the run, as explained in the paper on "Navigation," which it is one of the great objects of nautical astronomy to detect and be independent of. J. F. RUTHVEN.

THE LONDON UNIVERSITY BILL.

ALL friends of scientific and educational progress will be glad that the second reading of the London University Statutory Commission Bill was carried in the House of Commons on Tuesday without a division, and has been referred to the Standing Committee on Law. We are thus brought within sight of a long-delayed and much-needed reform, and all who have assisted in educating public opinion upon the measure, with the object of removing the unreasonable obstruction placed in its way, may congratulate themselves upon the success which their efforts have at last achieved. It is not to the credit of Ministers that a scheme of such deep importance to the best interests of the country should have been permitted to languish for so long a period, seeing that the necessity for establishing a teaching university in the metropolis is admitted by practically all public bodies connected with science and higher education in London. Had they possessed the courage of their convictions the measure would have passed into law without difficulty in 1896 or 1897, and its withdrawal upon each occasion must be counted as a lost opportunity. The opposition which then threatened the scheme would doubtless have collapsed so completely as it did on Tuesday, when it received so little support that the measure was agreed to even without a division. We reprint from the *Times* some parts of the speech made by Sir John Gorst in moving the second reading, and of the speeches which followed.

Sir John Gorst commenced by giving a general history of the scheme for a teaching University, and pointed out that the present Bill is based on the report of the Cowper Commission, which unanimously recommended that there should be no second University in London, and that the necessary modification of the constitution of the London University should be effected by means of a statutory Commission. He continued: "I should like to inform the House of the various bodies by which this scheme has been considered and accepted. It has, first of all, been accepted by the Senate of the University of London by a majority of 22 to 2—practically a unanimous acceptance by the Senate of the University of London. It has been accepted by the Royal College of Physicians, by the Royal College of Surgeons, by the Society of Apothecaries, by University College, by King's College, by the Bedford College for Women, by the twelve medical schools which exist in London, by six theological colleges, by the Society for the Extension of University Teaching, by the Technical Education Committee of the London County Council, by the Corporation of the City of London, by the City and Guilds Institute, by the Polytechnic Council, by the Royal Society, and all the other learned societies in London; and, finally, it has been accepted by the Convocation of the University. I say it has been accepted by the Convocation of the University of London because, by the charter of the University, a particular mode is specified in which the Convocation of the University of London shall express its opinion on the subject. The Convocation expresses its opinion by a meeting at which discussion takes place, and at which a vote is given by the persons there present. Such a meeting of Convocation has been held, and this present scheme has been approved in that legal and formal manner in which the charter of the University requires the opinion of Convocation to be expressed—by a majority of 460 to 239."

Referring to the views of graduates as shown by voting papers, Sir John Gorst said, "Even assuming that the existing graduates of the University of London were unanimous in their objection to the present scheme, I do not know why the personal feelings of London graduates should stand in the way of a great national reform—of a national development of higher education—when in the scheme, as I shall presently show, their rights and interests, such as they are, are most carefully and most securely preserved. There is a further objection brought forward which we shall no doubt hear of from the right hon. baronet, the member for the University of London, and that is a claim that the Convocation of London should have a veto upon any scheme which Parliament may enact for the purpose of developing the University of London. That claim is based upon Article 21 of the charter, which says that if a new or supplemental charter is given by the Crown to the University of London, the power of accepting it shall be exercised by the Convocation of the University. The answer to that is, first of all, that this is a restriction which applies to the charter and not to the action of this House. The Crown may very properly restrain its own power of granting any further charter, but it cannot restrain the power of the Houses of Parliament."

Sir John Gorst proceeded to point out how carefully the objections and fears of those who are opposed to this Bill have been met in the scheme which has been laid before Parliament. He said :—

"I am informed that there is a genera agreement among learned and scientific men, not only in this country, but in the whole of the civilised world, that in the highest parts of progressive science the attainments of students cannot be tested unless the teachers have some voice in setting the subjects of examination. That being the danger to be guarded against, the Bill appoints seven Commissioners by whom the statutes of the new University are to be framed. The Commissioners are Lord Davey; the Bishop of London; Sir William Roberts, a medical doctor and a Fellow of the University of London; Sir Owen Roberts, who is well known as having taken an active part in the spread of modern education; my hon. colleague the senior member for Cambridge University (Prof. Jebb); Michael Foster; and Edward Henry Busk, chairman of Convocation of the University of London. These Commissioners are constituted to frame the statutes for the purpose of carrying out the general scheme of the commission—that is, to so modify the existing University of London that it may fulfil the functions of a teaching University. I think the House may very well trust men like those I have named to frame statutes that will be in accordance with the best interests of education."

"The Government recommend this Bill to the House. It is not their scheme; it is a scheme which is the result of very long controversy and of a great deal of compromise, of give-and-take on the part of the various bodies, and they think it is a satisfactory conclusion of a very long discussed question. It will give a teaching University to London in the only way in which it can be given—namely, by the modification of the constitution of the existing University, and, in doing this, so far from injuring the existing University, it will increase its utility and its reputation."

Mr. Harwood moved an amendment for the rejection of the Bill, and Mr. Yoxall seconded it, but their views received little sympathy.

In speaking against the bill, Sir John Lubbock said those who had opposed the Bill had done so on four main grounds: first, that the result might be to imperil the position of science; secondly, that it might put the country colleges and private students at a disadvantage as compared with the candidates from London colleges; thirdly, that it might tend to lower the standard of the degrees; and, fourthly, that it took away the right at present possessed by his constituents to veto any change which in their judgment would interfere with the great work being carried on in the University. His objections were fully answered by Mr. Bryce, who, in the course of his remarks not only reminded his right hon. friend that Convocation had approved of the scheme, but also said that he should deny that Convocation had any more moral right than legal right to say what should be done with the University of London. He appealed to hon. members present who knew something both of the University of Oxford and of Cambridge, and he did not hesitate to say that the reforms which were passed some forty years ago with the greatest possible benefit and advantage both to the country and those Universities would never have been passed at all if the decision had rested with Convocation. His right hon. friend had set up, on behalf of the London University, a claim which was never listened to for a moment in that House in the case of the ancient Universities of Oxford and Cambridge. He submitted that they were not injuring the existing graduates. They were going to make the University a far more powerful and dignified body, and, incidentally, to enhance the value of her degrees. On a view of the whole matter it could not be shown that any injury at all would be done to the existing University. The work of teaching was incomparably more important than the work of examining. Much superstition attached to the degree; it was not so important as many people were inclined to believe; its value was as a test of teaching and stimulus to study, and the more it was made subordinate to teaching the better for education. For a long time the Bill had been wanted, for many schemes had been tried and had failed, and this scheme had received almost unanimous support from the teaching bodies and the approval of leading scientific men anxious to have a teaching University in London. He could not conceive that there was any foundation for the fear that science teaching or science examination would suffer; that was the last danger into which the new Senate would be likely to fall. All who had the well-being of University teaching at heart, who desired the extension of technical education with better facilities for the humbler classes of the community should unite in support of the scheme, which was approved by both political parties, and he earnestly hoped the House would accept it.

After other speeches the amendment was by leave withdrawn, and the Bill was read a second time, and referred to the Standing Committee on Law.

THE ART AND SCIENCE BUILDINGS AT SOUTH KENSINGTON.

THE agitation against the new departure of the Government in relation to the proposed extensions of the Science and Art Buildings at South Kensington grows apace.

Following upon the Report of the Select Committee of the House of Commons, and the Memorial addressed to Lord Salisbury by the President and Council and many Fellows of the Royal Society, comes still another Memorial, this time from the Royal Academy, and already signed by the President and Council and many members of the Royal Academy, with other representatives of Art, strongly urging that the policy stated in 1890 should be adhered to.

The Royal Academy memorial runs as follows :—

Memorial to the Most Honourable the Marquis of Salisbury, K.G., F.R.S., Premier and Secretary of State for Foreign Affairs.

Whereas in 1890 Parliament voted 100,000*l*. for the purchase of a site at South Kensington upon which to erect suitable buildings for the Science Museum of the Department of Science and Art, and for the extension of its science schools, in accordance with the recommendations of the Royal Commission, over which the Duke of Devonshire presided in 1874, as well as of various committees and other high scientific authorities, and of a Treasury committee appointed in 1889.

And whereas when in 1891 the Government had proposed to erect an art gallery on the site, a memorial, signed by the president and officers of the Royal Society and representatives of the Universities of Oxford, Cambridge, and of many other learned bodies both in London and in the provinces, was addressed to your lordship, showing cause why the site should not thus be allocated.

And whereas the scheme was withdrawn, and it was stated by the late Right Hon. W. H. Smith, M.P., in the House of Commons on April 16, 1891, that the "Government has at disposal more than three acres of vacant land facing the Imperial Institute, and considerable areas beyond to the south of the present Southern Galleries. A portion of these vacant lands can be utilised for the extension of the College of Science and for the future growth of the science collections. Additions to the College of Science must, in any case, take the form of a separate building divided from the present building by Exhibition Road"; while the Chancellor of the Exchequer, the Right Hon. G. J. Goschen, informed the deputation which waited on the Lord President of the Council in May 1891, that "we hope to bring science into one centre fronting the Imperial Institute."

And whereas this arrangement which left the ground on the east of Exhibition Road for the extension of the Art Museum has been generally accepted since 1876, when the Royal Commission for the Exhibition of 1851 offered land and a building with a view of carrying out the recommendations of the Duke of Devonshire's Commission in 1874 to provide the needed accommodation for science at South Kensington.

And whereas we are informed that this arrangement is in danger of being altered by the erection of science buildings on the east side of Exhibition Road.

We, the undersigned members of the Royal Academy and others practising various branches of the arts as a profession, desire most respectfully to express to your lordship our strong opinion that it is desirable to adhere to the former policy, which has been acted upon and publicly acknowledged by the Government since 1890, considering the urgent need of much additional space even for the present art collections of the South Kensington Museum, and the necessity for making some provision for their proper development, we are convinced that any attempt to provide on the east side of Exhibition Road for the necessary expansion of the science buildings will render it impossible to meet the future requirements of the industrial arts, for the promotion of which the South Kensington Museum was founded. We also feel that in praying your Lordship to reserve for art that portion of the land which still remains vacant on the east of Exhibition Road, we are not making an exorbitant demand. The whole plot of ground belonging to the Government on that side is much smaller than that devoted to the Natural History Museum, which only represents one branch of science without either teaching or applications, while the space on the east of Exhibition Road has to provide not only for the Art Museum, but also for the administrative offices of the Department of Science and Art, the Royal College of Art, and part of the Royal College of Science.

We hope to be able to give the full list of signatures next week.

NOTES.

AT the annual meeting of the Royal Society for the election of Fellows, held on Thursday last, the following were elected into the Society:—Mr. H. F. Baker, Prof. E. W. Brown, Dr. Alexander Buchan, Mr. S. F. Harmer, Mr. Arthur Lister, Lieut.-General C. A. McMahon, Prof. W. Osler, Hon. C. A. Parsons, Prof. Thomas Preston, Prof. E. Waymouth Reid, Mr. Alexander Scott, Mr. A. C. Seward, Mr. W. A. Shenstone, Mr. H. M. Taylor, and Mr. James Wimshurst. The certificates of these new Fellows, setting forth the scientific work accomplished by each, were reprinted in NATURE of May 12.

THE ladies' conversazione of the Royal Society was held on Wednesday in last week, and was attended by a large and brilliant assembly. Most of the objects and experiments which were shown at the conversazione were exhibited at the soirée held at the beginning of May; and as these have already been described in NATURE (p. 61), it is unnecessary to refer to them again. The exhibit which attracted the greatest amount of attention was the spectrum of krypton, the new constituent of atmospheric air, discovered by Prof. Ramsay and Mr. Travers.

PROF. H. A. LORENTZ, of Leyden, and M. Émile Picard, of Paris, have been elected, by the London Mathematical Society, honorary foreign members, in succession to the late Profs. Brioschi and Hertz.

WHEN Hutton published the two volumes of his famous "Theory of the Earth," in 1795, he left a third in manuscript, which was declared by his friend and biographer, Playfair, to be necessary for the completion of the subject. Yet this important contribution to science has not only never been published, but seems to have almost passed out of mind. Sir Archibald Geikie last year set inquiries on foot with the view of trying to trace the lost manuscript. A portion of the volume, comprising Chapters iv. to ix., came into the possession of Leonard Horner, who eventually presented it to the library of the Geological Society of London, where it has remained since 1856. But every effort to discover the rest of the work has hitherto failed. At Sir Archibald's request, the Society has agreed to publish the six chapters in its possession, each of which is complete in itself; and he is now engaged in preparing the work for the press. The chapters contain some interesting narratives of Hutton's journeys in Scotland in search of illustrations of his theory. In particular, they include his account of the celebrated visit to Glen Tilt, where he found the granite veins which filled him with such exuberant delight that his guides were convinced he must have discovered a vein of silver or gold. They contain also an account of an expedition into Galloway, and a remarkably full description of the geology of the island of Arran. The volume will be interesting to geologists as a continuation of one of the great classics of their science.

AS the two last nominations of foreign knights of the Prussian Order *pour le mérite* have fallen to British subjects, it may be of interest to give a list of the existing members. The Order received its French title from its founder, Frederick the Great, who, as is well known, had a partiality for that language. It was at first given for military services only, but its statutes were remodelled in 1842 by King Frederick William IV., and the class "für Wissenschaften und Künste" was instituted. The German knights of this class, with whom the election into the Order practically rests, are limited to thirty in number, and at present are: A. Menzel, Chancellor; T. Mommsen, Vice-Chancellor; the other members in the order of election being, in the Section of Science: R. W. Bunsen, Max Müller, E. Zeller, T. Noeldeke, J. V. du Vernois, A. Auwers, E. Pflüger, H. Vogel, A. v. Baeyer, O. Fürst v. Bismarck, F. Kohlrausch, H. Grimm, H. Brunner, A. v. Kölliker, H. Usener, W. Hittorf, A. Weber, C. Neumann and Schwendener. In the Section of Art: L. Knaus, A. Achenbach, J. Schilling, R. Begas, F. Schaper, E. v. Gebhardt, H. Ende and A. Hildebrand. The foreign knights, limited to the same number, are, in the Section of Science: O. v. Boethlingk, C. Hermite, Sir G. G. Stokes, N. A. E. v. Nordenskjöld, M. Berthelot, O. v. Struve, Lord Kelvin, Lord Lister, V. Jagic, P. Villari, H. Kern, J. G. Agardh, M. J. de Goeje, G. V. Schiaparelli, F. Imhoof-Blumer, J. H. van 't Hoff, A. O. Kowalevsky, W. Stubbs (Bishop of Oxford), O. Montelius, Sir John Murray and Sir W. H. Flower. In the Section of Art: L. Alma Tadema, G. Verdi, G. Monteverde, E. Wauters, L. Passini and F. Pradilla.

A SPECIAL meeting of the Royal Geographical Society will be held on Monday, June 27, at 4.30 p.m., when Prof. Elisée Reclus will describe his plans for the construction and erection of a great terrestrial globe on the scale of 1 : 500,000 (8 miles to an inch). The president, Sir Clements R. Markham, K.C.B., F.R.S., will occupy the chair. The subject is one which will interest both geographers and engineers.

THE Royal Commission for the Paris Exhibition of 1900 are now prepared to circulate information respecting the exhibition. The classification and rules for exhibitors, together with forms of application for space, can be obtained by applying to the Secretary of the Royal Commission, Paris Exhibition 1900, St. Stephen's House, Westminster, S.W.

IN connection with the seventieth meeting of the Society of German Naturalists and Physicians, to be held at Düsseldorf in September, a series of exhibitions of scientific apparatus and objects has been arranged. An exhibition of objects illustrating the history of medicine and science will be open from July to the end of September. An exhibition of apparatus and photographs illustrating scientific applications of photography will commence in August and continue open until the end of September. New instruments and apparatus will be exhibited from September 17 to September 28, and prizes will be awarded for the best of them. Any machine, apparatus, preparation, or object invented since 1888 may be entered for this exhibition. Objects illustrating methods of instruction in physics and chemistry will be exhibited from September 17 to September 25. Communications referring to the exhibitions should be addressed, Herrn Director Frauberger, Düsseldorf, Friedrichsplatz 3/5.

THE sixty-sixth annual meeting of the British Medical Association will be held at Edinburgh on July 26-29, under the presidency of Sir T. Grainger Stewart. A detailed statement of the arrangements which have been made for the meeting appears in the *British Medical Journal.* An address in medicine will be delivered by Prof. T. R. Fraser, F.R.S.; an address in surgery will be delivered by Prof. Thomas Annandale; and an address in psychological medicine will be delivered by Sir John Batty Tuke. The programme of business arranged by the officers of the sixteen sections is long and varied. In addition to the sections in which the business of the annual meeting is ordinarily carried on, there are for the first time this year sections devoted to medicine in relation to life assurance and to tropical diseases, two departments which have grown into positions of great practical importance during the present generation. A considerable number of distinguished members of the medical profession resident in America and the Continent of Europe have accepted invitations to take part in the proceedings.

THERE are at Prague two distinct botanical gardens, one belonging to the German, the other to the Bohemian University. The former is now under the direction of Prof. R. v. Wettstein, the latter under that of Prof. L. Celakovsky.

THE Rev. Arthur C. Waghorne, Bay of Islands, Newfoundland, for nearly twenty-five years a missionary in Newfoundland, offers for sale collections of Labrador and Newfoundland plants, both flowering and flowerless, named by competent authorities.

WE learn from the *Oesterreichische Botanische Zeitschrift* that M. Philippe Plantamour-Prévost has bequeathed his villa "Mon repos," on the shore of the lake, to the city of Geneva, for the reception of Delessert's herbarium, and for the botanic garden founded by A. P. de Candolle.

IN a note in the *Kew Bulletin*, No. 135, for March 1898, reference is made to the probable success of a process for the artificial manufacture of indigo on a large scale. The Badische Anilin und Soda Fabrik, Ludwigshafen, is now manufacturing "indigo-blue" at a price which very seriously threatens the prosperity of the culture of indigo in India.

ACCORDING to the *Botanical Gazette*, the coming meeting of the American Association for the Advancement of Science at Boston promises to be one of the most notable in the history of the Association. It is the fiftieth anniversary, and special efforts are being made to arrange a worthy celebration. The local committees have been appointed, and the week selected is August 22-27. The local secretary is Prof. H. W. Tyler, of the Massachusetts Institute of Technology.

PROF. JOHN W. HARSHBERGER, of the University of Philadelphia, pleads, in the *Botanical Gazette*, for the establishment of a tropical botanical station in Mexico. The locality especially advocated is a station called Las Canoas, on the Mexican Central Railroad, 144 miles from Tampico. Las Canoas is situated in a beautiful basin-shaped valley 3500 feet above the sea-level. There is an abundant supply of pure water, and the air is clear and bracing. The vegetation is described as of great luxuriance, and the flora is remarkably varied and beautiful. A temporary station could be established here with very little expense, and the virgin forest would supply enough botanical material for years to come.

AN important investigation in connection with mortality is being carried out jointly by the Institute of Actuaries and the Faculty of Actuaries, under the superintendence of Mr. T. G. Ackland, who now has a staff of thirty clerks constantly at work upon a large body of cards containing statistics supplied by assurance companies. The whole of the data relating to the experience in respect of annuitants have been dealt with, and the tables are now in the press. In response to applications made by the Presidents of the Institute and the Faculty, life assurance offices have undertaken to contribute liberally towards the cost of the investigation, which will necessarily be very heavy. The contributions of the companies at present promised or received amount to 10,953*l.*, which sum, it is hoped, will cover the larger portion of the expense, and thus relieve the Institute and the Faculty from any anxiety as to their ability to carry to a satisfactory conclusion this valuable investigation.

FROM a report before us we see that last year was an eventful one in the history of the New York Zoological Society, and it ended in the establishment of the Society as a permanent institution for the promotion of zoological knowledge. All the original objects have been furthered, and noteworthy results have been obtained. The proposal by the Society that 261 acres of land in South Bronx Park should be set apart as the site of the New York Zoological Park, has been unanimously adopted by the Commissioners of the Sinking Fund. The general plan of the Park has been completed and approved by the Park Commissioners. The collections and animal buildings, to cost not less than 250,000 dollars, are to be presented to the City by the Society; and the City is to prepare the ground for occupancy, and to maintain the Zoological Park when established. The sum of 100,000 dollars has been subscribed towards the gift from the Society to the City. This was the amount which had to be raised before the plans could be proceeded with, and work could not be commenced until it was subscribed. Since March 15, 1897, the membership of the Society has increased from 118 to 600; but in order to carry out the plans on a scale worthy of New York, the Society should enroll at least 3000 annual members. The Society has decided to systematically foster both the painting and sculpture of animals; and, with the idea of establishing a school of animal painting and sculpture, provisions for studios have been made in the plans of several of the buildings.

WE are glad to learn from the sixth annual report of the Sonnblick Society for the year 1898 that several improvements have recently been made in the arrangements of this important mountain station, and that the various observations and experiments are carried on with vigour. The meteorological observatory at the summit has now been quite separated from the visitors' refuge which existed in the same building, and a well-equipped station has also been established at the foot of the mountain, at which comparative observations will be regularly made, and will render those at the summit of higher value. These elevated stations are of much scientific interest in connection with the frequent ascents by manned and unmanned balloons for the purpose of investigating the higher regions of the air.

WE have received from Mr. N. A. F. Moos, the Director of the Bombay Observatory, his report to the Secretary to the Indian Government for the year ending March 31, 1898. This observatory is devoted chiefly to terrestrial magnetism and meteorology, astronomical observations being restricted solely to time observations. All the magnetographs have been in constant action throughout the past twelve months. On June 12 the traces clearly showed the small vibration due to the earthquake on that day; and on September 21, at 10h. 40m., small disturbance noticed in the horizontal force curve was traced to the earthquake in Borneo. The statement showing the extent to which the various observations have been reduced, and the reductions checked, indicates that these keep good pace with the observations themselves, nearly everything being checked to either February or March of this year.

THE following remarks from a lecture on the aims and methods of pharmacology, recently delivered at Oxford by Dr. W. J. Smith Jerome, and published in the *Lancet*, will interest many scientific investigators:—"Another method by which pharmacological knowledge is to be obtained is that which is generally understood as research. This, I think, is an ideal form of work, and the leisure and acquirements needed for it are, in my opinion, well worth striving after. A laboratory, it is true, may not be an attractive object. It is not usually gratifying to the æsthetic sense; there are apt to be too many and too obvious manifestations of matter apparently in the wrong place, but it possesses, or at least should possess, one of the fundamental attributes of beauty—viz. a fitness for the purpose it is intended to subserve; and if in itself not beautiful, it enshrines what is *par excellence* 'a thing of beauty and a joy for ever.' It enshrines, it is pervaded by, the spirit of truth—truth which serves both as a lamp to illumine and as a beacon to direct, and yet which shines with a pure and steady ray on those alone who seek to follow it in singleness of purpose. The work performed accords most aptly with Matthew Arnold's description of the work of nature. 'Toil unsevered from tranquillity. . . . Labour that in lasting fruit outgrows far noisier schemes, accomplished in repose, too great for haste, too high for rivalry.' And though it must be granted that the methods of the laboratory, like those of nature, are occasionally harsh, it must also be conceded that its results are useful and its aims beneficent. But even into this paradise of toil there enters or may enter one insidious sin—the lust of what is called 'priority.' This must be fought against and overcome, or else, like a gathering cloud, it will, if left unchecked, roll onwards and most surely darken all. And why should it not be fought against and overcome? Each fact discovered in the pursuit of knowledge, discovered it matters not by whom or when, and even when unimportant in itself, may prove a stepping-stone by which that knowledge mounts to other and far higher things. This is the worker's real recompense; it is this pregnant possibility which makes work, honest work, like virtue, its own great reward."

THE current number of the *Annales de l'Institut Pasteur* contains an account, by Dr. Sanarelli, of the preliminary results he has obtained in the use of antitoxic serum in cases of yellow fever. It will be remembered that Dr. Sanarelli was the first to isolate the specific bacillus of yellow fever, and he has since been endeavouring to procure through its agency an efficient antitoxin. Great difficulties have been experienced in rendering animals satisfactorily immune to infection, and it takes from twelve to fourteen months' treatment before a horse can be regarded as vaccinated. Dogs, which have undergone a series of inoculations during a year or more, and are ultimately able to withstand a large dose of the toxin, are still very adversely affected by each fresh inoculation of the virus. So far this anti-yellow-fever serum appears to exert a protective action against yellow-fever microbes, but not against their toxins, and in the present state of the investigations good results can apparently only be hoped for when the serum is employed at a very early period after infection, or as a precautionary measure to ward off the disease; in this latter respect, Sanarelli has obtained some highly encouraging results. The Government of the province of Saint Paul in Brazil have now decided to establish an institute for promoting the further study of the serotherapy of yellow fever, and it is hoped that before long the elaboration of a specific treatment, both curative and preventive, will succeed in banishing a disease which is with justice looked upon as the scourge of the American continent.

THE *Klinisches Jahrbuch*, published by Gustav Fischer of Jena, contains in its last number the report drawn up by Messrs. Kirchner and Kübler on leprosy in Russia. These gentlemen were deputed by the German Government to conduct this inquiry, and made a careful tour of inspection through the Russian eastern provinces right up to St. Petersburg. It is very difficult to obtain an accurate estimate of the number of cases of leprosy in Russia, as compulsory notification of the disease has only been recently introduced, but it is stated to be about 5000. Of late years great energy has been displayed in endeavouring to prevent the spread of infection. Numerous leprosy isolation hospitals have been established, and many of these were visited by the inspectors. They call attention to the fact that the majority of these leprosy establishments have been founded not by the Russian Government, but by the great landed proprietors in the district, and that private munificence helps largely in dealing with cases. The authors express decidedly their firm conviction of the contagious character of the disease, and state that the only hope of stamping it out is to establish institutes for the isolation and treatment of its victims.

MUCH attention has been paid in Italy during the last few years to the pulsations of distant earthquakes, and to the best means of recording them. In a valuable paper contributed to the *Bollettino* of the Italian Seismological Society (vol. iii. No. 9), Prof. Grablovitz compares the different types of instruments now in use for their registration. He deprecates the recommendation of an instrument for universal employment as premature, and as discouraging the improvement of other apparatus. Nevertheless he attempts to clear the ground so far as regards the mode of registration, preferring the mechanical methods used in Italy to the photographic methods used in Germany and England, on account of their comparative cheapness and the greater velocity that can be given to the moving paper. On this last point he lays special stress, as it gives a clearer diagram and enables the time of the different phases to be determined with greater accuracy.

IN the same journal, Dr. Cancani illustrates the value of these remarks by describing the horizontal pendulums recently erected by him at the Observatory of Rocca di Papa, near Rome. These are similar in principle to the instrument employed by von Rebeur-Paschwitz, but are much larger, the distance of the tip of the recording pen from the vertical through the upper fulcrum being 2·70 metres. Each pendulum carries a mass of 25 kg. and has a period of oscillation of 12 seconds. The record is made on a strip of paper which passes under the pens at the rate of 60 cm. an hour. A tilt of one second at right angles to the plane of the pendulum deflects the pens 2 mm. The interesting records of the Calcutta earthquake given by these pendulums is reproduced (on half the natural scale) in NATURE, vol. lvi. p. 346.

THOUGH fishing is carried on at most of the villages and towns around the coast of Jamaica, the amount of fish obtained is far from sufficient to supply the needs of the population of the island. It has long been surmised, however, that the industry is capable of considerable extension, that the waters are teeming with suitable fish, and that with improved modern methods, such as steam-trawling, sufficient fish might be obtained to render the fresh supply more adequate to the needs of the inhabitants, and that native cured fish should in a large measure take the place of the imported article. With this in mind, the Carribbean Sea Fisheries Development Syndicate was formed last year in England, and a steam trawler was chartered to test the possibility of increasing the fishing industry. The operations and results are described by Mr. J. E. Duerden, Curator of the Jamaica Museum, in the *Daily Gleaner* of April 16, and from them it appears that the endeavour to establish a fishery industry in Jamaican waters on the large scale attempted will not meet with success; firstly, on account of the coral nature of the greater part of the sea-floor rendering the use of a trawler impossible; secondly, and more important, because of a general scarcity of fish. It is a curious fact that fish from deep water, on being brought to the surface, are nearly always so distorted by the expansion of the gases within them as to be rendered useless for market purposes. With regard to the scientific results of the experiments, an abundance of material other than fish was obtained, some of which has been presented to the Museum of the Institute of Jamaica, and is briefly described by Mr. Duerden. Perhaps the most remarkable feature of the hauls from a depth of about ten fathoms is the variety, abundance, and size of the sponges. A large, black, massive, almost spherical form occurred in great quantity; specimens 5½ feet round and 20 inches high were often dredged. The small pores were thickly inhabited by a small species of the Crustacean *Alphæus*. Special interest attaches to the re-discovery of the peculiar West Indian genus *Bergia*, concerning the exact scientific position of which there is much doubt. The corals met with in greatest abundance by the trawl were the various species of *Madrepora*. Sometimes large pieces would be brought up, but usually only the small more fragile branches remained entangled in the net. A few other species of corals not obtainable from shallow water were also secured.

THE South-eastern Union of Scientific Societies recently held its third annual congress in Croydon, the Mayor and Corporation having placed the Town Hall at the service of the union for the purpose. The aim of the union is "to win for science such benefits as are found to accrue in manufactures from division of labour; and in trade, commerce, and finance from co-operation." No attempt, however, is made to secure uniformity among the thirty-one societies affiliated to the union. Last year's president of the union was the Rev. T. R. R. Stebbing, F.R.S., and the president-elect, who opened the congress, was Prof. G. S. Boulger. In his presidential address Prof. Boulger directed attention to the position of natural history in this country sixty years ago, with special reference to the character of field work and its organisation; contrasted that position and that character with those of our present-day geology and biology; traced briefly the cause of the difference, and suggested some lines along which future energies should be directed. The address was very appropriate to the occasion, and an instructive statement of the great change which the Darwinian theory had produced in scientific thought. The programme of the congress included papers by Mr. E. Lovett, on "The Folk-lore of Amulets and Charms"; Dr. H. Franklin Parsons, on "The nature of the soil in connection with the distribution of Plants and Animals"; "Entomology as a Scientific Pursuit," by Mr. J. W. Tutt; "Ancient and Modern Dene Holes and their Makers," and "Natural Gas in Sussex," by Mr. C. Dawson; "Place of Geology in Education," by Prof. Lobley; and "Photography in relation to Science," by Mr. J. H. Baldock. There was also a discussion of "Ideals for Natural History Societies, and how to attain them." The meeting was well attended, and should result in increased interest being taken in the study of nature.

THE fifth volume of the elaborate "System of Medicine," edited by Prof. Clifford Allbutt, F.R.S., has just been published by Messrs. Macmillan and Co., Ltd. The contents refer to diseases of the respiratory organs, of the pleura, and of the circulatory system.

AN interesting address upon "Light and Fire Making," delivered by Mr. Henry C. Mercer, has been issued by the Bucks County Historical Society, Doylestown, Pennsylvania. The address contains forty-five illustrations explaining the methods of producing fire by friction of wood, and by striking flint and steel; they also show some of the forms of lamps, candles, torches, and lanterns used in America and elsewhere.

AMONG handy reference volumes must be placed the "Yearbook of Scientific and Learned Societies," published by Messrs. Charles Griffin and Co., Ltd. The new volume contains particulars with regard to the constitution and membership of scientific societies in Great Britain and Ireland, lists of papers read during 1897 before societies engaged in fourteen departments of research, and a good index.

THE fourth edition of Prof. Wiedersheim's "Grundriss der vergleichenden Anatomie der Wirbelthiere" has just been published by the firm of Gustav Fischer, Jena. Since the appearance of the third edition five years have passed, and so much new work in morphology has been done in this period that the book has had to undergo complete revision. Not only has the new material been assimilated, but various changes have been made in the typography, and all references to authors have been placed in the excellent bibliography appended to the volume. Dr. Wiedersheim mentions that the second English edition of his work, adapted from the German by Prof. W. N. Parker, was prepared under his guidance, and the new material in the present German edition was taken into consideration.—The third revised edition of the attractive and exact "Lehrbuch der Botanik für Hochschulen," by Drs. Strasburger, Noll, Schenck, and Schimper has been published by Gustav Fischer. The first edition was published only four years ago, and the fact that three editions have now appeared is a testimony to its value and popularity. Botanists who have a difficulty in reading the German text will be glad to see the English translation which Messrs. Macmillan have lately published.—A large number of questions referring to heredity are discussed in the work entitled "La Famille Névropathique," by M. Ch. Féré, the second edition of which has been published by M. Félix Alcan, Paris. The volume brings together much information on the laws of inheritance in relation to disease, and the numerous references it contains will be found very valuable by students of heredity.—A second edition of a "Syllabus der Pflanzenfamilien," by Dr. Adolf Engler, has been published by the firm of Borntraeger, Berlin. The volume contains brief notes on medicinal and useful plants, and is intended more particularly for use by students of special and pharmaceutical botany.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss Nellie Biggs; a Dorsal Squirrel (*Sciurus hypopyrrhus*) from Central America, presented by Miss Trelawny; a Ring-necked Pheasant (*Phasianus torquatus*) from China, presented by Dr. C. Danford Thomas; a Pin-tailed Whydah Bird (*Vidua principalis*) from Africa, presented by Madame Caté; an Eyed Lizard (*Lacerta ocellata*), European, presented by Mr. H. F. Witherby; an Indranee Owl (*Syrnium indranee*) from Ceylon, a Florida Tortoise (*Testudo polyphemus*) from North America, deposited; four Wonga-Wonga Pigeons (*Leucosarcia picata*) from New South Wales, a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*) from Brazil, a Burrowing Owl (*Speotyto cunicularia*) from South America, two Purplish Guans (*Penelope purpurascens*) from Central America, a Sarus Crane (*Grus antigone*) from Northern India, a Four-lined Snake (*Coluber quatuorlineatus*), European; an Angulated Snake (*Leptodira annulata*) from Tropical South America, four Azara's Opossums (*Didelphys azaræ*) from La Plata, purchased.

OUR ASTRONOMICAL COLUMN.

ENCKE'S COMET.—Of the three comets which are due to return this year—namely Encke's, Winnecke's and Wolf's, having periods of 3⅓, 5½, and nearly 7 years respectively—the first seems to have just been found, according to a Kiel telegram dated June 14. Prof. Hussey, telegraphing to Kiel, states that Mr. Coddington, on June 11, 9h. 13·1m. Lick mean time, found a comet, which he terms bright, in position R.A. 16h. 24m. 45·9s. and Declination (south) 25° 14′ 20″, the daily motions in these coordinates being 51′ and 36′ respectively. The comet thus lies in the constellation of Scorpio, a little to the north of the bright star *α*. A further telegram from Mr. John Tebbutt, dated June 14, states that this observer found the comet on June 12 in position R.A. 16h. 21m. and Declination (south) 25° 52′ at 9h. 22·9m. Lick mean time.

Much interest is attached to this comet, since its period is one of the shortest known. It was first seen in 1818 by that diligent observer Pons, on November 26, perihelion being passed in the following January. It was Encke, however, who undertook to investigate its motions, proving that its period extended over 3⅓ years, and he predicted its return in 1822. At every succeeding return the comet has been observed, and it was even discovered that prior to 1818 it had been three times observed by Méchain, Caroline Herschel, and Thulis in the years 1786, 1795 and 1805. At its last return, in 1895, it was just visible to the naked eye at the time of its maximum brightness.

NEW DETERMINATION OF THE EARTH'S DENSITY.—Herr F. K. Ginzel, in the current number of *Himmel und Erde* (June, Heft 9), describes a new determination of the mean density of the earth by Dr. C. Braun, a former director of the observatory at Kalosca in Hungary. The apparatus used for this purpose was a torsion balance constructed by Dr. Braun himself, and from the description we learn that, excepting the suspension wires, glass globe, chronometer, chronograph, microscopes, and a few small parts, everything was made by himself. The method employed differed mainly from previous determinations in that the torsion balance was enclosed in a glass globe from which all air had been extracted. So complete was the vacuum that after four years no change could be detected. We leave our readers to gather from the above-mentioned source more details regarding the apparatus itself. The observations were begun in the year 1892, and two years later the computations were commenced. After all allowance had been made for corrections the final result gave for the value of the mean density of the earth 5·52765, which nearly corresponds with the best determination made by Prof. Boys. Herr Ginzel, in concluding his article, tells us that, disregarding the very high scientific importance that will be attached to this new determination, if we consider that Dr. Braun is considerably advanced in years, somewhat hard of hearing, and has not been blessed with good health during the last few years, and that he has been thinking over this problem for eleven years in addition to his usual official duties, all will agree in saying that this work is a rare proof of the scientific energy and ideal power of sacrifice for one man.

THE LARGE REFRACTORS OF THE WORLD.—The question of the efficiency of refractors of large apertures has recently been discussed in many articles, and the latest we owe to Prof. G. E. Hale, who deals in *Science* (May 13) with the frequently asked question, "Do large telescopes pay?" Prof. Hale points out the special kind of work to which refractors of large aperture should be employed, and shows that when used by a skilled observer very important work can be accomplished which would be impossible with a small aperture. An instrument, say, of forty inches aperture is more advantageous than one of ten inches, in that, first, it has the power of giving much brighter images, thus rendering faint stars visible. It can, secondly, give an image of a celestial body of measurable dimensions four times as large as that given by a lens of one-fourth its aperture and focal length; and, thirdly, its capacity of rendering visible, as separate objects, the components of very close double stars or minute markings upon the surface of a planet or satellite. Prof. Hale concludes that all the money and time and labour are well spent on refractors of large aperture, and he suggests that further sums might well be expended, particularly in the southern hemisphere, in the establishment of still more powerful instruments.

A propos of large refractors, a fairly complete list of existing large refracting telescopes appears in the current number of the *Observatory* (June), in which are given details concerning the aperture, focal length, location, maker, and date of erection of the various instruments. America comes first as regards the number of instruments and largest size of aperture, followed by France, England and Germany in the order respectively of the number of refractors exceeding 13·4 inches.

THE LEEDS ASTRONOMICAL SOCIETY.—It is always with pleasure that we refer to scientific societies for the promotion and extension of astronomical knowledge, when we know that they are doing useful work in this respect. The *Journal* (No. 5) of the Leeds Astronomical Society for the year 1897 is a good example of the interest displayed by its members in fostering astronomy, and during the past year many interesting papers were read at their meetings. Among these may be mentioned that on the nebular origin of our solar system, by Mr. Barbour, who refers to and extends the significant relationships between the distances and masses of the four superior planets suggested by Mr. Sutcliffe of Bombay, and previously referred to in this column (vol. lvi. p. 424). Other papers read had for their subjects the heat of the sun, the planet Venus, orientation of Egyptian temples, density of the earth, &c. This number contains also an excellent likeness of the retiring president, Mr. Washington Teasdale.

RECENT EXPERIMENTS ON CERTAIN OF THE CHEMICAL ELEMENTS IN RELATION TO HEAT.[1]

THE discovery that different substances have different capacities for heat is usually attributed to Irvine, but there can be no doubt that Black, Crawford, and others contributed to the establishment of the idea. The fact that equal weights of different substances in cooling down through the same number of degrees give out different amounts of heat, may be illustrated by the well-known experiment in which a cake of wax is penetrated with different degrees of rapidity by balls of different metals heated to the same temperature. But for the quantitative estimation of the different amounts of heat thus taken up and given out again, the physicist must resort to other forms of experiment, each of which presents difficulties of its own. Broadly speaking, three principal methods have been used in the past for the estimation of "specific heats." The first is based upon the observation of the exact change of temperature produced in a known mass of water by mixing with it a known weight of the substance previously at a definite temperature above or below that of the water. The second consists in determining the quantity of ice melted when the heated body is brought into contact with it in such a way that no heat from any other source can reach the ice. And the third method consists in observing the rate at which the heated body falls through a definite range of temperature when suspended in a vacuous space.

The process of intermixture with water was used by the earlier experimenters in the last century, and some of the best results extant have been obtained by this process, which, however, is not so easy as it appears when the highest degree of accuracy is desired.

Lavoisier and Laplace in 1780 devised the ice calorimeter which bears their name, and in a most interesting memoir, which is reprinted among Lavoisier's works, they show that they were familiar with the idea which in modern times is known as the principle of the conservation of energy. In this memoir they give the results of experiments in which the specific heats of iron, mercury, and a few other substances are estimated with a very tolerable approach to accuracy. Although many of the metals were known to them, it would not have been possible, had they persisted in this work, to make the discovery which was reserved for Dulong and Petit thirty-five years later, for the atomic theory had not been conceived and no atomic weights had been determined.

Dulong and Petit (*Ann. Chim.*, 1817, vii. p. 144) seem to have used at first the method of mixtures, and to have found by direct experiment that the specific heat of solids (metals and glass) increases with the temperature. They also studied (after Leslie) the laws of cooling of bodies; and two years after the publication of their first paper on the subject, they (Petit and Dulong, *sic*) arrived at the remarkable general expression which is associated with their names (*Ann. Chim.*, 1819, x. 395).

[1] A discourse delivered at the Royal Institution, Friday evening, May 13, by Prof. W. A. Tilden, D.Sc., F.R.S.

After pointing out that all the results of previous experiments, except those of Lavoisier and Laplace, are extremely incorrect, they describe their results obtained by the method of cooling, conducted with many precautions to avoid error.

COPY OF TABLE BY DULONG AND PETIT (*Ann. Chim. Phys.*, 1819, x. 403).

Specific heats		Atomic weights (o = 1)	Atomic weight × specific heat
Bismuth ...	... ·0288	13·30	·3830
Lead ..	... ·0293	12·95	·3794
Gold ...	... ·0298	12·43	·3704
Platinum ...	... ·0314	11·16	·3740
Tin ...	... ·0514	7·35	·3779
Silver ...	... ·0557	6·75	·3759
Zinc ...	... ·0927	4·03	·3736
Tellurium	... ·0912	4·03	·3675
Copper ...	... ·0949	3·957	·3755
Nickel ...	... ·1035	3·69	·3819
Iron ...	... ·1100	3·392	·3731
Cobalt ...	... ·1498	2·46	·3685
Sulphur ...	... ·1880	2·011	·3780

The statement of the law is best given in the words of the authors (p. 405):

"Les atomes de tous les corps simples ont exactement la même capacité pour la chaleur."

Here the question rested till resumed, many years later (1840), by Regnault, who in his first memoir (*Ann. Chim.*, 73, 5) points out the difficulties which attended the acceptance of the statement of Petit and Dulong in the form in which they gave it. He then discusses the three principal experimental methods, viz. (1) fusion of ice, (2) mixture, (3) cooling, and decides in favour of the second, which he used throughout his researches. The general form of the apparatus used by the great physicist has been a model for the guidance of successive experimentalists since his time.

Another quarter of a century elapsed before the question of the specific heat of the elements was resumed by Hermann Kopp. His results were communicated to the Royal Society, and are embodied in a paper printed in the *Philosophical Transactions* for 1865. After reviewing the work of his predecessors, he describes a process by which he has made a large number of estimations of specific heat, not only of elements but of compounds of all kinds in the solid state. Concerning his own process, however, he remarks that "the method as I have used it has by no means the accuracy of that of Regnault" (p. 84).

In 1870 Bunsen introduced his well-known ice-calorimeter. This is an instrument in which the amount of ice melted by the heated body is not measured by collecting and weighing the water formed, but by observing the contraction which ensues when the ice melts, contained in a vessel of special form. The results obtained by Bunsen himself are uniformly slightly lower than those of Regnault for the same elements.

Since that time experiments have been made by Weber, Dewar, Humpidge, and others in connection especially with the influence of temperature in particular cases.

Setting aside the elements carbon, boron, silicon and beryllium, as providing an entirely separate problem, the question is whether the law of Dulong and Petit is strictly valid when applied to the metals. Kopp, in his discussion of the subject, came to the conclusion that it is not; but the grounds for this conclusion are unsatisfactory, since neither the atomic weights nor the specific heats were at that time known with sufficient accuracy.

It has been customary to assume that the divergencies from the constant value of the product, At. Wt. × Sp. Ht., are due partly to the fact that at the temperature at which specific heats are usually determined, the different elements stand in very different relations to their point of fusion; thus lead at the temperature of boiling water is much nearer to its melting-point than iron. It has also been attributed to temporary or allotropic conditions of the elements. As to the relation to melting-point, the specific heats of atomic weight seem to be practically the same in separate metals and alloys of the same which melt at far lower temperatures. For example, the atomic heat of cadmium is 6·35, of bismuth 6·47, of tin 6·63, and of lead 6·50; while the mean atomic heat in alloys of bismuth with tin, and lead with tin, ranges from 6·40 to 6·66 (Regnault), which is practically the same.

Again, while the melting-point of platinum is at a white heat, and it becomes plastic at a low red heat, the specific heat at this lower temperature is very little less. Many other metals change considerably in properties at temperatures far removed from their melting-points, without substantial change in their capacity for heat.

As to allotropy it is a phenomenon which is comparatively rare among metals, and in the marked cases in which it occurs we have no information as to the value of the specific heats in the several varieties (such as the two varieties of antimony and the silver zinc alloy of Heycock and Neville), and they may be left out of account. Bunsen compared the so-called allotropic tin obtained by exposing the metal to cold for a long time, and found it ·0545 against ·0559 for the ordinary kind (*Pogg. Ann.*, 141, 27). In dimorphous substances, such as arragonite and calcite, there is often no difference. Regnault found for these two minerals ·2086 and ·2085 respectively.

The differences between metals hammered and annealed, hard and soft, were also found by Regnault to be very small (*Ann. Chim.* [3] ix.):—

Hard steel	·1175	Same, softened ...	·1165
Hard bronze	·0858	Same, softened ...	·0862

Kopp came to the conclusion, *first*, that each element in the solid state and at a sufficient distance from its melting-point has *one* specific or atomic heat which varies only slightly with physical conditions; and, *secondly*, that each element has essentially the same specific or atomic heat in compounds as it has in the free state. This last is practically identical with the statement which is known as Neumann's law. With Kopp's conclusions I agree, but from some of Regnault's results, coupled with my own, the effect of *small* quantities of carbon and, perhaps, of sulphur upon the specific heats of metals is greater than has been supposed.

If we take the results of Regnault and of Kopp, and combine them with the most accurately known atomic weights, the products are still not constant.

ATOMIC WEIGHTS MOST ACCURATELY KNOWN (1897), COMBINED WITH SPECIFIC HEATS.

	A.W. (H=1)	S. H. Regnault	S. H. Kopp	At. Ht. Regnault	At. Ht. Kopp
Copper	63·12	·09515	·0930	6·01	5·87
Gold	195·74	·03244	—	6·35	—
Iron	55·60	·11379	·1120	6·33	6·23
Lead	205·36	·03140	·0315	6·45	6·47
Mercury liq.	198·49	·03332	—	6·61	—
− 78° to + 10° sol.	198·49	·03192	—	6·34	—
Silver	107·11	·05701	·0560	6·11	6·00
Iodine	125·89	·05412	—	6·81	—

The law of Dulong and Petit is therefore only an approximation, but this may perhaps be due to impurity in the materials used. That is the problem which I have endeavoured to solve.

The introduction of a new method of calorimetry by Prof. J. Joly, and the excellent results obtained by the author in the use of the differential form of his instrument (*Proc. R. S.*, 47, 241), led me to think that with due attention to various precautions, such as exact observation of the temperatures and practice in determining the moment at which the increase of weight due to condensation is completed, results of considerable accuracy might be obtained.

The problem is to find two elements very closely similar in density and melting-point which can be obtained in a state of purity, and then to determine with the utmost possible accuracy the specific heat of each under the same conditions. The two metals cobalt and nickel were selected for the purpose. They were examined by Regnault, but the metals he used were very impure.

The cobalt employed in my experiments was prepared by myself. For the nickel I am indebted to Dr. L. Mond. Both were undoubtedly much more nearly pure than any metal available in Regnault's time. The results obtained are as follows:—

SPECIFIC HEATS OF COBALT AND NICKEL. PURE FUSED.

Cobalt S.G. $\frac{21^\circ}{4^\circ}$ 8·718	Nickel S.G. $\frac{21}{4^\circ}$ 8·790
·10310	
·10378	
·10310	·10953
·10355	·10910
·10373	·10930
·10362	
Arith. mean ·10348	·10931
Atomic heat	?

Further experiments will be made, because a single well-established case of this kind is sufficient to decide the question. Already, however, I feel certain that Kopp's conclusion is right, and that the law of Dulong and Petit, even for the metals, is an approximation only, and cannot be expressed in the words of the discoverers. For although the exact values of the atomic weights of these two elements are not known, it is certain that they are not so far apart as would be implied by these values for the specific heats, even assuming that the value for nickel is, as I believe, slightly too high.

Two other examples of somewhat similar kind are shown by gold and platinum, copper and iron.

SPECIFIC HEATS OF GOLD AND PLATINUM. PURE FUSED.

Gold S.G. $\frac{18^\circ}{18^\circ}$ 19·227	Platinum S.G. $\frac{18^\circ}{18^\circ}$21·323
·03052	·03147
03017	·03150
·03035	·03144
Arith. mean ·03035	·03147
Atomic heat 5·94	6·05

SPECIFIC HEATS OF COPPER AND IRON. FUSED.

Copper (pure) S.G. $\frac{20^\circ}{20^\circ}$ 8·522	Iron S.G. $\frac{15^\circ}{15^\circ}$ 7·745
·09248	Contains ·01 °/₀ C.
·09241	·11022
·09205	·11037
·09234	
Arith. mean ·09232	Arith. mean ·11030
Atomic heat 5·83	6·13

For the gold I naturally applied to my colleague Prof. Roberts-Austen. The platinum I prepared from ordinary foil by re-solution, and reprecipitation as ammonic chloride, &c. Both metals were fused into buttons before use. The atomic heats come closer together than those of cobalt and nickel.

Copper and iron differ considerably in melting-point, but both at the temperature of 100° are far removed from even incipient fusion. The copper was prepared from pure sulphate by electrolysis, the iron by reduction of pure oxide in pure hydrogen. Notwithstanding all our care, it was disappointing to find it contained ·01 per cent. of carbon, the source of which I am at a loss to explain. This iron is purer than any examined by Regnault or Kopp.

The differences observed between Co and Ni, and between Au and Pt, are manifestly not due to allotropy or to differences of melting-point, which in these cases can have no effect on the result.

So large a difference must be due to peculiarities inherent in the atoms themselves, and differences of atomic heat are to a certain extent comparable with the differences observed in other physical properties which, like specific volume, specific refraction, &c., are approximately additive.

If we try to think what is going on in the interior of a mass of solid when it is heated, the work done is expended not only in setting the atoms into that kind of vibration which corresponds to rise of temperature—that is, it makes them hotter—but partly in separating the molecules or physical units from one another (= expansion), and partly in doing *internal* work of some kind, the nature of which is not known. A difference between metals and non-metals has been brought out by the researches of Heycock and Neville, who find that metals dissolved in metals are generally monatomic; whereas it is generally admitted that iodine, sulphur and phosphorus in solution are polyatomic. It is, moreover, remarkable that although in respect to specific heat each element in a solid seems to be independent of the rest with which it is associated, when the separate elements are dispersed in vapour some rise in separate atoms like mercury, some in groups of atoms I_2, S_6, As_4, P_4, and these groups, as the temperature is raised, are simplified with very varying degrees of readiness.

Sulphur vapour, for example, diminishes in density from 7·9 at 468°, to 4·7 at 606° (Biltz), that is, from about S_7 to S_4, and iodine from density 8·8 at 253°, to 5·6 at 1570° (V. Meyer), that is, from about I_2 to $\frac{2}{3}$ I_2, but the dissociation of As_4 and P_4 begins only at much higher temperatures, while with mercury there is no corresponding change.

But, although these groups are taken as the chemical molecules, the physical unit in the solid is certainly the atom, whether united by combination or mere mixture.

The two metals, cobalt and nickel, with which I began my inquiry, have nearly the same atomic weight, but they differ from each other remarkably in chemical properties. For example, nickel forms a compound with carbonic oxide; on the other hand, cobalt produces many remarkable ammoniacal compounds, to which there is nothing corresponding among the compounds of nickel.

Having put aside the common excuses for the observed divergencies from the law of Dulong and Petit, we are compelled to look round for some other hypothesis.

The constitution of carbon compounds is now explained by a hypothesis concerning the configuration of the carbon atom introduced by Van t' Hoff and Le Bel twenty-five years ago, and which is now accepted by the whole chemical world. It seems not unreasonable to apply a similar hypothesis to the explanation of those cases of isomerism which have been observed in certain compounds of the metals, notably chromium, cobalt, and platinum. This has already been done by Prof. Werner of Zürich. Of course, as there is no asymmetry, there are no optical differences in the pairs of compounds thus represented. If the constitution of compounds can be safely explained by such hypothesis, this implies peculiarities in the configuration of the individual constituent metals around which the various radicles are grouped in such compounds, and hence peculiarities in the behaviour of such metals in the elemental form may possibly be accounted for. For the atom of cobalt, Prof. Werner employs the figure of the regular octahedron. For nickel, therefore, which differs from cobalt, especially in yielding the remarkable carbonyl compound discovered by Mond, and by not yielding ammines like those of cobalt, and in other ways, a different figure must be chosen. This, however, is for the present a matter of pure speculation.

SCIENCE IN THE THEATRE.

THE assimilation of nature on the stage! To what extent is assimilation possible, and what are the necessary methods and appliances for obtaining a satisfactory assimilation? This practically was the subject of a very valuable paper prepared for the Society of Arts by Mr. Edwin O. Sachs, the architect, which led to an animated discussion at the crowded meeting before which it was read. The title of Mr. Sachs' paper, it is true, was briefly "Stage Mechanism," but he went far beyond the mere description of the various appliances that can be used for obtaining certain scenic effects, and, more especially in his introduction, treated the subject on broad lines.

Though the presentation of drama and opera with some attempt at realistic surroundings is now accepted as a matter of course in all civilised countries, it can but rarely be said that the attempts are successful. In fact, only of recent years has the London manager been able to give us the presentation of indoor scenes with some claim to merit, and this only by building up his various scenes piecemeal in a most cumbersome way, which is all that is possible where the changes of scene are few and the "run" long. As to the presentation of scenes out of doors, the London manager has most lamentably failed, no matter how well painted individual canvases may have been, or how tricky the arrangements of individual scenic effects. A sky that looks like so much blue calico hanging on a wash-line, a horizon with angles, a tree that looks like a piece of cardboard, or a moon which suddenly rushes into the sky and then remains stationary, are all anomalies, and form only a few of the innumerable details which tend to make a scene incongruous.

Now according to Mr. Sachs, who fully recognises the attempts that have been made from time to time by Sir Henry Irving, Mr. Beerbohm Tree, Sir Augustus Harris, and others

FIG. 1.—Electric Turntable Stage. (From "Stage Construction.")

(assisted by such eminent painters as Mr. Burne-Jones, or Mr. Alma Tadema), the reason for the anomalous scenes we see to-day is to be primarily found on the one side in the inherited prejudice of the stage against the adoption of anything that is new; and on the other, in that curious want of recognition which the stage fails to obtain, not only from the Government and public authorities generally, but from men of science who do not hesitate to use their knowledge for far more prosaic matters, such as, for instance, the tinning of food, the condensing of milk, &c. Mr. Sachs' assertions as regards the prejudice with which innovations are met with on the stage were amusingly confirmed in the discussion by Mr. Mulholland, who explained the difficulties he had in trying to do away with the tin-tea-tray thunder so often heard on our stages, and of course many curious anecdotes could be told of how the ignorant stage-carpenter, or the stage-manager who is afraid of making experiments, or the prejudiced scenic artist who is afraid that improved effects might take away from his influence, all vie with one another in leaving the stage as it has been for a hundred years or more. Mr. Bernard Shaw also most wittily and scathingly showed how badly things are generally managed.

Now we cannot but recognise, as Mr. Sachs indicated, that much has been done in the way of painting good scenery. But what, as he said, is the use of the most beautifully painted piece of canvas if it is badly hung, wrongly lighted, and waves with every draught that there may be on the stage? What use is there, Mr. Sachs asked, in having a beautiful panorama scene, costing a thousand pounds, if the extra five pounds be grudged for a suitable appliance to make that panorama run smoothly? Mr. Moul, of the Alhambra, argued that there seldom were any spare five pounds. But there should be. Why not let the panorama scene cost ten pounds less and have the appliances?

Of course the average playgoer is not very critical; he is satisfied, as a rule, with the highly coloured picture and the blaze of light, and having been equally blind to the beauties of nature, sees nothing of the incongruities of the scene. He "sees" an actor with a streak of limelight following him round the stage, but does not grumble; he "sees" the actress, with her features distorted owing to a brilliant light from the footlights on her chin and a dark shadow on her forehead, but he does not know that there is anything wrong about this. Only that small percentage of playgoers who have visited some of the large model continental stages, or the Wagner productions at Bayreuth, perhaps appreciate the anomalies of the old English stage, and scoff at what the caterers of our public entertainments choose to put before them. They know full well the harmonious effect often obtained on a well-managed continental stage, where the faults, if any, do not lie in the want of recognition of the true art requirements, but are to be found in the poor quality of the scenery, for the improvement of which there may not be funds available. How regrettable it is, as Mr. Sachs pointed out, that we cannot have in the metropolis a happy combination of the artistic mounting of the Continent with the beautiful scenery for which our managers are ready to pay lavishly.

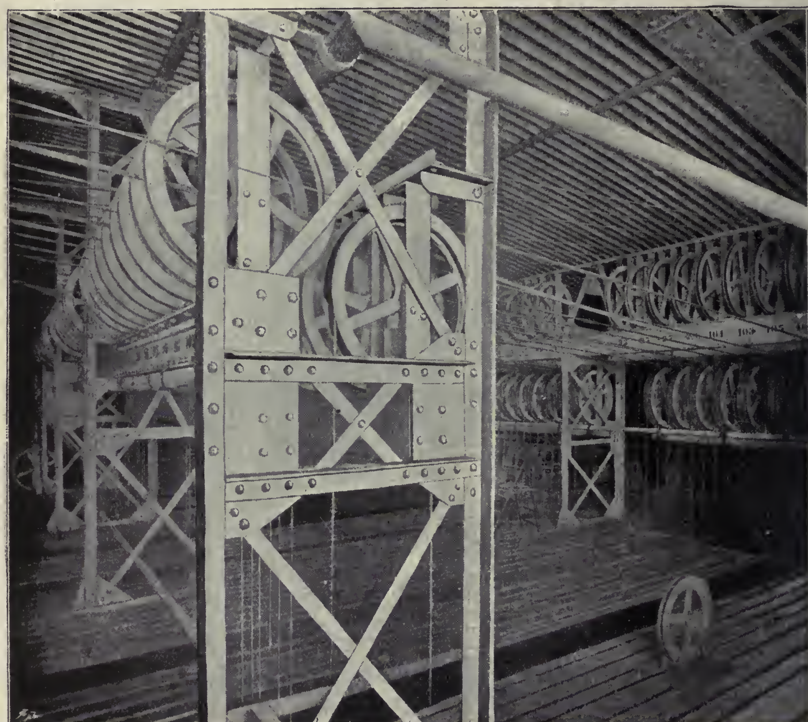


FIG. 2.—Court Theatre, Vienna. View of "Gridiron." (From "Modern Opera Houses and Theatres.")

When, however, we go into the detail of Mr. Sachs' instructive paper, we find that the vast subject which he has covered does not lend itself to a short article of this description, nor perhaps would his arguments be appreciated without the many illustrations which he was able to put before his audience at the Society of Arts. Yet we would point out that, in the first place, he divided the stages he had under consideration into (1) wood stages, (2) wood-and-iron stages, and (3) iron stages; and that he then again subdivided them according to the power used for moving the scenery, or obtaining certain effects, be it manual labour, hydraulics, or electricity.

In speaking of the wood stage of the metropolis, Mr. Sachs naturally does not omit to refer also to the wood stage of the Continent, which is but little better than our own; nor when he spoke of the wood and iron stage of Paris did he omit to speak of our "Palace" Theatre of Varieties, which is the solitary example of a theatre in this country in which a combination of wood and iron is to be found. When Mr. Sachs, however, came to speak of the iron stage, and more especially the iron stage worked by hydraulics or electricity, he had to confess that there was not a single iron stage to be found throughout the United Kingdom, that there was no stage worked by electric machinery, and that the only appliances in which hydraulics are being employed in this country were some so-called "bridges" at Drury Lane. But on the continent, the iron stage, with all its improvements for lighting, for showing a curved horizon, and —to summarise—for giving some semblance of nature, is already to be found in considerable numbers and of considerable variety.

By Mr. Sachs's courtesy we are able to show two illustrations—one of the great electrical turntable stage for Munich, so useful for Shakespearean drama, where a quick change of scene is desirable, and the other of a hydraulic stage at Vienna worked on the suspended system. In the first case a general view is shown which well describes itself. In the latter case a view of the "gridiron" is shown, which plainly indicates the modern forms of wiring adopted.

But we cannot go further into the technical detail of the question, and we only trust that Mr. Sachs's words will have had some effect on the many managers and stage engineers who had come to hear him, not forgetting Herr Kranich, from Bayreuth, one of the leading exponents of scenic mounting on true art lines.

But whatever may have been the influence of Mr. Sachs's advocacy, we would end by quoting him where he said "that the real secret of perfect scenic art lies in illusion, *i.e.* in visual deception, or in not allowing the eye of the spectator to discern the means whereby the semblance of reality is obtained; mere actuality will not accomplish this—crude realism alone would then result."

What the scenic artist and the stage-manager must attempt, according to Mr. Sachs, is to obtain a successful illusion; and this, he argues, is obtainable, not by any great *radical* reform, as desired by irresponsible faddists, but a *practical* reform of the methods and appliances which are to-day used on the stage of the metropolis, and which are, unfortunately, quite a hundred years too old.

Why should not our stage have the full benefits of science and art as practised now on the approach of 1900 A.D., instead of the makeshifts with which the world was satisfied at the beginning of the last century?

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Want of accommodation in more than one department of the University museum renders it impossible to carry on satisfactory work. The extracts printed below, from the report of the delegates of the museum, tell of a condition of "hope deferred, which maketh the heart sick." Prof. J. Burdon-Sanderson reports:—"The Regius Professor of Medicine takes this opportunity of expressing his bitter disappointment that another year has been allowed to pass without any step having been taken towards providing adequate accommodation for the teaching of medical science in the University. It is in his judgment to be feared that if the reasonable requirements of the medical school continue to be disregarded, its further development will be checked, and that the progress of those departments of teaching which have common interests with it will be seriously interfered with." Prof. R. B. Clifton, Professor of Experimental Philosophy, says: "Some electrical apparatus has been placed in the room formerly allotted to the professor as a private laboratory, and with that in the room devoted to the electrical work of the preliminary classes, it is now possible to offer some, though very restricted, facilities to Honour students who wish to gain experience in the methods of measuring electrical quantities. The professor and demonstrators have now, however, no place in which they can carry on research; and all attempts to undertake work of this character must in future be abandoned. After twelve years of fruitless effort to obtain extended accommodation for Honour students, and the means of providing for the increasing number of those working for the preliminary examination—a class of students not contemplated when the laboratory was designed—it is probably quite useless to trouble the delegates with any further application for assistance in this direction." It will be difficult for men of science on the Continent and in the United States to believe that so little encouragement is given to scientific work in the University of Oxford.

The 191st meeting of the Junior Scientific Club was held in the physiological lecture-room of the museum on Friday, June 10. After private business, Mr. V. H. Veley, F.R.S., read a paper on *Coleothrix methystes*, the active micro-organism which Mrs. Veley and himself recently discovered in "faulty" rum, and, it is hoped, will shortly form the subject of a monograph. After the paper a discussion took place, in which Dr. Ritchie and others joined.

CAMBRIDGE.—Mr. A. E. H. Love, F.R.S., of St. John's College, has been appointed University Lecturer in Mathematics in the room of Mr. Glazebrook, resigned.

The Senior Wrangler this year is Mr. R. W. H. T. Hudson, of St. John's College, son of Prof. W. H. H. Hudson, of King's College, London. Miss Cave-Browne-Cave, of Girton, is bracketed fifth wrangler.

The Vice-Chancellor announces that donations amounting to over 6000*l.* have been received for the University Benefaction Fund, started last year. A large number of the donations are ear-marked for the Medical School. A bequest of 10,000*l.* has also fallen to the University, but it is assigned to the foundation of a prize or scholarship in memory of the late Dr. Allen, Bishop of Ely.

Mr. C. F. Hadfield, of Trinity, and Mr. R. C. Punnett, of Caius, have been nominated to the University tables at the Naples Zoological Station; and Prof. E. W. MacBride, of St. John's, to the table at Plymouth.

The General Board propose that Mr. W. N. Shaw, F.R.S., should be appointed assistant-director of the Cavendish Laboratory for the ensuing year, in the place of Mr. Glazebrook.

DR. R. A. HARPER has been appointed professor of botany at the University of Wisconsin.

AT a meeting of the Court of Edinburgh University on Monday a letter was read from a benefactor of the University, intimating that he is prepared to give to the University such a sum as may be necessary, but not exceeding 10,000*l.*, to build and equip a laboratory and class-room to be used exclusively for the teaching of public health, the site of the proposed building to be provided by the University.

THE foundation-stone of a separate department for instruction in the technology of the leather industries, was laid at the Yorshire College, Leeds, on Monday. The ceremony was performed by Mr. A. B. Kent, Warden of the Skinners' Company of London, who have provided 5000*l.* in order to establish this department, and will contribute towards the working expenses.

THE new laboratories of physiology and pathology at the University College, Liverpool, will be formally opened on October 8. The laboratories have been erected and equipped in the most adequate way for study and research by the Rev. Thompson Yates, at a cost of 25,000*l.* Lord Lister, President of the Royal Society, has consented to perform the opening ceremony; and the Victoria University will take advantage of his visit to Liverpool to confer upon him the honorary degree of doctor of science.

AT the Science and Art Department on Friday last a conference was held of organising secretaries and other representatives of local organisations which have been recognised by the Department as responsible for science and art instruction within their several districts. The Vice-President of the Committee of Council on Education (Sir John Gorst) presided, and the conference was attended by representatives from a number of ounties. Various matters connected with the administrative arrangements between the local authorities and the Department were considered and decided.

AT the instance of the Headmasters' Conference, the Headmasters' Association, the Headmistresses' Association, and the Conference of Catholic Schools, a Bill dealing with the subject of secondary education will be introduced into Parliament this Session. The Bill proposes to transfer the powers relating to secondary education now vested in the Charity Commission, the Science and Art Department, and the Education Department to one central authority under the Committee of the Privy Council on Education, and to establish local secondary education authorities to administer areas not less than those of a county or a county borough. It is contemplated that the reconstituted Education Department will consist of two sections, for secondary and primary education respectively, these two sections being under one permanent secretary, who will be advised by chief assistant secretaries in regard to each of these two chief divisions of departmental work. The Bill further provides for the registration of secondary schools according to their different types and of teachers qualified to teach. The residue under the Local Taxation (Custom and Excise) Act, 1890, is to be allocated to education, and in the case both of residue and of Imperial grants now paid through the Science and Art Department such portions as the Treasury shall determine are to be allocated to secondary education and to technical instruction respectively.

THE new buildings of Reading College, under which name the University Extension College at Reading will in future be known, were opened by the Prince of Wales on Saturday. The College was established in 1892 as a direct outcome of Oxford University Extension work. Mr. H. J. Mackinder was appointed Student of Christ Church, Oxford, his appointment being made "with a view to giving system and completeness" to the educational work of one of the University Extension centres. His services were offered to Reading, and were accepted; and, largely owing to his efforts during the past six years, the College has advanced to the position it now occupies. The first home of the College was restricted to an ancient building, formerly part of the Hospital of St. John, attached to the Abbey of Reading. The accommodation was soon found to be insufficient for the increasing number of students. Mr. Herbert Sutton, chairman of the Council, purchased the vicarage of St. Lawrence, adjoining the Hospitium, and the acquisition of this property enabled certain necessary enlargements to be made, including the building of a dairy institute. The cost of the College properties and buildings exceeds upwards of 20,000*l.*; and it was this amalgamation of old and new buildings in one central educational organisation, to be known as Reading College, that the Prince of Wales formally opened on Saturday. In responding to the toast of "The Royal Family," at the luncheon after the opening ceremony, the Prince of Wales remarked:—"In the work we have done to-day, we have inaugurated an institution which has for its object the advancement of higher education, especially in those branches more particularly connected with science, art, and agriculture. To me this is particularly interesting on account of the early associations which render it a matter of interest to know that the new College owes its inception and encouragement to the University of Oxford, and to Christ Church, my old College. The presence of the Vice-Chancellor of Oxford and of the Dean of Christ Church, as well as the attendance of many other eminent men from Oxford, is a proof of the interest they take in this movement. Let me mention that the heads of colleges and the Hebdomadal Council have satisfied themselves of the high standard of efficiency of the education in Reading College, and have agreed with great liberality to affiliate Reading College to the parent University to the extent of conferring on it the privilege of allowing students, after spending three years at Oxford and passing certain scientific examinations there, to proceed to Reading, where one year's further study in the science and practice of agriculture should count as part of their University career, and entitle them to the B.A. degree on the completion of their full course. This proposal, although supported by a large and influential University, was, on a division, rejected by two votes, the numbers being 47 to 45. The interest which I take in University Extension teaching, which now includes agriculture, leads me to hope that another year may see the adoption of the important policy advocated by the important bodies to which I have alluded, and that its provisions may be carried through the subsequent stages to render it law."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 12.—"The Electrical Response of Nerve to a Single Stimulus investigated with the Capillary Electrometer." Preliminary communication. By F. Gotch, M.A., F.R.S., Professor of Physiology, University of Oxford, and G. J. Burch, M.A. (Oxon).

By means of a very sensitive capillary electrometer the authors have obtained photographic records of the electrical response in the sciatic nerve of the frog when excited by a single stimulus. The records differ in character according to the condition of the nerve. In uninjured nerve a rapid displacement of the meniscus in one direction is followed by a corresponding displacement in the other direction. In nerve which is the seat of a persistent electromotive change, whether through local injury or the passage of an appropriate polarising current, the record shows that the initial rapid displacement is succeeded by a prolonged after-effect of similar sign. The records are sufficiently pronounced to allow of the calculation of the E.M.F. of the potential difference between the electrometer contacts causing the initial displacement; this may reach as much as 0·032 volt, and attains its maximum very rapidly. In fresh nerve at 6° C. the first indications of such electrical change occur 0·002 second after the single stimulus has been applied at a distance of 30 mm. from the capillary contacts. The after-effect develops more slowly, taking from 0·006 to 0·01 second to culminate, its maximum E.M.F. is only one-tenth that of the initial change, and it subsides slowly; it is present in every nerve when one of the capillary contacts lies upon the cross section of the nerve.

"On the Magnetic Susceptibility of Liquid Oxygen." By Profs. J. A. Fleming, F.R.S., and James Dewar, F.R.S.

May 26.—"Note on the complete Scheme of Electrodynamic Equations of a Moving Material Medium, and on Electrostriction." By Joseph Larmor, F.R.S., Fellow of St. John's College, Cambridge.

This paper (in continuation of previous memoirs) undertakes in general form the exact expression of the electrodynamic relations of moving media which are polarisable, or are in motion through the æther. No foundation is available from which to investigate the modification that the ordinary equations of MacCullagh and Maxwell must then undergo, without going back to molecular theory. When that is done the crucial point in the investigation is the transition from a theory concerned with the individual molecules to a mechanical theory concerned only with the element of volume: this requires a separation between the influence of neighbouring molecules which affects only the structure of the material at that place, and the influence of the matter in general which induces polarisation and mechanical strain in the structure. It is shown that to express the influence of magnetic polarisation of the material, and also the influence of convection of electrically polarised material, these agencies must be replaced analytically by equivalent distributions of electric current. The resulting scheme of equations is wide enough to include the whole field of electrical and optical phenomena in continuous bodies, whether fixed or in motion, of which various cases are again incidentally considered.

Physical Society, June 10.—Mr. Shelford Bidwell, President, in the chair.—Dr. S. P. Thompson described and exhibited a model illustrating Max Meyer's theory of audition. Max Meyer abandons the audition theory of Helmholtz, and contends that analysis takes place in the ear otherwise than by resonance of the Corti organ. Imagine a jointed system, like a hand, to be oscillated from one end, *i.e.* from the finger-tips, A small motion affects only the top joints, but a large motion affects the whole structure. Such a structure is the membrane of the inner-ear. It widens towards one end, and is effectively damped by the contained liquid. Wave-motions of different amplitudes run along it to different distances before they are extinguished; these distances are recorded by nerves, and are thereby communicated to the Corti organ. In the model, the compound-wave to be analysed is cut out on the edge of a disc of zinc, so that, as the disc revolves, the motions are communicated to a frame-work. If the frame is thus moved through more than a certain distance, a displacement occurs which sets a second frame in motion, and so on to a third and fourth. The depth to which the motion penetrates is indicated by a series of glow-lamps connected electrically to the frames. Prof. Ayrton said it had for some time past occurred to him, when considering the way in which an expert telegraph clerk reads siphon-recorder signals on a long cable, that it might be possible to analyse waves without the supposition of a resonating apparatus. The clerk interprets not so much the motions to one side or other of the zero-line, as the rate of change of velocity, *i.e.* the acceleration of the siphon. This had been recognised in the design of those relays for long cables, where the lever makes contact when the received current exceeds a certain value, and breaks contact when the current falls below a certain minimum. Messrs. Siemens had adopted a relay in which the lever was carried on the suspended coil of a D'Arsonval galvanometer by a pivot with a small amount of friction. If contact was made, the coil could, nevertheless, continue its motion in a given direction. If that direction altered, contact was immediately broken, and the lever passed over to the opposite stop, thereby reversing the local circuit. It was possible that, in the process of hearing, something akin to this took place, the ear behaving as a mechanism responsive, not by resonance to the complete waves, but by its sensitiveness to changes of direction of the received impulses. Dr. S. P. Thompson thought that a mechanism similar to the relay described by Prof. Ayrton was contained in the telautograph of Elisha Gray; it was a "Prony" mechanism. In the acoustical problem the ear was probably sensitive to abrupt changes of shape in the waves as well as to reversals. In the case of mistuned octaves, something is heard that suggests "revolving" in the ear, indicating a cyclic change. In this regard it was necessary to take into account the phase-relations as well as the relative intensities of the component tones.—Mr. E. H. Barton then read a paper on the attenuation of electric waves along a line of negligible leakage. It forms a sequel to a paper communicated to the Physical Society and printed in their *Proceedings* of December 1897 and January 1898. Shortly after the publication of the earlier results, Mr. Oliver Heaviside drew attention to Lord Rayleigh's high-frequency formula for the "effective resistance" of wires to alternating currents, and suggested that the formula might be approximately applicable to the case; but he thought the experimental value of the attenuation would be considerably higher than the one derived from calculations. Mr. Barton here repeats the work, with special precautions as to the mode of insulating the parallel copper wires through which the wave-train proceeds. The value of the attenuation constant deduced from these experiments is 0·000013. By applying Lord Rayleigh's formula for the effective-resistance of the circuit, and using this value in Mr. Heaviside's expression for the attenuation, the calculated constant is 0·0000062. To account for the discrepancy, the author points out that the effective-resistance formula was originally developed for a wire placed at a considerable distance from other parts of the circuit, and for currents following the harmonic law. Whereas, in the experiments the conditions are (1) wires 1·5 mm. diameter, only 8 centim. apart, and (2) the waves are propagated in the form of a damped train, with the large end leading; they are extinguished after ten or a dozen vibrations. Mr. Oliver Heaviside (communicated) pointed out that, as there was human interest in error, it might be worth mentioning that at first it was supposed the previous experiments of Dr. Barton made the index of the attenuation factor to be six times that of the long-wave theory for simple periodic waves. And it was hard to account for so large a discrepancy. The discovery of an error in the figures, reduced the result from six to two. The small depth of the surface-layer of effective conduction, and the distance apart of the wires, seemed now to make it improbable that Dr. Barton's first reason (1) was adequate to account for the doubling of resistances. The second (2) was of course a substantial reason for increased resistance. A third one, Mr. Heaviside suggested, was the external resistance at the boundary of the waves. A combination of the second and third reasons, with a little of the first, might account for most of the extra attenuation observed, and, if more was wanted, one could "try the K.R. law." Mr. Appleyard said it was rather to be regretted that, in all the experiments, the distance between the wires had been the same, *i.e.* 8 cms. By taking a few different values (1) might have been checked. Lord Rayleigh's formula for the effective-resistance, involved the square-root of the magnetic permeability of the wires. The author had, throughout, used copper, a paramagnetic metal, and had assumed $\mu = 1$. It would be of advantage to try other metals. Mr. Barton, in reply, said he would make further experiments with the two conductors at different distances apart, and he would also try iron wires. With iron, the thickness of the surface-layer of the effective conductor was about one-thirteenth that of copper. Iron should therefore give a greater value of the attenuation than copper.—Mr. A. Griffiths then read a paper on diffusive convection, a phenomenon analogous to caloric convection. The differences of density that produce convection-currents are not due to changes of temperature, but to variations in the quantity of dissolved substance per unit volume. The author has devised an apparatus consisting of a vessel divided horizontally by a diaphragm, through which pass two vertical tubes of unequal lengths. A solution of copper-sulphate, maintained at constant strength, is placed in the lower compartment. The upper compartment is filled with water. Diffusion takes place up the tubes. One tube is 4 cm. long; the other is 4·05 cm. The tops of the tubes are exactly at the same level. Up the longer tube, and down the shorter, diffusive convection occurs at the rate of 5 cm. per year. This flow *increases* the quantity of copper-sulphate transmitted by the long tube by about 2 per cent., and *diminishes* that transmitted by the shorter tube by about the same amount. Consequently, the resultant increase due to the motion is only a fraction of 1 per cent. To detect the flow, the author employs a second piece of apparatus, in which the upper ends of the tubes are separated by a capillary, containing coloured liquid. By this means the motion is considerably magnified. Dr. S. P. Thompson asked whether, in a case where a large tube was used in determining the velocity, the viscosity of the liquid would not play a very much less part than with narrow tubes. Mr. Griffiths explained that viscosity was not important until very small tubes were considered, *e.g.* those of the order 0·001 mm. diameter.—The President proposed votes of thanks to the authors, and to Dr. Max Meyer for lending the Society his model.—The meeting then adjourned until June 24.

EDINBURGH.

Mathematical Society, May 13.—Mr. J. B. Clark, President in the chair.—The following papers were read:—On the second solutions of Lamé's equation, by Mr. Lawrence Crawford (communicated by Mr. J. W. Butters); on the insolation of a sun of sensible magnitude, by Mr. A. Ritchie Scott; the singular solutions of a certain differential equation of the second order, by Mr. Hugh Mitchell.

PARIS.

Academy of Sciences, June 6.—M. Wolf in the chair.—New photographic studies of the surface of the moon, by MM. Lœwy and Puiseux. A discussion of the data contained in the third part of the photographic atlas of the moon.—On a new absolute electrodynamometer, by M. Marcel Deprez. In the system described, the forces due to the action of the current are simple algebraic functions, rigorously and without approximation, of the dimensions of the fixed and movable circuits.—On a new constituent of the atmosphere, by MM. William Ramsay and Morris W. Travers (see NATURE, p. 127). M. Berthelot observed that the green ray of krypton coincided almost exactly with the bright green line of the aurora borealis. He suggested the name *eosium* for the new element.—On the propagation and deformation of the tidal wave which ascends rivers, by M. Partiot. The curve of the experimental results obtained on the Gironde and Garonne are compared with five formulæ; of these, that suggested by M. Boussinesq agrees best with the experiments.—On surfaces of total constant curvature, by M. C. Guichard.—On the systems of differential equations which satisfy the quadruply periodic functions of the second species, by M. Martin Krause.—On discontinuous functions which are allied to continuous functions, by M. R. Baire.—On the determination of the order of interference fringes, by MM. A. Perot and Ch. Fabry.—On the rotatory power of quartz in the infra-red, by M. R. Dongier. A comparison of the experimental results with those calculated from a formula given by M. Carvallo.—On the discharge of a Leyden jar, by M. R. Swygedauw.—Comparison of the Hertzian field in air and in oil, by M. Albert Turpain. In a resonator kept in a plane-perpendicular to the direction of the wires the wave-lengths vary with the nature of the dielectric; if the resonator is in the same planes as the wires, the wave-lengths are independent of the nature of the dielectric.—On resonators, by M. Oudin. The resonator now used consists of a solenoid of bare copper wire wound round a cylinder of paraffined wood, the high frequency current being produced by the arrangements of Hertz, of Tesla, or of d'Arsonval. This resonator creates a very intense alternating field, a Geissler tube being lit up at two metres distance. The discharge resembles in appearance that of a statically charged body, and causes lesions of the skin similar to those produced by the X-rays.—Visibility of the blind spot in the retina, by M. Aug. Charpentier. The experiments cited show that the spot where the optic nerve enters the retina, although insensible to light and blind in the proper sense of the word, is really represented in space by positive visual sensations occupying the same place, as if it were replaced in the eye by a real piece of retina in continuity with the rest of the membrane.—Quality of the fifteen vowels of the French language, by M. Monoyer.—Action of ammonium persulphate upon the silver in photographic negatives and the utilisation of this action, by MM. Lumière and M. Seyewetz. By means of a 5 per cent. solution of ammonium persulphate it is possible to reduce an over-exposed photograph in a manner not possible with the reagents previously suggested for this purpose, the persulphate acting first upon the most opaque portions of the negative, and leaving the half-shadows untouched.—On the causes of the imperfections in radiographs brought about by the use of reinforcing screens, by M. A. Londe. Comparative photographs were made with five screens, the platinocyanide of barium and of potassium, sulphide of zinc, Becquerel's violet sulphide, and Kahlbaum's screen. Whilst some of these increased the rapidity of action of the X-rays, it was always at the expense of clearness of definition, the image being accompanied by a kind of halo. Hence these screens cannot be employed in delicate work.—On the constitution of the ternary alloys, by M. Georges Charpy. A microscopical study of the bismuth-lead-tin and copper-tin-antimony alloys.—On the yttrium earths contained in the monazite sands, by M. O. Boudouard.—On the carbonic acid of the atmosphere, by MM. Albert-Levy and H. Henriet. The differences occasionally observed between the amounts of atmospheric carbon dioxide as determined by potash and baryta respectively, may possibly be due not to a different absorptive power for the gas with the two reagents, but to a slow oxidation of the organic matter present in the air which proceeds with different velocities in the two cases.—On a crystallised hepta-acetate of ouabaine, by M. Arnaud. Obtained by the action of acetic anhydride in presence of zinc chloride upon ouabaine.—On some acetals of pyrocatechol, by M. Ch. Moureu.—Nitration of cellulose and its hydroxy- and oxy-derivatives, by M. Léo Vignon.—A new mucin extracted from an ovarian cyst, by M. Charles Lepierre.—On the Holothuria collected by the *Travailleur* and *Talisman*, by M. Rémy Perrier.—On the embryogeny of *Serpula infundibulum* and *Hydroïdes pectinata*, by M. Albert Soulier.—Polymorphism in an Annelid (*Dodecaceria concharum*), by MM. Félix Mesnil and Maurice Caullery.—On the sexuality and relations of the Sphacelariaceæ, by M. C. Sauvageau.—On the palæozoic layers on the southern declivity of the Montagne-Noire, by M. J. Bergeron.—Characteristics of the bitumenous schist of the Bois-d'Asson (Basse-Alpes), by M. C. Eg. Bertrand.—On the transport of the sick, by M. Bonnafy. A discussion of the relative merits of State hospital-transports or ships chartered from the mercantile marine for this purpose.

DIARY OF SOCIETIES.

THURSDAY, June 16.

Royal Society, at 4.30.—Observations on Stomata: Francis Darwin, F.R.S.—Note on the Attenuation and Exaltation of the Virulence of the Organism of Texas Fever: A. Edington.—Mathematical Contributions to the Theory of Evolution. V. On the Reconstruction of the Stature of Prehistoric Races: Prof. K. Pearson, F.R.S.—On some Expressions for the Radial and Axial Components of the Magnetic Force in the Interior of Solenoids of Circular Cross Section: C. Coleridge Farr.—On the Source of the Röntgen Rays in Focus Tubes: A. A. C. Swinton.—On the Constituents of Argon: Prof. W. Ramsay, F.R.S., and M. W. Travers.—And other Papers.

Linnean Society, at 8.—Observations on the Seasonal Variations of Elevation in a Branch of Horse-Chestnut Tree: Miller Christy.—On Pantopoda collected by Mr. W. S. Bruce in Franz-Josef Land: G. H. Carpenter.—Morphological Relationships of the Actiniaria and Madreporaria: J. E. Duerden.—On some Fossil Leporines: Dr. C. I. Forsyth Major.

Chemical Society, at 8.—Ballot for the Election of Fellows.—Preparation of a Standard Acid Solution by Direct Absorption of Hydrogen Chloride: Dr. G. T. Moody.—Researches on the Terpenes. III. Halogen Derivatives of Fenchene and their Reactions. IV. On the Oxidation of Fenchene: J. A. Gardner and G. B. Cockburn.

SATURDAY, June 18.

Geologists' Association (London Bridge, L.B.S.C.), at 12.25.—Excursion to Crowborough. Directors: G. Abbott and R. S. Herries.

MONDAY, June 20.

Royal Geographical Society, at 8.30.—Tirah: the Geographical Results of the Recent Afridi Campaign: Colonel Sir T. Hungerford Holdich.

Society of Chemical Industry, at 8.—Aluminium as a Heating and Reducing Agent (in the Production of Chromium and other Metals): Dr. Hans Goldschmidt and Mr. Claude Vautin.

Victoria Institute, at 4.30.

TUESDAY, June 21.

Zoological Society, at 8.30.—Remarks upon Series of Specimens of Lepidosiren and other Fishes obtained in Paraguay: J. Graham Kerr.—Report on the Collection of Fishes made by Mr. J. E. S. Moore in Lake Tanganyika during his Expedition 1895–96; with an Appendix by Mr. J. E. S. Moore.—On the Scorpions, Spiders, and *Solpugæ* collected by Mr. C. Steuart Betton in East Africa between Mombasa and Uganda: R. I. Pocock.

Royal Statistical Society, at 5.—Annual General Meeting.

Royal Photographic Society, at 8.—Photographic Images: Captain W. de W. Abney.

WEDNESDAY, June 22.

Geological Society, at 8.—Post-Glacial Beds exposed in the Cutting of the New Bruges Canal; T. Mellard Reade.—High-level Marine Drift at Colwyn Bay: T. Mellard Reade.—Observations on the Geology of Franz Josef Land: Dr. Reginald Koettlitz.—Notes on Rocks and Fossils from Franz Josef Land brought home by Dr. Koettlitz, of the Jackson-Harmsworth Expedition, in 1897: E. T. Newton, F.R.S., and J. J. H. Teall, F.R.S.—On the Corallian Rocks of Upware: C. B. Wedd.

FRIDAY, June 24.

Physical Society, at 5.—Exhibition of an Apparatus illustrating the Action of Two Coupled Electric Motors: Prof. Carus-Wilson.—Exhibition of Weedon's Expansion of Solids Apparatus: J. Quick.—On the Theory of the Hall Effect in a Binary Electrolyte: Dr. F. G. Donnan.

SATURDAY, June 25.

Geologists' Association (Liverpool Street Station, G.E.R.), at 9.30 a.m.—Excursion to Sudbury. Director: Dr. J. W. Gregory.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Grundriss der Vergleichenden Anatomie der Wirbelthiere: Prof. R. Wiedersheim, Vierte, Gänzlich Umgearbeitete Auflage (Jena, Fischer).—The Wonderful Century: A. R. Wallace (Sonnenschein).—Royal University of Ireland Exam. Papers, 1897 (Dublin, Ponsonby).—University Extension College, Reading, Calendar 1897–98, 3rd edition (Reading).—The Cubomedusæ: F. S. Conant (Baltimore, Johns Hopkins Press).

Pamphlets.—Lessons in Domestic Science: E. R. Lush, Part 1 (Macmillan).—The Romanes Lecture, 1898: Types of Scenery and their Influence on Literature: Sir A. Geikie (Macmillan).

Serials.—Zeitschrift für Wissenschaftliche Zoologie, lxiii. Band, 4 Heft (Leipzig).—Physical Review, February, March, April (Macmillan).—Die Vertheilung der Erdmagnetischen Kraft in Österreich-ungarn: Prof. J. Liznar, ii. Theil (Wien, Gerold).—American Journal of Science, June (New Haven).—Sechster Jahres-Bericht des Sonnblick-Vereines für das Jahr 1898 (Wien).—Himmel und Erde, June (Berlin).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1897, No. 4 (Moscou).—Journal of the Institution of Electrical Engineers, June (Spon).—Brain, Part 81 (Macmillan).

CONTENTS.

THURSDAY, JUNE 23, 1898.

THEORETICAL MECHANICS.

Theoretical Mechanics: an introductory treatise on the Principles of Dynamics, with applications and numerous examples. By A. E. H. Love, M.A., F.R.S., Fellow and lecturer of St. John's College, Cambridge. Pp. xiv + 379. (Cambridge: at the University Press, 1897.)

THIS book is vibrating with dynamical modernity, and proves in effect that Theoretical Dynamics has not yet been reduced to the level of one of the Exact Sciences; and so it shows little tendency to bridging over the gap still existing between the two modes of treatment of the one science of Mechanics. The two different methods are described by Newton in the preface of the "Principia"—

"Auctoris præfatio ad lectorem. Cum Veteres Mechanicam (uti Auctor est Pappus) in rerum Naturalium investigatione maximi fecurunt; et Recentiores, missis formis substantialibus et qualitatibus occultis, Phænomena Naturæ ad leges Mathematicas revocare aggressi sint: Visum est in hoc Tractatu Mathesin excolere, quatenus ea ad Philosophiam spectat.

"Mechanicam vero duplicem Veteres constituerunt: Rationalem quæ per Demonstrationes accurate procedit, et Practicam. Ad Practicam spectant Artes omnes Manuales, a quibus utique Mechanica nomen mutuata est. Cum autem Artifices parum accurate operari solent, sit ut Mechanica omnis a Geometria ita distinguatur, ut quicquid accuratum sit ad Geometriam referatur, quicquid minus accuratum ad Mechanicam. Attamen errores non sunt Artis sed Artificum. . . .

"Pars hæc Mechanicæ à Veteribus in Potentiis quinque ad artes manuales spectantibus exculta fuit, qui Gravitatem (cum potentia manualis non sit) vix aliter quam in ponderibus per potentias illas movendis considerarunt. . . ."

Rankine had this preface in his mind in preparing his inaugural address (1856), a "Preliminary Dissertation on the Harmony of Theory and Practice in Mechanics," prefixed to his treatise on Applied Mechanics.

"In physics and mechanics the notions of the Greeks were very generally pervaded by a great fallacy, which obtained its complete and most mischievous development amongst the mediæval schoolmen, and the remains of whose influence can be traced even at the present day—the fallacy of a *double system of natural laws;* one theoretical, geometrical, rational, discoverable by contemplation, applicable to celestial, ætherial, indestructible bodies, and being an object of the noble and liberal arts; the other practical, mechanical, empirical, discoverable by experience, applicable to terrestrial, gross, destructible bodies, and being an object of what were once called the vulgar and sordid arts."

We want in our theoretical treatises more of the spirit expressed on the title-page of Hayes's Fluxions, 1704, "A work very useful to those who would know how to apply Mathematics to Nature."

To do this we must come to close quarters, and "missis formis substantialibus et qualitatibus occultis" fire off the elegant artillery of analysis; in fact, reduce the formulas to their numerical applications; it is in this way only that the various differences so notable in the mode of treatment in different schools can ultimately become reconciled.

Suppose we set up our author as the champion of the first of these two schools of thought described above by Rankine, and pit him against Prof. Perry, as the champion mathematician of the engineers.

The first point of dispute will be the measurement of force; the engineer will insist on retaining in Dynamics the statical gravitational measure of force, considering that he works in a field of gravity, practically uniform over the surface of the Earth, on which the human race is imprisoned; and also because the gravitational measure of a force is the only one capable of direct experimental determination to the highest degree of accuracy; this is not the case with the absolute measure of force, the one solely adopted in the demonstrations of the present treatise.

There are certain advantages in recording the results of cosmical, electrical, magnetical, and astronomical results in absolute measure; for if the author should succeed in having his treatise adopted on another planet, his C.G.S. units would be immediately applicable, on the assumption of perfect astronomical observation and measurement; but for experimental verification each planet would have recourse to its own gravitation system.

A problem proposed recently in an American technical journal, "to find the work required to lift the Earth one foot," might perhaps serve a useful purpose in focussing discussion between the merits of absolute and gravitation measure.

A curious note on the last page of this treatise dismisses the units in which all our engineering calculations are carried out, in a few lines, such as—

"Thus the equation which we write $P = mf$, where P is the force producing acceleration f in a body of mass m, could be written in these units $P = (m/g)f$, where g is the same constant."

"It does not tend to simplicity that the writers who use these (*i.e.* the gravitation) units also use the word 'weight' for the quantity we call 'mass,' and the letter W where we use m, and thus they write the above equation $P = (W/g)f$."

"Much confusion has thereby been produced."

But Prof. Perry will retort by saying that the confusion is produced by those writers who never have to employ the theory they teach; and that the words "frequently not" should be changed to "never" in the statement in § 299—

"The C.G.S. system of units, although generally used in scientific work, is frequently not employed in practical applications of science."

Such a thing as an arithmetical mistake is unknown among those who work with gravitation units; the same cannot be said of the adherents of absolute measure who are very apt to slip a g in their calculations (there is a g missing in the result of ex. 60, p. 75.)

How does our author reconcile his definitions in Chapter v. with the precise legal terminology of the Act of Parliament on Weights and Measures?—

"The *weight* in vacuo of the platinum *weight* (mentioned in the First Schedule to this Act), and by this Act declared to be the imperial standard for determining the imperial standard pound, shall be the legal standard measure of *weight*, and of measures having reference to *weight*, and shall be called the imperial standard pound, and shall be the only unit or standard of *weight* from which all other *weights* and all measures having reference to *weight* shall be ascertained."

How does Mr. Love propose to edit this clause? The word *weight* makes its appearance seven times where Mr. Love says the right word to employ is *mass;* he cuts the Act of Parliament to pieces on p. 98; and we have mass occur in almost every line. And if the word *weight* is to go, what is to be done with *pound*, *poids* (de kilogramme), and *avoirdupois*, all derived from the Latin *pondus?* According to § 91, *pondus* is given in dynes, and the word *pondus* above must be replaced by *massa.*

If this process of Restoration (to use the banal architectural word—

> "to erect
> New buildings of correctest conformation
> And throw down old, which he called *restoration*."
> DON JUAN.)

is to be carried out systematically, what is to be done with the words "in ponderibus movendis" of Newton's preface? and how are Ovid's lines to be restored describing the statue of Ladas, the work of the sculptor Myro?—

> "Quæ nunc nomen habent operosi signa Myronis
> Pondus iners quondam duraque massa fuit."

Or again the lines—

> ". . . et gravitate carentem Æthera. . . .
> Cum quæ pressa diu massa latuere sub illa . . ."

Love's *Dynamics* versus Ovid's *Ars amatoria!* not to mention the ecclesiastical usage of Christmas, Childermass, Candlemass, Ladymass, Lammas, Loafmass, Martinmass, Soulmass, Michaelmass, . . . now exciting controversy in another place.

"The common use of the word "weight" covers two notions which are essentially distinct, the notion of pressure which a heavy body exerts on a support, and the notion of quantity of matter. In scientific writing and speaking, different words must be used to express distinct notions" (p. 99).

A very useful aphorism, worth adding to Newton's "Regulæ Philosophandi"; and so scientific writers must invent two new words to express these two distinct notions, and not attempt to force a word of common currency out of its most extended meaning.

At the same time another rule might have been made —"The names of a thing must not be multiplied more than is necessary."

"Since the centre of inertia of body small enough to be handled coincides with its centre of gravity as defined in Statics, we shall denote it by the letter G" (p. 102).

And now we have three names, *centre of mass* (d'Alembert), *centroid* (Clifford), and *centre of inertia*, where the single name centre of gravity is sufficient for ordinary purposes. It is a pity to waste the expression "centre of inertia" in this way, as it may prove useful for designating a point distinct from the centre of gravity, in the case of non-rigid systems, such as a carriage on wheels, or a fish, bird, or projectile moving in its medium.

This brings us to the "Conception of a Rigid System" in § 114—

"If the particles of a rigid system continuously fill a surface, the system is a rigid body, and the surface is the surface of the body."

At this rate the ball-bearings of a bicycle constitute a rigid system, contrary to the function for which they are designed.

The bicycle has done wonders in familiarising our youth with dynamical sensations; and the machine itself can be used in a variety of ways to illustrate the theory of the pendulum and the gyroscope. When testing the wheels for friction and balance, the elliptic functions, defined in rather a condensed way in § 191, can easily be watched in their fluctuations; while the new drawing-room game of trying to walk round holding a revolving wheel serves to emphasise gyroscopic domination. With this stimulus the languishing study of elliptic functions may again become popular, and lead on to the dynamical applications of the hyper-elliptic functions, sketched out by Prof. Klein in his Princeton lectures, as required for the complete solution of the bicycle problem, especially as the Prize offered by the French Academy for this subject is still open.

The influence of wind will excite an interest in § 212, on the motion in a resisting medium. In this article the author could have simplified the treatment, by introducing the notion of "terminal velocity," as in ex. 155, p. 227.

The statement on p. 195, that the resistance of the air is better represented by the cubic law, is not valid, except for a very limited region in the neighbourhood of the velocity of sound; but, considering that the retardation

$$\frac{d^2s}{dt^2}$$

can be replaced by

$$\frac{d^2t}{ds^2}v^3,$$

Mr. Bashforth found it convenient, in the reduction of his screen records, to take out the factor v^3, and to measure carefully the other factor, $\frac{d^2t}{ds^2}$.

The Science of Dynamics does not consist in labelling certain physical quantities with letters, such as m, W, f, g, . . .; these letters really mean numbers, expressed each in its own unit. Mathematical Tripos questions unfortunately pay scant attention to the units involved, and our mathematical students learn to loathe all numerical applications, and so lose sight of the true meaning of these algebraical symbols for numbers. One reason for this dislike of numerical computation is the absurd system of using 7 figure logarithms, where, as in the case of the gravitation constant γ, upon which all Celestial Dynamics depend, the numbers do not warrant such refinement. A gigantic cheese-auger cannot be driven into the earth, to determine the density of the strata up to the centre, so we have to be content with the indication of the Cavendish experiment, which, even in the experienced hands of Mr. Boys, do not warrant the use of logarithms of more than 4 places.

The two papers on the theory of the oscillations of a ship, and of the stresses produced thereby, read recently before the Institution of Naval Architects by Captain Kriloff, Professor at the Naval Academy of St. Petersburg, are worth the attention of theoretical students in showing the numerical computations, given to 3 significant figures only, required in a complicated problem of Rigid Dynamics, and showing also the system of gravitation units invariably employed in such calculations.

The letters m and W are the modern dynamical equivalents of the θ and π, the θεωρητική and πρακτική, embroidered on the hem of the robe of the vision which appeared to Boethius in his dungeon, to inspire his *Consolation of Philosophy*.

Let the letter W still continue to denote the number of pounds of matter in the body, and let m denote the number of grammes; let us adopt the method of Prof. T. W. Wright's "Mechanics," reviewed by Prof. Perry, a new edition of which has just appeared, and employ the absolute system with Metric units only, so that the "poundal" is merely mentioned once to point out its uselessness. Now Prof. Perry can denote W ÷ 32·1912 by the letter M, so that the unit of M is a 32·1912 pound shot; and if he calls M the mass of the body, in opposition to Mr. Love, he is only following the custom which can be traced back through the treatises of Todhunter, Parkinson, Earnshaw, Whewell, Poisson, Lagrange, &c., up to Euler.

Thus M. de Freycinet writes, in his *Essais sur la philosophie des Sciences*:—

"Il ne suffit pas d'avoir la notion claire de la masse. Il faut aller plus loin. Pour les besoins de la Dynamique il est nécessaire de savoir *chiffrer* les masses.—Une quantité d'eau peu inférieure a 10 décimètres cubes, soit 9 litres, 8088, . . . le nombre habituellement désigné par la lettre g, voilà l'unité de masse."

With these writers we find that the gravitation unit of force alone is employed, and, contrary to Mr. Love's classification in § 294, the unit of mass is a *derived* unit, being that quantity of matter which will receive unit acceleration from the gravitational unit of force. The same method is employed in all engineering treatises, but we are inclined to agree with Mr. Love in thinking it might be abandoned with advantage, as being a mere lazy device to avoid writing $\frac{W}{g}$; and coming back to Euler, we find him explaining at length, in some six pages of his "Dynamics," 1760, that the acceleration $a = \lambda \frac{P}{M}$, due to a force P acting on a mass M, and that we must take $\lambda = 2g$, where g is taken by Euler to measure the distance a body falls from rest in one second.

Students will be grateful to the author for the two elegant and complete chapters on two-dimensional Motion of a Rigid Body, a great desideratum. A very large and valuable collection of illustrative examples are brought together, most of which are capable of experimental verification in our field of gravity; and in such cases it would increase the instructiveness to employ the gravitation measure of force, the only one capable of exact measurement.

"When, as in astronomy, we endeavour to ascertain (these) causes by simply watching their effects, we *observe;* when, as in our laboratories, we interfere arbitrarily with the causes or circumstances of a phenomenon, we are said to *experiment*" (Thomson and Tait).

In recording theoretical results of astronomical observation, absolute units are certainly appropriate, but they are all susceptible to the probable error in the determination of the gravitation constant γ.

The author has performed a useful service in § 277, in calling attention to the looseness of the ordinary school-book definitions, that "the weight of a body is the force with which it is attracted by the Earth."

But we must return to the charge again, and protest against the assumption that the addition of the word "weight" to "pounds" is required to connote the idea of force. Architects may measure the pressure on foundations in cwt/ft², but there is no such thing in existence as a pressure gauge graduated in lbs-wt/in²; it is always in lbs/in²; more than that, we doubt the existence of any gauge graduated in dynes/cm², or barads; and the stock of instruments at present in use is sufficiently large to resist this innovation. The centesimal measurement of time, required for the completeness of the metric decimal system, never came into use, if only because of the number of clocks, watches and chronometers in existence; so that the C.G.S. system is a mongrel one, involving the sexagesimal second of time.

In the careful examination of the ultimate axioms of Dynamics which he has set himself for reconsideration, the author has thrown down a challenge to the Metaphysicians, in the theory of the relativity not only of motion, of rotation as well as of translation, but also of time, matter, force, &c., which we trust will not pass unnoticed.

This minute survey of the foundations of Dynamics has, like a visit to the dentist, revealed so many unsuspected flaws, that it seems doubtful if Dynamics can remain an exact Science. Considering that the gravitation of a body varies with the velocity relative to the Earth, how are we justified in accepting the sacred definitions of the C.G.S. units, which may be affected by similar defects? A spirit of dynamical scepticism is in the air, as testified by the treatises of Mach and his disciples, Hertz, Boltzmann, and by Poincaré on Hertz in the *Revue générale des Sciences.* Maxwell's and Clifford's work does not appear to have influenced the author.

According to the Preface, "The foundations of Mechanical Science were laid by Newton"; but we think that the claims of Galileo are passed over, not to mention Archimedes. Galileo appears throughout this treatise as Galilei; both forms of the name are correct, according to the German student song—

"Auch ging er wohl mitunter
Zur Kirche als frumber Mann;
Doch beten und singen nicht kunnt er,
Schaut lieber zur Decke hinan:
Was sah er da in der Höhi?
Tschahi, tschaheia ho—
Die Ampel sah Galilei
Und auch der Galileo!" &c.

Some novelties in the way of nomenclature are welcome, such as "frame of reference" for "coordinate axes," "localised vector," "kinetic reaction" (due to Mr. Larmor, we believe) for d'Alembert's reversed effective force"; but when the writer proposes to upset the well-established use of common words, and teach us a new language of recent invention, he might as well set to work to change the names of the stars and planets; and we are compelled to protest, in the words of Biron,

"These earthly godfathers of heaven's lights,
That give a name to every fixed star,
Have no more profit of their shining nights
Than those that walk, and wot not what they are."

A. G. GREENHILL.

LONDON BIRDS.

Birds in London. By W. H. Hudson. 8vo. Pp. xvi + 339; illustrated. (London: Longmans, Green, and Co., 1898.)

As a writer on the habits of animals and their natural surroundings, and one, moreover, gifted with an unusually facile and interesting mode of expression, Mr. Hudson has already established such a reputation that any new work from his pen is almost sure of meeting with a favourable reception. And, in our opinion, the present volume is as full of interest as the nature of the subject permits; many of his descriptions bringing into prominent notice the amount of attraction to be found in the open spaces in and around London if only we go about with our eyes open, and can snatch a few half-hours of repose from the business and pleasures of the great city. Most of us, who either live in the country, or spend our holidays there, quite fail to realise how gladsome must be the sight of the bird-life in our London parks to those who have little or no opportunities of escape from the wilderness of bricks and mortar; and Mr. Hudson, in his enthusiasm for his subject, says that not only do such glimpses brighten the existence of our toilers, but that they are almost essential to such existence. Be this as it may, his description of the delight afforded to our poorer neighbours by the contemplation of the birds kept in the little enclosure at the eastern end of the Serpentine is quite pathetic reading, and affords full justification for all that is being done to encourage the feathered denizens of our parks to remain and multiply.

From a scientific point of view the work, it must be confessed, cannot lay claim to a high place; and it was doubtless not intended so to do. The decimation of the species that formerly lived in and around London, and the introduction, either natural or artificial, of extraneous kinds, preclude it being considered as a manual of the avian fauna of the district. Still even the scientific ornithologist ought to find some interesting matter in regard to the persistence of some species and the disappearance of others; and more especially so when he finds that in some cases it is the apparently hardier and bolder forms that have disappeared, and the more delicate that have remained. Still more remarkable is the recent colonisation of certain spots by such apparently shy and retiring species as the dabchick and moorhen.

In some ways, perhaps, the author is inclined to take matters a little too seriously; and, personally, we fail to assent to his strictures concerning the rearing of wild ducks on the Serpentine. If we read him right, he would have them partly, if not entirely, disestablished in favour of his pet species the crow. But, to our own thinking, it is a far more generally interesting, and certainly a far less common sight to watch the evolutions of the flights of duck on our park waters, than it would be to observe the sedate manner of crows and rooks, which most of us, if so disposed, can see elsewhere. Still more uncalled for are the author's strictures on the annual battue held to keep the numbers of the ducks within proper limits. Somebody must undertake the duty; and if the duty be also a recreation, surely the Ranger or his deputies should not be debarred from enjoying it. But apparently Mr. Hudson is of opinion that nothing but outdoor natural history is worth anybody's attention, since he goes out of his way (p. 80) to attack the Government for the purchase of the Blenheim pictures.

Although there may have been reasons for their removal unknown to the general public, our personal sympathies are, however, decidedly with the author over the felling some years ago of the elms in Kensington Gardens, and the consequent total disappearance of the rooks.

Even to summarise the contents of the book would largely exceed our limits to space, but attention may especially be directed to the chapters devoted to the open spaces on the outskirts of London, and to the two on the protection of birds in our parks, and on those most suitable for encouragement or introduction. In the last of these the author is strongly of opinion that water-fowl, if properly protected, will return to their assigned haunts to breed, adding: "I believe that our ornamental water-fowl ought never to be pinioned except in the cases of a few rare exotic species. When a bird is pinioned its chief beauty and greatest charm are lost; it is then little more than a domestic bird, or a bird in a cage." With this commendable sentence we take leave of a very pleasantly written and charmingly illustrated little book.

R. L.

OPTICAL ACTIVITY.

Das optische Drehungsvermögen organischer Substanzen und dessen praktische Anwendung. By H. Landolt, assisted by Drs. O. Schönrock, P. Lindner, F. Schütt, L. Berndt and T. Posner. Second Edition. Pp. xxii + 655. (Braunschweig: Friedrich Vieweg und Sohn, 1898.)

The first edition of this book, which appeared nineteen years ago, has since its publication been the standard work on the rotation of the plane of polarised light by active substances. Since 1879, however, the number of active substances known has increased from 300 to over 700, the methods of determining the rotation have been much improved, and considerable advances have been made in the theory of the asymmetric carbon atom, to mention only a few of the directions in which progress has been made. All this necessitated a thorough revision of the "Drehungsvermögen"; and in order to cope, in reasonable time, with the mass of material, the author has called in the assistance of the specialists above named in writing several of the chapters. The writers must be congratulated on the way in which they have welded the different chapters into a homogeneous whole, the disjointedness which so often arises from such joint-authorship having been most happily avoided. Comparing the present edition with the former one, the progressive broadening and consolidation of our knowledge of optical activity is very apparent. Twenty years ago the main outlines of the subject were already sketched in, and these remain practically unchanged; how much has been done in the interval, in filling in details, can best be appreciated by reading the present work.

The arrangement of the material remains very much the same as in the former edition, but the revision has been very thorough; so far as we have been able to judge, nothing of importance has been omitted.

The first part contains a classification of all active substances known, and a succinct account of the theory of Van 't Hoff and Le Bel. The properties of the active, racemic and inactive modifications of a substance are then contrasted, and the methods of converting them into and separating them from each other described. A chapter by Prof. Lindner, on the micro-organisms employed in splitting up racemic compounds into their constituents, should be helpful to chemists. In the third part the rotation is considered from the physical point of view, the chapter on the influence of solvents on rotation being especially interesting. Many of the phenomena observed are still unexplained, and it would appear that a study of these should be capable of throwing some light on the nature of solutions. After a discussion of Guye's hypothesis, which is found to be insufficient, the author remarks that it will probably be impossible ever to discover the numerical connection between chemical constitution and rotation.

One hundred and forty-two pages are devoted to a very excellent account, by Dr. O. Schönrock, of polarimeters and saccharimeters, the subsidiary apparatus connected with them, and the methods of using them. Dr. Schütt contributes Part 5, on saccharimetry and the determination of several other active substances of technical importance, and the book terminates with a collection of the rotatory powers of all active substances known, which is complete up to the middle of 1896, and includes some of the data published since that date. A good index is added. T. E.

OUR BOOK SHELF.

The Span of Gestation and the Cause of Birth. By John Beard. Pp ix + 132. (Jena : Gustav Fischer, 1897.)

COMMENCING with the assumption that there is a "critical period" in the development of every mammal "when the embryo is first beginning to look like the form whose offspring it is," Dr. Beard proceeds, in this monograph, to point out the close connection existing between the extent of time, or "critical unit," which elapses before the "critical period" is attained and the ovulation and total gestation periods.

Dealing shortly with the probability of an alternation of generations in mammals, which he has so ably advocated in earlier communications, he reaffirms now his previous conclusion that the attainment of the "critical period" is coincident with the completion of all the important parts of the sexual generation, and with the commencing degeneration of the asexual generation or phorozoon. The length of the "critical unit" is, therefore, the length of the life of the phorozoon, and when it is completed, in the more primitive forms, *e.g.* the marsupials, the birth of the sexual generation occurs.

Obviously the simpler conditions prevailing in the lower forms have been altered in the higher mammals, and at first sight the alterations have not occurred along definite lines, for the "critical unit" is not a fixed quantity; on the contrary, it varies in length from $7\frac{3}{4}$ days, in the opossum, to 47 days, in man. Dr. Beard is convinced, however, that the variations can only occur in conformity with some discoverable law, and he shows that the "critical unit" is either slightly less than one, or than two combined ovular periods, which he proposes to term "ovular units." He suggests that if ovulation was not previously restricted it became impossible when gestation was established, and could only recur, in the most favourable circumstances, shortly after birth, and thus the "critical unit" came to govern the "ovulation unit." But the intimate correlation between the critical and ovulation units is not closer than that which exists between the "critical unit" and the gestation period, for the latter is always some multiple of the former, and the greater the number of the "critical units" contained in the gestation period the greater is the stage of the development of the fœtus at birth; nevertheless, the completeness of the development of a fœtus at birth is not dependent merely upon the length of its gestation period, but upon the number of critical units in that period, for the "critical unit" has probably been doubled or trebled in certain cases, and the author believes that such lengthening is associated not with increase of the development, but only with increase in the size of the fœtus.

The points raised in this interesting memoir are clearly stated, the evidence in their support is well arranged, and the author is to be congratulated on having thrown light on some obscure problems. It is to be hoped that he will push his observations further, and that he will eventually succeed in demonstrating "the cause of birth."

ARTHUR ROBINSON.

A New Astronomy. By Prof. David P. Todd, M.A. Ph.D. Pp. 480. (New York, Cincinnati, Chicago: American Book Company.)

ASTRONOMY is pre-eminently a practical science, yet instruction in it, and especially in the branch which pertains to geography, usually consists of a course of study of text-books. This is not as it should be. It is far better to observe the apparent movements of the stars and planets than to learn that they are hundreds of thousands of miles away from us; and to note the annual movement of the sun among the stars is more instructive than to learn the dimensions of some sun-spots and prominences. In astronomy, as in other sciences, the only firm conceptions are those obtained from direct observation. Prof. Todd's book marks a new departure by showing how the fundamental principles of the subject may be studied with the aid of tangible objects, somewhat as in physics and chemistry. The result is most successful. No book with which we are familiar contains a clearer account of astronomical geography, and certainly none show so well how to observe celestial movements or illustrate astronomical phenomena with simple appliances. The pupil who learns astronomy through Prof. Todd's book will have a real idea of the motions and measurements of the heavenly bodies instead of abstract conceptions concerning them.

The practical presentation of what may be termed the geometry of astronomy only forms, however, one commendable feature of the book. Other characteristics which call for just as much praise are the large number of illustrations—well reproduced and well chosen—and the attention that is given to the advances made in recent years in all branches of celestial science. Throughout the book the endeavour has been to present the subject in a way which will induce the student to think for himself, and not merely commit facts to memory. In other words, Prof. Todd shows how astronomy may be given an educational value, instead of being presented as a collection of isolated and imperfectly connected facts. Fortunate is the pupil whose teacher instructs him in astronomy on the sound methods described in this book.

Lessons in Domestic Science. Part i. By Ethel R. Lush. Pp. viii + 88. (London: Macmillan and Co., Ltd., 1898.)

THIS instructive little book has been prepared for use by children in public elementary schools. It contains simple information on food, clothing, and personal hygiene, and is well adapted for the purpose for which it is intended. Wherever possible, the principles described are illustrated by experiment.

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.*]

Liquid Hydrogen.

IN his letter published in your issue of the 9th inst., replying to mine published on May 26, Prof. Dewar does not question the accuracy of the following statements, which form the most important part of my letter: (1) That the combination which I described in that letter as constituting the self-intensive method of refrigeration was proposed by me at the Royal Institution to his chief assistant, Mr. R. N. Lennox, in November 1894; (2) that this combination had not been previously employed; (3) that it formed the chief novelty of Prof. Dewar's paper and experiments of December 1895; (4) that it is essential to the apparatus which has made the step from liquid air to liquid hydrogen. These facts make a sound claim on my part to the invention of the process and to recognition in historical or explanatory accounts of work which involves the use of the process. Prof. Dewar says: "My results would have been attained had Dr. Hampson never existed, just as they have been developed." On the other hand, at the Society of Arts (see *Journal*, March 11, 1898, p. 382), in speaking of Dr. Linde's process, which is admitted to be substantially the same as mine, Prof. Dewar said that "after some fourteen years' work he ought to know something about low temperatures, but he must confess that the practicability of such a mode of working had never struck him." In illustrating the paper of December 1895, after showing an apparatus in which my process is embodied, and which has since been manufactured and sold by a firm of which his assistant, Mr. Lennox, is a member, Prof. Dewar said in my hearing that the chief credit for persevering with the development of that apparatus to a successful issue was due to Mr. Lennox. In his account (published in your issue of May 19) of the hydrogen apparatus, which also employs my process, Prof. Dewar says that it was constructed by Mr. Lennox's firm, and afterwards, in recognising "the invaluable aid of Mr. Robert Lennox," says "it is not too much to say that but for his engineering skill, manipulative ability, and loyal perseverance, the present successful issue might have been indefinitely delayed." I must allow that it is unfortunate for Prof. Dewar that an assistant so very useful and helpful should have kept the source of his inspiration on the vitally important features of the new development from the knowledge of his chief, who, in discussing my paper of May 2 before the Society of Chemical Industry, stated that he had been quite unaware of my communication of plans and drawings to Mr. Lennox. He ought however, when he did learn the facts, to have done me justice; whereas he says in his letter of the 9th inst.: "My assistant has explained his position in the matter in letters addressed to *Engineering* within the last few weeks." I earnestly hope that all who care for the credit of science will read for themselves the series of letters to *Engineering* by "Arenel," Mr. Lennox, and myself, from March 25 to May 13, in which it will be difficult to find a satisfactory explanation of Mr. Lennox's position. As I fear, however, that few people will exert themselves to look up these letters, I shall be pleased to send a copy of the series to any one who writes for it to No. 20 Gower Place, W.C.

Prof. Dewar criticises my statement that I was the first in this country to liquefy air and oxygen without employing other refrigerants, on the ground that it had previously been done in experiments at the Royal Institution. Now Mr. Lennox has been given very great credit for the work in these experiments; and I do not admit that experiments by my method, developed in collaboration with a gentleman to whom I had explained the method embodied in them, and who had confessed that this method was a novelty to him, and had promised to help me to the appliances required to work it, can be quoted as anticipations of my own work; but to make my statement more correct literally, I will say that my method (as compared with that of Dr. Linde, which differs from it in details) was the first in this country to liquefy air and oxygen without employing other refrigerants.

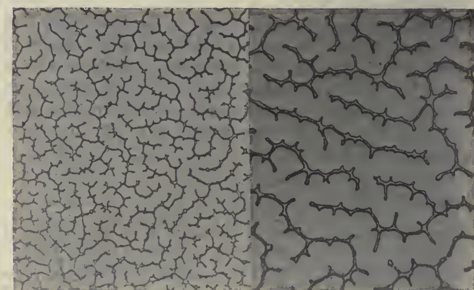
I may add that I mentioned my introduction to Mr. Lennox, not as an "excuse" for calling on him, a course which obviously needs neither excuse nor justification—but to show that I made my visit deliberately for a definite purpose, knowing that I was in possession of an invention of great value for work such as he was practically engaged in. W. HAMPSON.

June 11.

Dendritic Patterns caused by Evaporation.

I HAVE been much interested in Miss Raisin's Royal Society paper "On certain structures formed in the drying of a fluid with particles in suspension," of which an account appears in NATURE for June 2. In connection with this subject it may be worth while placing on record the fact that the presence of suspended particles is not essential for the production of dendritic forms.

Many years ago, when dabbling in microscopy, I mounted a number of objects in glycerine jelly, and was much troubled by the production of bubbles starting from the object and spreading in all directions, leaving a highly elaborate network of ramifications caused, no doubt, by the evaporation of water and consequent shrinkage of the jelly. Having called attention to this defect in a box of slides circulated by the Postal Microscopical Society, Mr. J. J. Wilkinson, of Skipton, very kindly sent me the two accompanying photographs taken with magnifications of 25 and 50 diameters respectively. An additional interest attaches to these from the fact that the slide from which they were taken belonged to the collection of the late Mr. Tuffen West. Needless to say, this slide was mounted for an entirely



× 25 × 50.

different object, and the specimen it contained was rendered worthless by the subsequent formation of these beautiful but troublesome vacuoles. It should be explained that it is the thin branches which are formed of the remains of the jelly, the air filling the broader species between them. G. H. BRYAN.

Bangor, June 10.

Iridescent Surf at Cromer.

CAN any of your readers account for what seems to me to be a singular phenomenon, as, although familiar with the beautiful sea-coast and clear green waves of many lands, I have never seen anything of the sort elsewhere.

The cliffs here, though fine when seen from a distance, are only composed of sand and earth, large quantities of which have been washed down by the recent rains, so that the sea is very dirty, each turning wave being dark with mud. This mud has apparently some curious property, which causes a very moderate surf to deposit long lines of foam all along the shore. Of this foam (which is in no hurry to disperse) each bubble is brilliantly iridescent, even on the dullest day of cold sea-fog, when there is not one gleam of sunshine to produce prismatic effects.

The inhabitants take this so entirely as a matter of course, that a lady whose attention I called to it, said that having always seen it, she had supposed it to be the natural condition of all sea-foam.

Beautiful in themselves as are these myriad rainbows of the shore, I am glad they are not universal, if they are only to be seen as compensation for a discoloured sea!

It would be interesting to learn what is the ingredient in the mud which, when combined with salt waves, produces such tints. CONSTANCE F. GORDON CUMMING.

Cromer, Norfolk, June 15.

Aquatic Hymenopteron.

IT may be of interest to some of your readers to know that, after years of unsuccessful search, I have at last bred *Prestwichia aquatica* (Lubbock) from eggs of Notonecta.

From one single egg there emerged no less than fourteen specimens, one male and thirteen females. This astonishing fact, besides proving that *Prestwichia* is an ovivorous parasite, beats all previous records of the number bred of allied species; but this record has since been put into complete shade. On Friday, from another egg, I bred six males and twenty-eight females; thirty-four parasites from a single egg.

After this astounding fact we must be prepared for something strange, now that the life-history of these marvellous ovivorous parasites is being worked out. FRED ENOCK.

13 Tufnell Park Road, N.

"A High Rainbow."

THE "rainbow" described by Mr. Moreland (in your issue of June 16) was evidently of the same character and origin as an inverted arc near the zenith, which occurred in connection with a mock-moon phenomenon at Birmingham, on May 31, 1895.

An illustrated description of this, by the writer, may be found in *Symons's Meteorological Magazine* for September 1895, p. 122. F. J. ALLEN.

Mason College, Birmingham, June 17.

THE ETIOLOGY AND PREVENTION OF MALARIAL FEVER.

THE study of the causes of intermittent or malarial fevers has received a marked impetus through the discovery by Laveran (*Traité des fièvres palustres*, 1884) of the presence in the blood of the affected persons of definite living bodies belonging to the protozoa. A large amount of important research has been carried on since, concerning these bodies or corpuscles of Laveran, which has yielded not only a clearer understanding of their morphological and biological characters, but has more accurately defined and placed on a firm basis the relation of these protozoa to the different known types of malarial fevers: febris quotidiana, tertiana, quartana—terms denoting the rhythm of the fever paroxysm. The researches of Laveran, of Marchiafava and Celli, of Golgi, of Celli and Guarneri, Grassi and Feletti, Councilman, Danilewsky, Mannaberg and others have definitely established that malarial fevers are characterised by and due to the presence, within the red blood discs of the patient, of parasites belonging to the group of protozoa known as sporozoa (gregarinida, coccidia and hæmosporidia); that is to say, of minute amœboid corpuscles, measuring not more than a sixth or an eighth or less of the broad diameter of a red blood disc, having entered into a blood disc pass their life cycle intraglobularly, growing in size at the expense of the blood disc, consuming the latter's substance till of the host nothing but a small mass of black pigment—the remnant of the blood pigment—is left. The final phase in the life-history of this plasmodium malariæ or hæmoplasmodium malariæ is reached when by a process of simultaneous fission its body produces a number of minute oval spores. These becoming free in the blood fluid are carried by the circulation into the different internal organs: marrow of bone, brain, and notably the spleen. Here at the proper time each spore germinates into an amœboid plasmodium, which passes as such into the general circulation, and, having invaded a red blood disc, goes through all the stages of its intraglobular growth and final sporulation. There is a good deal of evidence to show that the phase of sporulation and consequent dissolution of the central part of the parasite, not consumed by the spores themselves, is actually one of the direct causes of the fever paroxysm; at any rate, these events coincide with the commencement of the febrile attack. One of the most important amongst the many interesting facts elucidated is this, that the duration of the life cycle of the plasmodium malariæ stands in a direct ratio to, and determines the rhythm of the consecutive fever attacks in this way: in febris quartana the plasmodium finishes its cycle in seventy-two hours, in febris tertiana in forty-eight hours, and in febris quotidiana and perniciosa — so common and so virulent in tropical and subtropical regions—the whole process of development is very rapid, the plasmodia are conspicuously small and very numerous, very active, and sporulation takes place chiefly in the internal viscera, notably the spleen.

There are other details elucidated, by which the different types of plasmodium malariæ can be distinguished from one another; as by their size, the number of spores produced in each type, the character and intensity of the amœboid movement, &c., not the least important and fundamental detail being the artificial production by inoculation of the different types of fever: quartana, tertiana or quotidiana, according to whether for the inoculation one or the other or the third definite type of the plasmodium is employed. From all this it seems justifiable to assume that the different types correspond, if not to different species, at any rate to different well-defined varieties of the plasmodium malariæ. Whether or no these varieties have become "set" and permanent (form-constant), or whether they may in one or another generation, owing to alteration of the conditions of host, season, climate or other factors, undergo transition one into the other—as is maintained by some observers—remains to be seen. This, however, has become evident, that by careful microscopic examination of the blood the nature, type and severity of the fever paroxysms can be readily diagnosed and accurately determined. This is of particular value in those atypical and irregular forms of malarial fevers, where clinical diagnosis becomes difficult and indefinite, as, for instance, when there exist several generations of plasmodia in the same affected body, and when these different generations do not start at the same time, and do not finish at the same time their life cycle, as in quartana duplex and triplex.

Koch, in a recent lecture before the Colonial Society in Berlin, lays justly stress on the importance of systematic examination of the blood by experts, so as to determine the type and character of the parasite, because —and herein lies the chief burden of Koch's remarks— the accurate determination of the type of the plasmodium should guide the treatment of the case.

It is within common knowledge that the administration of quinine is invaluable in the treatment of ague, but it is equally known that in some cases its administration is either of no avail or has proved positively harmful.

Now, Koch insists on this, that since quinine has the power to arrest and inhibit the growth and development of the plasmodium, without killing it, the administration of the quinine should be so timed that it is capable of unfolding its effects at the proper phase in the life cycle of the plasmodium, that is about the time of sporulation—immediately before the onset of the fever paroxysm —or immediately after the germination of the spores into the plasmodia—that is immediately after the onset of the fever paroxysm. These phases can only be determined by accurate and systematic microscopic examination of the blood in each individual case.

Also in another direction Koch's remarks are of value, viz. in drawing renewed attention to the high probability of the view first expressed by Laveran, then maintained and expressed with ability by Dr. Manson, to the effect that, similarly to what has been proved in Texas fever of cattle for the tick, so also in human malarial fevers the mosquito (or gnat) plays an important part in the transmission and spread of the disease, being in fact the instrument by which natural inoculation is effected. Thus Koch mentions an island off the coast of German (malarial) East

Africa, in which the absence of the mosquito is associated with a conspicuous absence of ague. It would, however, be premature to sweep aside by such observations those of many previous writers, according to whom infection with the malarial poison occurs both by way of the alimentary canal (through drinking water) and of the respiratory organs (through air). However this may be, whether malarial infection under natural conditions is carried out to a large extent by way of inoculation through mosquitoes; whether the mosquito serves merely as the instrument of infection; or whether it is—as is maintained by Laveran, and notably by Manson—the host of the malarial plasmodium; whether artificial immunity against malarial fever is procurable and by what means, are some of the questions which, having a principal bearing on prevention, ought to receive an immediate answer.

It is for reasons of this kind that Koch's great authority and weighty opinion are welcome; they ought to stimulate to action those Governments whose possessions in tropical and subtropical countries impose on them the responsibility of better protecting the health and life of their civil and military subjects, a responsibility which hitherto, unfortunately, does not seem to have weighed heavily on them. Our own Indian Government has with laudable spirit initiated important work by appointing for specific research on malaria an able young military surgeon, Surgeon-Major Dr. Ronald Ross. While this is a beginning, it is small as compared with what is needed to meet the case; what is wanted is a staff of specialists, whose systematic and concerted work is required to elucidate the many problems connected with the subject. The Colonial Office also, with its sway over vast malarial territories in tropical and subtropical Africa, might do a great deal in the matter, considering that the health and life of their numerous civil and military servants is exposed continually in some of the most notorious hotbeds of deadly fevers to dangers which ought to, and with advancing exact knowledge might be prevented.

E. KLEIN.

THE UNIVERSITY OF LONDON COMMISSION BILL.

THE second reading of the University of London Commission Bill last week, without a division, should make its passage into law this Session certain. After the elaborate pains taken by the leaders of the irreconcileable graduates to personally instruct members of Parliament during the week preceding the debate, the feeble nature of the actual opposition came as something of a surprise. It is dangerous to treat Parliament as if it were a body of graduates with a vote to cast at a senatorial election, and methods suitable for the one kind of campaign are likely to fail in the other, as Sir John Gorst made plain, when he referred to the misstatements of fact which are inseparable from a contested election. But the danger is by no means altogether overpast. Having failed to persuade Parliament to reject the Bill, Sir John Lubbock and his friends are now preparing to do their best to wreck it and to ensure its passage in a form which will effectually prevent the University from adding to its present usefulness or doing anything to encourage learning and research. The member for the University has placed his name to two amendments, each of them, if accepted, calculated to stultify the labours of half a generation for the advancement of higher education in the metropolis. To begin with he proposes to abolish the thirty-mile limit, which is necessary if the reconstituted University is to be a seat of learning for London as well as of London. The effect of this would be to encourage those provincial Colleges at present unconnected with any University to apply for incorporation with London, to delay indefinitely the formation of a University for the Midlands—a foundation much to be desired, and to render impracticable the working of the Boards of Studies of the new University in London—a provision upon which a large part of its efficiency will depend. It would be difficult to imagine any single amendment which could reach further in its evil consequences, or be more destructive of the whole purpose of the Bill than this.

But Sir John is not content with making any unity of policy unattainable; he is anxious to ensure that as large a proportion as possible of the University scholarships and exhibitions shall help to maintain the students of other seats of learning. It has long been one of the anomalies of the present University that a large number of the scholarships are won by men and women who are studying elsewhere than in London, and very frequently at other Universities. Especially is this the case with mathematics, the rewards for which study are almost invariably taken by Cambridge men. In order to maintain and extend this condition of things, the member for the University proposes that external students shall be admitted to the examinations for internal students. Under the dual examination system which the Senate will have the power of establishing, by the terms of the Bill, should it seem advisable to do so, internal students will be admitted to the examinations for external students; and rightly, for these tests, like the present ones, will be open to all the world, irrespective of the manner or place of study. But this is no argument for reciprocity in regard to the internal examinations. Should an internal student win an external scholarship, the University funds will at least go to the encouragement of learning in London itself; but should an external student take an internal scholarship, the University chest will, in the large majority of instances, be depleted for the benefit of some other institution. And what is even more objectionable, this amendment would divest the internal degree of its chief value in the eyes of students and the public alike, the guarantee namely which it will give under the Bill as it stands, that its holders have undergone a definite course of training and study. This guarantee is far more valuable in the eyes of those who understand educational matters than the difficulty of the questions which a candidate may succeed in answering during a few days at the close of his studentship, under conditions which at best admit a large measure of chance.

It is hard to believe that the Colleges will consent to take a part in reconstitution on these lines, or that Parliament will play into the hands of the wreckers by accepting such amendments. The proposal to bind the hands of the Senate and force them willy-nilly to subject external and internal students to the same examination—a point to which so much attention was directed in the recent debate—is not worth serious argument; for apart from its inherent impracticability, the facultative dual examination was the basis of the compromise on which the present Bill rests, and to destroy this would be to render legislation ineffectual because unacceptable to all the teaching bodies interested.

THE SCIENCE AND ART BUILDINGS AT SOUTH KENSINGTON.

WE were able to print last week the text of the Memorial forwarded to the Government by the President of the Royal Academy, pointing out how disastrous it would be for the future of Art in this country if the new proposals regarding the buildings at South Kensington were carried out. As our readers will remember, the same course had already been taken by the President of the Royal Society with regard to the Science side of the question.

We are now enabled to give the names of those who have signed the Art Memorial.

Edward J. Poynter, P.R.A.	Cyrus Johnson.
W. B. Richmond, R.A.	Frank Walton.
Fredk. Goodall, R.A.	Ernest A. Waterlow, P.R.W.S.
G. W. H. Boughton, R.A.	Walter C. Horsley.
Walter W. Ouless, R.A.	Charles Fowler.
Ernest Crofts, R.A.	J. D. Crace.
Thos. G. Jackson, R.A.	Edwin Bale, R I.
Hamo Thornycroft, R.A.	M. R. Corbet.
H. H. Armstead, R.A.	Edith Corbet.
Harry Bates, A.R.A.	W. J. Hennessy.
Alfred Gilbert, R.A.	H. R. Mileham.
Briton Riviere, R.A.	James E. Grace.
E. Onslow Ford, R.A.	Harold Rathbone.
William Holt, of Oldham.	H. R. Hope-Pinker.
John M. Jones.	H. Cecil Drane.
W. P. Frith, R.A.	G. E. Wade.
Frank Dicksee, R.A.	Lionel Cust.
Phil. R. Morris, A.R.A.	Walter McLaren.
George Frampton, A.R.A.	Alfred Drury.
Hugh de T. Glazebrook.	Fanny W. Currey.
Luke Fildes, R.A.	W. Hounsom Byles.
Val Prinsep, R.A.	L. Fairfax Muckley.
Marcus Stone, R.A.	R. Falconer MacDonald.
Colin Hunter, A.R.A.	Elinor Hallé.
G. F. Watts, R.A.	J. Fitz Marshall, R.B.A.
John R. Clayton.	May E. Gordon.
Reginald Barratt.	A. T. Yowell.
Fredk. Smallfield.	Mary Grace.
Lewis F. Day.	Henry T. Wells.
Thos. J. Grylls.	J. Calcott Horsley.
Morant and Co.	William F. Yeames.
L. Alma Tadema, R.A.	Seymour Lucas, A.R.A.
Andrew C. Gow, R.A.	Eyre Crowe, A.R.A.
Sydney P. Hall.	G. D. Leslie.
Alfred East.	Thos. Brock.
John Charlton.	W. Holman Hunt.
Oliver Murray, A.R.A.	Edward Burne-Jones.
C. E. Johnson.	Arthur Severn.
J. Y. Hunter.	C. E. Hallé.
R. Phene Spiers, F.S.A.	Thos. Stirling Lee.
Gordon Thomson.	Gleeson White.
John Tenniel.	Walter Crane.
Edmd. M. Wimperis.	Carlisle.
Herbert Schmalz.	W. Q. Orchardson, R.A.
S. Melton Fisher.	

NOTES.

IN the presence of a brilliant and representative gathering of citizens, the freedom of the City of Edinburgh was conferred upon Lord Lister on Wednesday, June 15.

GERMANY owes most of her success in the commercial and industrial world to her readiness to act upon the advice of her men of science. The German Emperor has just given further evidence that he understands the value of scientific opinion in matters affecting national welfare, and recognises the importance of technical education, by nominating Prof. Slaby, of the Technical College at Charlottenburg, Prof. Launhardt, of the Technical College at Hanover, and Prof. Intze, of the Technical College at Aachen, to be life members of the Upper House of the Prussian Diet. The *Times* correspondent at Berlin states that while Prof. Slaby was delivering his lecture at Charlottenburg on Wednesday, he was interrupted by the receipt of a telegram from the Emperor, which he proceeded to read to his class. It was in the following terms :—"In recognition of the importance which technical knowledge has acquired at the end of our century, and in profound respect for the exact sciences in general, I wish to confer upon the Technical College of Charlottenburg a seat and a vote in the Herrenhaus, and I nominate you as the most fit person to be its representative.—William, I.R." Prof. Slaby, addressing the students, expressed his sense of the significance of the step which the Emperor had taken in conferring upon the technical colleges the right of representation in the Upper House of the Prussian Diet, a privilege which the Universities had long enjoyed.

THE preliminary programmes of the sections of the American Association for the Advancement of Science are beginning to be published. Section A (Mathematics and Astronomy) announces twenty-five papers, and reports of five committees. Section C (Chemistry) announces that on Tuesday, August 23, under the auspices of the American Chemical Society, the morning session will be devoted to the subject of analytical chemistry, led by Dr. P. De P. Ricketts, of Columbia University; the afternoon to teaching of chemistry, Dr. F. P. Venable, University of North Carolina. On Wednesday, August 24, the Association will make an excursion to Salem as guests of the Essex Institute. On Thursday, August 25, the morning will be given to inorganic chemistry, led by Dr. H. L. Wells, Yale University; the afternoon to organic chemistry, Dr. Ira Remsen, Johns Hopkins University; and the evening to physical chemistry, Dr. T. W. Richards, Harvard University. On Friday, August 26 (Harvard Day), in one of the Harvard University rooms, the subject of physiological Chemistry will be opened by Dr. E. E. Smith, New York; President Eliot will deliver an address to the Association at large in the evening. On Saturday, August 27, the morning will be given to agricultural chemistry, led by Dr. H. A. Weber, Ohio University; and the afternoon to technical chemistry, Dr. N. W. Lord, Ohio University.

THE issue of the *Revue Scientifique* of June 11 contains an interesting critical notice of the Royal Society's International Catalogue scheme by M. Charles Richet, a well-known expert in such matters. M. Richet fears that the apathy which the public manifest towards all such enterprises may make it difficult to obtain the necessary funds from subscriptions. He cordially welcomes the proposal to issue the catalogue in two forms—as slips and in book form—but regards the preparation of slips of the character suggested as a work of great difficulty on account of its magnitude. Being an ardent advocate of the Dewey system, he naturally deplores the fact that it has been put aside; but yet finally expresses his conviction that all advocates of the system will rally, without hesitation, to the system proposed by the Royal Society, which, being advocated by such a body, has the greatest chance of success. Of the scheme as a whole, M. Richet writes: "C'est une belle œuvre à accomplir: et le plan est excellent, dans son ensemble. Nous espérons donc fermement que tous les savants de France et de l'étranger prêteront leurs concours actif à cette magnifique publication." If all receive the proposals in the same generous spirit of appreciation and self-abnegation, there can be little doubt of the success of the enterprise.

PROF. O. C. Marsh, Yale University, New Haven, has been elected a Foreign Member of the Geological Society.

PROF. B. GRASSI, M. Hippolyte Lucas, and Dr. August Weismann have been elected honorary members of the Entomological Society of London.

THE death is announced, at the age of seventy-two, of Sir James Nicholas Douglass, F.R.S., late Engineer-in-Chief to the Hon. Corporation of Trinity House. During his tenure of this post he carried out many important engineering works both at home and abroad, such as the Wolf, Longships, Great and Little Basses, Eddystone, and Muricoy lighthouses, and he effected numerous technical improvements connected with lighthouses and their illuminating apparatus, as well as in buoys and beacons. He was elected a Fellow of the Royal Society in 1883, and retired from his post at the Trinity House in 1892.

THE *Times* reports that the Norwegian Geographical Society gave a banquet last Saturday to the expedition under Captain Sverdrup, which is on the point of leaving for exploration along the north and north-west coast of Greenland. Several of the Norwegian Ministers were present, as well as the Presidents of the two Houses of Parliament, Dr. Nansen, Prof. Mohn, and other distinguished men.

AN international fisheries exhibition, together with an exhibition of Norwegian industry, agriculture, art and home industries, is now open at Bergen. The directors of the Society for promotion of Norwegian fisheries are of opinion that besides the many various meetings which will take place during the exhibition, an International Fisheries Congress ought, if possible, to be arranged. They therefore invite Norwegians as well as foreigners interested in fisheries to join in such a Congress, to be held in Bergen on July 18–21.

ACCORDING to a report of the French Minister at Stockholm, referred to in the *Board of Trade Journal*, the industry of textiles made from peat-fibre has just been introduced into Sweden. The fibres, produced from peat by a mechanical process, can be mixed in the proportion of 75 per cent. with pure wool, for the manufacture of yarn similar in appearance to common woollen yarn.

THE Pilot Chart of the North Atlantic Ocean, issued by the United States Hydrographic Office for the month of June, shows that the ice season has now set in on the Grand Banks, and that the amount of icebergs is equal to the average of past years. In addition to the ordinary useful information there is a sub-chart showing the distribution of atmospheric pressure and the prevailing winds in the South Atlantic, taken, with some modifications, from the Meteorological Atlas of the Deutsche Seewarte. It shows that a belt of high pressure extends east and west along the parallel of 25° S. To the southward the pressure diminishes rapidly and with great uniformity, and the decrease is continuous as far towards the pole as observations have been carried. Some useful general remarks are made as to the system of winds to which this high pressure area gives rise in various seasons of the year.

IN the last annual number of the *Journal of the Scottish Meteorological Society* (vol. xi.), Dr. Buchan has published a most important paper on the mean atmospheric pressure and temperature of the British Islands, with twenty-six coloured maps and tables of monthly and yearly values for forty years, 1856–1895. Fifteen years ago similar data for twenty-four years were published, but since that date a large number of stations have been added, the total now reaching 400, and a more satisfactory inspection of stations has been brought about, chiefly by the valuable aid rendered by the Meteorological Council, so that better averages are now obtainable. This monumental work teems with interesting and strictly trustworthy results, but we can only briefly refer here to one or two general remarks pointed out in the author's instructive discussion. The most striking feature is the down-curving of the annual isobaric lines as they cross the Irish Sea and St. George's Channel. Another distinct feature of the isobars is the influence of the land in increasing the barometric pressure, and the opposite influence of the sea in depressing the isobars. In the discussion of the temperature observations the author arrives at a conclusion of great importance for invalids, viz. that where a winter climate is sought, offering, in the highest degree the combined qualities of mildness and dryness, anywhere afforded by the British Islands, such a climate is to be found on the shores of the Channel, from about Dover to Portland.

MR. W. ERNEST COOKE, Government Astronomer of Western Australia, has forwarded to us particulars received from Captain Odman with regard to a remarkably severe storm experienced off the north-west coast of Australia between March 30 and April 3. Captain Odman was commanding the S.S. *Albany*, and evidently passed right into the "eye" of the storm. Strong north-east winds were met on April 1, and the barometer fell until 10 a.m. of the following day, when the weather became calm. An hour later the barometer rose quickly, and south-west winds were experienced. The following extracts from the log are instructive, as showing the characteristics of wind and atmospheric pressure in a rotary storm:—April 1, lat. 19·00, 12 a.m., barometer 29·58, strong N.E. winds and clear; 3 p.m., barometer 29·48, blowing N.E. gale with heavy rains; 11 p.m., barometer 29·42, wind N.E., blowing and raining, the force of the wind being indescribable, and continuing with fearful hurricane force up to 10 a.m. on 2nd. April 2, lat. 20·00, 10 a.m., barometer 27·80, suddenly and without warning it became calm; in fact, we could not feel a breath of wind, or tell from which direction it came. The barometer then stood at 27·80, and continued stationary till 11 a.m, when it suddenly rose to 27·90, and the wind could be heard roaring and the sea boiling before we felt it, when it suddenly struck the ship from S.W., in an entirely opposite direction to that previously experienced, and, with the rain, became almost as dark as night, and continued to blow at much greater hurricane force than it had done before, the barometer still rising. The gale still continued with violent force up to midnight, the barometer still rising and the wind decreasing from then. Captain Odman states as a positive fact that the men's dungaree suits and his own canvas one were blown to ribbons during the storm. The barometer fell an inch between 6 and 10 a.m. on April 2, and rose an inch again by 6 p.m. Mr. Cooke informs us that the storm struck the towns of Cossack and Roeburne, and almost demolished them. Cossack registered 15·42 inches of rain, Roeburne 14·66, and a place called Whim Creek had 36·53 inches. Mr. Cooke failed, however, to trace the storm inland. He expected it to work overland towards Eucla, at the head of the Great Australian Bight, but no traces of it were perceptible at the inland meteorological stations.

IT may be remembered that in May of last year Dr. Le Neve Foster, F.R.S., nearly met his death by carbonic oxide poisoning while investigating the circumstances attending an underground fire at the Snaefell Lead Mine, Isle of Man (see NATURE, vol. lvi. p. 58). A detailed report upon this mine accident has just been published in a Blue Book, and it is not merely a statement of facts as to the condition of the mine and the method of working, but a document containing information which will prove of service to persons exposed to the risk of carbonic oxide poisoning, and also be of scientific interest to physiologists. Dr. Foster points out that although the gas occurs occluded in certain rocks and minerals, it has never been found as a natural constituent of the atmosphere of mines. He had, therefore, to seek for some artificial source of the poison when investigating the accident, and he found sufficient evidence to justify the conclusion that the deaths of the twenty victims of the Snaefell disaster were due to carbon monoxide produced by timber burning in the mine. It is startling to find how small a quantity of timber need be burnt to pollute to a dangerous extent the passages of a mine. By the combustion of a cubic foot of larch, which was the kind of timber employed at Snaefell, enough carbon monoxide is produced to occupy 417 cubic feet of space at a temperature of 60° F., and a pressure of 30 inches. Twenty-five cubic feet of timber contain carbon enough to produce sufficient carbon monoxide to give an atmosphere with 1 per cent. of the noxious gas all through the mine, which proportion is quite sufficient to cause almost immediate loss of consciousness, followed speedily by death. Dr. Foster therefore recommends that the linings and fittings of all mine shafts and roadways in mines should be made fire-proof, or of fire-resisting materials, unless the shafts and roadways are decidedly wet or damp. The use of oxygen in restoring sufferers from carbonic oxide poisoning is referred to, and the suggestion is made that a supply of compressed oxygen should be available in every district, and also apparatus for penetrating into noxious gases. With Dr. Foster's report is a report by Dr. Miller upon physiological effects of carbon monoxide poisoning, and an appendix containing statements concerning the sensations, symptoms, and after-effects produced by breathing the gas.

DR. ISSATSCHENKO, of the bacteriological laboratory attached to the agricultural department of the Russian Government, has just made a preliminary communication on a new microbe pathogenic to rats which he has discovered. A disease, which assumed epidemic proportions, broke out amongst the rats kept for experimental purposes in the laboratory, and from the liver and spleen of affected animals a bacillus was isolated, which proved on inoculation to be extremely fatal as regards both rats and mice. Receiving food infected with this organism rats and mice invariably succumbed, the former after from eight to fourteen days, the latter after from four to eight days. Following Pasteur's example in the case of a bacillus similarly fatal to rabbits, attempts were made to turn this new microbe to practical account and utilise it as a living rat poison. The results so far have not been very encouraging, but further experiments are being made in this direction. It is apparently quite without effect upon pigeons and rabbits. As regards its artificial cultivation this microbe is very accommodating, growing luxuriantly upon all the customary culture media with the exception of potatoes. In microscopic appearance it varies, as is so often the case, according to the nature of the medium in which it has been previously grown. It is mobile, and is endowed with lateral flagella.

INCREASING attention is paid nowadays to the elevation and sub-soil by those who are in a position to choose their place of residence. It is true that many circumstances have to be taken into consideration in fixing upon a home, and not the least important is the construction of the house itself—more important, probably, than the question of a gravel or clay sub-soil. Elevation and surroundings, again, may confer advantages not to be had in a low-lying gravel area. To those, however, who are seeking for homes on particular sub-soils or in particular situations the handsome embossed model just published by Mr. E. Stanford, London, will prove an excellent general guide. If the more elevated regions of Shooter's Hill, Sydenham and Wimbledon, of Hampstead, Highgate and Harrow, appear to stand out in somewhat mountainous form, owing to the horizontal scale of one inch to a mile and the vertical scale of one inch to a thousand feet, the main features can nevertheless be readily grasped. The leading roads and railways are shown, the sub-soils are distinctly coloured, and along the margin of the model there are sections depicting the underground structure of the country. The model itself measures 2 feet by 1 foot 8 inches, including its frame, and it takes in Barking on the north-east, a part of Harrow on the north-west, Long Ditton on the south-west, and Orpington on the south-east. The model is made of tinned steel plate, enamelled in colours, and its price is 15*s*. It has been prepared by Mr. James B. Jordan, the geology being compiled from the maps of the Geological Survey, the work chiefly of Mr. Whitaker. House-hunters who consult it will see at a glance the advantages to be gained from certain localities, and also the districts that should, if possible, be avoided. For educational purposes in schools the model may prove of considerable service.

AN interesting address entitled "Types of Scenery and their Influence on Literature," recently delivered at Oxford by Sir Archibald Geikie as the Romanes Lecture, has been published by Messrs. Macmillan and Co., Ltd. The object of the address was to point out the leading types of scenery that distinguish the British Isles, and to show that it is possible to trace from each of them an influence upon the growth of English literature. For instance, Sir Archibald points out that the English lowlands have had a distinct influence upon our literature. They are washed by the sea along the whole of their eastern and northern borders. Moreover, the coastline is indented by numerous bays, creeks, and inlets, which furnish many admirable natural harbours. There can be no doubt that this feature in our topography has powerfully fostered that love of the sea which has always been a national characteristic. To the same cause may be traced that appreciation of the poetry of the sea so noticeable in our literature. For a century after Milton's time poetry became with each generation more polished and artificial. When at last a reaction set in, the impulse that led to the most momentous revolution in the history of English poetry came in large measure from the writings of three poets, each of whom drew his inspiration from lowland scenery—Cowper, Thomson, and Burns. The uplands, which include the border country of England and Scotland, produced the Border ballads, and the highlands of Western Argyleshire are portrayed in Macpherson's "Ossian"; while the Lake District, also mountainous, claims attention for its influence on the progress of national literature, for it was amidst its scenery that William Wordsworth was born and spent most of his long life. Towards the end of his interesting address Sir Archibald Geikie remarks:—"It is curious to remember that three of the poets whom I have singled out as illustrations of the influence of our lowland, upland, and highland scenery upon our literature have held up the geologist to ridicule. Cowper put that votary of science into the pillory among the irreligious crowd, about whose ears the poet loved to 'crack the satiric thong.' Wordsworth treated the geological enthusiast with withering scorn. Scott, with his characteristic good humour, only poked fun at him. It was reserved for a poet of our own day to look below the technical jargon of the schools, and to descry something of this wealth of new interest which the landscape derives from a knowledge of the history of its several parts. But Tennyson only entered a little way into this enlarged conception of nature. There remains a boundless field for some future poetic seer, who, letting his vision pierce into the past, will set before the eyes of men the inner meaning of mountain and glen."

THE twenty-sixth annual report of the Board of Directors of the Zoological Society of Philadelphia has been received. The number of visitors to the Gardens of the Society during the year covered by the report was 173,999. In addition to this, 125,000 free tickets were issued to the Board of Education for the admission of pupils of the public schools. The Society's collection of animals numbers 1019, of which 339 are mammals, 421 birds, 238 reptiles, and 21 batrachians. Among the additions to the collection were two young West Indian seals (*Monachus tropicalis*). Although the existence of a peculiar species of seal in the Caribbean Sea has been known for several centuries, no detailed description has been given of it until very recently, and no living specimens had been procured until a schooner was sent out last spring by a firm of merchants for the purpose of capturing some, which was finally effected on a small coral reef off the Campeachy coast of Yucatan. These animals were distributed among various zoological collections, and three were secured by Philadelphia. It was hoped that observations might be made upon the habits of this almost unknown species, but unfortunately, in all these cases, the animals were induced to take food with difficulty and in small quantity, and they lived only a short time. The genus *Monachus* includes the present species and one other found in the waters of the Mediterranean, these seals being the only ones belonging to the *Phocidæ*, or the group without external ears, which are found in subtropical regions of the Atlantic. Referring to the death of a male orang belonging to the Society, it is noted that though it has more than once been pronounced by high authority to be anatomically impossible for the orang to maintain an erect attitude without touching some means of support, this animal was repeatedly observed walking about his cage in an absolutely erect position without having his hands in contact with any fixed object.

WRITING in the annual volume of the *Sitzungsberichte der physikalisch medicinischen Societät in Erlangen*, Prof. E. Wiedemann and Dr. G. C. Schmidt give some noteworthy observations on the electric properties of gases. In the first of their papers the authors discuss the absorption of electric oscillations by gases, and arrive at the somewhat remarkable result that gases which are excited to incandescence by electric discharges will absorb electric waves falling on them, even when they would not do so if unexcited; but the dark space surrounding the kathode is only feebly absorbent of such oscillations, thus behaving like a non-conductor. Prof. Wiedemann and Dr. Schmidt also discuss the effects of Goldstein's rays ("kanalstrahlen") on electric oscillations, and find that the oscillations emanating from a Lecher condenser are absorbed by gases which have been excited by these rays.

IN a second paper, Prof. Wiedemann and Dr. Schmidt discuss the view that the conduction of electricity through rarefied gases is an electrolytic phenomenon. This view is negatived by their present observations. In some cases, as with chloride, bromide and iodide of mercury, no products of electrolysis appeared at the electrodes; in other cases, where decomposition did take place, the amounts liberated were found not to follow Faraday's Law. In a further communication to the same journal, Dr. G. C. Schmidt discusses the relation between fluorescence and photo-electric susceptibility; the results of these observations do not altogether favour the hypothesis of Elster and Geitel as to a parallelism between the two phenomena.

SOME of the catalogues published by many photographic firms, besides containing useful information on photographic lenses, cameras, shutters, &c., are really works of art of no mean merit. We have just received the fourth edition of Messrs. Newman and Guardia's catalogue, which quite falls into this category if one examines the series of illustrated specimens of the work done with their so-called "N. and G." cameras. The beauty of these reproductions will be fully appreciated by all who peruse this book, the half-tone blocks having been produced by the Swan Electric Engraving Company.—Messrs. Ross, Ltd., have also forwarded to us their catalogues for the present year, containing a mine of information about lenses, cameras, &c., of every conceivable kind, and many other optical instruments which this firm manufactures.

IN the *Bollettino della Società Sismologica Italiana* (vol. iii. No. 8) a list of earthquakes observed in Greece during the year 1897 (January–June) is given by S. A. Papavasiliou, in continuation of the catalogue compiled by the author before his retirement from the observatory at Athens. The number of shocks recorded during the six months is about 130. Other papers are:—A new contour-map of the central crater of Etna, by A. Riccò; seismoscope with clock, by C. Guzzanti, describing an arrangement for starting mechanically a clock, previously set at a known time; seismology and palæography, by E. Oddone; notices of earthquakes recorded in Italy (May 23–June 11, 1897), by G. Agamennone, the most important being the Ionian Sea earthquake of May 28–29, and earthquakes of distant origin on May 23–24, 24–25, and June 3.

A NEW part (vol. ii. Isopoda, part ix. x.) of Prof. G. O. Sars' monograph on the "Crustacea of Norway" has just been issued by the Bergen Museum. The Munnopsidæ are concluded in this new part, which also contains descriptions of members of the tribe of Oniscoida, four families of which are represented in the fauna of Norway.

THE second volume of the Cape Photographic "Durchmusterung," by Dr. David Gill, F.R.S., and Prof. J. C. Kapteyn, has just been published as vol. iv. of the *Annals of the Cape Observatory*. The arrangement of the stars in the catalogue is precisely similar to that of vol. i., recently reviewed in these columns (p. 513). The new volume contains the positions of stars in the zones $-38°$ to $-52°$.

MR. T. CHALKLEY PALMER has an interesting note in the *Proceedings* of the Academy of Natural Sciences of Philadelphia, on the peculiar movements of the diatom *Eunotia major*, which he considers to be connected with an actual process of assimilation or elimination of oxygen, and to be produced by special pseudopode-like organs; these he calls "coleopodia," and he believes them to be present also in other diatoms belonging to the Fragilarieæ.

THE fourth German edition of Dr. A. Classen's work on "Quantitative Chemical Analysis by Electrolysis" differs from the previous editions in several respects, among which may be mentioned the insertion of a section devoted to theory, and the addition of descriptions of various measuring instruments and electrolytic experiments. The revision was carried out with the assistance of Dr. W. Löb; and the authorised English translation of the revised and enlarged edition, prepared by Prof. W. H. Herrick and Dr. B. B. Boltwood, has been published by Messrs. J. Wiley and Sons (London: Chapman and Hall, Ltd.). The book is a more complete, scientific and logically arranged work than heretofore, and is altogether a useful manual on electro-chemical analysis. The illustrated account of the Electro-chemical Institute at Aachen, where Drs. Classen and Löb are at work, should lead to the foundation and equipment of similar institutions here for purposes of instruction and research in this most important branch of science. It should not be left to Germany to extend and apply the principles discovered by Davy and Faraday.

REPORTS of papers read before the Royal Society of Edinburgh regularly appear in the columns of NATURE shortly after the papers are read, so it is unnecessary to do more now than briefly refer to the papers which appear in their complete form in the *Transactions* of the Society for the sessions 1895–96, 1896–97. Among the subjects and authors of papers in the volumes are the following:—Observations on the phonograph, by Prof. J. G. M'Kendrick; the strains produced in iron, steel, and nickel tubes in the magnetic field, by Prof. C. G. Knott; the temperature variation of the magnetic permeability of magnetite, by Dr. E. H. Barton; the weather, influenza, and disease, by Dr. A. Lockhart Gillespie; torsional oscillations of wires, by Dr. W. Peddie; the meteorology of Edinburgh (two papers), by Mr. R. C. Mossman; some nuclei of cloudy condensation, by Mr. John Aitken (in this paper Mr. Aitken shows, by experiments on the effect of sunshine on the gases in the atmosphere, that it is possible for cloudy condensation to take place in the absence of dust); the fossil flora of the Yorkshire coal-field, by Mr. Robert Kidston; and the automatic linear transformation of a quadric, by Dr. Thomas Muir. The *Proceedings* of the Society (vol. xxii.) contain several papers by Lord Kelvin; notes on specimens of rock from the Antarctic Regions, by Sir Archibald Geikie; observations of instrumental disturbances at the Colaba Observatory during the Indian earthquake of June 12, by Mr. N. A. Moos; the velocity of graded actions, by Dr. James Walker, and other papers.

THE additions to the Zoological Society's Gardens during the past week include a Guinea Baboon (*Cynocephalus sphinx*) from West Africa, presented by Captain C. C. Wyatt; three Common Marmosets (*Hapale jacchus*) from South-east Brazil, presented by Colonel A. H. Maclean; two White-tailed Gnus (*Connochœtes gnu*, ♂ ♀) from South Africa, presented by Mr. C. D. Rudd; a Cape Zorilla (*Ictonyx zorilla*), a Little Ichneumon (*Helogale parvula*), a Spotted Eagle Owl (*Bubo maculosus*) from South Africa, presented by Mr. J. E. Matcham; two South African Kestrels (*Tinnunculus rupicolus*) from South Africa, presented by Mr. C. Southy; a Naked-footed Owlet (*Athene noctua*), European, presented by the Hon. Mrs. Barrington; two Senegal Parrots (*Pœocephalus senegalus*) from West Africa, presented by Miss E. L. Barford; four Fieldfares (*Turdus pilaris*), a Black Guillemot (*Uria grylle*) from Christiansund, North Norway, presented by Dr. R. B. Sharp; an Indian Python (*Python molurus*) from India, presented by Mr. Percival F. Tuckett; a Four-lined Snake (*Coluber quatorlineatus*), European, presented by Mr. J. W. Temple; twelve Algerian Skinks (*Eumeces algeriensis*) from Algeria, presented by Mr. Robert S. Hunter; a Malabar Squirrel (*Sciurus maximus*, var. *dealbatus*) from India, two Forster's Ceratodus (*Ceratodus forsteri*) from Australia, deposited; a Crowned Partridge (*Rollolus cristatus*) from Malacca, four Common Cormorants (*Phalacrocorax carbo*) from Holland, two Cereopsis Geese (*Cereopsis novæ-hollandiæ*), two Forster's Ceratodus (*Ceratodus forsteri*) from Australia, purchased; three Triangular-spotted Pigeons (*Columba maculosa*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMETS NOW VISIBLE.—Last week it was noted in these columns that Mr. Coddington had discovered a comet in the position R.A. 16h. 24m. 45·9s., and Declination (South) 25° 14′ 20″. Circular (No. 7) of the *Centralstelle* gives the elements and ephemeris of the comet, based on the positions observed on June 11, 13 and 15, and calculated by Prof. A. Berberich. The former are as follows:—

$$T = 1898 \text{ August } 4{\cdot}478 \text{ Berlin M.T.}$$

$$\left.\begin{aligned}\omega &= 206^\circ\ 8'{\cdot}5\\ \Omega &= 73\ 58{\cdot}7\\ i &= 76\ 48{\cdot}3\end{aligned}\right\}1898{\cdot}0$$

$$\log q = 0{\cdot}31850$$

As the comet is moving rapidly south, and has now a Declination (South) of about 32°, we do not give the ephemeris. This comet was independently discovered by Dr. W. Pauly in Bucharest on June 14.

We have received two telegrams from Kiel concerning another comet, Perrine (June 14). The former gives the observation made on June 14 at Lick mean time 15h. 16·0m., giving the position Right Ascension 3h. 29m. and Declination + 58° 36′, the latter showing the position to be Right Ascension 3h. 34m. 58s. and Declination + 58° 24′ 2″ at Lick mean time 14h. 12m. on June 15. A Circular (No. 5) from the *Centralstelle* gives us the elements and ephemeris calculated by Perrine and Aitken from the observations made on June 14, 15 and 16. These are:—

Elements.

$$T = 1898 \text{ August } 17{\cdot}40 \text{ Greenwich M.T.}$$

$$\left.\begin{aligned}\omega &= 196^\circ\ 46'\\ \Omega &= 260\ 6\\ i &= 69\ 42\end{aligned}\right\}1898{\cdot}0$$

$$q = 0{\cdot}7418$$

Ephemeris for 12h. Greeenwich M.T.

1898.	R.A. h. m. s.	Decl. ° ′	Br.
June 20	... 4 2 52	... +57 15	... 1·18
24	... 4 25 24	... 55 56	
28	... 4 48 48	... 54 20	
July 2	... 5 10 0	... +52 27	... 1·72

The comet will thus gradually brighten as July is approached, but takes a somewhat southerly course.

Another Kiel telegram, dated June 18, tells us that Perrine found Wolf's comet on June 16, at 15h. 5·3m. Lick mean time, in position—

R.A. 2h. 16m. 19s., and Declination + 19° 42′ 44″.

Still another and last telegram from Kiel, dated June 19, informs that comet Giacobini was seen on June 18 at 13h. Nice mean time in the position of Right Ascension 20h. 36m. 30s. and Declination − 21° 14′ 0″.

THE 40-INCH YERKES REFRACTOR.—Prof. Barnard, writing in the *Astronomical Journal* (No. 436) with respect to a series of measures of the satellite of Neptune, gives an interesting account of the behaviour of the Yerkes telescope. Actual observation was not possible until the best season was essentially over, but it was found that even a part of this unfavourable weather permitted the power of the telescope to be tested. On one or two occasions, when observing double stars, he was able to use powers of several thousand diameters, and on one date he employed a power of 3750 with good success. The object-glass he finds entirely free from any form of ghost, and the definition is at times very good, showing, as he says, that "this last great work of Alvan Clark is one of his noblest monuments." The driving clock moves the great tube with such perfect steadiness that he was astonished at the result, and so stable is the mounting of the instrument that the effect of the clock, rewinding itself automatically at periods of 1h. 48m., does not in the least interfere with micrometer work. Very satisfactory also are the electrical contrivances at the eye end for clamping and slow motion; the clock takes up the tube upon the application of the electric clamp in Right Ascension perfectly instantaneously, and the slow movement is so exact that a star can be brought from the edge of the field and stopped instantly behind the micrometer-wire, the motion being about 1′ in 8 seconds. Prof. Barnard further mentions the ease with which the instrument can be handled; as an instance, he says that he placed the telescope on the west side of the pier in position of + 50° declination, and by means of the electric motors he moved it on the other side of the pier to the same Declination in 1m. 50s. An important addition to the dome is the wind-break. This consists of two curtains working on endless chains, one rising from the base of the slit, and the other passing through the zenith from the rear. With these, excepting at low altitudes and right in the face of the wind, the tube is always perfectly protected even on the windiest nights.

VARIABLE STARS OF SHORT PERIOD.—Prof. E. C. Pickering describes in a *Harvard College Observatory Circular* (No. 29) a very simple means of detecting variables whose periods are short if the observer is provided with a telescope mounted equatorially and a fairly good driving clock. The method is so simple and complete that it has probably been tried before, although, so far as we know, no mention of it has come under our notice. The idea is to expose a photographic plate in a telescope, the clock of which is working somewhat fast, and at intervals of ten and fifty minutes to alternately expose and cover the lens by an electrical attachment. Prof. Pickering describes one of the plates so exposed. An 8 × 10 plate was exposed in a telescope with a Cooke anastigmatic lens, aperture 2·6 cm. and focal length 33·3 cm. and eight successive images of each star were obtained in the period of about eight hours, The plate covered a region of about 33° square, and a portion of it, shown in the *Circular*, indicates the variable intensity of the images of the star U Cephei, while those of the neighbouring stars show no such variations.

On this scale forty plates would cover the whole sky from north to south pole, and Prof. Pickering proposes to undertake this work as soon as the best method of taking the plates has been determined. By the above plan it is hoped to secure a complete list of all variable stars of short period brighter than the ninth magnitude at maximum, whose variation exceeds half a magnitude, and whose period is less than a day. In such a sweep, probably, many other variable stars of longer period, and stars of the Algol type will be discovered.

The beauty of the above method lies in the simple equipment that is necessary to obtain results of considerable value. It will be noticed that the method is a differential one, clouds passing across the field of view during an exposure affecting all the photographic images alike.

THE OXFORD UNIVERSITY OBSERVATORY.—The twenty-third annual report of the visitors of the University Observatory appears in a recent number (June 14) of the *Oxford University Gazette.* The report refers to the period from June 1, 1897, to May 31, 1898, and exhibits the state of the observatory on the last-named day. One of the main points referred to by Prof. Turner in the report, is that of the necessity of completing the observatory by attaching to it a residence. This, he points out, is urgent, since it is most imperative that the official staff should be as near their work as possible when both routine observational work and students have to be dealt with. Prof. Turner refers to a very curious accident that occurred to the level belonging to the Barclay transit circle that is used for time determinations, which is well worth repeating. "The striding level, weighing 19 lbs., which was suspended over the instrument by means of a cord, pulley and counterpoise, fell (from its usual position when not in use near the roof) a distance of three or four feet on to the instrument, owing to the snapping of the cord. It was found the next morning standing upright, with its feet on the pivot covers as if in position for an observation. The blow had thus been received by the pivot covers, and no other part of the instrument had apparently been damaged or even struck. The brass tube of the level itself was shattered, but the glass-tube inside was not broken!" Surely this is quite a unique accident?

The measurement and reduction of the plates for the Astrographic Catalogue seem to be proceeding apace, an average of 3951 measures of the star positions and magnitudes being made every week, the total number for the year being 205,443. The main result of the year's work is that the prospects of achieving the object aimed at are brighter than previously; this was, as Prof. Turner states, that by the middle of 1901 we may be ready to furnish, or demand, the positions and magnitudes of the brighter stars in zones $+24°$ to $+32°$ to the number of something like a quarter of a million. The speed at which these measures can be made, can be gathered from the statement that "whereas at first thirty or forty star-measures an hour was thought fair work, the more skilful can now measure 150 per hour or more." The new photographic transit circle has involved much experimental work, and is proceeding satisfactorily.

THE SUPPOSED VARIABLE Y AQUILÆ.—In the series of measures to determine the light curves of variable stars of short period north of $-40°$ Declination with the meridian photometer, the curve of the star $+10°$ 3787 was not found to be smooth. This star had previously been catalogued by Chandler as varying from 5·3 to 5·7 in a period of 4·986 days. It was also suspected by Gould, confirmed by Chandler 1894, and also by Yendell. Mr. Wendell has recently made some observations (*Harvard College Observatory Circular*, No. 30) with the photometer attached to the 15-inch equatorial telescope, on six nights in May last, eighty sittings being made each night, the comparison star employed being $+10°$ 3784. The mean of the differences of magnitude showed very little variation, and, as Prof. Pickering states, fails to show any evidence of variation, since deviations of a tenth of a magnitude may be ascribed to errors of observation. Since it is "impossible to prove that the light of a star never changes, this star may still be an Algol variable with a short time of variation, or the period may be entirely wrong."

COMPANIONS OF ARGON.[1]

FOR many months past we have been engaged in preparing a large quantity of argon from atmospheric air by absorbing the oxygen with red-hot copper, and the nitrogen with magnesium. The amount we have at our disposal is some 18 litres. It will be remembered that one of us, in conjunction with Dr. Norman Collie, attempted to separate argon into light and heavy portions by means of diffusion, and, although there was a slight difference[2] in density between the light and the heavy portions, yet we thought the difference too slight to warrant the conclusion that argon is a composite substance. But our experience with helium taught us that it is a matter of the greatest difficulty to separate a very small portion of a heavy gas from a large admixture of a light gas; and it therefore appeared advisable to re-investigate argon, with the view of ascertaining whether it is indeed complex.

In the meantime, Dr. Hampson had placed at our disposal his resources for preparing large quantities of liquid air, and it was a simple matter to liquefy the argon which we had obtained by causing the liquid air to boil under reduced pressure. By means of a two-way stopcock the argon was allowed to enter a small bulb, cooled by liquid air, after passing through purifying reagents. The two-way stopcock was connected with mercury gas-holders, as well as with a Töpler pump, by means of which any part of the apparatus could be thoroughly exhausted. The argon separated as a liquid, but at the same time a considerable quantity of solid was observed to separate, partially round the sides of the tube, and partially below the surface of the liquid. After about 13 or 14 litres of the argon had been condensed, the stopcock was closed, and the temperature was kept low for some minutes in order to establish a condition of equilibrium between the liquid and vapour. In the meantime the connecting tubes were exhausted, and two fractions of gas were taken off by lowering the mercury reservoirs, each fraction consisting of about 50 or 60 cubic cm. These fractions should contain the light gas. In a previous experiment of the same kind a small fraction of the light gas had been separated, and was found to have the density 17·2. The pressure of the air was now allowed to rise, and the argon distilled away into a separate gas-holder. The white solid which had condensed in the upper portion of the bulb did not appear to evaporate quickly, and that portion which had separated in the liquid did not perceptibly diminish in amount. Towards the end, when almost all the air had boiled away, the last portions of the liquid evaporated slowly, and when the remaining liquid was only sufficient to cover the solid, the bulb was placed in connection with the Töpler pump, and the exhaustion continued until the liquid had entirely disappeared. Only the solid now remained, and the pressure of the gas in the apparatus was only a few millimetres. The bulb was now placed in connection with mercury gas-holders, and the reservoirs were lowered. The solid volatilised very slowly, and was collected in two fractions, each of about 70 or 80 cubic cm. Before the second fraction had been taken off, the air had entirely volatilised, and the jacketing tube had been removed. After about a minute, on removing the coating of snow with the finger, the solid was seen to melt, and volatilise into the gas-holder.

The first fraction of gas was mixed with oxygen, and sparked over soda. After removal of the oxygen with phosphorus it was introduced into a vacuum tube, and the spectrum examined. It was characterised by a number of bright red lines, among which one was particularly brilliant, and a brilliant yellow line, while the green and the blue lines were numerous, but comparatively inconspicuous. The wave-length of the yellow line, measured by Mr. Baly, was 5849·6, with a second-order grating spectrum. It is, therefore, not identical with those of sodium, helium, or krypton, all of which equal it in intensity. The wave-lengths of these lines are as follows:—

Na (D_1)	5895·0
Na (D_2)	5889·0
He (D_3)	5875·9
Kr (D_4)	5866·5
Ne (D_5)	5849·6

The density of this gas, which we propose to name "neon" (new), was next determined. A bulb of 32·35 cubic cm. capacity was filled with this sample of neon at 612·4 mm. pressure, and at a temperature of 19·92° it weighed 0·03184 gram.

Density of neon ... ... 14·67

This number approaches to what we had hoped to obtain. In order to bring neon into its position in the periodic table, a density of 10 or 11 is required. Assuming the density of argon to be 20, and that of pure neon 10, the sample contains 53·3 per cent. of the new gas. If the density of neon be taken as 11, there is 59·2 per cent. present in the sample. The fact that the density has decreased from 17·2 to 14·7 shows that there is a considerable likelihood that the gas can be further purified by fractionation.[1]

[1] "On the Companions of Argon." By William Ramsay, F.R.S., and Morris W. Travers. Paper read at the Royal Society, June 16.

[2] Density of lighter portion, 19·93; of heavier portion, 20·01 (Roy. Soc. *Proc.*, vol. 60, p. 206).

[1] June 21.—After a preliminary fractionation, the density has been still further reduced to 13·7.

That this gas is a new one is sufficiently proved, not merely by the novelty of its spectrum and by its low density, but also by its behaviour in a vacuum-tube. Unlike helium, argon, and krypton, it is rapidly absorbed by the red-hot aluminium electrodes of a vacuum-tube, and the appearance of the tube changes, as pressure falls, from carmine red to a most brilliant orange, which is seen in no other gas.

We now come to the gas obtained by the volatilisation of the white solid which remained after the liquid argon had boiled away.

When introduced into a vacuum-tube it showed a very complex spectrum, totally differing from that of argon, while resembling it in general character. With low dispersion it appeared to be a banded spectrum, but with a grating, single bright lines appear, about equidistant through the spectrum, the intermediate space being filled with many dim, yet well-defined lines. Mr. Baly has measured the bright lines, with the following results. The nearest argon lines, as measured by Sir William Crookes, are placed in brackets:—

Reds very feeble, not measured.		
First green band, first bright line	5632·5	(5651 : 5619)
First green band, second bright line	5583·0	(5619 : 5567)
First green band, third bright line	5537·0	(5557 : 5320)
Second green band, first bright line	5163·0	(5165)
Second green band, second bright line ...	5126·5	(5165 : 5065) brilliant.
First blue band, first bright line	4733·5	(4879)
First blue band, second bright line	4711·5	(4701)
Second blue band, first bright line	4604·5	(4629 : 4594)
Third blue band (first order)	4314·0	(4333 : 4300)
Fourth blue band (second order)	4213·5	(4251 : 4201)
Fifth blue band (first order), about	3878	(3904 : 3835)

The red pair of argon lines was faintly visible in the spectrum.

The density of this gas was determined with the following results:—A globe of 32·35 c.c. capacity, filled at a pressure of 765·0 mm., and at the temperature 17·43°, weighed 0·05442 grams. The density is therefore 19·87. A second determination, made after sparking, gave no different result. This density does not sensibly differ from that of argon.

Thinking that the gas might possibly prove to be diatomic, we proceeded to determine the ratio of specific heats:—

Wave-length of sound in air	34·18
,, ,, gas	31·68
Ratio for air	1·408
,, gas	1·660

The gas is therefore monatomic.

Inasmuch as this gas differs very markedly from argon in its spectrum, and in its behaviour at low temperatures, it must be regarded as a distinct elementary substance, and we therefore propose for it the name "metargon." It would appear to hold the position towards argon that nickel does to cobalt, having approximately the same atomic weight, yet different properties.

It must have been observed that krypton does not appear during the investigation of the higher-boiling fraction of argon. This is probably due to two causes. In the first place, in order to prepare it, the manipulation of air, amounting to no less than 60,000 times the volume of the impure sample which we obtained was required; and in the second place, while metargon is a solid at the temperature of boiling air, krypton is probably a liquid, and therefore more easily volatilised at that temperature. It may also be noted that the air from which krypton has been obtained had been filtered, and so freed from metargon. A full account of the spectra of those gases will be published in due course by Mr. E. C. C. Baly.

University College, London.

ON THE STABILITY OF THE SOLAR SYSTEM.[1]

ALL persons who interest themselves in the progress of celestial mechanics, but can only follow it in a general way, must feel surprised at the number of times demonstrations of the stability of the solar system have been made.

Lagrange was the first to establish it, Poisson then gave a new proof; afterwards other demonstrations came, and others will still come. Were the old demonstrations insufficient, or are the new ones unnecessary?

The astonishment of these persons would doubtless be increased if they were told that perhaps some day a mathematician would show by rigorous reasoning that the planetary system is unstable. This may happen, however; there would be nothing contradictory in it, and the old demonstrations would still retain their value.

The demonstrations are really but successive approximations; they do not pretend to strictly confine the elements of the orbits within narrow limits that they may never exceed, but they at least teach us that certain causes, which seemed at first to compel some of these elements to vary fairly rapidly, only produce in reality much slower variations.

The attraction of Jupiter, at an equal distance, is a thousand times smaller than that of the sun; the disturbing force is therefore small; nevertheless, if it always acted in the same direction, it would not fail to produce appreciable effects. But the direction is not constant, and this is the point that Lagrange established. After a small number of years two planets, which act on each other, have occupied all possible positions in their orbits; in these diverse positions their mutual action is directed sometimes one way, sometimes in the opposite way, and that in such a fashion that after a short time there is almost exact compensation. The major axes of the orbits are not absolutely invariable, but their variations are reduced to oscillations of small amplitude about a mean value.

This mean value, it is true, is not rigorously fixed, but the changes which it undergoes are extremely slow, as if the force which produces them was not a thousand times, but a million times smaller than the solar attraction. One may, therefore, neglect these changes, which are of the order of the square of the masses. As to the other elements of the orbits, such as the eccentricities and the inclinations, these may acquire round their mean value wider and slower oscillations, to which, however, limits may easily be assigned.

This is what Lagrange and Laplace pointed out, but Poisson went further. He wished to study the slow changes experienced by the mean values—changes to which I have already referred, and which his predecessors had at first neglected. He showed that these changes reduced themselves again to periodic oscillations round a mean value which is only liable to variations a thousand times slower.

This was a step further, but it was still only an approximation. Since then further advance has been made, but without arriving at a complete definitive and rigorous demonstration. There is a case which seemed to escape the analysis of Lagrange and Poisson. If the two mean movements are commensurable among themselves, at the end of a certain number of revolutions, the two planets and the sun will be found in the same relative situation, and the disturbing force will act in the same direction as at first. The compensation, to which I have referred, will not any more be produced, and it might be feared that the effects of the disturbing forces will end by accumulating and becoming very considerable. More recent works, amongst others those of Delaunay, Tisserand, and Gyldén, have shown that this accumulation does not actually occur. The amplitude of the oscillations is slightly increased, but remains, nevertheless, very small. This particular case, therefore, does not escape the general rule.

The apparent exceptions have not only been dispensed with, but the real reasons of these compensations, which the founders of celestial mechanics had observed, have been better explained. The approximation has been pushed further than was done by Poisson, but it is still only an approximation.

It can be shown, in certain particular cases, that the elements of the orbit of one planet will return an infinite number of times to very nearly the initial elements, and that is also probably true in the general case; but it does not suffice. It should be shown

[1] Translation of a paper, by M. H. Poincaré, in the *Annuaire du Bureau des Longitudes*, 1898.

that these elements will not only regain their original values, but that they will never deviate much from them.

This last demonstration has never been given in a definite manner, and it is even probable that the proposition is not strictly true. The statement that is true, is that the elements can only deviate extremely slowly from their original values, and this after a long interval of time. To go further, and affirm that these elements will remain not for *a very long time*, but *always* confined within narrow limits, is what we cannot do.

But the problem does not take this form.

The mathematician only considers fictitious bodies, reduced to simple material points, and subject to the exclusive action of their mutual attractions, which rigorously follows Newton's law. How would such a system behave, would it be stable? This is a problem which is as difficult as it is interesting for an analyst. But it is not one which actually occurs in nature. Real bodies are not material points, and they are subject to other forces than the Newtonian attraction. These complementary forces ought to have the effect of gradually modifying the orbits, even when the fictitious bodies, considered by the mathematician, possess absolute stability.

What we must ask ourselves then is, whether this stability will be more easily destroyed by the simple action of Newtonian attraction or by these complementary forces.

When the approximation shall be pushed so far that we are certain that the very slow variations, which the Newtonian attraction imposes on the orbits of the fictitious bodies, can only be very small during the time that suffices for the complementary forces to destroy the system; when, I say, the approximation shall be pushed as far as that, it will be useless to go further, at least from the point of view of application, and we must consider ourselves satisfied.

But it seems that this point is attained; without quoting figures, I think that the effects of these complementary forces are much greater than those of the terms neglected by the analysts in the most recent demonstrations on stability.

Let us see which are the most important of these complementary forces. The first idea which comes to mind is that Newton's law is, doubtless, not absolutely correct; that the attraction is not rigorously proportional to the inverse square of the distances, but to some other function of them. In this way Prof. Newcomb has recently tried to explain the movement of the perihelion of Mercury. But it is soon seen that this would not influence the stability. It is true, according to a theory of Jacobi, that there would be instability if the attraction were inversely proportionate to the cube of the distance. It is easy by rough reasoning to account for this; with such a law, the attraction would be great for the small distances and extremely feeble for great distances. If therefore, for any reason, the distance of one of the planets from the central body were to increase, the attraction would diminish rapidly until it would not be capable of retaining the planet in its orbit. But that only takes place with laws very different from that of the square of the distances. All laws, near enough to that of Newton's to be acceptable, are equivalent from the stability point of view.

But there is another reason which opposes the theory that bodies move without ever deviating much from their original orbits. According to the second law of thermodynamics, known by the name of Carnot's Principle, there is a continual dissipation of energy, which tends to lose the form of mechanical work and to take the form of heat. There exists a certain function called entropy, which it is unnecessary to define here; entropy, according to this second law, either remains constant or diminishes, but can never increase. When once it has deviated from its original value, which it can only do by diminishing, it can never return again. as it would have to increase. The world consequently could never return to its original state, or to a slightly different state, so soon as its entropy has changed. It is the contrary of stability.

But the entropy diminishes every time that an irreversible phenomenon takes place, such as the friction of two solids, the movement of a viscous liquid, the exchange of heat between two bodies of different temperatures, the heating of a conductor by the passage of a current. If we observe, then, that there is not in reality a reversible phenomenon, that the reversibility is only a limiting case—an ideal case which nature can more or less approach but can never attain—we shall be led to conclude that instability is the law of all natural phenomena.

Are the movements of the heavenly bodies the only ones to escape? One might believe it by seeing that they move in a vacuum, and are thus free from friction. But is the interplanetary vacuum absolute, or do the bodies move in an extremely attenuated medium of which the resistance is extremely feeble, but nevertheless is capable of offering resistance?

Astronomers have only been able to explain the movement of Encke's comet by supposing the existence of such a medium. But the resisting medium which would account for the anomalies of this comet, if it exists, is confined to the immediate neighbourhood of the sun. This comet would penetrate it; but at the distances at which the planets are, the action of this medium would cease to make itself felt, or would become much more feeble. As an indirect effect, it would accelerate the movements of the planets; losing energy, they would tend to *fall* on the sun, and by reason of Kepler's third law the duration of the revolution would diminish at the same time as the distance to the central body. But it is impossible to form an idea of the rapidity with which this effect would be produced, as we have no notion of the density of this hypothetical medium.

Another cause to which I am now going to refer must have, it seems, a more rapid action. It had for some time been imagined, but was first more especially brought to light by Delaunay, and afterwards by G. Darwin.

The tides, which are direct consequences of celestial movements, could only stop if these movements ceased. But the oscillations of the seas are accompanied by friction, and consequently produce heat. This heat can only be borrowed from the energy which produces the tides—that is to say, to the *vis viva* of the celestial bodies. We can therefore foresee that, for this reason, this *vis viva* is gradually dissipated, and a little reflection will enable us to understand by what mechanism. The surface of the seas, raised by the tides, presents a kind of wave. If high tide took place at the time of the meridian passage of the moon, this surface would be that of an ellipsoid, the axis of which would pass through the moon. Everything would be symmetrical in relation to this axis, and the attraction of the moon on this wave could neither slow down nor accelerate the terrestrial rotation. This is what would happen if there were no friction; but in consequence of this friction, high tide is late on the moon's meridian passage; symmetry ceases; the attraction of the moon on the wave no longer passes through the centre of the earth, and tends to slow down the rotation of our globe.

Delaunay estimated that, for this cause, the length of the sidereal day increases by one second in a hundred thousand years. It is thus he wished to account for the secular acceleration of the moon's motion. The lunation would seem to us to become shorter and shorter, because the unit of time to which we ascribed it, the day, would become longer and longer.

Whatever we may think of the figures given by Delaunay, and the explanation which he proposes for the anomalies of the moon's movement, it is difficult to dispute the effect produced by the tides.

It is just this that may help us to understand a well-known but very surprising fact. It is known that the period of rotation of the moon is exactly equal to that of its revolution; in such a way that, if there were seas on this body, they would have no tides—at least, tides due to the attraction of the earth; because for an observer situated at a point on the surface of the moon, the earth would be always at the same height above the horizon. It is also known that Laplace tried to explain this curious coincidence. How can the two velocities be *exactly* the same? It is exceedingly improbable that this strict equality is due to mere chance. Laplace supposes that the moon has the form of an elongated ellipsoid; this ellipsoid behaves like a pendulum, which would be in equilibrium when the major axis is directed along the line joining the centres of the two bodies.

If the *initial* velocity of rotation differs slightly from that of revolution, the ellipsoid will oscillate about its position of equilibrium without ever deviating much from it. A pendulum which has received a slight impetus behaves in this way. The *mean* velocity of rotation is then exactly the same as that of the position of equilibrium round which the major axis oscillates; it is, therefore, the same as that of the straight line which joins the centres of the two bodies. It is therefore strictly equal to the velocity of revolution.

If, on the contrary, the initial velocity differs considerably from the velocity of revolution, the major axis will not oscillate any more round its position of equilibrium, like a pendulum which under a strong impulse describes a complete circle.

It suffices, therefore, that the velocity of revolution should be *almost* equal to the *initial* velocity of rotation, in order that it may be exactly equal to the *mean* velocity of rotation. A strict equality being no longer necessary, the paradox does not exist any more. The explanation is nevertheless incomplete. What is the reason of this approximate equality, of which the probability is no longer zero, it is true, but still very small? And, especially, why does not the moon undergo slight oscillations about its position of equilibrium (if we eliminate, of course, its numerous librations, due to other well-known causes)? These oscillations must originally have existed; they must have become extinct by a kind of friction, and everything tends to make us believe that the mechanism of this friction is that which I have just analysed with respect to the ocean tides.

When the moon was not yet solid, and formed a fluid in the form of a spheroid, this spheroid must have experienced enormous tides, by reason of the proximity of the earth and of its mass. These tides could only have ceased when the oscillations became almost entirely extinct.

It seems that Jupiter's satellites, and the two planets nearest the sun, Mercury and Venus, have also a rotation, the duration of which is the same as that of their revolution; it is doubtless for the same reason.

It might be thought that this tidal action has no connection with our subject. I have as yet only spoken of rotations, and in the studies relative to the stability of the solar system the movements of translation are only dealt with; but a little attention shows that the same action makes itself equally felt on the latter.

We have just seen that the attraction of the moon on the earth does not act exactly through the centre of the earth. The attraction of the earth on the moon, which is equal and exactly opposite, would not pass either through this centre; that is to say, through the focus of the lunar orbit. A disturbing force is the result, very small in reality, but sufficient to make the moon increase in energy. The active force of translation thus gained by the moon is evidently smaller than that of rotation, lost by the earth; because a part of the energy must be transformed into heat in consequence of the friction engendered by the tides. The period of revolution of the moon lasting about twenty-eight sidereal days, a very simple calculation shows that this body gains twenty-eight times less *vis viva* than the earth loses.

I have already explained the action of a resisting medium; I have shown how, by making the planets lose energy, their movements are accelerated; on the contrary the action of the tides, by increasing the energy of the moon, retards its movements; the month lengthens therefore as well as the day. Now if this cause acts alone, what is the final state towards which the system will tend? Obviously this action would only stop when the tides have ceased—that is to say, when the rotation of the earth would have the same duration.

This is not all: in the final state the orbit of the moon must have become circular. If it were otherwise, the variations of the distance of the moon to the earth would suffice to produce tides. As the movement of rotation would not have changed, it would be easy to calculate what angular velocity would be common to the earth and to the moon. One finds that, at the limit, the month, like the day, would last about sixty-five of our actual days.

Such would be the final state if there were no resisting medium, and if the earth and the moon existed alone.

But the sun also produces tides, the attraction of the planets likewise produces them on the sun. The solar system therefore would tend to a condition in which the sun, all the planets and their satellites, would move with the same velocity round the same axis, as if they were parts of one solid invariable body. The final angular velocity would, on the other hand, differ little from the velocity of revolution of Jupiter. This would be the final state of the solar system if there were not a resisting medium; but the action of this medium, if it exists, would not allow such a condition to be assumed, and would end by precipitating all the planets into the sun.

It must not be thought that a solid globe which was not covered by seas would, by the absence of tides, find itself free from actions analogous to those just mentioned, even by admitting that the solidification had reached the centre of the globe. This body, which we suppose solid, would not on that account be an invariable one; such bodies only exist in text-books on rational "mechanics." It would be elastic and be subject, by the attraction of neighbouring celestial bodies, to deformations analogous to tides and of the same order of magnitude.

If the elasticity were perfect, these deformations would occur without loss of work, and without the production of heat. But perfectly elastic bodies do not exist. There would be in consequence development of heat, which would take place at the expense of the energy of rotation and translation of the bodies, and which will produce absolutely the same effects as the heat engendered by the friction of the tides.

This is not all: the earth is magnetic, and very probably the other planets and the sun are the same. The following well-known experiment is one which we owe to Foucault: a copper disc rotating in the presence of an electromagnet suffers a great resistance, and becomes heated when the electromagnet is brought into action. A moving conductor in a magnetic field is traversed by induction currents which heat it; the produced heat can only be derived from the *vis viva* of the conductor. We can therefore foresee that the electrodynamic actions of the electromagnet on the currents of induction must oppose the movement of the conductor. In this way Foucault's experiment is explained. The celestial bodies must undergo an analogous resistance because they are magnetic and conductors.

The same phenomenon, though much weakened by the distance, will therefore be produced; but the effects, being produced always in the same direction, will end by accumulating; they add themselves, besides, to those of the tides, and tend to bring the system to the same final state.

Thus the celestial bodies do not escape Carnot's law, according to which the world tends to a state of final repose. They would not escape it, even if they were separated by an absolute vacuum. Their energy is dissipated; and although this dissipation only takes place extremely slowly, it is sufficiently rapid that one need not consider terms neglected in the actual demonstrations of the stability of the solar system.

ON THE USE OF METHYLENE BLUE AS A MEANS OF INVESTIGATING RESPIRATION IN PLANTS.

IT has long been known that methylene blue is capable of being decolorised by reducing agents, and the object of the present communication is to point out its use as a means of demonstrating in a striking manner the reducing power possessed either by living protoplasm or at any rate by substances intimately associated with the exercise of its vitality. Its employment is not new to animal physiologists, but botanists appear not to have recognised the possibilities latent in the method, perhaps because some ten years ago Pfeffer ("Oxydationsvorgänge in Lebenden zellen") stated that although fermenting yeast would decolorise the blue solution, green plants would not do so. Doubtless this was true under the conditions of Pfeffer's experiments, but nevertheless many green plants are, as a matter of fact, found to give admirable results.

If germinating seedlings of barley or peas be placed in test tubes filled with a 0·0005 per cent. solution of methylene blue, which has been boiled in order to expel air, it will be found that in the course of a few hours the liquid around them will have lost its colour. The most striking way of performing the experiment is to suspend the peas in the solution, then a decolorised zone is formed between the upper and lower parts of the liquid, each of which still retain its blue colour. Gradually the clear zone extends until the entire mass of the liquid, except just at the surface where it is in contact with the air, becomes decolorised. At first the radicles of the seedlings are strongly stained; they finally again become white.

If some of the decolorised liquid be drawn off by means of a pipette, and shaken up with air, the blue tint speedily returns. If some of the seedlings be removed from the now colourless liquid, and be rinsed in boiled water and then exposed to the air, they soon become blue, and the stain gradually extends into the internal tissues as these become gradually aerated. The "development" of the blue can readily be seen in sections, quickly made, under the microscope.

Cress seedlings are far more active than either barley or peas, just as would have been expected from the relations which they exhibit towards oxygen.

But perhaps the most remarkable results are those obtained from a plant like *Chara*. This alga is suspected to possess peculiar properties in regard to its connection with oxygen (*Annals of Botany*, vol. x. p. 288), and I have since ascertained in several ways that the plant is nearly as greedy for oxygen as are many seedlings. A branch of *Chara* placed in the methylene blue and *put in the dark*, will decolorise the surrounding liquid in a few hours; but if the tube containing it be exposed to the action of bright daylight the colour soon returns when the plant is alive, owing to the evolution of oxygen consequent on its splitting up the carbon dioxide which has been evolved by it, and which has been accumulating in the water, during the plant's stay in darkness. (Of course it is hardly necessary to state that the carbon dioxide is not itself the cause of the loss of colour in the liquid.) The experiment can be repeated several times with the same *Chara* plant, and we have succeeded in keeping it alive (as proved by the continuance of the protoplasmic movement) for four days. Naturally if the experiment is performed in continuous daylight no decoloration is effected.

Many other plants fail to give such quick results; thus *Elodea* requires about two days in darkness to obtain the reaction. All the plants experimented on give a result much more quickly if they have previously been starved of oxygen. And this indicates that under these conditions, as also under those of the experiments above described, the oxygen is not directly utilised either by the protoplasm, or some of the normal combustible bodies present in the cell, but by some dissociation product formed during the metabolic activity of the protoplasm. Of course decoloration of the blue does not occur when the plants are exposed to the action of free oxygen; this element can then be obtained more cheaply than by reducing the aniline dye. But this is not the place in which to discuss the meaning of the reaction or the nature of the substance which primarily reduces the methylene blue. The facts have been arrived at during an investigation, which is still proceeding, into the respiratory processes of plants. The method here detailed is, however, so simple, and seems likely to prove useful to teachers and others as a demonstration-experiment, that it appeared worth while to make it generally known. J. B. FARMER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In connection with the extracts printed last week (p. 165) from the reports of the delegates of the University Museum, referring to the want of accommodation and equipment for research in certain branches of science, it may be worth while directing attention to the leading article in *Literature* of June 11, regretting that little original work is being done in the domain of letters. The opinion is expressed that the Royal Commission which sat on the Universities rather more than twenty years ago, "made Oxford and Cambridge much more effective places for teaching and examining than they had been before, while at the same time it helped to ruin them as places for study." The leader concludes with the words:—"Englishmen are by nature somewhat too much inclined to look for an immediate advantage; to bring all things to a common-sense, even a commercial, test; to distrust theory; to despise action for an abstract end. One of the functions of a University is to keep alive a higher faith by giving an example of thorough and devoted work done without a commercial object. Our Universities, as they are at present managed, do no such thing."

The research degree of Bachelor of Science was conferred upon Mr. A. E. Tutton in Congregation on June 16. Mr. Tutton is the first recipient of a degree for research in natural science or natural philosophy, the only other research degree yet conferred being for mathematical work. In order to qualify for the degree eight terms must be kept, and one or more original theses presented. Mr. Tutton presented two theses—one his paper on the crystallography of the selenates of potassium, rubidium and cæsium, and the other on the new interference dilatometer exhibited by him at the recent conversazioni of the Royal Society. The B.Sc. research degree ranks with the B.C.L. immediately after the M.A. degree, and before the B.A. degree. It is hoped that, by requiring a high standard of qualification for the new degree, research will be encouraged, and the scientific work of the University will be increased in value and amount.

CAMBRIDGE.—Among the ten recipients of honorary degrees on June 15 were the Italian Ambassador (General Ferrero) and Mr. F. C. Penrose. General Ferrero early distinguished himself in mathematics, and, after an active military career, he became connected with the military and geographical Institute of Florence, editing all its publications from 1873 to 1893, and being at its head from 1885 to 1894. He organised the general topographical and cadastral survey of Italy, which led to the publication of important maps of the country, in the preparation of which valuable aid was derived from photography. In 1883 General Ferrero was made a Member of the Accademia dei Lincei, and in 1892 a Senator of Italy. Since 1874 he has taken an important part in the International Commission for the measurement of the earth's surface, and in this respect (amongst others) he has a European reputation.

Mr. Penrose has not only made valuable contributions to archæology, but also to astronomy, and his papers on the orientation of Greek temples exhibit the rare combination of archæological and astronomical knowledge.

The following are the speeches delivered by the Public Orator, Dr. Sandys, in presenting General Ferrero and Mr. Penrose for the honorary degree of LL.D. and Litt.D. respectively:—

Olim in hoc ipso loco Italiae legatum belli et pacis artibus illustrem salutavimus; hodie eiusdem adiutorem atque adeo successorem insignem non minus libenter salutamus. In Academia Taurinensi scientia mathematica excultus, et rei militaris et geographiae studiis deditus, Italiae toti accurate dimetiendae et describendae summa cum laude est praepositus. Huic imprimis debemus regionum Italiae tabulas depictas, partim lucis ipsius auxilio in lucem emissas; hunc non modo Linceorum Academia Romana sociis suis, sed etiam Italia tota senatoribus suis merito adscripsit; huius fama ultra patriae fines a se ipso tam diligenter descriptos etiam in alias Europae partes latissime diffusa est. Asiae regiones pulcherrimae (Vergilio si credimus) Italiae cum laudibus certare nequeunt; Europae gentes maximae Italiae legatum insignem certatim laudant. Belli certe et pacis artes feliciter consociatae sunt Italiae in legato illustri, ANNIBALE FERRERO.

Hodie reducem salutamus alumnum nostrum qui abhinc annos fere septem et quinquaginta Thamesis inter undas e certamine nautico cum Oxoniensibus commisso semel tantum victus, plus quam semel victor evasit. Olim Academiae nomine in Italiam et Graeciam missus, de Atheniensium templis opus egregium edidit, in quo Parthenonis et columnas et epistylium columnis impositum lineis non rectis sed leviter curvatis contineri primus omnium ostendit, et ordinis Dorici maiestatem artificio tam minuto adiuvari demonstravit. Idem nuper de templis Graecis ad stellas quasdam orientes conversis ingeniose disputavit. Illud vero felicitatis conspicuae documentum Nestori nostro contigit, quod et Athenis et Londinii architecturae studiis diu deditus, non modo Sancti Pauli ecclesiae cathedralis in culmine sed etiam Iovis Olympii columnarum in fastigio solus omnium mortalium constitit. Viro ad tantam altitudinem evecto non sine reverentia quadam in hoc templo honoris lauream nostram laeti decernimus.

Duco ad vos Collegii Magdalenae socium, Britannorum Scholae Archaeologicae Atheniensi et Regio Architectorum Instituto nuper praepositum, FRANCISCUM CRANMER PENROSE.

THE vote of 8,520,175*l.*, for public elementary education in England and Wales, was passed by the Committee of Supply of the House of Commons on Friday. To this sum of money, contributed towards elementary education by the Imperial Government, must be added the sums derived from voluntary subscriptions and the rates. Last year the former amounted to 845,000*l.*, and the latter to 2,325,801*l.* There is no reason to believe that in the coming year these sums will substantially decrease; therefore it may be assumed that in the coming financial year a total sum of no less than 11,690,762*l.* will be spent by England and Wales upon elementary education.

THE annual Commencement at Columbia University on June 8 was noteworthy as the first to be held in the new and permanent home of the University on Morningside Heights. The number of degrees conferred was greater than on any previous occasion, amounting to 485 in cause, and four honorary. An unusual feature was the presentation of the Loubat prizes for the best works on the history, geography, archæology, ethnology or numismatics of North America. These prizes, amounting to 1000 dollars for the first and 400 dollars for the second, are to be awarded every five years, beginning with the present year; and are not to be less than the amounts named, but may hereafter exceed those amounts. The first prize was awarded to William Henry Holmes, for his book on "Stone Implements of the Potomac-Chesapeake Tide-water Provinces." The second prize was awarded to Dr. Franz Boas, for his work on "The Social Organisation and Secret Societies of the Kwakiutl Indians." Honourable mention was made of work by Dr. Carl Lumholtz, Mr. Frank H. Cushing, and Mr. Walter Hoffman, of America; and Mr. Alfred P. Maudslay, of London.

SCIENTIFIC SERIALS.

American Journal of Science, June.—A theory to explain the stratification of the electric discharge in Geissler tubes, by H. V. Gill, S.J. The phenomenon of stratification is a form of Kundt's experiment in which the heaps of powder which accumulate at the nodes are replaced by the strata of molecules between which the discharge is taking place in a luminous form.—Orthoclase as a gangue mineral in a fissure vein, by Waldemar Lindgren. During the examination of Silver City mining district, in southern Idaho, a vein was encountered containing a gangue of unusual character, consisting of quartz and orthoclase, the latter sometimes preponderating. It occurs as large, irregular milk-white grains, intergrown with vein quartz. This occurrence, together with various other forms, demonstrates the aqueous origin of the mineral. The analysis indicates typical adularia. The artificial production of orthoclase in the wet way, by heating powdered muscovite with a solution of potassium silicate, has a direct bearing upon its natural occurrence. The reason why orthoclase is not more frequently found on mineral veins lies possibly in the abundant presence of carbon dioxide in thermal waters, which would rapidly attack orthoclase and form more stable compounds, such as muscovite or sericite.—Notes on rocks and minerals from California, by H. W. Turner. The rocks discussed include a peculiar quartz-amphibolite-diorite, a new amphibole-pyroxene rock, a quartz-alunite rock, gold ores containing tellurium, selenium, and nickel, and gravels containing zircons.—A psychrometer applicable to the study of transpiration, by Robert G. Leavitt. The psychrometer consists of four nickel-plated tubes which can be kept at various temperatures by a mixture of hot and cold water. The dew point is indicated immediately by noting which of the tubes bears a deposit, and by varying the temperatures within narrow limits it may be found within 0·1° C. The apparatus was employed to determine the effect of light on the transpiration of plants, and a decided fall of the dew point was noticed as accompanying a diminution of light.—Comments on *Bulletin* No. 21, "Solar and terrestrial magnetism in their relations to meteorology," by F. H. Bigelow. The *Bulletin* attempts to overthrow two positions held in terrestrial magnetism: (1) that the sun is not a magnetic body because it is too hot, and (2) that the variations of the terrestrial magnetic field can be accounted for by electric currents in the cirrus cloud region. The earth is immersed in an external magnetic field of such a direction and strength as to make the inference necessary that its seat is in the sun. Else it will be necessary to assert that the earth's changes are sufficiently strong to disturb the sun's state, which is absurd.

Bulletin of the American Mathematical Society, May.—Concise abstracts are given of nine papers read at the third regular meeting of the Chicago Section of the Society, held on April 9. At the afternoon meeting Prof. Michelson exhibited the workings of his new harmonic analyser, a description of which was published in the *Philosophical Magazine* for January 1898.—Prof. M. Bôcher finishes his paper on the theorems of oscillation of Sturm and Klein. In the present portion Prof. Bôcher proves two simple theorems of Sturm's, and uses these to throw Sturm's theorem of oscillation into a slightly generalised form; he then proves Klein's theorem in a very general form. He proposes, in a subsequent paper, to come back to some more general cases which do not seem to present any serious difficulty.—The construction of special regular reticulations on a closed surface, by Prof. H. S. White, was read, in part, at the January 1897 meeting of the Society, and in final form at the recent April (30) meeting. The reticulations here discussed are called regular for two reasons: the number of termini of edges (r) assembled in one vertex is the same for all vertices (V) of the reticulation, and the number of edges (s) in the boundary of a face (F) is the same for all faces. The writer remarks that the regularity of these reticulations is not the same as that defined by Dyck and Klein in function-theoretic investigations; the two definitions overlap, but neither includes the other. The points discussed are (1) the mutual derivations of two dual reticulations from each other (dual when r, s, V, F of the first are equal respectively to s', r', F', V' of the second, and when each face of the one corresponds to a vertex of the other in such a way that the succession of vertices about each face corresponds exactly to the succession of faces about the corresponding vertex). (2) Two processes for multiplying the number of vertices or faces; and (3) the dissection of a Riemann surface into a fundamental polygon.—Dr. L. E. Dickson, in systems of simple groups derived from the orthogonal group, continues previous work (*Bulletin*, February number).—A proof of the theorem $\frac{d^2u}{dxdy} = \frac{d^2u}{dydx}$ follows, by Mr. J. K. Whittemore (read at the April meeting). This is short and neat.—Miss Frances Hardcastle contributes an interesting article entitled, "Some observations on the modern theory of point groups," in which she indicates some of the converging lines of the German and Italian work. In her first section she discusses some of the technical terms, and in the second section she starts from the Riemann-Roch equations by the suggestion of certain lines of inquiry which may prove useful in the classification of algebraic curves. A useful bibliography is appended.—A note on contact transformations is intended, by Prof. E. O. Lovett, to correct some misapprehensions that a reader of a note in the *Zeitschrift für Mathematik und Physik* (vol. xxxvii., 1892) to a paper by Dr. Mehmke may carry away.—Dr. Staude's "die Focaleigenschaften der Flächung zweiter ordnung" is reviewed; and Mr. J. E. Campbell, in a note, admits the validity of an objection brought by Prof. E. O. Lovett (in the November 1897 *Bulletin*) against a statement in his paper (*Proc. L.M.S.*, vol. xxviii.—incorrectly xxiii. in the *Bulletin*—pp. 381–390), and expresses his meaning more clearly.—"Notes" and "publications" close the number.

Wiedemann's Annalen der Physik und Chemie, No. 5.—Susceptibility of water and aqueous solutions, by H. du Bois. Determinations of the molecular susceptibilities of the salts of some paramagnetic metals, such as the chlorides of Ce, Cu, Ni, Fe, and Mn, go to confirm the rule observed by Jäger and Meyer that the atomic susceptibilities of the metals Ni, Co, Fe, and Mn are in the ratios 2 : 4 : 5 : 6.—Magnetic after-effect, by C. Fromme. The "magnetic creeping" or after-effect diminishes when the reduction of the field to zero takes place rapidly. This may be explained by supposing that the molecular magnets are thereby thrown into a more violent commotion, and are better able to attain stable positions. A similar effect may be brought about by heat or mechanical stress.—Magnetisation of hollow and solid iron rings, by F. Kirstädter. To determine whether the outer parts of a rod or ring screened the inner portions against magnetisation, the author split a ring in two halves, and bored round holes so that on recombination a hollow ring was formed. By boring the holes larger and larger the surface of the ring was given various thicknesses. It was found that the inner layers acquired the same magnetisation as they would have done had they been exposed to the immediate action of the magnetising field.—The function of the condenser in an induction apparatus, by P. Dubois. There is a certain maximum spark length obtainable in any given induction coil circuit by means of a condenser. When the capacity of the condenser exceeds that maximum, the effect diminishes. For a resistance of some 200 ohms in the circuit, the maximum useful capacity for the condenser is 3 microfarads.—On the rays proceeding from thorium compounds and some other substances, by G. C. Schmidt. These rays differ from uranium rays in not being polarised by tourmaline, and from Röntgen rays in being refracted. But like uranium and Röntgen rays, they impart a temporary conductivity to air and other gases.—Potential gradients at electrodes discharged by X-rays, by C. D. Child. When the discharge passes between two plates with air between rendered conducting by means of X-rays, the gradient is steeper near the plates and less steep in the middle, as may be proved by a Kelvin water-dropping electrometer.—Proof of the existence of the thin Zenker's plates in colour photographs taken by Lippmann's method, by R. Neuhauss. The layers of metallic silver to which, according to Zenker's theory, the colour effects in Lippmann's photographs are due, have been actually seen and photographed by the author under a microscope magnifying 4000 times in a cross section of a film taken by a very good microtome and operator. The distance between the lamellæ for red light is, as postulated, equal to the wave-length of the light.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 26.—"Contributions to the study of 'Flicker.'" By T. C. Porter (Eton College). Communicated by Lord Rayleigh, F.R.S.

The first part of the paper describes experiments made to ascertain the exact relative rotations at which the flicker of a disc, half black, half coloured, vanishes in the different colours of the spectra of sun- and lime light, formed by a diffraction grating of 14,434 lines to the inch. The main precautions which must be taken are briefly stated, with a short discussion of the results, which may be summed up as follows.

The rate of rotation of the disc that the flicker may just vanish is highest for the yellow, decreasing for the succession of colours on either side of this one, being the same for the deepest visible crimson and full green; from the full green to the violet end of the spectrum the rate continues to fall off, till in the last visible rays it is very nearly one-half its maximum for the yellow.

When the intensity of the different spectra is varied, the greater the intensity the more rapid is the rate of rotation necessary for flicker just to vanish; thus, as the stimulus applied to the retina increases in intensity, the impression produced retains its maximum value for a shorter and shorter time. That a brighter illumination of the disc does produce a greater stimulus (*i.e.* that neither the contraction of the pupil, nor any other cause, overcomes the effect of brighter illumination) is proved by the fact that the brighter the light, the brighter on the whole is the disc, when flicker has just vanished. Research was made to discover in what way the rotation of a black and coloured disc must be varied for flicker to vanish, when the proportion of the coloured to the black sector varied by stages of 10° at a time, the experiments being carried out in each of the main colours of the lime-light spectrum.

Throughout this series of experiments the intensity of the illuminant was kept constant. The results are expressed in a series of rather remarkable curves, the rate of rotation rising rapidly with the instalments of 10° to the coloured sector, then remaining at its maximum, and constant within the errors of experiment, from a coloured sector of about 150° to one of about 240°, after which the rate of rotation falls off somewhat more rapidly than it rose when the coloured sector was small.

The remainder of the paper is devoted to the discussion of these curves, and it concludes by proving from a series of points, taken at random on one of them, that the duration of the impression on the retina undiminished is inversely proportional to the time during which the retina is stimulated. Some other conclusions of interest are arrived at; but for the reasoning and description of experiments necessary, we must refer to the paper itself: *e.g.* (1) When flicker has just vanished, the effective stimulus at any point of the retina is to the maximum stimulus the coloured sector can produce, as the angle of the yellow sector is to the angle of the whole disc (*i.e.* 360°), the illumination being supposed constant. (2) The coloured sector always requires a finite time in order to produce its maximum effect on the retina. (3) When the width of the white or coloured sector is increased in steps of 10° at a time, the increment in the apparent brightness in the rotating and flickerless disc follows, within the errors of experiment, the series of 1/0, 1/1, 1/2, 1/3, 1/4, &c., as it should. The paper is the first of a series on the subject.

"Aluminium as an Electrode in Cells for Direct and Alternate Currents." By Ernest Wilson. Communicated by Dr. J. Hopkinson, F.R.S.

This paper deals with the apparent great resistance which aluminium offers to the passage of an electric current when coated with a film and used as an anode in cells containing, for instance, such an electrolyte as alum in water.

Part i. deals with experiments made on aluminium-carbon cells with direct currents, the electrolytes used being alum solution, dilute sulphuric acid, and sodium hydrate in water.

After making a preliminary experiment in which an exploring electrode inserted between the plates was used to allocate the distribution of potential difference in the cell, the author describes a series of experiments made with a view to finding the effect of variation of current density and temperature upon the potential difference between the Al and C plates. Two cells were constructed and, during the forming process, which consisted of passing a current of ·005 ampere per square inch of the Al anode for forty-seven hours, one of them contained a dilute H_2SO_4, and the other a saturated potash alum solution. The apparent resistance was not nearly so marked in the H_2SO_4 solution cell as in the other.

The H_2SO_4 solution was then replaced by a saturated alum solution, and the two cells submitted to a further forming process for thirteen hours. The two cells were then experimented upon at approximately constant temperature, but the current density varied. The potential difference in the two cases rose from 1·89 to 34·5 volts as the current density varied from ·00006 to ·12 in the case of the H_2SO_4-formed plate, and from ·00011 to ·041 in the other. With about 39 volts directly applied to each the current rapidly increased in the two cells, accompanied by rapid increase of temperature from its final value of about 20° C.

The cell containing the alum-formed plate was next heated; the current density of the Al anode kept approximately constant at ·019 ampere per square inch, and the temperature raised from 13° to 70° C. The potential difference fell from 30 to 3 volts under these conditions.

The potential difference was not materially increased by cooling a cell in a freezing mixture of carbonic acid snow and ether.

One of these films was examined under a microscope and analysed by Mr. Herbert Jackson, of King's College, London, who states "that the skin over the plate is seen to be full of minute cracks, giving the impression of a dried gelatinous pellicle; not an unexpected appearance if the plate had been covered when wet with a thin coating of the gelatinous aluminium hydroxide. The analysis of the film over the metal shows it to consist of basic aluminium sulphate."

An experiment was made upon a film which was formed without the passage of current by first submerging a bright Al plate in alum solution, and then exposing it to the atmosphere. The author concludes that this film has the same effect as another formed during the passage of current.

Part ii. deals with alternate currents. Experimenting first with Al-C plates in potash alum solution, the frequency was varied from 16 to 98 periods per second, and the current density varied from ·0396 to ·583 ampere per square inch of the Al plate. The results show that small currents are accompanied by large phase difference; but the effect looked for, namely a large ratio between the maximum coulombs in the two halves of a period, has not time to properly develop at the frequencies tried.

The next set of experiments deals with a "rectifier" for alternate currents proposed by Graetz, in which Al-C cells are employed. It is shown that a uni-directional current can be produced by the Graetz arrangement, and the efficiency of such a system is discussed.

The concluding portion of these experiments deals with aluminium plates only for the purpose of forming the electrodes of a condenser for alternate currents. Soda, ammonia, and potash alums, both saturated and non-saturated, are employed as electrolytes. The frequency is varied from 7·5 to 100 periods per second, and the current density from ·0139 to ·6. The results show that phase differences of the order of 60° and 70° (360° = 1 period) can be obtained by a suitable choice of current density and temperature. Maximum phase difference develops with small currents at low temperature. With regard to frequency, both saturated and non-saturated solutions give a higher efficiency at the higher frequency. The conclusion is that the metal aluminium is suitable for use as the plates of condensers if due regard be given to current density and temperature.

Royal Microscopical Society, May 18.—Mr. E. M. Nelson, President, in the chair.—The President exhibited a simple form of student's microtome, suitable for cutting soft sections. It was made by Messrs. Reynolds and Branson, of Leeds, and was on the principle of the Williams microtome, but consisted only of a plate of glass and an adjustable casting carrying the razor. The chief point of interest was its low cost.—The President read three short papers which had been received from Mr. Jourdain. The first was on a new apochromatic objective constructed without the use of fluorite. This objective is made by the Bausch and Lomb Optical Company, who have promised to send examples to Mr. Jourdain for examination. The other papers by Mr. Jourdain were on a method of adjusting the sizes of coloured images yielded by the Cooke lens, and on the construction of the planar lens and its use in low power photomicrography.—The President read a note on the optics of photographic lenses.—A paper by Mr. F. W. Millett, which was a continuation of his "Report on the Foraminifera of the Malay Archipelago," being of a highly technical character, was taken as read.—There was a very interesting exhibition of microscopic aquatic life by members of the Quekett Microscopical Club and Fellows of the Society.

Anthropological Institute, May 24.—Mr. F. W. Rudler, President, in the chair. —Prof. E. B. Tylor, F.R.S., having exhibited lantern photographs of the great totem-post from Queen Charlotte's Island, sent over by Mr. Bertram Buxton, and now erected in the grounds of Fox Warren, near Weybridge, the residence of Mr. Charles Buxton, took this as the text for a critical examination of totemism in general, as regards both its real importance and the somewhat extreme ideas of its place in anthropology and theology, which have been gaining ground ever since J. F. McLennan brought it into notice in his "Primitive Marriage." This writer at first looked at it purely in its legal aspect, the group of clans named after animals—as Wolf, Bear, Tortoise, Snake, &c.—being used as a means of dividing tribes, so as to regulate their exogamy or marrying-out; a Wolf man, for instance, not being allowed to marry a Wolf, though he might marry a Bear. Later McLennan wrote papers on the worship of animals and plants in the *Fortnightly Review*, which he did not republish, but which have served to model public opinion since. As bringing the subject into scientific view, these papers were admirable; but they plunged into somewhat reckless theories which have held their own, notwithstanding incompatibility with evidence. Especially the word totemism, originally referring to exogamous human clans named from animals, was used in the large and complex sense of animal-worship, to only a fraction of which the totem-clans really belong. This discrepancy became serious when, for instance, in Fiji a god who embodied himself in serpents, was treated as if his worshippers formed a serpent-clan; in such a case the serpents being regarded as totems, and it being further supposed that the superior gods of the land were evolved out of such totem-animals. When this notion was later expanded in the works of Frazer and Jevons, it gradually produced a theory of totem-animals having been the origin from which a rude form of monotheism arose in the religion of mankind. As an instance how misleading such reasoning may be, it was pointed out that the great Heaven-god Tangalsa, whose veneration extends over the islands of the Pacific, is in Samoa incarnate in a species of snipes. According to this totemic theory of gods, the vast Sky-god would be a developed and exaggerated snipe. It was argued also that attempts to support Robertson Smith's doctrine of the Slain-god, with its further sacramental implications, by certain supposed piacular sacrifices of totem-animals to the totem-god, were not to be depended on, the few instances alleged being cases of animals put to death for reasons not necessarily sacrificial. As to the real meaning and origin of totemism, Prof. Tylor pointed out that modern information has thrown considerable light on the annuistic processes by which totems probably came into existence. The evidence of Wilken and Codrington, from the Malay and Melanesian region, shows the prevailing doctrine of transmigration of soul to convert an ordinary form of animal-worship into what hardly wants more than the name to become a totem. An influential native on his death-bed will announce to his family the animal into which his soul will migrate, perhaps a crocodile or shark by preference; taking him at his word, his kinsfolk will worship the creature —above all, not killing or eating it—and the crocodile or shark species becomes their protector. Such a family multiplying, and being called after sacred animals, will become crocodiles or sharks, clans whose totem is the crocodile or the shark.

Entomological Society, June 1.—Mr. R. Trimen, F.R.S., President, in the chair.—Mr. P. B. Mason exhibited a specimen of the rare *Lathridius filum* from his own herbarium. It had been previously taken at Edinburgh by McNab, and he understood that an example had been found in a sealed envelope containing *Marchantia* from Franz Josef Land.—Mr. J. J. Walker exhibited a singular blue variety of *Carabus monilis*, Fabr., resembling in colour *C. intricatus*, and taken at Iwade, Kent, in flood-rubbish in May.—Mr. F. Merrifield forwarded for exhibition from Riva on the Lago di Garda larvæ of the "Corsican form," var. *ichnusa*, of *Aglais urticæ*.—Mr. G. C. Champion called attention to Mr. A. Somerville's recently-published sheet of the county and vice-county divisions of the British Isles for biological purposes, and a discussion ensued thereon.—Papers were communicated by Sir G. F. Hampson, Bart., on "The Moths of the Lesser Antilles," and by Mr. J. H. Leech on "Lepidoptera Heterocera from Northern China, Japan, and Korea."

Chemical Society, June 2.—Prof. Dewar, President, in the chair.—The President announced the death of the Right Hon. Lord Playfair, the senior past President, and last surviving founder of the Society.—The following papers were read:—The boiling point and density of liquid hydrogen, by J. Dewar. Liquid hydrogen boils at about $-238°$ C., and its density at the boiling point, determined by measuring the gas obtained by evaporating 10 c.c., is about 0·07. Since the hydrogen occluded by palladium has the density 0·62, it cannot be associated with the metal in the liquid state.—The action of hydrogen bromide in presence of ether on carbohydrates and certain organic acids, by H. J. H. Fenton and Mildred Gostling. The formation of ethylic dihydroxymaleate by the interaction of the acid with dry ether and hydrogen bromide is generally applicable to the preparation of alkylic salts. On applying the reaction to carbohydrates and polyhydric alcohols, it is found that an intense purple or red coloration is sometimes obtained with ether and hydrogen bromide; the coloured matter produced resembles the metafurfurol of Stenhouse and others.—Production of some chloropyridinecarboxylic acids, by J. N. Collie and W. Lean.

Linnean Society, June 2.—Mr. Albert D. Michael, Vice-President, in the chair.—The Chairman announced that the President had nominated Messrs. William Carruthers, Frank Crisp, Albert D. Michael, and Dr. D. H. Scott to be Vice-Presidents for the ensuing year.—Dr. St. George Mivart, F.R.S., contributed a paper entitled "Notes on Lories." Referring to a recently published paper by Captain Hutton on the value of specific characters (*Linn. Soc. Journ.*, *Zool.* xxvi. p. 330) in which the writer had stated the results of his examination of a large number of pigeons belonging to the genus *Ptilopus*, and his reasons for concluding therefrom "that the specific characters of these species could not have arisen as 'recognition marks' or from any other mechanical mode of origin," Dr. Mivart adduced other examples in support of this view from the family *Loriidæ*, or brush-tongued parrots. From the facts collected he expressed his conviction that the cause of specific characters still remained an unsolved enigma, the solution of which would probably not be achieved until the higher psychological problems of biology were more widely understood, and the light thus gained had been reflected on questions of ordinary physiology.—Mr. E. S. Salmon read a paper entitled "A Revision of the Genus *Symblepharis*." This genus of mosses, he said, as founded by Montagne in 1839, had proved too narrow, through the limits imposed by certain peristome characters, and he was of opinion that Mitten's later emended description should be accepted.—Surgeon-Captain Cummins read a paper on the food of the Uropoda. The nature of the food of these mites, which belong to a highly specialised genus of the *Gamasinæ*, had long been a puzzle even to those who have paid particular attention to their organisation. From careful experiments and observation, the author of the paper had come to the conclusion that amongst the organisms on which the Uropoda live were many species of bacilli, including the potato bacillus and the earth bacillus. Wild yeast-cells were rapidly devoured, as also were *Micrococci*. He had little doubt that they consumed the gonidia of Fungi, for species of *Penicillium* and *Mucor* never appeared in the boxes which contained mites in large numbers; otherwise they were commonly present. Mr. A. D. Michael, in criticising the paper, pointed out the distinguishing characters of the Uropoda as compared with others of the *Gamasinæ*, and especially the peculiar form of the mandibles, which suggested a different mode of feeding to that adopted by other mites.—Mr. C. B. Clarke, F.R.S., gave a summary of a paper on the subdivision of biological areas in India, and in the course of his remarks mentioned some interesting facts in connection with plant distribution in the Indo-Oriental region. Dr. Otto Stapf, in commenting on the paper, expressed the opinion that the limits of the subdivisions proposed were natural, and might well be accepted by botanists.

Geological Society, June 8.—W. Whitaker, F.R.S., President, in the chair.—On the discovery of natural gas in East Sussex, by C. Dawson. Inflammable natural gas was first recorded by Mr. H. Willett in his thirteenth quarterly report of the Subwealden Exploration. Another discovery was in a deep artesian boring in the stable-yard of the New Heathfield Hotel. In 1896, at a site about 100 yards distant from the last-mentioned locality, a boring was put down by the London, Brighton and South Coast Railway Co., the details of which are given in the paper, together with those of the earlier Heathfield boring. From this boring gas has been escaping for the last eighteen months, with a pressure of not less than 15 lb. to the square inch, and at the rate of about 12½ cubic feet per hour (with a pressure of 20 tenths maintained), although the tube is stopped up, and is partially filled with water (see NATURE, vol. lii. p. 150). Though deficient in illuminating quality, the gas burns well when mixed with air, and gives a good bunsen-flame. The author considers that it is probably derived from the lower beds pierced, that is, the Purbeck strata, or by percolation from the still lower Kimeridge beds, which were not reached by the borings. The borings pierce the southern slope of the great anticline which runs from Fairlight into mid-Sussex, and is joined at Heathfield by another considerable anticline running through Burwash.—Note on natural gas at Heathfield Station (Sussex), by Dr. J. T. Hewitt. A sample of natural gas from the boring described above was taken in December 1897, and analysed with the following result: Methane, 91·9; hydrogen, 7·2; nitrogen, 0·9. Oxygen, carbon dioxide, carbon monoxide, olefines, and hydrocarbon vapours were altogether absent.—On some high-level gravels in Berkshire and Oxfordshire, by O. A. Shrubsole. The high-level gravels are divided by the author as follows, beginning with the oldest: (1) Pebble-gravel, composed very largely of flint or chert; (2) the Goring Gap gravel; (3) quartzose gravel, with only a small proportion of flint-pebbles; (4) quartzite-gravel, with purple and brown quartzite-pebbles; (5) local flint-gravels.—The *Globigerina*-marls of Barbados, by G. F. Franks and Prof. J. B. Harrison, with an appendix on the Foraminifera by F. Chapman. After a reference to previous publications on the island by one of the authors and Mr. Jukes-Browne, an account is given of the tectonic structure of Bissex Hill, on which the principal exposures of the *Globigerina*-marl occur. In the appendix a list of 146 species of foraminifera is given. Fifteen of these occur only in strata ranging from the Cretaceous to the Pliocene Period. The rocks bear some resemblance to the limestones and marls of Malta and to the *Globigerina*-beds of Trinidad; the recent foraminifera indicate that the deposit was formed at a depth of about 1000 fathoms and at some distance from land.

Zoological Society, June 7.—Dr. Albert Günther, F.R.S., Vice-President, in the chair.—Mr. L. A. Borradaile read the second part of a paper on Crustaceans from the South Pacific. In this part twenty-one species of *Macrura anomala*, examples of which had been collected in the islands of Rotuma and Funafuti by Mr. J. Stanley Gardiner, were enumerated, and notes were given on several of them. Under the head of *Petrolisthes lamarcki* the author proposed to unite a number of forms previously considered as specifically distinct.—A communication was read from Mr. A. E. Shipley containing an account of the gephyrea or unsegmented worms collected by Mr. J. Stanley Gardiner at Rotuma and Funafuti. These comprised examples of two species of Echiuroidea and twelve of Sipunculoidea. Of the latter group two new species were described, viz. *Sipunculus rotumahensis* and *S. funafuti*, and *Physcosoma varians* was recorded for the first time from the Pacific.—Mr. G. A. Boulenger, F.R.S., read a fourth report on the additions to the Batrachian Collection in the Natural History Museum, containing a list of the species of this class (115 in number), new or previously unrepresented, of which specimens had been added to the collection since November 1894. Eight new species were described in this paper.—Mr. G. A. Boulenger, on behalf of Count Peracca, gave an account of a new species of newt (*Molge italica*), recently discovered in Southern Italy, and exhibited some living specimens of it.—A communication was read from Mr. L. W. Wiglesworth, entitled "Theories of the Origin of Secondary Sexual Characters," which contained arguments in favour of the theory of the stimulation of parts to higher development through use or external violence or irritation, as observed in birds.—A communication was read from the Rev. O. Pickard Cambridge, F.R.S. It contained an account of a collection of Araneidea from Savoy, comprising examples of twenty-four species, one of which (*Gnaphosa molesta*) was described as new.

Mathematical Society, June 9.—Prof. E. B. Elliott, F.R.S., President, in the chair.—The President briefly noticed the loss sustained by the Society owing to the recent deaths of Mr. H. Perigal (elected January 23, 1868) and of the Rev. Dr. Percival Frost, F.R.S. (elected December 9, 1869) (see NATURE, No. 1493, p. 131).—The following communications were made: Point-groups in a plane, and their effect in determining algebraic curves, by Mr. F. S. Macaulay.—On a regular rectangular configuration of ten lines, by Prof. F. Morley.—On the conformal representation of a pentagon on a half-plane, by Miss M. E. Barwell.—On the general theory of anharmonics, by Prof. E. O. Lovett.—On the calculus of equivalent statements (eighth paper), by Mr. H. MacColl.—On a continuous group defined by any given group of finite order (second paper), by Prof. W. Burnside, F.R.S.—On certain regular polygons in modular network, by Prof. L. J. Rogers.

Royal Meteorological Society, June 15.—Mr. F. C. Bayard, President, in the chair.—A paper by Mr. R. C. Mossman was read on the frequency of non-instrumental meteorological phenomena in London with different winds from 1763-1897. In previous papers the author has discussed the secular and seasonal variation of various phenomena, and he now gives the results of an analysis of the direction of the surface winds observed during the occurrence of snow, hail, gales, thunderstorms, lightning, fog, and aurora. Snow is of most frequent occurrence with north and east winds, and least common with S.W. winds. Hail showers occur most often with W., N.W., and N. winds. Gales are most frequent with W. and S. winds. The greatest number of both summer and winter thunderstorms occurs with W. winds, although the values in summer are high with E., S.E., and S. winds. The greatest number of fogs are recorded on calm days, closely followed by days on which the wind blew from the east.—A paper, by Mr. A. L. Rotch, was also read on the exploration of the free air by means of kites at Blue Hill Observatory, Mass., U.S.A. After giving a brief account of the use of kites for scientific purposes from 1749 to the present time, the author describes the various forms of kites which have been employed at Blue Hill Observatory, viz. the Eddy, or Malay tailless kite; the Hargrave cellular or box kite; and the Lamson aero-curve kite. The highest flight was on October 15, 1897, when, by means of four kites having a combined lifting surface of 150 square feet, the meteorograph at the end of 20,100 feet of wire was raised vertically 11,080 feet above the hill. About 200 records from kites have been obtained in the free air at heights from 100 to 11,000 feet in all kinds of weather. Mr. Rotch maintains that the kite can be made of the greatest importance for meteorological investigation. At the recent meeting of the International Aeronautical Committee at Strassburg it was recommended that all central observatories should employ kites as being of prime importance for the advancement of meteorological knowledge.

EDINBURGH.

Royal Society, June 6.—Lord McLaren in the chair.—Prof. C. G. Knott read a paper on magnetic strains, being a continuation of a paper already published in the *Transactions*. Iron, nickel, and cobalt tubes of various dimensions were studied in detail. As a rule each was the subject of four distinct experiments. The change of length in the magnetic field was first measured; then the change of volume of the material; thirdly, the change of volume of the bore; and finally the change of external volume of the tube when plugged up at both ends. From these the coefficients of strain of an element at both the internal and external surface were calculated. Many details of interest were touched upon, and the general conclusion arrived at that the system of stresses required to maintain the complicated state of strain indicated could not be accounted for in terms of any of the recognised theories connecting magnetism and stress.—Dr. A. T. Masterman read a paper on the further anatomy and the budding processes of *Cephalodiscus dodecalophus*. Among the chief features dealt with may be mentioned the following. The pharynx has special adaptations for the separation of food and water currents, *e.g.* hyper- and hypo-pharyngeal grooves, the peripharyngeal groove, the pharyngeal clefts, &c. The notochord of the *Chordata* may be primarily derived from this source as a channel for cloacal water. The pedicle or ventral sucker has a ventral nerve cord and two ventro-lateral cords, a dorsal and a ventral blood sinus and complete inner layer of longitudinal muscles. The buds arise usually in pairs ventrally. The pharyngeal clefts arise as endodermal diverticula, which break through the ectoderm to the exterior. The sexual development commences in the egg capsule whilst attached to the inner wall of the cœnœcium, and results in the form of a larva segmented into two parts by an annular constriction.—Mr. Malcolm Laurie gave a description of a new Silurian scorpion from the Pentland Hills, the fourth that had been found in Silurian rocks. Regarding certain structures on the abdominal segments, the hypothesis was advanced that the new form was a water-breathing animal. A description was also given of some new Eurypterids, of which no fewer than twelve species had been found in this particular Pentland bed.—Dr. Masterman also communicated a paper on the theory of archimeric segmentation, considered in relation to the classification of the *Cœlomata*. This was a following up of a suggestion made in a recent paper that in the morphology of the *Cœlomata* there are two distinct types of segmentation: (*a*) a primitive or archimeric type, having in its constitution evidences of a radial origin, and (*b*) a secondary or metameric segmentation superposed upon the former, and bearing evidence of a bilateral origin.

Mathematical Society, June 10.—Dr. Mackay in the chair.—The following papers were read:—Notes on permutations, &c., by Mr. R. F. Muirhead.—Extension of the method of displacement-sequence, by Mr. R. F. Muirhead.—Converse theory of binomial theorem, by Mr. Sita Noth Chokrobarthy.—Elementary notes, by Mr. W. J. Butters.

DUBLIN.

Royal Dublin Society, May 18.—Prof. D. J. Cunningham, F.R.S., in the chair.—Dr. F. T. Trouton, F.R.S., communicated a method of measuring the surface tension of liquids which depends on the rate at which a column of liquid fills, or empties itself out of a tube of fine bore. The tube is placed horizontally and has one end bent downwards into a vessel of the liquid. By altering the level of the liquid it can be either arranged to measure the rate the tube fills, in which case the capillary forces draw the liquid up, or the rate it empties, the capillary forces retarding. Were the flow viscous the distance traversed would be proportional to the square root of the time. This was shown to be approximately true. Experiments were described using an inclined tube with a wide bent-down portion attached to the lower end. The rate of emptying could be made constant by making the height of the liquid in the wide part equal to the capillary elevation in the fine tube. Experiments were also described made with liquids such as soap solution, where surface tension varies with time.—The Rev. H. O'Toole exhibited and described a new hydrometer, which consists of a stem at the lower end of which is a weighted bulb, as in any of the common forms of hydrometer; higher up on the stem is another bulb, which causes the instrument to float, and at the top is a dish in which weights may be placed. Between the floating bulb and the dish there is another bulb, which may be called the standard bulb. The method of use is as follows: the apparatus is immersed in a given liquid, and weights added to make it sink to a marked point between the floating and standard bulbs; additional weights are then added to immerse the standard bulb to another marked point near the dish; these additional weights are evidently the weight of a volume of the liquid equal to the volume of the standard bulb. The weight of the same volume of water may be similarly found, and thus the specific gravity determined.—Prof. D. J. Cunningham, F.R.S., and Mr. Joseph Welland exhibited an apparatus for lantern-photography of microscopic objects. This is of interest as affording a means of using an ordinary optical lantern, with or without a microscopic projector, for making enlarged photographs of transparent microscopic objects, the precise degree of enlargement wished for being readily obtained. It has been employed chiefly for photographing large sections of the brain, and it is particularly well adapted for this purpose. Further, by means of this apparatus, transparencies reproducing the different colours of stained and injected tissues can be readily obtained by the Joly process. Slides showing a section through a kidney injected in two colours (red and blue) and a picrocarmine specimen of hair follicles were exhibited.—Mr. Richard J. Moss exhibited an apparatus for drying bodies *in vacuo* at various temperatures. Steam or other vapour is passed through a flat coil of pipe in an inverted bell-jar, closed with a glass plate and rubber ring, and attached to a water vacuum pump. A flat-bottomed platinum capsule containing the substances to be dried rests on the coil of pipe, and any desired desiccant is placed in a tray above it.

PARIS.

Academy of Sciences, June 13.—M. Wolf in the chair.—Liquid air, by M. d'Arsonval. An account of the Linde process of liquefying air. An expenditure of rather less than three horse-power gives a litre of liquid air per hour.—Spectroscopic researches on atmospheric air, by MM. H. Moissan and H. Deslandres. A sealed note deposited May 11, 1896.—Remarks by M. H. Moissan on the above.—On the direct measurement of a quantity of electricity in electromagnetic units; application to the construction of a current meter, by M. R. Blondlot. A coil in the form of a ring is hung on a vertical axis inside a long horizontal bobbin, the same current passing round both coils. The product of the intensity of the current into the time of oscillation, that is, the quantity of electricity which traverses any given section of wire during one swing, is a constant quantity, depending only on the construction of the two bobbins. By the application of a device for counting the vibrations of the small coil, a practical coulombmeter is obtained, which works equally well with continuous and alternating currents.—On differential equations of the second order at fixed critical points, by M. Paul Painlevé.—On the problem of integration from the point of view of real variables, by M. R. Baire.—On mixtures of gases, by M. Daniel Berthelot. A discussion of Dalton's Law of mixed gases. Starting with the assumption that the law of Avogadro is only true in the limiting case of infinite volume, an expression is developed for the constants in the Van der Waal equation to the mixture. The results found experimentally by MM. Leduc and Sacerdote are in perfect agreement with the theory.—On the study of the radiations of mercury and the measurement of their wave-lengths, by MM. Ch. Fabry and A. Perot. A comparison of the green line and two yellow lines of mercury with the cadmium lines by means of the interferential spectroscope described in previous papers.—On the electrical resistance of steel, by M. H. Le Chatelier. The steels were examined in the form of well annealed bars, 20 cm. long and 1 sq. cm. in section. The resistance increases with increasing percentage of carbon, and similarly with silicon, 1 per cent. of the latter having double the effect of the same amount of carbon. Steels containing manganese, nickel, chromium, tungsten, and molybdenum were also examined.—Entoptic vision, and sensibility in the yellow spot, by M. Aug. Charpentier.—On the atomic weight of nitrogen, by M. M. Vèzes. From the densities of nitrogen and its compounds M. Daniel Berthelot has deduced an atomic weight of 14·005 for nitrogen, whilst the figure given by Stas is 14·044. This discrepancy cannot be accounted for, as MM. D. Berthelot and Leduc have assumed, by the systematic error introduced by oxygen dissolved in the silver, as M. Stas has himself carefully reconsidered the whole of his work in the light of this objection of Dumas, and has shown that the effect is practically negligible, the atomic weight in question being only lowered from 14·044 to 14·040. The cause of the difference still remains to be explained.—On the atomic weight of tellurium, by M. R. Metzner. The tellurium employed in this research was prepared by the decomposition of tellurium hydride at 500°; it is certain that this metal must be free from antimony and bismuth. The reactions chosen were the conversion of the metal into its sulphate, and the reduction of tellurous acid with carbon monoxide. The mean result is 127·9.—Action of sodammonium in excess upon red phosphorus, by M. C. Hugot.—On the preparation and properties of a new carbide of tungsten, by M. Percy Williams. The carbide is produced by the interaction of tungstic acid, carbon, and iron at the temperature of the electric furnace. Its formula is WC, and is distinguished from the carbide W_2C, discovered by M. Moissan, in not being attacked by chlorine.—New method of separating geraniol and citronnellol, by MM. J. Flatau and H. Labbé. The essence is converted into phthalic ethers by heating with benzene and phthalic anhydride, and these separated by means of ligroin. The ethers are described in detail.—On the composition of fish, crustacea, and molluscs, by M. Ballard. Determinations of water, nitrogen, fat, extractives, and ash for a large number of fish, crustacea, and molluscs.—On the crystalline forms of quartz from Meylan, by M. Ferdinand Gonnard.—On the direct fertilisation in some plants in which the flowers would appear to be adapted to cross fertilisation, by M. C. Gerber.—On a remarkable fault between Brives, Périgueux and Angoulême, by M. Ph. Glangeaud.—On new sources of petroleum in the Caucasus, by M. Venukoff. Naphtha-bearing sand has been found near Anaclie, in the Eastern Caucasus.—

Atmospheric situation at the time of ascent of experimental balloons, by M. H. Tarry.—The registration of atmospheric electric discharges, by M. Ducretet. The registration was effected by the Hertzian waves set up; the recording instrument was a Branly radio-conductor.—International balloon ascent of June 8, by M. W. de Fonvielle. The ascents were made on the same day at Paris, Brussels, Strassburg, Vienna, Berlin, St. Petersburg, and Munich.—Short account of the results of the ascents of three captive balloons at Trappes, by M. L. Teisserenc de Bort.

NEW SOUTH WALES.

Linnean Society, April 27.—Mr. P. N. Trebeck in the chair.—Some new genera and species of fishes, by J. Douglas Ogilby.—On the affinities and habits of *Thylacoleo*, by Dr. R. Broom. The author reopens a much-debated question in the light afforded by the interesting little fossil marsupial recently described by him under the name *Burramys parvus* [P.L.S.N.S.W., 1895, p. 563]. This little form, which is evidently the representative of a sub-family of the *Phalangeridæ*, in most of its characters agrees with the phalangers, but it possesses the greatly enlarged and grooved premolars of the rat-kangaroos; and not only does it show evidence of a group which fills the only remaining gap between the kangaroos and the phalangers, but as a phalanger with the posterior premolars enormously enlarged, it comes nearer to *Thylacoleo* than does any extinct or living form hitherto discovered. The conclusions arrived at are—That *Thylacoleo* is descended from a phalangeroid form not very dissimilar from *Burramys*, and that it was almost certainly a purely carnivorous animal.—Descriptions of new Australian lepidoptera: with a note on the occurrence of *Deilephila livornica*, Esp., at Broken Hill, N.S.W., by Oswald Lower. The beautiful sphingid, *Deilephila livornica*, Esp., was noticed by the author to be common during the early part of March last, at the electric lights at Broken Hill. On one occasion individuals were literally swarming. The species occurs in Europe, Africa, and S. Asia. It was first recorded from Australia by Mr. Miskin from a Queensland specimen. It is also known from Adelaide, but has not yet been reported from Victoria, Tasmania, or West Australia; nor has it been recorded previously from New South Wales.—Descriptions of a new Australian grass, by Fred. Turner. The species of *Panicum* described is a capital forage plant from the Liverpool Plains, N.S.W., its nearest allies being *P. semitonsum*, F.v.M., and *P. antidotale*, Retz, from North Australia.—Mr. Hedley exhibited a specimen of fully developed *Gundlachia* recently taken by Mr. H. Leighton Kesteven from a pool in the Botanical Gardens, Sydney. This is the second instance of its occurrence in Australia, and the first in New South Wales. The genus has been treated of at some length in vol. viii. (2nd series) of the Society's *Proceedings*. Possibly no real *Ancylus* exists in Australia, and all those hitherto reported will ultimately be shown to assume occasionally and at rare intervals the Gundlachia form.—Mr. Ogilby exhibited the type of the new bathybial fish from Lord Howe Island, described in his paper as *Æthoprora perspicillata*, and remarked that it may be distinguished from the three Atlantic species by the presence of a pair of supernumerary photophores between the upper angle of the eye and the ante-orbital.

DIARY OF SOCIETIES.

FRIDAY, JUNE 24.

PHYSICAL SOCIETY, at 5.—Exhibition of an Apparatus illustrating the Action of Two Coupled Electric Motors: Prof. Carus-Wilson.—Exhibition of Weedon's Expansion of Solids Apparatus: J. Quick.—On the Theory of the Hall Effect in a Binary Electrolyte: Dr. F. G. Donnan.

SATURDAY, JUNE 25.

GEOLOGISTS' ASSOCIATION (Liverpool Street Station, G.E.R.), at 9.30 a.m. —Excursion to Sudbury. Director: Dr. J. W. Gregory.

MONDAY, JUNE 27.

ROYAL GEOGRAPHICAL SOCIETY, at 4.30.—Plans for the Construction and Erection of a Terrestrial Globe on the Scale of 1 : 500,000: Prof. Elisée Reclus.

THURSDAY, JUNE 30.

LINNEAN SOCIETY, at 8.—A Revision of the Genus *Elæocarpus*, Linn.; Sir D. Brandis, K.C.I.E., F.R.S.—Observations on the *Membraniporidæ*, a Family of Marine Bryozoa: A. W. Waters.—On the Fruit of *Chnoospora fastigiata*, J. Agardh: Ethel S. Barton.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Essai Synthétique sur la Formation du Système Solaire: G. Lafouge, Part 1 (Paris, Gauthier-Villars).—Calculations in Hydraulic Engineering: Prof. T. C. Fidler, Part 1 (Longmans).—South American Sketches: R. Crawford (Longmans).—Twenty-first Annual Report of the Connecticut Agricultural Experiment Station, for 1897 (New Haven).—Catalogue of Earthquakes on the Pacific Coast, 1769 to 1897: Dr. E. S. Holden (Washington).—Report of the U.S. National Museum for the Year ending June 30, 1895 (Washington).—Leçons Elémentaires d'Acoustique et d'Optique: Prof. C. Fabry (Paris, Gauthier-Villars).—A Manual of Bacteriology: Dr. R. T. Hewlett (Churchill).—Lectures on the Geometry of Position: Prof. T. Reye, translated and edited by Prof. T. F. Holgate. Part 1 (Macmillan).—The First Philosophers of Greece: A. Fairbanks (K. Paul).—The Study of Man: A. C. Haddon (Bliss).—Year-Book of the U.S. Department of Agriculture, 1897 (Washington)—Cape Photographic Durchmusterung for the Equinox 1875: Drs. Gill and Kapteyn, Part 2 (Darling).—Text-Book of Zoology: H. G. Wells and A. M. Davies (Clive).

PAMPHLETS.—Contribution iii. to the Coastal and Plain Flora of Yucatan: Dr. C. F. Millspaugh (Chicago).—Medical Missions in their Relation to Oxford: Sir H. W. Acland (Frowde).—Advanced Exam. Papers in Book-Keeping, with Notes by J. Thornton (Macmillan).—Boron Food Preservatives, &c. (Perkins).

SERIALS.—Journal of the Franklin Institute, June (Philadelphia).—Proceedings of the American Philosophical Society, December 1897 (Philadelphia).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1897, October–December (Philadelphia).—Transactions of the Wagner Free Institute of Science of Philadelphia, Vol. v., January (Philadelphia)—Annals of the Astronomical Observatory of Harvard College, Vol. xlii. Part 1 (Cambridge, Mass.).—Académie des Sciences de l'Empereur François Joseph I. Bulletin International (Sciences Mathématiques et Naturelles et Médecine) (Prague).—Memorie della Societa Geografica Italiana, Vol. vii. Parte Seconda (Roma).—An Account of the Crustacea of Norway: G. O. Sars, Vol. 2, Parts 9, 10 (Bergen).—Archives of the Röntgen Ray, May (Rebman).—American Naturalist, April (Ginn). Morphologisches Jahrbuch, 26 Band, 1 Heft (Leipzig).—Botanische Jahrbücher, Sechsr. Band, 1 Heft (Leipzig).—Journal of the Scottish Meteorological Society, third series, Nos. 13 and 14 (Blackwood).—Zoologist, June (West).—Jahrbuch der K.K. Geologischen Reichsanstalt, Jahrg. 1897, xlvii. Band, 2 Heft (Wien).—Die Gastropoden der Trias um Hallstatt: E. Koken (Wien).—Psychological Review Monographs, Vol. ii. No. 4 (Macmillan).

CONTENTS.

THURSDAY, JUNE 30, 1898.

THE COLOURS OF INSECTS CLASSIFIED ACCORDING TO THE METHODS OF ART.

Observations on the Coloration of Insects. By Brunner von Wattenwyl. Translated by Edward J. Bles, B.Sc., King's College, Cambridge. Pp. 16, and 9 Coloured Plates. (Leipzig: W. Engelmann, 1897.)

THIS publication consists of a series of nine beautifully coloured plates containing 118 numbered figures, in addition to several others distinguished by letters. Accompanying the plates is a brief descriptive letter-press which explains the plan on which the illustrations have been selected and grouped, and the theoretical views of the author, the eminent orthopterist. The expense of the plates, which must have been very heavy, was aided by a grant from the Wedl Fund of the Imperial Academy of Sciences in Vienna.

The translation is, on the whole, extremely good, only a sentence now and then serving to recall the (to us) clumsy form of the original. Mr. Bles, in a cautiously worded translator's note, excuses himself from the acceptance of the author's philosophy.

The printing and general get-up are of the very highest character.

The views of the author upon mimicry, protective resemblance, &c., are already well known from his previous writings. Thus in 1883 he suggested (*Verh. der K.K. zool. bot. Ges. in Wien*, 1883, p. 247) the term "Hypertely" to express the supposed fact that resemblance to surroundings may be more perfect and detailed than is required by the struggle for existence. Thus Brunner could perhaps accept the view that resemblance to a leaf is useful for concealment from enemies, although likeness to a leaf which has been mined by larvæ went, he contended, too far, and transcended the limits of the useful. It was therefore of the highest interest to ascertain whether the criticism of so distinguished an entomologist was purely destructive—for "Hypertely" merely meant that he could not accept the explanation offered by natural selection—or whether he had not some alternative theory to explain the facts. Hence the expectant interest with which this publication will be received by all naturalists who are interested in theories which are supposed to account for evolution.

In the Introduction the author describes the plan of his memoir in these words: "The following work contains simple observations on the phenomena of coloration. I have attempted to classify these phenomena, and I have found laws which have no connection with the care for the preservation of the species." These "laws" consist in classifying a large number of the colours and patterns of insects according to their forms, and especially according to the relationship they bear to the various methods of decorative art as applied by man.

It must be regarded as a serious error that the author should have used a monograph of this kind for the burial, rather than the publication, of the description of a few new species.

The following groups are recognised and beautifully illustrated in the plates: (1) *Uniform and Rainbow Coloration*, the simplest and commonest of all; and next to it (2) *Stripes, Bands and Spots.* Under this head it is well shown that the stripes often persist over certain contours or surfaces of the body, regardless of the various anatomical features which are traversed; and also that the continuity of stripes can only be made out, in certain cases, by placing the insect in its position of rest. When an insect possesses a "single narrow band which extends, mostly in a straight line, over the different parts of the body, sometimes vertically, sometimes horizontally or obliquely," and when this band only becomes continuous in a certain position of the insect, Brunner calls it (3) *The Line of Orientation*, "because it indicates the position assumed by the insect in receiving its coloration." (The form of words used should be noted.) Numerous excellent examples of such lines are figured. The next group consists of (4) *Strokes and Dots*, a special form of pattern which gives "the impression of a simple pen-and-ink drawing." A certain West African Locustid (*Mustius Afzelei*) is "marked with a pen-and-ink design" in the form of rings round the antennæ, on the borders and tips of the wings in the position of rest, and on the ends of the feet. A detailed description is given by the author "in order to show that in this insect the pen-and-ink markings are, so to speak, the finishing touches to the coloration of the insect." (5) *Eye Spots.* A beautiful series of these striking markings has been selected and figured. The species belong to the Coleoptera, Orthoptera and Lepidoptera. (6) *Spirals.* Another very striking and remarkable form is found in many moths and in the Mantid family *Harpagidæ*, which, however, are described under Section 9. (7) *Splash Marks* are distinguished from the markings hitherto described by their irregularity and want of symmetry. In two species of *Aularches* from the Oriental region, "the effect of the whole is as though the insect with folded wings had been irregularly splashed with a body-colour." Splash marks when crowded may be modified into (8) *Clouded Markings*, although in this case the pigment is "not applied like a body-colour." The author, "speaking figuratively," prefers to "regard these markings [as in the fore-wings of *Œdipodidæ*] as produced by the impression of a thumb moistened with colour."

Up to this point coloration has been considered "as though produced by painting with a brush. Besides this, forms of coloration are met with which imply, when carefully considered, another method of application." The first of these are (9) *Stencil Patterns*, in which "the colour is perfectly uniform throughout with hard contours, like the wall paintings produced with the aid of stencil plates." "In many instances, various colours are laid on in different shapes, like in polychrome decorations." The examples are selected from dragon-flies and Orthoptera. The realistic manner in which the author follows up his own metaphor is well shown in his description of the marking on the fore-wings of the Harpagid (*Mantidæ*) *Pseudocreobotra ocellata* from Natal.

"One sees on the transparent, somewhat yellowish ground of the fore-wings, firstly, a green patch laid on as with a stencil. Then, in the middle of the green portion, opaque citron-yellow is laid on in the form of a spiral. The spiral is bordered with a heavy black line,

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and in the centre of the spiral there is a round spot of the same colour. The black line obviously is meant to serve as a setting of the yellow spiral,"

but it is somewhat misplaced in the design, being shifted, together with the central spot, towards the base of the wing.

"We have, consequently, three colours stencilled on the glassy wings: first green (Fig. 70 *b*), then lemon-yellow (*c*), and, to complete the picture, a black body colour; the latter is somewhat misfitted, as it may also be at times in our coloured prints."

All the specimens examined were found to exhibit the same displacement of the black band, so that it is not "a mere chance occurrence in an individual." The author reaches the remarkable conclusion—"The species was ornamented *once for all*, and just as it emerged from this operation, so has it been transmitted by inheritance." Stencil painting also occurs in Lepidoptera, although it requires "a little good will" to find it. Indeed Brunner is inclined to look upon this as the primitive coloration, which has been in the Lepidoptera "frequently effaced by selection and by simply going to the bad."

The transparent patches which occur on the wings especially of Orthoptera and Lepidoptera are classed under (10) *Erosion.*

These ten groups of marks are followed by general Sections dealing with the alterations which occur in pattern as it is traced through a series of allied forms. In Section (11) *Changes of Pattern*, it is pointed out that unlike the *Pseudocreobotra*, described above, the outlines of spots and stripes and even their position are variable in Lepidoptera.

The author therefore compares

"the first method of coloration with colour printing, and the latter with hand painting; thus indicating the fact that on one hand we meet with undeviating similarity, and on the other with a certain freedom."

The methods by which the changes are effected are then considered in (12) *Enlargement and Diminution of Spots and Bands*, (13) *Dislocation*, the change in position which corresponding marking may undergo in allied species, principally illustrated from the *Hesperidæ*. (14) *Diminution of Patterns*, in which a "pattern remains unchanged and only diminishes in size." The fascination for metaphor which possesses the author leads him to say concerning diminution (as opposed to "the simple breaking down of a design"),

"We have a process before us, which is carried out physically when a magic lantern picture is diminished on the screen by manipulating the lenses."

The title of Section (15) is *Changes of Colour due to Adaptation.* Although the choice of these words seems to imply the recognition of natural selection, such an explanation is by no means congenial to the author. After alluding to his previous description of a Locustid from the Soudan which resembles an ant, the shape of the latter being indicated in black pigment on the body of the former of which all other parts are coloured with a pale tint, he inquires "is this imitation an accidental freak of nature?" Indeed throughout this section Brunner seems to doubt his own explanations. He gives numerous instances of insects living on plants "in which the leaves of the habitat or parts of them are doubtlessly imitated"; but follows the list, which is illustrated by eight figures, with the paragraph—

"With the aid of the imagination, one may recognise the most various figures in the arrangements of spots and ocelli, and if, perchance, these can be referred in any way to protective resemblance, your case of mimicry is established."

Apart from the fact that such a description is a caricature, exception must also be taken to the inconvenient confusion between protective resemblance and mimicry, two principles which, although bearing a close relationship to each other, are better kept separate.

(16) *Staining of Contiguous Parts.*—This Section contains the somewhat crude and entirely unsupported assertion that when an intensely coloured part of the body is of the same tint as other parts which are in contact with it, the latter have been stained by the former. Careful microscopic investigation at the time during which the pigments are developed would settle the matter, and without it no such assertion can be justified.

(19) *Fading in Covered Parts.*—In many instances the parts of wings which are covered in the position of rest are of a different tint from the exposed portions. From this well-known fact, and without the remotest attempt at proof, the author observes

"these facts convey the impression that the brighter colours are produced by daylight. If one exposes to the action of the sun and of the air several sheets of white paper of different sizes lying one upon the other, then, in a short time, the silhouette of the smaller pieces will stand out on the larger either in lighter or in darker tints. It is probable that the phenomena observed in Blattodea and Phasmodea belong to this category of light effects."

The author's method of dealing with natural selectionists may be fairly used against himself. If, perchance, it is possible to institute a crude comparison between the colour effects produced by physico-chemical forces upon dead matter, and the arrangement of tints in a highly organised being, you have probably established a valuable "law" which you can then place before the world, without troubling to inquire whether you have been misled by a resemblance which is purely superficial.

(18) *Colouring in Relation to Position.*—In this Section the patterns which pass over the body irrespective of its parts, and produce a "homogeneous" effect, are distinguished as *holotypic* from those *correlative* markings which are similar upon homologous parts, as in the repetition of ocelli upon the corresponding areas of fore and hind wing, &c. Numerous interesting and beautiful illustrations are given. It is common for the same insect to possess more than one holotypic pattern having reference to more than one position. This at least is the way in which a follower of natural selection, or indeed a Lamarckian, would express the facts, and he would then attempt to ascertain the meaning of the patterns in relation to the positions. Brunner expresses them very differently and in a manner which is significant of his views of creation. With him the position represents the attitude of the insect when the pattern originally fell upon it. Such a view is expressed again and again, the best example being contained in the next and last

Section (19) dealing with *Arbitrariness of Coloration* (viz. the fact that colouring often has no "reference to the somatic importance of organs"). He here speaks of a black Australian bug of the genus *Pirates*, in which the wings of the male and the abdomen of the wingless female are similarly striped and spotted with dirty yellow. "What, then, does this mean? When the pattern was produced, it fell upon the wings of the male, and in the female on the uncovered abdomen."

There is a conspicuous want of method and arrangement in the Sections recognised by the author. Thus the idea of a pattern which persists over the body surface independently of structural features but related to attitude, is the central conception of many of the Sections, and even those as widely separated as (3) is from (18) and (19). It is interesting to compare this point of view with that of the late Alfred Tylor, who ingeniously attempted to show that the true significance of pattern is to be found in its relation to underlying structure. Undoubtedly many patterns possess this relationship, and undoubtedly many others as conspicuously lack it. The facts on which both naturalists relied are certainly right, while their conclusions are as wrong as they are contradictory of each other—Brunner, that pattern is produced upon the organism by some power outside it, and caring nothing for its structural differentiation; Tylor, that there is some deep and significant bond between pattern and underlying structure, so that the former becomes the outward and visible sign of the latter.

The attempt has now been made to give the whole of the "laws which have no connection with the care for the preservation of species" which the author claims to have found. To the majority of naturalists these "laws" will appear to be the grouping of certain markings and patterns according to more or less superficial resemblances between them; and this being done, the real interest now begins—the attempt to ascertain their significance in the lives of their possessors. Much interest, too, awaits a minute investigation of many of the groups in order to make out whether they are based on superficial appearances, and therefore artificial, or whether they are real and natural.

To the author, however, it all means far more than this. As the memoir was being studied, the continual pursuit of detailed metaphor led to the belief that the author did not regard his imagery as metaphor only. In the brief Conclusion he speaks out on the question.

"In the above paper I have brought into a system the divergent facts of coloration. In so doing, simple principles have been formed which coincide in a remarkable manner with those of the human painters' arts. The agreement is so striking that one is tempted to use the terms of our own technique in descriptions. I speak of splashing, stencil-painting and brush-painting, also of the position of the insect when the colour was applied, of sketching in the pattern in different ways, &c."

"This is figurative language, but the uniformity of the phenomena forces one to the conjecture, that the process in nature is of a similar character; that is to say, a phenomenon which acts from without, independent of the biology of the animal coloured and in nowise connected with its structure."

When we inquire what this power can be, the author replies as follows:—

"The exact sciences have accustomed us to refer all natural phenomena to the action of definite, inviolable laws. In the coloration of insects, however, we meet with an *arbitrariness* striving to produce attributes without regard for their possessors and, therefore, obviously to be looked upon as the emanation of a Will existing above the universe."

Thus Brunner leads us back to a form of special creation. Paley was convinced by the argument of design; Brunner by the argument of want of design. Most of us, while rejecting both, will distinctly prefer the philosophy of the old theologian to that of the great orthopterist.

The "Will existing above the universe," the Will which Brunner supposes to work out "purposes in creation far more lofty than the mere preservation of the species," is mainly to be recognised by the resemblance of its handiwork to that produced by the methods of the craftsman, and especially by the remarkable likeness which it presents (as in the wrongly-placed stencil pattern) to a poor form of human art, at its worst.

The reasons given for rejecting the Darwinian explanation are indeed remarkable, but far more remarkable are the hypotheses which the objectors prefer to put in its place.

E. B. P.

BLANFORD'S BIRDS OF INDIA.

The Fauna of British India. Birds, Vol. iv. By W. T. Blanford. 8vo. Pp. xxi + 500. (London: Taylor and Francis, 1898.)

THE present volume completes the Vertebrates of the Indian Fauna, and the editor (in this case also the author) is to be congratulated on having thus far so successfully accomplished a very important and at the same time a very difficult task. The volume before us is, perhaps, the most generally interesting of the four devoted to birds, seeing that it treats of groups like the pigeons, the sand-grouse, the game-birds, and the ducks and geese, which claim attention from a wider circle of readers than is attracted by the perching birds and picarians. Since the author, in addition to his scientific qualifications, is also a sportsman who has shot a large number of the species he describes, his work can scarcely fail to prove as acceptable to his brother sportsmen as to scientific ornithologists. Limitations of space have necessarily curtailed the amount of matter devoted to the habits of most of the species, but within such limitations the notices leave little to be desired.

From its geographical situation, India, we need scarcely remind our readers, is visited during the cold season by vast swarms of game-birds and ducks of various kinds; and the fauna of these groups is consequently very much larger than might *à priori* have been expected. Sportsmen accordingly often experience considerable difficulty in identifying the species contained in their "bag," but with the publication of the present volume such difficulties should cease.

Turning to the more strictly scientific aspect of the book, it may be noted that the author is careful to state how much he is indebted to the British Museum Catalogue of Birds, certain volumes of which devoted to several of the groups he describes have appeared at more or less recent dates.

On comparing these volumes of the Museum Catalogue with the work before us, it will be found that in many instances Mr. Blanford has somewhat simplified the classification adopted. This is most markedly the case in the pigeons, the existing members of which were divided by Count Salvadori into five families; whereas Mr. Blanford, so far at least as Indian forms are concerned, admits but one. Although he has not to deal with the former on this occasion, he further suggests that the separation of the *Tetraonidæ* as a family apart from the *Phasianidæ* seems scarcely justifiable by the facts. And on turning to the minor groups, we find a similar wide and comprehensive view taken as to their respective limitations. Leaving out of consideration the very distinct demoiselle crane (*Anthropoides*), it may be noticed as an example of this feature that recent writers have assigned the three species of true cranes which visit India proper to as many distinct genera, respectively distinguished, mainly, if not entirely, by the comparatively insignificant character of the extent to which the head is clothed with feathers. All the three species are indeed structurally similar and essentially the same type of bird, and to many at least it will be a source of satisfaction to find them once again reinstated in the original genus *Grus*. Possibly a further improvement would have been to have placed the Burmese representive of the Sarus crane of India as a sub-species rather than a species, but this is a matter of detail.

In museum work (as in stamp-collecting) there seems to be an inevitable and inherent tendency on the part of specialists to go on refining and discriminating in the detection of small points of difference, and thus to raise the individuals or groups in which such minute points of difference occur to a higher and higher rank. And in consequence of this extremely natural ultra-refinement (due to a ripe knowledge of minuteness of detail), the mutual affinities of animals tend to become obscured or even lost, while the science is cumbered with an excess of more or less superfluous terms. It is therefore a distinct advantage when a man with the wide experience and knowledge derived from the study of other groups, possessed by the author of the present volume, sets himself the task of revising the classification of a group which has occupied the attention of a large number of specialists. And whatever may be the opinion from the specialist point of view, it can scarcely be doubted that to naturalists who desire to take a broad and comprehensive view of zoological affinities, Mr. Blanford's simpler arrangement is decidedly preferable to the numerous sub-divisions adopted by some of his fellow workers.

As regards the general classification adopted, it is gratifying to notice that it has not been considered necessary by the author that he should propose any new scheme; and the various major groups accordingly, for the most at any rate, appear under the old familiar names. In some instances, however, generic terms in common use have had to be rejected on account of priority or preoccupation, and a few birds consequently appear under unfamiliar titles. The horned pheasants, for example, figure as *Tragopan* in place of *Ceriornis*, but since the former name is often used as the popular title of these birds, the change in this case is less startling than usual. As in all those made by the author, this substitution was a necessity according to the rules of nomenclature.

The total number of Indo-Burmese birds regarded as entitled to rank as distinct species in the four volumes devoted to the group is given by the author as 1626. Years ago, from a much smaller area, Jerdon recognised 1016. In Mr. Hume's catalogue of 1879 a total of 1788 entries were recorded, but of these 106 were rejected as invalid, and 74 regarded as doubtful, thus leaving a total of 1608, or very nearly the same as the number admitted by Mr. Blanford and his fellow author Mr. Oates. Since a large number of new species have been described of late years, this indicates that due attention has been given on the part of ornithologists to the elimination of nominal ones. An exact estimation of the number of species of any group of animals inhabiting a particular country must, however, depend to a considerable extent on the personal equation of the describer. As the author well observes:—

"The precise number of species is naturally dependent on a personal factor, some writers being more liberal than others in admitting the claims to specific rank of races which are distinguished by small differences of plumage or measurement, or which are connected by intervening links with the typical form. Such races or sub-species, as they are called, have not, as a rule, been separately numbered and described in the present work, but they have received due notice and their characters have been explained."

From this it would appear that Mr. Blanford has not yet brought himself to accept the principle of trinomialism for birds, although his recent paper on the large Indian squirrel seems to show that he has already done so in the case of mammals; and the innovation would, to our thinking, be an advantage among the former.

As is always the case with the author's work, his descriptions are most accurately and concisely written, and they all bear the impress of having been drawn up afresh from the birds themselves, and not merely extracted and furbished up from the writings of others. In many of the groups described, and especially the game-birds, the females are so different in plumage from the males, as to require a description nearly as long as that devoted to the latter, so that the labour involved in the work is almost double that which might at first sight be supposed necessary. Equally exact, and at the same time important, are the details given in connection with the geographical range of the genera and species; a subject too often neglected by the earlier writers.

One thing we should like to suggest to the author, and that is that in future works he should give the reference to the place of publication of the generic names and their synonyms, instead of merely citing the author and date. The characters of the eggs in each genus might also have been added; while a few more details regarding the nesting habits of some of the more important species would, if space permitted, have added to the interest of the book.

Many books on Indian game-birds and the kindred groups are already in existence, and a new one on a small scale is now in course of publication; but it may be safely said that as a work of reference, embodying all the important information regarding these groups, the present volume will long remain the standard, both to the naturalist and to the sportsman. While lacking the advantage of plates, it has the compensations of portability, accuracy, and completeness; and it forms a worthy companion to its fellow volumes of the same series. R. L.

NAVIGATION AND CYCLONES.

Méthode pour abréger les traversées en utilisant les perturbations de l'Atmosphère. Par M. A. Fieron, capitaine de frégate. Pp. 91. (Paris: Imprimerie Nationale, 1891.)

THIS little book bears the date 1891, and is extracted from the *Annales hydrographiques* of that year. The object of the author, who was attached to the *Calédonien*, and thus had considerable experience of the Southern Seas and of the weather prevalent in those latitudes, is to indicate methods by which navigation may be facilitated and the duration of voyages, in sailing ships especially, diminished by taking advantage of the cyclonic and anticyclonic movements in the atmosphere. By so manœuvring that the violence of the storm is utilised in carrying the ship in the direction desired, it is contended that these destructive agents can be turned to useful account. It may be true, as the author asserts, that in every area of low pressure there is always one part which can be made useful—one sector in which favourable winds will be found. But careful navigators are rather prone to give these areas of disturbance a wide berth; and it speaks much for the trustfulness of the author, and of the calm confidence in which he reposes on scientific deductions, that he does not propose to avoid these dreaded cyclonic storms, but is prepared to steer into their midst and make their violence subservient to his ends. His system is based upon instrumental observations, chiefly of the barometer, from which may be learnt the direction and force in which the cyclone is moving. Experience teaches the behaviour of the atmosphere in a region of low pressure in different latitudes, and by the aid of a few rules, easily learnt and remembered, it is not difficult to perceive whether one be on the navigable or dangerous side of a cyclone, and arrange accordingly. The author therefore gives in very considerable detail, the condition of the weather, the direction of the wind, and the appearance of the sky, which may be expected in the various positions in which the ship finds itself relative to the centre of the storm.

We have practically to do with a system of weather forecasting, based upon knowledge which cannot always be exact or sufficient, and therefore it would seem must sometimes lead astray. But the author declares that he has never been in error, and that he has never had any hesitation in selecting the proper route which would enable him to find the most favourable wind to carry him most swiftly in the direction he desired to travel. He is, however, careful to add that his rules for observance apply only on the open ocean, where land masses do not interfere with the aerial current, and his success may be to some extent due to the employment of the system under the conditions of the greatest simplicity.

This work has been before the maritime public now some seven years, and presumably the procedure has been submitted to frequent test by those who have to navigate in those seas, which have been made the subject of study, but the testimony in its favour does not seem to be overwhelming. Several causes may be assigned to explain the indifference with which the practical suggestions contained in the book have been received by the mariner and the shipowner. The most evident is the steady decline in the tonnage of sailing vessels, and the tendency to convert many of these into floating warehouses containing grain. When a shipowner knows that he will have to pay rent for storage of the cargo on arrival, he is practically indifferent how long the voyage may last, and safety is of greater consideration than swiftness. The recognition of trade routes and the maintenance of particular lines of navigation pursued by vessels which can both steam and sail, forbid a haphazard, self-selected route, which, if it shorten the time of passage, increases the chances of collision. The author, it is true, considers his system particularly applicable to this kind of steamer, employing the steam to carry the vessel into a position in which it would enjoy favourable breezes. A few tons of coal would be well expended, he urges, if it enabled a skipper to bring his steamer alongside a friendly cyclone which would carry it along on a twenty-knot breeze in the coveted direction. We imagine that the few tons of coal would more frequently be expended in carrying the ship away from a region in which disaster is quite as likely to be encountered as material assistance to be rendered.

Possibly, knowing the destructive effects that these cyclones can work, our mariners have received them with too much distrust, and not sought to derive from them what little advantages they may offer. M. Fieron's book is directed towards creating a more favourable opinion of these atmospheric disturbances. The issue must be left to the expert, who has before his eyes Board of Trade inquiries and nautical assessors who may not share the hopeful views of the author. One very real source of danger on which the author does not appear to insist sufficiently is the swell which arises from the heavy seas, that accompany typhoons, tornadoes, &c. A well-found sailing vessel may withstand the force of the wind, after due precaution, but suffer grievously from heavy confused cross seas. This point and others of much importance are discussed in a pamphlet recently issued by Dr. Doberck, the director of the Hong Kong Observatory. The director has here incorporated the experience of many years' study gained in an observatory which exists mainly for the purposes of warning the mercantile marine against the dangers arising from the approach of typhoons and similar atmospheric disturbances. During the last thirteen years, the tracks of nearly 250 typhoons have been examined and discussed, from information supplied, either from ships at sea, or from fixed stations. The causes that produce variation from regularity, such as the geographical position of the origin of the storm, the presence of land masses in the path, the condition of the monsoon, &c., have been taken into account, with the result that successful prediction is generally secured, and rules for the management of vessels, under whatever conditions they are placed, have been formulated with scientific precision.

OUR BOOK SHELF.

Notes from a Diary, 1873-1881. By the Right Hon. Sir Mountstuart E. Grant Duff, G.C.S.I. Vol. i., pp. iv + 334; Vol. ii., pp. 394. (London: John Murray, 1898.)

THE only scientific interest which these volumes possess is due to the fact that a number of distinguished men of science are referred to in their pages, and occasional mention is made of botanical species found in the places visited by the author. Chatty reminiscences of this kind are always interesting, and they become much more so when they are related by a man with a wide circle of friends among leaders in many branches of intellectual and political activity. Almost all reference to the working-day part of the author's life has been eliminated, though during the whole period covered by the volumes the author was a member of Parliament actively engaged in political affairs. The volumes are concerned with the lighter and recreative side of the life of a public man, and as such contain notes on many amusing occurrences, as well as open expressions of opinions by distinguished men. Whether it is desirable to give a permanent form to stories told in private conversation, or to record casual opinions, may be doubted; but, by bestowing care upon the preparation of the notes for the press, Sir Mountstuart Grant Duff has been able to avoid publishing anything likely to give offence.

The volumes will provide after-dinner speakers with a wealth of capital anecdotes. In 1877 the author was shown an egg of the great auk, and was told that on account of its rarity it was worth 60*l*. Since then, a great auk's egg has been sold for nearly 300*l*. Referring to the auk the author says: "This was the creature whose name brought down on the ornithologist who used it at the Belfast meeting, the criticism of the lady who remarked—'He can't be an educated man, he speaks of the great 'awk!'" The following entry in the diary for March 24, 1878, is interesting:—

"At High Elms, Lyon Playfair, amongst others, being of the party. *A propos* of the Algerian conjurors, who apply hot metal to their bodies without suffering, he explained to us that, if only the metal is sufficiently hot, this can be done with perfect security; and told an amusing story of how, when the Prince of Wales was studying under him in Edinburgh, he had, after taking the precaution to make him wash his hands in ammonia, in order to get rid of any grease that might be on them, said: 'Now, sir, if you have faith in science, you will plunge your right hand into that cauldron of boiling lead, and ladle it out into the cold water which is standing by.' 'Are you serious?' asked the pupil. 'Perfectly,' was the reply. 'If you tell me to do it, I will,' said the Prince. 'I do tell you,' rejoined Playfair, and the Prince immediately ladled out the burning liquid with perfect impunity."

Several stories are told in connection with Darwin. The following is an entry on December 15, 1880:—

"Drove with my hostess to Liverpool. She told me that she had lately explained to Darwin the state of her sight, which is very peculiar. 'Ah! Lady Derby,' said the great philosopher, 'how I should like to dissect you.'"

The volumes are full of accounts of similar amusing incidents, and will serve to while away many leisure hours.

Elements of Descriptive Astronomy. By Herbert Howe, A.M., Sc.D. Pp. 340 + xii. (London: George Philip and Son, 1897.)

THIS is an elementary text-book which touches briefly upon the more important principles, facts, and theories of astronomy. In such a general treatment of a large subject, opinions are bound to differ as to what should be included and what omitted, but the author has on the whole made good use of his space. The arrangement of matter is only marred by the subordinate position given to the spectroscope and the principles of spectrum analysis. While the telescope is treated of in a separate chapter, the spectroscope is given a few paragraphs in a chapter on the sun, an arrangement which is apt to be misleading now that the astronomical applications of the latter instrument are as wide as those of the telescope.

The author wisely insists on the necessity for actual observations, even without instruments, and draws attention to the need for the cultivation of what is happily called the "geometric imagination." Each chapter is provided with a number of exercises which seem to be well adapted to assist the student. The illustrations, including a set of star maps, are, with one exception, admirable. Though the colouring of the plate of spectra is excellent, several of the details are inaccurate: for example, the spectrum of sodium is represented as consisting of a bright line and two dark ones, having no connection with the solar lines, and the hydrogen spectrum is quite unrecognisable.

In spite of the necessarily meagre character of much of the information, the book has many attractive features, and will give the student a good idea of the principal teachings of astronomy.

South American Sketches. By Robert Crawford, M.A. Pp. xx + 280. (London: Longmans, Green, and Co., 1898.)

THREE-FOURTHS of this volume consist of narratives of amusing and exciting personal experiences; the remainder contains general information on the natural history, climatology, and geography of Uruguay. The author resided in Uruguay for three and a half years, during which period he was engaged in the construction of a railway, and had good opportunities of observing the nature of the country and the manners of the people. The life of a railway engineer is never without its adventures, so it is easy to imagine that the author did not lack exciting incidents. Of course he witnessed a revolution, and experienced some of the discomforts suffered during periods of political disturbances in South America. The descriptions of these incidents of public and political life, and of perils by land and sea, are well worth reading. Referring to the change of character of streams in a few hours, Mr. Crawford says: "I have known a little stream that I have repeatedly jumped across on foot spread out to a width of more than a hundred yards, with a depth of from ten to fifteen feet, in five or six hours, and fall again as rapidly." The rivers, as well as the smaller rivulets and brooks, are affected in a similar way.

Though the volume is not expressly intended for schools, it contains enough adventures to interest young readers, and conveys at the same time a large amount of information concerning conditions of life in Uruguay.

The Making of a Daisy; "Wheat out of Lilies"; and other Studies in Plant-Life and Evolution. A Popular Study of Botany. By Eleanor Hughes-Gibb. Pp. 126. (London: Charles Griffin and Co., Ltd., 1898.)

UNDER a cumbersome title, we have here a half-dozen short papers containing elementary descriptions of the parts of a few common flowers and their functions. The object of the author has been "to help my readers to form some idea of the principles on which the classification of flowering plants are based, and at the same time to give a view of the chief divisions marked out upon these principles." There is, however, little novelty either in the plan or execution of the volume; and though a certain amount of instructive information may be extracted from its pages, it is garnished with too many platitudes to be interesting. For readers who like to draw moral lessons from natural processes, the book will be found attractive; but as a popular work on botany little can be said in its praise.

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.*]

Liquid Air at One Operation.

IT is to be hoped that personal matters will not divert attention from the very interesting scientific questions involved. The liquefaction of air at one operation by Linde and Hampson is indeed a great feat and a triumph for the principle of regeneration. But it must not be overlooked that to allow the air to expand without doing work, or rather to allow the work of expansion to appear as heat at the very place where the utmost cooling is desired, is very bad thermodynamics. The work of expansion should not be dissipated within, but be conducted to the exterior.

I understand that attempts to expand the air under a piston in a cylinder have led to practical difficulties connected with the low temperature. But surely a turbine of some sort might be made to work. This would occupy little space, and even if of low efficiency, would still allow a considerable fraction of the work of expansion to be conveyed away. The worst turbine would be better than none, and would probably allow the pressures to be reduced. It should be understood that the object is not so much to save the work, as to obviate the very prejudicial heating arising from its dissipation in the coldest part of the apparatus. It seems to me that the future may bring great developments in this direction, and that it may thus be possible to liquefy even hydrogen at one operation. RAYLEIGH.

Terling Place, Witham, June 26.

Liquid Hydrogen.

I OBSERVE with some amusement that you still allow Mr. Hampson to embellish your columns with vain repetitions of accusations which he was compelled to withdraw when he met me face to face at the meeting of the Society of Chemical Industry.

It is idle to discuss any question with a man whose notion of argument is to restate in somewhat different language what has already been refuted, and then to assert that the accuracy of his propositions has not been questioned.

Mr. Hampson must be a singularly dull person if he fails to appreciate the magnitude of the draft he makes upon the credulity of the world. He asks men of the world to believe that he, being convinced of the general dishonesty of Royal Institution methods, and being in possession of a novel and valuable invention, fully completed but not protected by patent, came unbidden and unsought to reveal all the details to a man whom he knew to be my assistant.

He further expects the world to believe that having thus given himself away, he refrained from protecting his invention until the rival inventor had had ample time to profit by his childlike simplicity. But even this is not all; for the world is further asked to believe that after he had placed the Royal Institution in possession of full information concerning a finished invention, it took me more than a year to utilise his generosity, while in the interval Dr. Linde had published his method and apparatus. Does not all this amount to rather a large order?

But perhaps no one can answer Mr. Hampson so well as Mr. Hampson himself. At the meeting of the Society of Chemical Industry on May 2, Mr. Hampson expressed himself as follows (*The Journal of the Society of Chemical Industry*, No. 5, vol. xvii. p. 421):—"Prof. Dewar will do me the justice to say that I have nowhere published any statement that he had made use of anything I had communicated, or of what I had invented. I have, therefore, nothing to withdraw, since I have nowhere suggested that a communication had been passed on to him. . . . I am not to be understood as saying that my proposal was passed on to Prof. Dewar."

What is Mr. Hampson to be understood as saying in the letters you have published, if not the precise contrary of what he said when brought to book at the Society of Chemical Industry?

How otherwise is the "credit of science" involved?

It is worth noting that in March 1896, a year and a half after the famous interview with Mr. Lennox, Mr. Hampson threatened Messrs. Lennox, Reynolds, and Fyfe with legal proceedings on the ground that a lecture apparatus made for my Chemical Society paper of 1895, and subsequently advertised by them in NATURE, was an infringement of his patent. They replied that he might take any action he pleased. He has never taken any.

Mr. Hampson's extract from my speech at the Society of Arts, reported in the *Journal* for March 11, 1898, is so completely isolated from the context as to convey a totally wrong impression. When Mr. Hampson made it, he had before him my statement that "although this regeneration system had been carried by Dr. Linde to the acme of perfection, no one who constructed low temperature apparatus rejected the cool gas without utilising it; the great advance was that Dr. Linde did so completely."

If all that Mr. Hampson wants is "recognition in historical or explanatory works" of his claim to be the inventor of a general claim to intensive refrigeration, he will find Solvay, Dr. Linde, and Prof. Onnes obstacles quite as serious as myself. Further, this attempt to justify going behind my back in his relations with a member of the staff of the Royal Institution, is a too transparent subterfuge to require further comment.

JAMES DEWAR.

The Spectrum of Metargon?

IN the account given by Prof. Ramsay of his researches on the "Companions of Argon," he has omitted to draw attention to a very curious similarity between the spectrum of his new gas "metargon" and the ordinary spectrum of carbon, with which every student of spectrum analysis is familiar.

The following comparison of wave-lengths will make the similarity apparent.

		Ramsay's metargon.	Carbon (Angström and Thalén).
Citron band	1	5632·5	5633·0
	2	5583·0	5583·0
	3	5537·0	5538·0
Green band	1	5163·0	5164·0
	2	5126·5	5128·0
Blue band	1	4733·5	4736·0
	2	4711·5	4714·5
Indigo band		4314·5	4311·0

There are three of Ramsay's bands not included in this list, but these are nearly coincident with known bands in the cyanogen spectrum.

It seems hardly credible that Prof. Ramsay has not guarded against the possibility that all these bands may be due to carbon, and not to a new gas; but some explanation seems required, for though the coincidences in the two sets of bands is not complete, there is no case known in which two different elements have spectra so nearly alike as those of carbon and metargon seem to be. ARTHUR SCHUSTER.

Anatomy of the Swallows.

MY friend Dr. R. Bowdler Sharpe, of the British Museum, has favoured me with a copy of his recent and very useful memoir upon the swallows (*Hirundinidæ*), and we find the group treated under the several heads of (1) an introduction; (2) geographical distribution; and (3) the literature of the Subject. In the last, the author of this contribution has evidently intended to present a very complete list of the titles of works that have been written about swallows, extending between the years 1731 to 1894 inclusive; while in the introduction he makes the statement that "The Swallows appear to us to be such a well-marked and isolated Family of Passeres, that, in the absence of any detailed account of their anatomy and general structure, which, so far as we know, has not been attempted, there remains little for us to say." As one, perhaps, who has had occasion to keep a little better track of the literature of hirundine morphology, permit me to invite the attention of this distinguished systematist to a memoir published by me in the *Journal* of the Linnean Society of London for 1889 (vol. xx. pp. 299–394, with 39 lithographic figures); he will find in it, under the title of "Anatomy of the North-American Hirundinidæ," not only a complete account of the pterylography of every species of swallow in the United States, but myological descriptions of the same; with references to their visceral anatomy; and an entire chapter devoted to the osteology of all the United States genera. Not only this, but on the plates, illustrating the same memoir, Dr. Sharpe will find very accurate figures of the skulls (nat. size) of *Progne subis*, *Chelidon erythrogaster* and *Tachycineta thalassina*—all important forms of swallows, of which the "anatomy and general structure" are very well known. In that paper he will also see that I have attempted to compare the anatomy of all our swallows, with the structure of the American swifts, and with *Ampelis*, and a great many other birds. This paper of over one hundred pages, and numerous plates, is not found in Dr. Sharpe's works upon the life-history and structure of swallows find no place "Literature" of the *Hirundinidæ*. Numerous other important works upon the life-history and structure of swallows find no place in Dr. Sharpe's bibliography of this group. In this connection, then, it may be said that our author distinguishes but *twelve genera* of swallows in the world's avifauna, and of these I have carefully compared, illustrated and published full accounts of the anatomy of no less than *six* genera, or in other words fifty per cent. of those known at present to science. And, as *Stelgidopteryx* was included among these, I very much question that any very marked anatomical differences will be found to exist among the unexamined types.

Further, as has been the case with not a few other anatomists, I have treated the subject of the systematic position of the swallows in numerous places, but more particularly in my "Contributions to the Comparative Osteology of the Families of North American Passeres," in which the skeletons of all the passerine birds in the United States were, in a comparative way, passed in review, the swallows with the rest. This is another formal work dealing with the *Hirundinidæ*, overlooked by our bibliographer of this family of birds. R. W. Shufeldt.

2508 University Place, Washington, U.S.A., June 11.

Rotifers in Lake Bassenthwaite.

It may be of some interest to readers of Nature to call attention to the fact that during the warm days of June 16–18, the beautiful Rotifer *Asplanchna priodonta* was to be found in the surface waters of Lake Bassenthwaite, Cumberland, in very great abundance. After dragging a small tow-net through the water from a row-boat for twenty minutes, the water collected in the bottle attached to the end of the net was perfectly turbid with the multitude of these animals, interfering very materially with the observation of the other constituents of the plankton. Observations taken by Mr. Ashworth in different parts of the lake in the early morning, mid-day and the evening, proved that they were not present merely in a localised cloud, but distributed in immense numbers all over the lake, from the surface to a depth of ten feet or more.

The observation is of interest, as the "Lakes" are not given in the great work on Rotifers, by Hudson and Gosse, as a locality for this genus, nor is there mention made of its occurrence in such great numbers. Perhaps some of your readers may be able to inform me if this phenomenon has previously been recorded in England. Sydney J. Hickson.

The Owens College, Manchester.

Lion-Tiger Hybrid.

Some of the readers of Nature who have the opportunity of visiting the exhibition at Earl's Court may be interested to know that one of the members of the "Happy Family" now on show there is evidently a hybrid between a lion and a tiger. The animal appears to be about two years old. By artificial light the ground colour closely resembles that of a lion, being tawny rather than reddish yellow; but the tiger-stripes, though faint, are quite visible, especially on the tail. Such stripes might perhaps be mistaken for unusually strong cub-markings of the lion retained for an unusual length of time. But apart from the stripes, the tiger-strain comes out strongly in the blackness of the corners of the mouth, the hairs of the lips in this place being jet black in the tiger, white in the lion. R. I. Pocock.

Natural History Museum, June 22.

Transference of Heat in Cooled Metal.

J'ai l'honneur de vous envoyer pour votre si intérressant journal, une remarque qui pourra intéresser peut-être quelques lecteurs de Nature.

Il s'agit d'un phénomène certainement bien connu et qui n'a peut-être pas attiré l'attention des physiciens, comme il semble le mériter. Prenons dans la main l'extremité d'une barre de métal et chauffons l'autre extrémité aussi fortement que possible, mais pourtant de manière à pouvoir tenir la barre sans se brûler par la première extrémité. Cela étant, refroidissons brusquement l'extremité chauffée, soit en la plongeant dans l'eau, soit au moyen d'un jet d'eau. *Nous constatons alors que la température de la partie non chauffée monte et que nous sommes obligés de lâcher la barre, si nous ne voulons pas nous brûler.* C'est ce que savent très bien, tous ceux qui ont travaillé à la forge ou qui ont fait des soudures de petites pièces métalliques tenues à la main. Les ouvriers disent que la chaleur est *repoussée* par le froid vers la partie non chauffée. Le phénomène a-t-il été étudié scientifiquement et connait-on sa cause? Henry Bourget.

Astronome adjoint à l'observatoire de Toulouse, juin 14.

Parker and Haswell's "Text-book of Zoology."

In reply to Prof. Ray Lankester's references to me in his review of Parker and Haswell's "Text-book of Zoology" in this journal for May 12th, I should like to state as follows:—(1) That I had nothing to do with correcting the "final revise" of this book. (2) That the new English edition of Prof. Wiedersheim's "Comparative Anatomy of Vertebrates" is not a translation, but an "adaptation." (3) That the assertion with regard to the ossification of parts of the skeleton in Elasmobranchs in the latter work is not the same as that to which Prof. Lankester objects in the "Zoology," whether the latter be right or wrong. (4) That Götte in 1878 distinctly stated that true bone is undeniably present in the vertebral centra of several Elasmobranchs the histology of which he describes, and that all kinds of intermediate stages between calcified cartilage and true bone occur in these centra. (5) That in the fourth edition of Marshall and Hurst's "Practical Zoology" true bone is said to occur in the centra of *Scyllium*, and that this statement does not appear in previous editions of the book. (6) That in the fourth German edition of Wiedersheim's "Grundriss der vergleichenden Anatomie," which was published a week or two ago, the centra of Elasmobranchs are described as being "kalkknorpelige resp. knöcherne." W. N. Parker.

SOME RESULTS OF MY RESEARCHES ON OCEANOGRAPHY.

By Albert, Prince of Monaco.

The devotion that has been quite lately given to the new science called "oceanography," has decided me to dedicate some of the strongest efforts of my life to its advancement. I set about my work in 1885 with a small sailing schooner of 200 tons, the *Hirondelle*, and I explored the Atlantic as far as the coast of Newfoundland, and as deep as 1600 fathoms, without any power greater than the arms of my fourteen sailors. Later on I built a steam vessel of 560 tons, better fitted for such rough work; this was the first *Princess Alice.* Now I

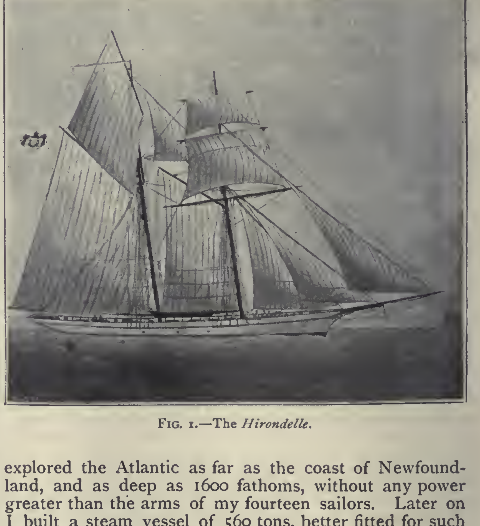

Fig. 1.—The *Hirondelle.*

have just built another one still more powerful, of 1400 tons, also called *Princess Alice*. Thus the love of science, and the successful combat of the difficulties met with in its employment in researches at sea, enlarges constantly the horizon and demands more powerful means.

I began by trying to find out experimentally how the currents moved on the surface of the Atlantic, and for this purpose I dropped, in three different cruises, 1675 floats between Europe and North America. These floats were mostly a strong glass bottle protected by a sheet of brass, ballasted so as to keep just at the level of the surface, and containing a document written in several languages to invite the finders to return it with particulars as to place and date.

Out of these, 226 had been returned to me up to the year 1892, when I drew, by working scientifically the course that each of them had probably been following, a definite map of the currents. And I may add that this result is certainly very near the truth in its general lines, because the elements employed have always been numerous for each region.

Fig. 2.—The second *Princess Alice*.

The floats have landed on almost all the shores of the North Atlantic, from the North Cape to the south of Morocco, along Central America, and on the islands of Canaries, Madeira, Azores, Antilles, Bermudas, Shetlands, Hebrides, Orkneys and Iceland. Not one has appeared as far south as the Cape Verd islands.

They show an immense vortex which begins towards the Antilles and Central America with the Gulf Stream, which issues from the Gulf of Mexico, and with the equatorial current; passing the banks of Newfoundland at a tangent, it turns to the east, approaches the European coasts, and runs southward from the Channel to Gibraltar, after having sent a branch which runs along the coast of Ireland and the coast of Norway as far as the North Cape.

It then returns to the west, encircling the Canaries. Its centre oscillates somewhere to the south-west of the Azores.

My observations enabled me also to establish a very good average for the speed at which these floats have been travelling in the different sections of the vortex, and for every twenty-four hours.

Between the Azores, France, Portugal and the Canaries: 5·18 miles.

From the Canaries to the Antilles, the Bahamas, and as far as the Bermudas: 10·11 miles.

From the Bermudas to the Azores: 6·42 miles.

The mean speed for the North Atlantic is 4·48 miles. These values being under rather than over the truth.

When I began to work on the bottom of the sea to study animal life, as constant sounding is required for that purpose, I found that most of the sounding machines in use were defective, and I had one constructed according to my own ideas. It is completely automatic in all the details of its action, so as to allow a single man to take a sounding at any depth; the line that I have used for four years is no longer a steel wire, but a steel cable made up of many very thin wires; it is, therefore, stronger and more pliable. It is paid out at the required speed, hauled up again, dried, greased, and regularly rolled up on a drum by an automatic guide. The brake is a powerful spring.

Among the observations for which this machine is wanted, I will mention those concerning the temperature of the water at different levels. I am using, to obtain them, a thermometer designed for my cruises by Mr. Chabaud, a French instrument maker. It is very much like Negretti and Zambra's pattern, but the part of the tube containing the mercury reservoir is recurved so as to prevent the mass of this metal forcing itself by its own weight through the constricted angle which serves to break the column; and such an accident used to happen now and then.

When I went into the study of the density of the water, I found that Buchanan's bottle was the best for collecting samples of the stratum nearest to the bottom. But to obtain samples at any intermediate depth, Dr. Jules Richard, chief of my laboratory, has designed a thoroughly trustworthy instrument with which we have been able to study the gases contained in these samples, and to demonstrate that they are not dissolved in the depths at any other pressure than they are at the surface. This instrument can be shortly described by saying that it is a bottle filled with mercury, and inverted with its neck dipping into a dish also full of mercury. In this position it is sent along a steel cable as far as the required depth, where it meets a platform, and where a mechanical action raises the neck of the bottle over the mercury of the dish. The mercury of the bottle then runs out into the dish, and water takes its place. Soon after this, a messenger sent from the ship reaches the instrument, and acts so as to dip again the neck of the bottle into the dish containing the whole of the mercury. In this last position the instrument can be hauled up without any risk of the sample of water being mixed with outside water; and if there was any gas dissolved in it at a high pressure (which was not the case in my observations), it would gather on the surface of the sample, as this pressure would diminish as the instrument came nearer to the surface of the sea. This research led Dr. Richard to announce in 1895 the presence of argon in the swimming bladder of certain fishes.

Very soon after this, I had the satisfaction of presenting the French Academy of Science with very interesting observations made by M. Knudsen during the cruises of the Danish steamer *Ingolf*. This investigator proved by analyses of samples of water made *in situ* that predominance of animal or vegetable life in any part of the sea causes the variations in the amount of contained oxygen or carbonic acid.

One of the most difficult questions to investigate is the penetration of light in the depth. Photographic plates turned towards the heavens have been exposed by Hermann Fol, and impressed as deep as about 200 fathoms. I have myself used, as far as about 90 feet, an instrument invented by Dr. Regnard for my experiments; it is a cylindrical box with a narrow slit in the direction of its length. Inside is a sensitive paper, which is made to pass slowly under the slit by means of clockwork, capable of running for twenty-four hours. If there is any light falling on it, it is shown on the paper when developed, and with the increasing or the decreasing power before or after noon. But by this method one obtains no absolute information, as some more sensitive matter may be discovered any day.

FIG. 3.—*Photostomias Guernei.*

Indeed, light exists everywhere in the depths: where the rays of the sun do not reach themselves, numbers of animals furnish it by special phosphorescent organs which are real accumulators of light. Besides, I have found animals with perfect eyes at every depth; and science teaches us that an organ always atrophies or disappears when the conditions are such as to prevent its use.

Among the special circumstances created by the statical and dynamical conditions of this space, organic life presents itself under aspects which appear strange to those who are accustomed to its appearance near the surface. I endeavoured to obtain from all the levels of the sea as many samples of the species belonging to them as it was possible, but I had to find other apparatus than the old trawl used for the former scientific cruises, which can only get animals fixed on the bottom of the sea, or hiding in the mud, or possessing very slow means of progressing. Of course I have used it a great deal, because no other instrument can collect for us a certain fauna; but when it occurred to me that there must be in the deep waters some nimble animals able to escape such a net as a trawl, I first built a trap of a special shape and very large, in order to attract these supposed animals, when properly baited. The trap is lowered to the bottom with a steel cable, and hauled up again after having been left there for a day or two attached to a buoy.

The handling of this was very difficult in the beginning, and required several years' practice to be brought up to positive rules, but it has given most brilliant results, animals quite unknown coming into my hands perfectly well preserved against shocks, frictions and other causes of damage to which they would be liable in a trawl.

One interesting fact they have shown is the enormous numbers in which some animals exist in certain places. As an example, I obtained one day in a trap that had been lying on the bottom at 700 fathoms depth for twenty-four hours, 1198 fish called *Simenchelys parasiticus*, which was only known by one or two samples in a more or less imperfect state. I have succeeded in sending these traps as low as three thousand fathoms with complete success.

On another occasion my trap brought up a new crab,

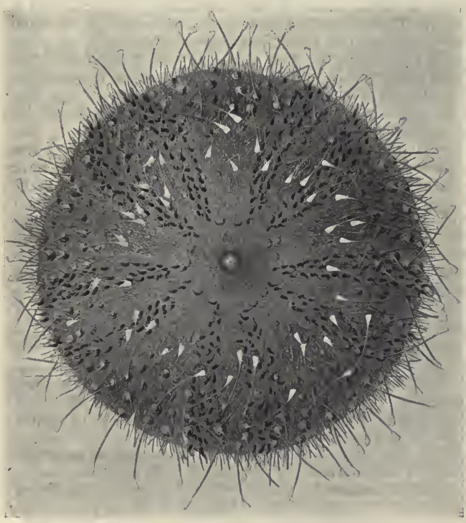

FIG. 4.—*Sperosoma Grimaldii.*

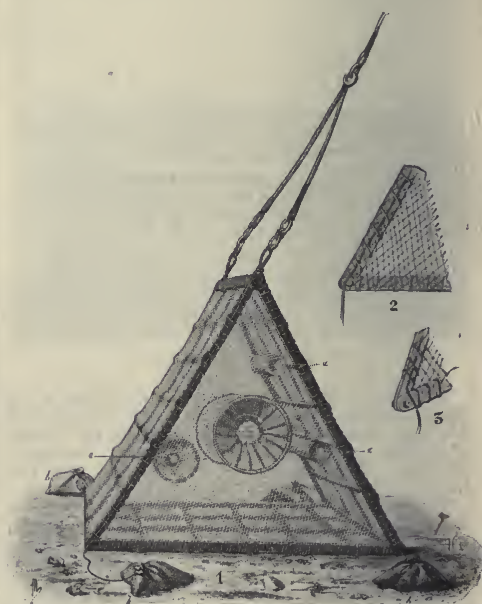

FIG. 5.—Deep-sea trap.

one of the largest ever known, *Geryon affinis*, and there were sixty-four specimens of it. Curiously enough, several of them, which had not yet found the entrance of the trap when it was hauled up, made the whole voyage of many hundreds of fathoms, clinging voluntarily to the outside of the trap.

Another time, again (and this was of a special interest because the event took place in the great depths of the Mediterranean, where previous investigations with trawls had led to the supposition that life was almost absent), a trap returned with over eighty sharks called *Centrophorus squamosus*.

For two years I have been trying to use in great depths a net which is very good when used on inshore fishing grounds. This is the trammel; but its use has proved to be exceedingly difficult because of its frailty and its size. Still, I have already obtained with it results which prove how useful it can be. I worked it as low as 1500 fathoms.

The most difficult regions to explore in the sea are the intermediate depths between the surface and the bottom, because the animals living there are very active and very suspicious, and have ample space where they can escape easily, and where they find abundant prey for their food. Besides, the apparatus used must be built in such a manner that they show at what level animals have been caught, or else the scientific conclusion can not be made complete; therefore such an apparatus must be so as to be lowered shut to the determined region, there open and work, and lastly shut again before leaving the region.

Many instruments have been devised for this purpose, but I know only one of them offering complete safety; this is a net invented by Prof. Giesbrecht, which has been slightly altered by Dr. Richard and myself. But it would be difficult to make it of a large size; therefore we get only specimens of very small species.

Lately I have obtained a certain number of large animals living in those intermediate depths and belonging to the very interesting group of cephalopods, by examining the stomach of several cetaceans who feed upon them. Since this interesting fact, I added to the scientific gear of my vessel a complete whaling arrangement. This new method has given me the most remarkable animals of my whole collection; one especially, the *Lepidoteuthis Grimaldii*, can be classified in no actually known species, genus, or even family of his order. It was vomited in 1895 during the dying struggles of a sperm whale, but had unfortunately lost its head by the last adventures of its life. The fragment is about one yard in length, and the complete animal must have measured over seven feet; adding the arms, we get a monster of colossal strength. Its most remarkable feature is a cuirass of large prominent scales which cover its visceral bag; these are quite unknown with animals of that order.

The vomitings of the same sperm whale, who covered two acres of the sea with his blood, contained another immense cephalopod, a Cucioteuthis with arms as strong as a man's, and carrying suckers armed with claws as powerful as those of a tiger; this animal is furnished with luminous organs.

In 1897 another large cetacean, that I was attacking with my whale boats, vomited a large fragment of a cephalopod which was peculiar in being of viscid substance not unlike glycerine; no net could retain it, and we only secured it by "dipping" it up with a large tub as well as the mass of water in which it was floating.

But it will be convenient to remind the reader that cetaceans divide themselves into two principal groups. One, to which belongs the right whale or other marine mammals chased by whalers, and who feed upon very small animals that they absorb simply by moving about with their mouths open. They have no teeth, but a sort of sieve made of what is called whale bone.

Another group, to which belongs the sperm whale, is armed with powerful teeth, a single one weighing sometimes as much as six pounds. They live upon big preys, mostly cephalopods, as aforesaid. These cetaceans are ferocious, while the others have a much milder temper, and some of them, as the *Orca Gladiator*, can be very dangerous to attack. Two years ago I chased a school of three of these, just off the Monaco rock, and very soon one was struck by my whaler's harpoon. While it was ending with violent struggles, the two others came alongside the whale boat and seemed willing to fight for their companion. They swam round and round, sometimes so close that the men touched their enormous backs with their hands. I had to release at once that boat, and for an hour we were (seventeen men and three boats) engaged in a most grand wrestling. The result was that a second orque was killed by a spear stroke.

On the previous day we had caught a grampus, also a cetacean; so we returned to the harbour of Monaco with three of these monsters captured within fifteen miles of that place.

The orques are black and white, much like a magpie, and these were 16 and 18 feet long. They seem to feed exclusively on porpoises. My two, when opened, contained each of them a dozen pieces of porpoise in its stomach like heaps of paving-stones: they had just taken a meal when they were struck.

Tail. Lower jaw. Head.

FIG. 6.—Sperm whale being broken up.

Among many remarkable facts that I have observed during my studies of the ocean, one has especially called my attention because of its practical consequences; that is, the intensity of life appearing on the surface at certain hours.

Almost in every region of the North Atlantic where I have carried on my investigations, I have ascertained the existence of large tunny fishes which morning and evening chase smaller fishes whose shoals cover sometimes the sea on such a large area that we sail or steam hours and hours across them.

Then, if we sight some wreckage—as a log or a barrel—we always find under it or near it fishes of a good size and of different species that never seem to abandon this guide that they have chosen, and that takes them across the Atlantic. They are very easily caught with a fish spear, and the tunny fish are hooked with a tow-line baited with a rough imitation of a squid.

I once speared in that way fifty fishes weighing 300 pounds altogether, which were following a log on the Atlantic; and their number seemed not to have been much lessened by such a breach. Another day, while I was alongside a log, very anxious to make a good bag, because I had just picked up the crew of an English vessel, the *Blue and White*, sunk under my eyes, and we were already short of provisions, I was disturbed in this occupation by a large shark, who was himself living about the log, and who, after having looked at me with his cruel eyes, stuck himself under my dinghy. His head and his tail projected beyond the ends of this boat, and the friction of his back against the keel gave a rather uncomfortable feeling. Therefore, after I had made a few catches of the usual fishes, which gave him some excitement, I left the log and returned on board, escorted for some distance by the disagreeable wanderer.

On the other hand, we have on many occasions caught dozens of tunny fishes in a day by simply using the aforesaid tow-line.

Thus I can state that many sailors wrecked on the Atlantic, and abandoned for days and weeks on its apparently uninhabited wilderness, have died of hunger among a most abundant and attainable food, and that they could have been saved had they simply known it, and possessed the very simple gear required. Therefore I think that all the principal boats of a ship ought to be permanently provided with a few lines and hooks and with a fish spear.

There is no very obvious explanation of the fascination which any floating or drifting object seems to have for marine animals of various sorts. Even turtles, which are very stupid, and sperm whales or other cetaceans, which seem intelligent, are attracted by a buoy or by a ship, and any kind of apparatus brought up from the depth, even a cable end, is often accompanied by single fish or small companies, which get hopelessly bewildered when the object disappears out of the water.

REPRODUCTION BY PHOTOGRAPHIC PROCESSES.

IT is not difficult to understand the survival and general adoption of those photographic methods in which the light, by shining upon the sensitive surface, produces shading or blackness. Although the first product, as obtained in the camera, by such a process is itself useless as a photograph, the lights and shades being reversed; this "negative," as it is termed, becomes a means of reproduction, as by laying the negative over a sensitive surface more or less similar to that first used, and allowing the light to shine through it, any required number of prints or copies in true light and shade may be obtained. Such a process is necessarily slow, as in working upon this system the production of each individual print or photograph involves an exposure to light, and the rapidity of reproduction is limited by the chemical intensity of that light which is available, and also by the sensitiveness of the material used.

Another system of reproduction, and one which is month by month becoming of greater industrial importance, evades the necessity of a special exposure to light for obtaining each individual print or copy, this being effected by the production of a printing surface or plate from which copies may be printed by mechanical means. Prints obtained by a special exposure to light for each copy are often called solar prints, or true photographs, while those prints which are printed mechanically from a plate or surface which itself is photographically produced, are now so generally called process prints, that the title of "The Process Year-Book"[1] is by no means ambiguous in its meaning to those who are current with the technological phraseology of the day. "The Process Year-Book" well represents the present state of process craft, not only by giving numerous representative illustrations, but by articles from the leading authorities in such matters. The articles are, however—as should be in a work of this kind—written rather for the expert than for the comparative outsider, and we shall give our readers a better general idea of the development and present condition of reproduction by the photo-mechanical processes if we drift away from our text, than if we confine our remarks to the matter before us in Mr. Gamble's volume.

It is interesting to note that the early experiments of Nicéphore Niepce, which were commenced as far back as 1813, were undertaken with the view of obtaining printing surfaces by photographic agency, so the history of photographic process work includes the first chapter in photographic history. Niepce coated lithographic stones or metal plates with a varnish the solid material of which tends to become insoluble in its menstruum where exposed to light. There are many such varnishes, and as an example we may mention a solution of bitumen in a volatile oil like that of turpentine. Those portions of the film which are still soluble after exposure are next dissolved away, while the insoluble portions form a ground, or resist against the etching fluid, which is next used. A heliographic etching on metal by Niepce, made about 1824, is still extant, and in 1827 he brought several specimens to England; but very little attention was given to photographic matters until, in 1839, the daguerreotype was introduced with its perfect rendering of the most delicate degrees of light and shade, and this by a very short exposure in the camera.

Considering that the daguerreotype image is of the nature of a deposit on a smooth metal surface, the idea of moulding by the electrotype process so as to produce an intaglio printing plate, naturally presented itself; as also that of etching the metal, in the hope that the image on the surface might serve as a local resist. Grove, Chevalier, Claudet and others made experiments with the view of obtaining printing plates from the daguerreotype by such methods, but most etchings were wholly unsatisfactory; and although the electrotype casts of the plate were perfect as reproducing in intaglio every tone of the original, the plate had neither that grain nor that depth which are essential to the satisfactory printing of a photo-engraved plate.

Mr. Fox Talbot, whose Calotype or Talbotype process on paper was made public practically at the same time as the daguerreotype, was one of the first to produce satisfactory intaglio printing plates, and his method is specially interesting as being the basis of that process of intaglio photogravure which is most in use at the present time. Talbot coated the metal plate with a wash or film of gelatine made sensitive to light by the addition of bichromate of potassium, and he exposed under a transparent positive. Where the light acted to the full, the gelatine became impervious to aqueous fluids; but where protected from the light, the film allowed such fluids to pass readily, and between these extremes were all degrees of intermediate resistance to the passage of the aqueous etching fluid. Talbot used such saline etching materials as platinic chloride or ferric chloride, and from time to time he suggested and used various methods of producing an ink-holding grain, such as a resinous dust, a network, or a kind of aqua-tint ground formed by the evaporation of a solution of camphor and common resin in chloroform. The chief present-day method of photogravure is Herr Klic's modification of the Talbot method, the chief differ-

[1] "The Process Year-Book, a Review of the Graphic Arts." Conducted by William Gamble. (London and Paris: Penrose and Co.)

ence being that the film of chromated gelatine, hardened by the action of light, which forms a resist to the etching fluid, is transferred to the metal plate after being exposed; a proceeding which affords one very important advantage. The gelatine, which remains soluble or unaffected by light, can under these circumstances be washed away by warm water, leaving on the metal plate a resist of graduated thickness. The frontispiece of "The Process Year-Book" for last year is a very fine example of photogravure by the Talbot-Klic process, the work of Mr. Horace Wilmer; a specimen interesting as showing that, in process work, the amateur may stand fully level with the professional. The frontispiece of the current issue (1898) is a good specimen of similar work by Dr. E. Albert of Munich.

Printing by hand from the intaglio plate is a very slow process, especially in the case of the finer class of work; and although we gather from "The Process Year-Book" that very much progress has recently been made in the rapid printing of intaglio plates by machine, the chief or general aim of the process-worker now-a-days is the rapid production of plates or blocks which can be set up with a forme of type, and printed together with the type and without any complication of the method of printing.

Methods of making such photo-typographic blocks are very numerous, but according to that system of working which is now most general, the first and most delicate task is to obtain a negative in which the degrees of transparency are rendered by the increasing size of minute windows ranged in regular order all over the subject; but where the negative is most opaque the size of each of these windows may be reduced to *nil*, and where the negative is most transparent the windows may run into each other and give an area of virtually clear glass. Such a negative is obtained if a glass plate or screen, closely ruled with opaque cross-lines, is set in the camera a little way in front of the sensitive plate, each window in the screen forming a pin-hole image of the aperture of the lens. The question of the best use of the ruled screen and the most suitable kind of ruling is a very complex one, as evidenced by several very recondite articles in "The Process Year-Book." The screen-negative having been obtained, an impression is made on a metal plate coated with a sensitive resist, which sensitive resist may be bitumen, sensitive albumen, or, more often in practice, the highly soluble and almost gum-like gelatine sold as fish glue. Each window of the screen negative makes an insoluble spot of corresponding size on the sensitive film, after which the soluble portions of the film are dissolved away, and the insoluble spots of graduated size form the resist in the next stage: etching the plate. When sufficiently etched, the plate is ready for being printed from, and it naturally gives an impression in which each window of the screen-negative is rendered by a dot of printing ink of corresponding size.

There are many other methods of photographic process reproduction in use, and still more methods which have been worked out experimentally but have not yet obtained any commercial status. As regards the application of three-colour heliochromy to process work, we need say no more than to remark that any method of process reproduction may be applied to the formation of the triad of printing surfaces from which it is necessary to print in true register with appropriate pigments; and the question of the successful application of heliochromy to process work depends rather on the colour-sensitising of the negative films, the use of appropriate colour-screens and of suitable printing pigments, than on the purely process side of the work. Those wishing to learn more, or to see representative examples of results, cannot do better than to obtain "The Process Year-Book."

T. BOLAS.

THE FORTHCOMING MEETING OF THE BRITISH ASSOCIATION.

THE following epitome of the programme of the forthcoming Bristol meeting of the British Association has been prepared by the Local Secretaries. We have already given a provisional list of the excursions, and shall supply our readers with further details as soon as the routes are finally settled and the arrangements complete.

Tuesday, September 6.—The Cabot Tower, on Brandon Hill, will be opened at 3 p.m. by the Marquess of Dufferin and Ava, K.P., G.C.B.

Wednesday, September 7.—Drill Hall Exhibition opened at 3 p.m., by the Marquess of Dufferin and Ava, K.P., G.C.B. Address by the President, Sir William Crookes, F.R.S., in the Colston Hall, at 8 p.m.

Thursday, September 8.—The Biological Exhibition at the Zoological Gardens, Clifton, will be opened at 3 p.m. by Sir John Lubbock, Bart., M.P. Garden party given by Mr. and Mrs. W. M. Roscoe, at Crete Hill, Westbury-on-Trym, 3.30 to 6 p.m. (200). Garden party, given by Mr. E. P. Wills and Miss Wills, at Hazlewood, Sneyd Park, 3.30 to 6 p.m. (200). Conversazione, at Clifton College, given by the Chairman of the Council (the Lord Bishop of Hereford), the Head Master and Mrs. Glazebrook, 8.30 to 11.30 p.m.

Friday, September 9.—Garden party, given by Mr. and Mrs. Frank Jolly, at Rockwell, Henbury, 3.30 to 6 p.m. (100). Garden party, given by Mr. Lewis Fry, M.P., and Miss Fry, at Goldney House, Clifton, 3.30 to 6 p.m. (300). Garden party, given by Mr. J. Colthurst Godwin and Miss Godwin, at Ellenthorpe, Stoke Bishop, 3.30 to 6 p.m. (200). Lecture by Prof. W. J. Sollas, F.R.S., on "Funafuti: the Study of a Coral Island," in the Colston Hall, at 8 p.m. "Symposium," in honour of the President, Sir William Crookes, F.R.S., at the Merchant Venturers' Technical College, at 10 p.m. (limited to 250).

Saturday, September 10.—Excursions. Lecture to working men, by Prof. E. B. Poulton, F.R.S., "The Ways in which Animals Warn their Enemies and Signal to their Friends," in the hall of the Young Men's Christian Association, at 8 p.m. Public banquet, arranged by the President and members of the Bristol Chamber of Commerce, at the Colston Hall.

Sunday, September 11.—Special sermons by the Lord Bishop of the Diocese (Cathedral, 11 a.m.), Prof. Bonney (Redcliffe Church, 6.30 p.m.), and Rev. D. Richards, 11 a.m., and Rev. John Gerard, S.J., 6 p.m. (Pro-Cathedral, Park Place, Clifton). The band of the Royal Artillery (mounted) will perform a selection of music at the Drill Hall, at 3 p.m.

Monday, September 12.—Garden party, given by the headmaster and assistant masters of Clifton College, 3.30 to 6 p.m. Lecture by Mr. Herbert Jackson, on "Phosphorescence," in the Colston Hall, at 8 p.m.

Tuesday, September 13.—Garden party, given by Mr. and Mrs. Edward Robinson, at The Towers, Sneyd Park, 3.30 to 6 p.m. (200). Garden party, given by Mr. and Mrs. G. A. Wills, at Burwalls, Leigh Woods, 3.30 to 6 p.m. (200). Conversazione at the Colston Hall, given by the Local Committee, 8.30 to 11.30 p.m.

Wednesday, September 14.—Concluding general meeting, in the Lecture Theatre, Bristol Museum, at 2.30 p.m. Garden party, given by Mr. and Mrs. Herbert Ashman, at Cook's Folly, Sneyd Park, 3.30 to 6 p.m. (200).

Thursday, September 15.—Excursions.

Friday, September 16 to 20.—Excursion through Devonshire, extending over five days. Exeter, Torquay, Dartmouth and Plymouth have taken up the matter very warmly, and kindly offers of hospitable entertainment have been received from them.

The Committees of the leading Clubs in Bristol and Clifton have consented to grant the privilege of honorary membership to visiting members of the Association during the meeting.

NOTES.

THE centenary of the Paris Conservatoire des Arts et Métiers was celebrated on Friday last. The Priory of Saint-Martin-des-Champs, where the collections of the Conservatoire are installed, contains fourteen thousand exhibits. Seventeen professors hold evening classes in the building, and there are eight laboratories, one of photography and photometry being a recent addition. The Academy of Sciences has on several occasions presented objects of scientific interest to the museum of the Conservatoire, among them being its collection of machines, physical apparatus, and part of the contents of Lavoisier's laboratory.

THE programme of the fourth International Congress of Zoology, to be held at Cambridge in August, has been issued. The meeting will open on Monday, August 22, with a reception at the Guildhall by the Mayor of Cambridge. On the following day, the formal opening of the Congress and election of officers will take place in the morning, and the Sections will meet in the afternoon. The Sections will be: (*a*) General Zoology; (*b*) Vertebrata; (*c*) Invertebrata (except the Arthropoda); (*d*) Arthropoda. On Wednesday, August 24, there will be a general meeting of the Congress to discuss the position of sponges in the animal kingdom. The discussion will be opened by Prof. Yves Delage, of Paris, and Mr. Minchin, of Oxford. On Thursday a general meeting will be held to discuss the origin of Mammals. The discussion will be opened by Prof. H. F. Osborn, of New York, and Prof. Seeley, of London. The Sections will meet on Friday, August 26, and on Saturday a general meeting will be held to settle the time and place of the fifth International Congress.

WE notice with regret the announcements of the deaths of wo distinguished botanists: Prof. Anton Kerner, Ritter von Marilaun, professor of systematic botany in the University of Vienna, and Prof. Ferdinand Cohn, professor of botany in the University of Breslau.

THE tenth Congress of Russian Naturalists and Physicians will be held at Kieff on August 21–30, under the presidency of Prof. J. Rachmaninow.

M. E. A. MARTEL, whose researches in underground caverns have often been referred to in these columns, has been created a Chevalier of the Legion of Honour.

AT the annual general meeting of the Royal Statistical Society, held on Tuesday, it was announced that the subject of the essays for the Howard medal, which will be awarded in 1899, with 20*l.* as heretofore, is "The Sentences on, and Punishments of, Juvenile Offenders in the Chief European Countries and the United States." The essays should be sent in on or before June 30, 1899.

A DESTRUCTIVE earthquake was experienced in some parts of Italy on Monday night. The shock was felt all along the Antrodoco valley, and several buildings were thrown down in the commune of Santa Rufina. The disturbance was felt at Rieti shortly after midnight.

CAPTAIN SVERDRUP'S polar expedition on board the *Fram* left Christiania on Friday morning.

A REUTER telegram from Tromsö reports that Mr. Walter Wellman, the American explorer, left on Monday on board his ice steamer *Frithyof* for the North Polar regions. Just before his departure from England Mr. Wellman gave to Reuter's representative an account of his expedition, in which he said that his aim was to reach the North Pole, and also to explore the still unknown northern parts of Franz Josef Land. The party consists of Prof. James H. Gore, Columbia University, a geodesist; Lieut. Evelyn B. Baldwin, who was on the Greenland ice cap with Lieut. Peary; Dr. Edward Hofma, naturalist and medical officer; and Mr. Quirof Harlan, physicist, from the United States Coast and Geodetic Survey. Norwegians experienced in Arctic work make up the remainder of the party of ten. Mr. Wellman proposes to reach the Pole by a sledging expedition over the pack ice.

THE Geologists' Association have arranged an excursion to Birmingham from July 28 to August 3, under the direction of Prof. C. Lapworth, F.R.S., Prof. W. W. Watts, Mr. W. J. Harrison, and Mr. W. Wickham King. A sketch of the geology of the Birmingham district, with special reference to this excursion, will be given at the meeting of the Association to-morrow, July 1.

MR. WALTER E. ARCHER, Inspector of Salmon Fisheries under the Fishery Board for Scotland, has been appointed Chief Inspector of Fisheries to the Board of Trade, in succession to Mr. A. D. Berrington, who has retired. On Mr. Berrington's retirement, the Fisheries Department and the Harbour Department of the Board of Trade have been combined into one department, which will be called the Fisheries and Harbour Department, and will be under the charge of the Hon. T. H. W. Pelham, as Assistant Secretary.

THE death is announced of Dr. Charles E. Emery, the well-known American engineer. Dr. Emery was a member of the Institution of Civil Engineers, and received a Watt medal and Telford premium for a paper in which he described the plant constructed by him at New York for the house-to-house distribution of steam raised in a central boiler. He was a prominent member of the principal American engineering societies, and was president of the New York Electrical Society in 1896-97. He also held the post of non-resident professor of the Cornell University.

THE Committee appointed to consider the present state of the law with regard to the storage, transport, and sale of petroleum have decided to recommend Parliament to raise the legal flash-point of oil from 73° F. to 100° F. It is believed that comparatively few lamp accidents will occur when the use, as an illuminant, of oil with a flash-point below 100° F. is forbidden; but unless the suggested legislation also provides against the construction and sale of lamps with glass reservoirs and of faulty design, the raising of the flash-point of the oil burned in these lamps will only partly prevent the accidents.

THE annual general meeting of the British Institute of Preventive Medicine was held on Friday, June 24, at Chelsea. The meeting was attended by the Duke of Westminster, Earl of Feversham, Lord Lister, Dr. Pye-Smith, Dr. Thomas Bridgwater, and others. The Report states that during the year the work of the Institute has been marked by progression and expansion. The internal fittings of the new building are in an advanced state, some departments are already in full operation, and it is confidently anticipated that all will be fully equipped in the early autumn. The demand for diphtheria and streptococcus serum has increased, and there has also been an increased demand for mallein and tuberculin. The Institute has rented laboratory accommodation to the Local Government Board for the purpose of preparing glycerinated calf lymph. The volume of *Transactions*, published by Messrs. Macmillan and Co. on behalf of the Institute, contained nine original contributions by members of the staff. A number of fresh investigations have been conducted and completed during the year; some of these are published, and others are on the eve of publication. There are also other investigations in progress, and the laboratories continue to attract research workers. The Institute has endeavoured to encourage the periodical examination of water and water supplies, and several local authorities have requested the Institute to undertake this systematic examination on their behalf. Bacteriological work has also been undertaken for several additional sanitary authorities. In the new building every facility is being provided for the furtherance of bacteriological research. The Institute will require, however, a considerable addition to its funds to enable it to carry out adequately the objects for which it was founded.

THE preliminary programme of the sixteenth Congress of the Sanitary Institute, to be held in Birmingham, from September 27 to October 1, has now been issued. The President of the Congress is Sir Joseph Fayrer, Bart., K.C.S.I., F.R.S. Dr. Christopher Childs will deliver the lecture to the Congress, and Dr. Alex Hill, Master of Downing College and Vice-Chancellor of Cambridge University, will deliver the popular lecture. Excursions to places of interest in connection with sanitation will be arranged for those attending the Congress. A conversazione will be given by the Right Hon. the Lord Mayor (Councillor C. G. Beale), and a garden party, at the Botanical Gardens, Edgbaston, will be given by members of the Sanitary Committee. It appears from the programme that over three hundred authorities, including several County Councils, have already appointed delegates to the Congress, and, as there are also over two thousand members and associates in the Institute, there will probably be a large attendance in addition to the local members of the Congress. In connection with the Congress, a Health Exhibition of apparatus and appliances relating to health and domestic use will be held as a practical illustration of the application and carrying out of the principles and methods discussed at the meetings; which not only serves this purpose, but also an important one in diffusing sanitary knowledge among a large class who do not attend the other meetings of the Congress. The Congress will include three general addresses and lectures. Three Sections will meet for two days each, dealing with (1) Sanitary Science and Preventive Medicine, presided over by Dr. Alfred Hill; (2) Engineering and Architecture, presided over by Mr. W. Henman; (3) Physics, Chemistry, and Biology, Dr. G. Sims Woodhead. There will be five special conferences: Municipal Representatives, presided over by Alderman W. Cook; Medical Officers of Health, presided over by Dr. John C. McVail; Municipal and County Engineers, presided over by Mr. T. de Courcy Meade; Sanitary Inspectors, presided over by Mr. W. W. West; Domestic Hygiene, presided over by Mrs. C. G. Beale (the Lady Mayoress). The local arrangements are in the hands of an influential local Committee, presided over by the Right Hon. the Lord Mayor of Birmingham, with Prof. A. Bostock Hill, Mr. W. Bayley Marshall, and Mr. J. E. Willcox as Honorary Secretaries.

DR. G. VAILATI, writing in the *Bolletino di Storia e Bibliografia Matematica*, has brought to light an obsolete book of Euclid dealing with balances and the principle of the lever. This work has become known through an Arabic translation by Ibn Musa in the National Library at Paris, an account of which was given in 1851 by Woepke in the *Journal Asiatique*, but seems to have been overlooked by mathematicians. Euclid's reasoning is based on the two axioms: (1) that if a loaded lamina balances about a horizontal axis, it will continue to balance when the weights are displaced parallel to the axis; (2) if a lamina balances horizontally about two intersecting axes in its plane, it will also balance about their point of intersection. From these axioms, Euclid deduces a proposition *practically* equivalent to a special case of the theorem that three equal weights placed at the vertices of a triangle will balance about a median. Then by the first axiom a second proposition is proved, virtually amounting to the statement that a single weight on one side of a lever will balance two equal weights on the opposite side if the distance of the first from the fulcrum is equal to the sum of the distances of the second and third. By the superposition of such sets of equilibrating systems, and the removal of pairs of weights symmetrically placed on opposite sides of the fulcrum, Euclid arrives at the conditions of equilibrium on a lever whose arms are in the ratio of two whole numbers by a method closely analogous to that adopted by Archimedes.

DR. ADRIEN GUÉBHARD, of St. Vallier-de-Thiey, sends us a number of papers dealing with the supposed photographic representation of currents emanating from the human body, concerning which much appears to have been said in France a few months ago, when the subject was brought into prominence by the announced discoveries of Dr. Baraduc and the late Dr. Luys. Briefly told, when a slightly fogged photographic plate is developed in a shallow bath, and the experimenter presses his fingers on the plate during the process, streaks are observed to radiate from the parts touched. So far from the effect being due to "animal magnetism," or any of the other occult influences with which spiritualists are wont to deal, Dr. Guébhard shows that the lines are simply caused by convection currents produced by the warmth of the operator's finger. If for the latter there be substituted a small india-rubber ball filled with warm water, exactly the same impressions are produced. Similar results are obtained with a body cooled below the temperature of the developer, and in each case their intensity is greater the greater the difference of temperature. In some of Dr. Guébhard's figures the lines closely resemble the lines of flow due to sources and sinks, or the lines assumed by iron filings in the presence of magnets; as representations of the lines of flow of convection currents, these figures may interest the physicist.

WE have received a copy of the observations made at the Blue Hill Meteorological Observatory, Massachusetts, during the year 1896, forming Part i. vol. xlii. of the *Annals* of the Astronomical Observatory of Harvard College, containing results of observations made at three stations as in former years. The primary station is the observatory on the summit of Great Blue Hill, at an elevation of 640 feet above mean sea-level, and the two secondary stations are situated northwest of it, one being at the base of Blue Hill. In addition to the usual meteorological tables and hourly cloud observations and measurements of heights and velocities recommended by the International Meteorological Committee, the work contains an interesting study of special cloud forms and their relations to cyclones and anticyclones, as well as to other phenomena, by A. E. Sweetland. One of the principal features of the work of the observatory is the exploration of the air by means of kites. A full description of the methods employed is given by S. P. Fergusson, and a valuable discussion of the records by H. H. Clayton. This exploration was begun in August 1894, and is, we believe, the most thorough study of the lower strata of free air ever made, and occasionally very high altitudes are also attained. We are glad to see that the continuance of the useful observations at Blue Hill, now maintained by the liberality of Mr. A. L. Rotch, has been assured by the leasing of the land around the observatory by Harvard College, and that it is expected that the work will ultimately become a part of that carried on directly by that University.

VARIOUS schemes have from time to time been suggested for utilising the power of the tides and waves as a motive force, and ingenious models have been constructed showing the various methods proposed. The plans consist generally either of a system of reservoirs for storing the water at high tide and using it by means of water-wheels or turbines as the tide falls, or else by compressing air in a chamber and making use of its expansion in working an engine. None of these schemes have, however, so far been carried into practical effect. On one or more tidal creeks in this country there have, however, existed water-wheels for grinding corn worked by the tides. Across the creek self-acting doors are placed which open to let the tide flow up, and automatically close as soon as it begins to recede. For several hours each tide there is thus afforded a supply of water with sufficient head to work a water-wheel which turns the machinery. Recently, at Los Angeles, an attempt has been made to make use of the waves. At the end of a pier 350 feet long, three floats were constructed acting on hydraulic air compressors connected with storage tanks holding water situated at different levels. By means of the compressed air the water is driven from a lower into a higher tank, which affords the head required to work a water motor. The waste water from the motor flows back again into the lower tank, to be again raised by the compressor. The varying effect of the waves is compensated by this arrangement of air and water pressure. The experiment is said to have proved sufficiently satisfactory to warrant the extension of the system so as to develop 200 horse-power.

It is seldom that military operations afford much opportunity for scientific research, but the Ashanti expedition of 1896 was fortunately an exception. Upon the recommendation of Kew, Surgeon-Captain H. A. Cummins accompanied the expedition as a member of the medical staff, and he succeeded in bringing back a collection of about two hundred species, including nine which were new, and one new genus. A list of these plants, with their geographical distribution and descriptions of the new species, and notes on the physical and botanical characters of the country traversed by Surgeon-Captain Cummins, appears in the latest issue of the *Kew Bulletin* (Nos. 136–137). The economic products of the region from Cape Coast Castle to the Moinsi Hills, which are 150 miles inland, are numerous. "Plantains are largely grown, and form the principal food of the inhabitants. Indian corn is extensively cultivated and grows freely. Sugar-cane is grown in many of the villages. Pineapples are found all over the country in such a way as to lead persons who have travelled far inland to believe them indigenous. Cola, rubber and gum trees grow plentifully in the forest region, and are reported to be more numerous in the districts around Kumassi." In addition to these plants, there are many trees producing valuable wood in great quantity. The country is unhealthy, but Surgeon-Captain Cummins states that if a railway penetrated the forest zone, establishing a rapid means of communication with the healthy mountainous interior, trade in the vegetable and mineral products of the country could be carried on without the present limitations.

Another interesting article in the *Kew Bulletin* is a brief account of the principal botanical museums in Belgium and Holland, by Mr. J. M. Hillier, assistant in the museums of the Royal Gardens. A noteworthy preservative solution, consisting of alcohol with the addition of two per cent. of hydrochloric acid, was found in use at the University Botanic Garden, Ghent. The object to be preserved is placed in this solution for a few weeks according to discretion, after which it is put into methylated spirit for permanent preservation. In the Commercial Museum at Brussels scientific names are not as a rule attached to the products, but useful details are given on the labels with regard to prices, &c. Mr. Hillier describes Prof. Errera's process for preserving flowers and other objects in their natural colours. "The specimen to be preserved is placed in a conical-shaped paper bag, the narrow diameter resting in the mouth of a glass jar. The bag is carefully filled up with finely sifted sand, after which the jar, together with its contents, is kept at a warm even temperature for two or three weeks, at the expiration of which time the sand is carefully removed and the dried specimen placed in a stoppered jar. The stopper must be hollow and filled with unslaked lime, the latter being kept in position by a thin piece of leather tied over the portion of the stopper which is inserted into the mouth of the jar. The lime absorbs all moisture, and so preserves the specimen from deterioration by damp."

Mr. Frank Finn, Deputy Superintendent of the Indian Museum, contributes a number of interesting notes on natural history to the *Proceedings* of the Asiatic Society of Bengal. Much remains to be done in the observation of living birds, even when these belong to quite common and well-known species. Mr. Finn's notes on peculiarities of attitude, &c., of various birds are, therefore, very useful contributions to ornithology. In a note on the position of the feet of the "Picarian" birds and of parrots in flight, he concludes from his experiences that "supposing the same habit of carrying the feet to run through a family, the forward position of the feet in flight probably characterises hoopoes, woodpeckers, and barbets, and the backward one certainly obtains among kingfishers, rollers, hornbills, cuckoos, and parrots." In other notes Mr. Finn describes various species of Grebes, with especial reference to the power of walking and digestion possessed by these birds; brings forward an instance which confirms the common belief in India that the whip-snake has a propensity for deliberately striking at the eye; and shows that the Indian Gossander can walk like other ducks, and does so in the same attitude. Such notes as these, on imperfectly known points in the habits and economy of birds, are of distinct service to students of avian classification.

Messrs. W. Wesley and Son, Essex Street, Strand, have issued a Catalogue (No. 131) of works on gardening in all its branches, reaching to 714 publications.

We have received the reports, for 1896 and 1897, of the Botanical Department of the Indiana Agricultural Experiment Station, by Mr. J. C. Arthur, State botanist, including an account of experiments on the cultivation of various agricultural crops and garden flowers.

From the Government Laboratory, Antigua, we have received a report of the results obtained on the Experimental Fields, at Skerrett's School, 1897. It refers almost entirely to the cultivation of the sugar-cane, especially to the relative values of different varieties, and to the diseases to which the cane is subject, and the remedies for them.

Messrs. Sealy, Bryers, and Walker, of Dublin, announce for early publication Mr. H. Chichester Hart's "Flora of Co. Donegal, with Introduction on Topography, Geology, Geographical Distribution, &c., and Appendices on Plant Names and Plant Lore and Climate."

The Department of Agriculture, Victoria, has issued a brochure of additions to the fungi on the vine in Australia, by Mr. D. McAlpine, Government Vegetable Pathologist, assisted by Mr. G. H. Robinson. It includes a very full account of twenty-three species, fourteen of which are parasitic and nine saprophytic fungi, ten of them being new to science. The report is very copiously illustrated.

In *Bulletin* No. 1 of the Geological Survey of Western Australia, Mr. A. Gibb Maitland, Government Geologist, gives a bibliography of the works, papers, reports, and maps bearing upon the geology, mineralogy, mining, and palæontology of the Colony. The publications are arranged in alphabetical order under authors' names.

THE tenth issue of "The Wealth and Progress of New South Wales," by Mr. T. A. Coghlan, bringing the affairs of the Colony up to the end of 1897, has just been distiibuted by the Agent-General for New South Wales. The volume contains more than a thousand pages, and is filled with accurate information of service to persons who are engaged in the active life of the Colony, and not without interest to those who are not concerned about the details of local affairs. It would be to the credit of all our Colonies if they published such admirable life-histories as the one for which Mr. Coghlan is responsible.

THE first volume of a second edition of a useful directory of German makers of optical instruments, and other instruments of precision, has been published by the firm of F. and M. Harrwitz, Berlin. This "Adressbuch" is edited by Herr F. Harrwitz, the editor of the journal *Der Mechaniker*, and has been greatly enlarged. It contains the names and addresses of German mechanicians, opticians, glass instrument makers, and allied callings, arranged alphabetically according to names of firms, towns, and specialities. How numerous these makers of scientific instruments are in Germany may be judged from the fact that the directory just issued contains nearly four hundred pages.

THE number of the *Journal of the Royal Microscopical Society* for June contains a reference by the President, Mr. E. M. Nelson, to an old book on optics, Zahn's "Oculus Artificialis," published in 1702. The following figures, taken from the work, are reproduced in the *Journal*:—A telescope-sight for a musket and a cannon, with the legend: "Bombardae et omni genere balistarum ac tormentorum bellicorum tubum opticum sive telescopicum aptare, quo visus ad scopum exactè dirigi poterit." A sunshine recorder or "Organum heliocausticum," with the legend "Horas Luce Sono tibi sphaerula Vitrea monstrat, ignis nil mirum Coelicus urget opus." A series of mirrors for a telescope called "Catoptrico dioptrica telescopica." The same number of the *Journal* contains a lengthy abstract of Dr. A. Clifford Mercer's important paper on "Aperture as a Factor in Microscopic Vision," delivered as a presidential address to the American Microscopical Society; also an abstract of Mr. E. M. Nelson's paper on "Microscopic Vision," read before the Bristol Naturalists' Society; and the commencement of a series of papers by Mr. Fortescue W. Millett on recent Foraminifera of the Malay Archipelago, collected by Mr. A. Durrand, illustrated by plates.

AMONG the volumes lately published by W. Engelmann, Leipzig, in Ostwald's valuable series of reprints and translations of scientific classics (*Klassiker der exakten Wissenschaften*) is a translation, with notes, by Herr W. Abendroth, of Newton's first book on optics, dealing with reflection, refraction, and colour, Four of Ernst von Brücke's papers on plant physiology, published between 1844 and 1862, are reprinted in No. 95 of the series; and a paper, translated from the Swedish of Eilhard Mitscherlich (1821), on the relation between the chemical composition and crystalline form of salts of arsenic and phosphorus, forms No. 94. The article on crystallography and crystallometry, contributed by J. F. Christian Hessel to Gehler's *Physikalische Wörterbuche* in 1830, appears as a reprint in Nos. 88 and 89, edited by Herr E. Hess. Prof. Ernst von Meyer edits No. 92, containing a paper by H. Kolbe (1859) on the natural connection of organic with inorganic compounds, and its bearing upon the classification of organic bodies. No. 90 is a translation from the French of a geometrical paper (1848) by A. Bravais; and No. 91 is a German edition of a paper by G. Lejeune Dirichlet (1839-40) on various applications of infinitesimal analysis to the theory of numbers.

THE value of the Reports of the U.S. National Museum has been so often referred to in these columns, that the announcement of the publication of a new volume containing a report upon the condition of the Museum and the work accomplished in its various departments, is sufficient to convey to all who are familiar wlth the Smithsonian Reports the fact that a large amount of information has been added to the pabulum of scientific readers. The Report just issued runs into 1080 pages, is lavishly illustrated, and is full of interesting matter. In an elaborate paper, Dr. Franz Boas describes and illustrates the collections of the Museum referring to the social organisation and secret societies of the Indians of the coast of British Columbia. His paper is based upon personal studies made during a series of years, and forms a very valuable contribution to the ethnology of the Kwakiutl Indians. Many brilliant reproductions of photographs taken during the performance of native ceremonies are given, and also the transcriptions of a series of phonographic records of songs belonging to the ceremonials. "The Graphic Art of the Eskimos" is dealt with by Dr. W. J. Hoffmann in another long and well-illustrated essay, which will interest archæologists as well as anthropologists. In addition to the researches in pictography, the paper contains much information upon the gesture language of the various tribes studied. A comparison of the pictographs, and various painted records found in different parts of the United States, with the Eskimo work, show the latter to be superior to the former, especially in faithful reproduction of animal forms and delicacy of artistic execution. The remaining papers in the volume are much shorter than the two already mentioned. Among the subjects dealt with are the tongues of birds, taxidermical methods in the Leyden Museum, and the antiquity of the Red Race in America.

SINCE the memorable researches of Humphry Davy on the decomposition of the alkaline earths, many methods have been suggested for preparing the metal calcium in the pure state. M. Moissan, in the current number of the *Comptes rendus*, after showing that none of these yield a pure metal, describes two ways of preparing crystallised calcium containing less than one per cent. of impurities. The first of the methods depends upon the property possessed by calcium of dissolving in liquid sodium at a dull red heat, and separating out in crystals on cooling. By treating the mass cautiously with absolute alcohol the sodium is removed, and the calcium is obtained in the form of brilliant white hexagonal crystals. Similar white crystals of calcium can be obtained by the electrolysis of fused calcium iodide. It is noteworthy that calcium has usually been described by previous workers as a yellow metal; doubtless owing to the presence of impurities.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis*, ♀) from West Africa, presented by Miss Gladys Carey; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Miss Stankowski; a Brush-tailed Kangaroo (*Petrogale penicillata*, ♂) from Australia, presented by Mr. C. J. Leyland; two Red-backed Pelicans (*Pelicanus rufescens*) from the River Niger, presented by Mr. H. S. Bernstein; a Black Hangnest (*Cassidix oryzivora*) from the Amazons, presented by Mr. R. Phillipps; two Yellow-cheeked Lemurs (*Lemur xanthomystax*), two Madagascar Tree Boas (*Corallus madagascariensis*) from Madagascar, a Banded Ichneumon (*Crossarchus fasciatus*), an Angulated Tortoise (*Testudo angulata*) from Africa, a Blue-fronted Amazon (*Chrysotis æstiva*) from Brazil, six Algerian Tortoises (*Testudo ibera*) from Algeria, deposited; a Great Ant-eater (*Myrmecophaga jubata*), a Tamandua Ant-eater (*Tamandua tetradactyla*) from South America, a Green-winged Trumpeter

(*Psophia viridis*) from the Amazons, two White-necked Storks (*Dissura episcopus*) from Africa, two Dusky Francolins (*Pternistes infuscatus*) from British East Africa, a Madagascar Tree Boa (*Corallus madagascariensis*) from Madagascar, purchased; two Red and Yellow Macaws (*Ara chloroptera*) from South America, received in exchange; a Hybrid Zebra (between *Equus caballus*, ♂, and *Equus burchelli*, ♀), a White-tailed Gnu (*Connochætes gnu*, ♂), two Thars (*Hemitragus jemlaica*, ♂ ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY:—

July 3. 8h. 57m. Partial eclipse of the moon. Magnitude 0·934.
4. Wolf's comet due at perihelion.
13. Venus 1° north of α Leonis (Regulus).
15. Venus. Illuminated portion of disc 0·765.
15. Mars. ,, ,, ,, 0·904.
15. Jupiter. Polar diameter, 31″·9.
15. Saturn. ,, ,, 16″·6.
16. 6h. 31m. to 9h. 25m. Transit of Jupiter's Sat. III.
18. 8h. 7m. Annular eclipse of the sun invisible at Greenwich.
18. Wolf's comet 27′ distant from Mars.
19. Saturn. Outer minor axis of outer ring, 17″·89.
26. 22h. 0m. Mercury nearly occults α Leonis (Regulus).
28. 12h. 49m. Moon in conjunction with α Scorpii (Antares).
28. Many meteors from Aquarius and Perseus.
30. 7h. 31m. to 8h. 41m. Occultation of λ Sagittarii (mag. 3·1) by the moon.

COMETS THAT ARE NOW VISIBLE.—There is plenty of cometary news in the three most recent numbers of the *Astronomische Nachrichten* (3498–3500). As regards comet Coddington-Pauly, which has a declination too southern for the ephemeris to be of any use in this column, Prof. Berberich publishes some new elements (*Astr. Nach.*, No. 3500) based on other observations than those previously used by him, which differ somewhat from the values given in his first computation. The comet has a southerly movement, so that it will not be visible in our latitude.

Comet Perrine (June 14), on the other hand, has a great northerly declination, and is increasing in brightness very rapidly. The elements and ephemeris of this comet have been computed by Perrine and Aitken, and also by Berberich. The elements obtained by the former we published last week, but they differ slightly from those calculated by Berberich, these being as follows:—

$$T = 1898 \text{ August } 4{\cdot}7473 \text{ Berlin M.T.}$$

$$\left.\begin{aligned} \omega &= 235^\circ\ 16'{\cdot}77 \\ \Omega &= 252\ \ \ 2{\cdot}34 \\ i &= 72\ \ 11{\cdot}43 \end{aligned}\right\} 1898{\cdot}0$$

$$\log q = 9{\cdot}44405$$

The ephemeris for the current week, according to these values, is:—

Ephemeris for 12h. Berlin M.T.

1898.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	log r.	log Δ.	Br.
June 30	5 4 3	+52 57·9			
July 1	9 56	52 23·3	9·9817	0·2061	2·34
2	15 46	51 46·9			
3	21 34	51 8·7			
4	27 19	50 28·7			
5	33 1	49 46·7	9·9415	0·1904	3·03
6	38 40	49 2·7			
July 7	5 44 15	+48 16·7			

The new comet discovered by Giacobini is gradually decreasing its southern declination, but the elements at present calculated are described as uncertain. With a diameter of 2′, an excentric condensation, and of about the 10th magnitude (June 21), the comet is not an easy object. Those wishing to observe it will find the following positions useful.

Ephemeris for 12h. Berlin M.T.

1898.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	Br.
June 29	... 18 5 48 ...	−21 36·2 ...	1·35
July 3	... 17 8 1 ...	19 28·6 ...	1·22
7	... 16 20 13 ...	16 47·2 ...	1·01
11	... 15 43 37 ...	−14 11·4 ...	0·79

THE FIRST SATELLITE OF JUPITER.—In two early numbers of *Astronomy and Astrophysics* (November 1894 and May 1893) our readers may remember that Prof. W. H. Pickering contributed an account of a very interesting series of observations on the shapes of the satellites of Jupiter, and the conclusions he arrived at were that the discs were by no means round, but assumed very decided irregularities as they performed their rotations. These satellites have been further minutely examined by Mr. A. E. Douglass during last year, and in the *Astronomische Nachrichten* (No. 3500) he describes what knowledge has been gained by the observations of the first satellite. These were made in Mexico, from February 18 to March 28, with the Clark 24-inch, and in Flagstaff from May 16 to June 9. We must confine ourselves to a very brief summary of this paper, and refer our readers to the original for the minute details given both in the text and accompanying plate.

Although the markings on the satellite were sometimes well seen, the observations were not numerous enough over a long period of time to effectively map and determine the period of rotation by tracing the succession of detail. Mr. Douglass adopted Prof. Pickering's method of observing the changes in the elliptical form of the satellite's disc. After an elaborate trial of several periods he was led to deduce a period of 12h. 25·8m. for the year 1897, a value not very different from that found by Pickering in 1892, namely 13 hours. Most peculiar are the markings on this satellite. Assuming the axis of the satellite to be perpendicular to the plane of its orbit, they appear to extend from about + 60° to − 60° in latitude, and they take roughly the form of lines directed either to the north or south pole. Their general distribution can be best described and their symmetry best illustrated, as Mr. Douglass says, "by saying that they nearly form portions of five great circles passing round the satellite."

The micrometer measures for determining the elliptical form of the disc gave indications of a large ellipticity. Mr. Douglass thinks that this flattening is real, and not due to the presence of surface markings near the limb. The following brief table shows the values of the ellipticity and period of rotation for the periods observed since 1892:—

Date.	Ellipticity.	Period. h. m.	Obs.	Telescope
Dec. 1892 ...	100–110 ...	13 3	... Pickering ...	13 inch
Oct. 1894 ...	108–120 ...	13 3	... ,, ...	18 inch
March 1895 ...	104–120 ...	(?)	... Douglass ...	,,
March 1897 ...	115–130 ...	12 25·8 ...	,, ...	24 inch

The indications of an increase in the ellipticity and decrease in the period of rotation led Mr. Douglass to investigate the question of whether a decrease in the size of the disc had been observed. An examination of the existing measures showed that such a change has probably taken place, but the values cannot be relied on for certain. If this decrease in size be an actual fact, then the increase in rotational velocity and increase in mean polar compression would naturally follow.

THE METEOR SHOWER OF NOVEMBER 13, 1897.—Those who intend to systematically observe or photograph the meteor shower next November, will find in the account of the arrangements made last year at the Harvard College Observatory (*Annals*, vol. xli. No. 5) many interesting suggestions. Prof. W. H. Pickering, as will be gathered from his description in the above-mentioned *Annals*, made arrangements for a combined attack on the night of the 13th at various stations connected with the observatory. To present an idea of the scale in which such work is undertaken in America, in addition to visual observations, we give the number of plates exposed and instruments used. Three plates were taken with the Draper 11-inch telescope, with two objective prisms of 15°. Fourteen plates with the 8-inch, with two objective prisms of 6° each. Twelve plates with the 6-inch, with objective prism of 6°. Eight plates with a Voigtländer 5-inch, with an objective prism of 6°. Three plates with a Ross rapid rectilinear lens of 1·5 inch, angle of prism 15°. With such a collection of fine instruments at work, it was only too disappointing that the meteors were so few and faint;

but it is consoling to think that the experience gained that night will undoubtedly be used to render the work at the time of the next November meteor shower more efficient. As regards the best form of lens to employ, Prof. Pickering advocates "a portrait lens of the kind formerly used by photographers." The plates should be exposed for half an hour, and at the end of this time the camera should be again pointed to the region fifteen minutes preceding the radiant point. At the Solar Physics Observatory, at Kensington, the methods employed were to fix a camera on the tube of a large equatorial (near the object-glass end), and also on the hour-angle circle of a siderostat, both cameras being moved by the clock-work of each instrument. Other cameras were fixed and oriented towards the radiant point and other directions. The 9-inch equatorial with objective prism was also used, but no bright meteor, unfortunately, passed across the field. May the meteorological conditions be such that the meteor shower of November 1898, will be well observed and successfully photographed!

HIGH SPEED TELEGRAPH TRANSMISSION BY MEANS OF ALTERNATORS.

ALTHOUGH, at the present day, high speed transmission is much more limited in its application than at an earlier period in the history of telegraphy, owing to the commercial aspects of the question having been unavoidably altered, attempts have been made from time to time to produce improvements in this direction; but until lately the admirable system invented by the late Sir Charles Wheatstone, and considerably improved by the British Post Office Telegraph Administration, has been the best available method of automatic high speed signalling.

The speed at which a series of waves can be passed over a given line depends primarily and inversely upon the product of the total resistance into the total capacity, the form of the wave having a considerable influence on the speed where any measurable capacity is present.

In the ordinary Wheatstone automatic fast speed system of telegraphy, the letters are formed by waves of different duration, a dot being produced by a short wave, a dash by a longer one. This renders it necessary to charge the line longer for a dash than for a dot, which is a grave defect in fast speed working; but the condenser compensation, introduced and employed by the British Post Office, practically doubles the speed attainable on any given line by, in some measure, equalising the line charges. That is to say, the condenser used is always of a capacity which admits of a full charge during the time interval of a dot, and a current of the duration of a dash does not give the condenser any higher charge. Indeed condenser compensation has such a beneficial effect, that the defect of unequal impulses is almost overcome, inasmuch as the increase of speed obtained by this arrangement and equal impulses, is only 5 per cent. greater than that obtained with currents of unequal duration. Again, although the signals be made equal in this system, another difficulty presents itself; that is, the waves that are sent through the line are the results of the sudden applications of the full E.M.F. used (in practice 100 volts), and consequently a reversal means a sudden change of 200 volts, *i.e.* from 100 volts positive to 100 volts negative. The form of the current wave with such a system depends almost entirely on the nature and form of the circuit. It is easy to produce correspondingly sudden and complete changes in the current when the circuit possesses only resistance, but when capacity, &c., is present, the form of current wave is vastly different to the impressed E.M.F. wave; for example, take the letter "A," the actual current curve on a land line without condenser compensation is shown in Fig. 1, while Fig. 2 represents the effect of shunted condenser compensation.

Prof. A. C. Crehore, of Dartmouth College, U.S.A, in conjunction with Lieut. G. O. Squier, of the United States Artillery, have, however, been led to make some experiments with alternators, and have suggested a mode of high speed signalling which, although presenting some mechanical difficulties, has recently been tried by the inventors of the Post Office telegraph lines in England, under the direction of Mr. Preece, and found to produce a distinct increase of speed.

Fig. 3 shows an ordinary sine wave as produced by an alternator, and it is this form of wave that Messrs. Squier and Crehore use in their so-called "synchronograph" system of fast speed telegraphy.

The signals are obtained by the omission of certain complete cycles or semi-cycles, the message being read by means of the blanks in the regular succession of recorded dots; or signals can be recorded on chemically prepared paper.

This system is to some extent a synchronous one with this great advantage over the many well-known synchronous systems, that the synchronism is not required between the transmitter at one end and the receiver at the other end of a line, but between the alternator and transmitter at the sending end of the line. This is easily obtained by driving the transmitter from the generator shaft. The transmitter itself is exceedingly simple, and consists of a wheel the circumference of which is one continuous conductor, presenting a smooth surface for the brushes to bear upon. If the periphery of this wheel be divided into forty equal parts, and be geared to run at one-fourth the speed of the armature of a ten-pole alternator, clearly one of these equal parts will correspond to one semi-cycle of E.M.F. produced by the alternator. Upon the surface of the wheel bear two

FIG. 1.

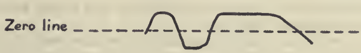

FIG. 2

brushes, carried by an adjustable brush-holder. One brush is joined to the generator, and the other to the line, so that the current entering one brush from the generator passes across the transmitting wheel to the other brush, and thence out to the line.

Now if a piece of paper $\frac{1}{40}$ of the circumference of the wheel be fixed thereon in such a position as to pass under one of the brushes, one semi-cycle or half-wave of current will be omitted in every twenty complete waves, and by means of a suitably prepared paper ribbon, or "slip," any combination of signals can in this simple manner be transmitted. The brushes are adjusted so that the periods of disconnection and connection coincide with the zero points of E.M.F. The transmitter may, however, have only one brush joined to line, and the wheel itself may be made the connection to the generator. With this mode of signalling much higher E.M.F.s may be used, and connections and disconnections made almost without spark at the brush contacts.

The speed of the transmitting wheel with respect to the generator shaft is immaterial, the essential being that its circumference should contain an integer number of times the arc which a point fixed with respect to the field would describe on such circumference during one semi-period of current.

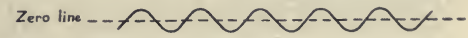

FIG. 3.

Complete control of every semi-cycle of current thus permits the maximum speed of transmission of signals with a given frequency. If the transmitter does not act in synchronism with the generator, the "make" and "break" of the circuit occurs when the current is not naturally zero, and considerable interference results; care is, therefore, taken to ensure that the "slip" admits of the line connections being made at the proper times only.

Athough the received signals were originally intended by Messrs. Squier and Crehore to be recorded on chemically prepared paper, they have also devised a very ingenious massless receiver, although at present it is not in a practical form. It is based on the well-known discovery of Faraday that a beam of polarised light may be rotated by means of a magnetic field, the direction of rotation of the ray being the same as the direction of the current producing the field; the rotary power depends upon the intensity of the magnetic field, and the total amount of rotation upon the length of the rotary medium in which this magnetic field exists and through which the ray passes.

The method adopted is to pass a beam of light through a

Nicol's prism, thence through a long tube with plane glass ends containing liquid carbon bisulphide, and afterwards through a second Nicol's prism. The ray of light is received on a screen having a sensitised surface, which is carried forward at an uniform speed; a long coil is wound round the tube containing the carbon bisulphide, the prisms being adjusted so that no light passes through the tube when no current is flowing through the coil, the source of light being an arc lamp.

The passage of a current rotates the polarised ray within the tube, and the light then falls on the sensitised screen, and is thereby recorded.

As neither of these methods of reception are suitable for everyday use, the British Post Office undertook, in conjunction with the inventors, a series of valuable and interesting experiments over the departmental lines under more practical conditions. The existing departmental records of capacity, resistance and mileage, compiled for the whole country, proved invaluable by supplying exact data for each of the experiments performed, and enabled reliable tables and curves to be constructed. The experiments consisted of determinations of the highest limits of speed for the Wheatstone automatic, as well as the synchronograph system on various lines, the following combinations being specially compared:—

(1) Ordinary Wheatstone automatic with condenser compensation as is used at present.

(2) The synchronograph sine wave transmission system with chemical receivers.

(3) A combination of the synchronograph sine wave transmission with Wheatstone receivers.

The alternator used for these experiments consisted practically of several separate alternators on one shaft, each being independent of the remainder, and so constructed that, with the same speed of revolution, different frequencies or wave speeds could be obtained, transformers being used in those cases where it was desirable to maintain the E.M.F. unaltered.

Careful estimations were made not only of the force employed, which is about 50 per cent. higher than that ordinarily used on Wheatstone circuits, but also of the wave speed, and its equivalent value in "words per minute" in each case.

On a line from London to York and back, mainly composed of copper, having a total mileage of 431½, and a K.R. equal to 33,000, a speed of 540 words per minute was attained with Wheatstone receiver and Crehore-Squier transmitter (synchronograph), although the maximum limit was not reached. The speed obtainable with this K.R. being only 360 when ordinary Wheatstone automatic was used.

From London to Aberdeen and back, with a total mileage of 1097½ and a K.R. of 261,000, a speed of 135 words per minute was obtained by the Crehore-Squier Wheatstone combination, as compared with 46 words per minute on the ordinary Wheatstone automatic with the best compensating arrangements.

These two cases are typical of the whole series of observations, which enabled the comparative wave speeds of the different systems to be estimated as follows:—

Wheatstone automatic alone	1
Crehore-Squier transmission and Wheatstone receiver ...	2·9
Crehore-Squier transmission and chemical receiving ...	2·9

In the first two cases the number of waves necessary for each word is of course the same, but in the last-named case, where chemical receiving is employed, a further gain is obtained by using fewer waves for each word, making the word speed in the three cases bear the ratio 1, 2·9 and 7.

Chemical receiving is by no means so convenient as ordinary Wheatstone, and the most pressing practical requirement at the present day is not higher speeds for short distances, but higher direct working speeds over long lines where at present intermediate "repeaters" are necessary.

It is satisfactory to note that the maximum wave speed attainable by synchronograph transmission with the chemical receiver or with the Wheatstone receiver is exactly the same on any circuit where the speed is limited by the line itself and not by the receiving apparatus.

On the Wheatstone system shunted condensers are necessary to compensate for two distinct effects—the unequal duration of the signals, and the inductance of the receiver. Where the synchronograph transmission is employed on short cables or open lines, no line compensation is required, and a fixed condenser can be shunted across the receiver coils so as to compensate for the inductance of the receiver for any given speed. In connection with this question the inductance of the Post Office receiver was carefully verified, and was found to be 3·46 Henrys, the necessary condenser compensation depending solely on the speed of transmission (or wave-frequency) and the arrangement of the receiver coils, and in no instance having any direct or complicated relation to the line capacity.

On an artificial cable, equal to about 200 miles of ordinary submarine cable, where condenser compensation is used at both ends, the increase of wave speed obtained by the synchronograph was only 50 per cent. instead of 190 per cent. as in the case of open wires. It would therefore appear that with further experiment some line compensation might be found to be necessary for cable working.

The experiments show that where the capacity of the line is not great, as in the case of aerial lines, the transmission of the current in sine waves produces the best results, and leaves the factor of the inductance of the receiving instrument to be dealt with separately, and consequently in a more exact manner.

The principal difficulty in the application of the system is the necessity for the use of a new code of signals, or a reduction in the speed value to admit of conformity with existing codes. The existing Wheatstone automatic instruments are also light, portable, and adapted for use in outlying districts at short notice, where the synchronograph would probably be found to be less suitable. The perforator at present in use for the preparation of the transmitting "slip" has also, by a process of evolution, become extremely convenient, and equally suitable for hand working in confined spaces, or where power is available.

A suitable and easily manipulated perforator for the synchronograph has yet to be devised. Messrs. Squier and Crehore, however, deserve great credit for the discovery, with limited means of experiment, of an improved and promising system of high speed transmission.

OBSERVATIONS ON STOMATA.[1]

THE method described depends on the fact that in adult leaves transpiration is stomatal rather than cuticular, so that, other things being equal, the yield of watery vapour depends on the degree to which the stomata are open, and may be used as an index of their condition. In principle, it is the same as the methods of Merget (*Comptes rendus*, 1878) and Stahl (*Bot. Zeitung*, 1894). These observers used hygroscopic papers impregnated with reagents which change colour according as they are dry or damp, and Stahl, who employed paper soaked in cobalt chloride, has obtained excellent results. In my laboratory I have used, for some years, a hygroscope for demonstrating cuticular transpiration, in which evaporation is indicated by the untwisting of the awn of *Stipa pennata* (Darwin and Acton, "Practical Physiology of Plants," 1st edition, 1894); my present instrument is of the same general type, but the index is made of "chinese leaf," *i.e.* shavings of pressed and heated horn.[2] If a strip of horn is placed on a dry substance, *e.g.* the astomatal surface of a leaf, it does not move, but on the stomatal surface it instantly curves strongly away from the transpiring surface. In the hygroscope the degree of curvature is read off on a graduated quadrant, and in this way a numerical indication of the condition of the stomata is obtained.

The instrument makes no claim to accuracy, but has proved extremely useful when used comparatively to indicate and localise small changes in the transpiration of leaves, and therefore, by implication, changes in the condition of the stomata. By observing under the microscope the uninjured leaf of *Caltha palustris*, and comparing the variations in the size of the stomata with the variations in the readings of the hygroscope, it is easy to convince one's self of the value of the method. It must be especially noted that though a fall in the hygroscope readings corresponds with a narrowing of the stomatal opening, it does not follow that zero on the hygroscopic scale means absolute closure of the stomata. This want of sensitiveness has one advantage, namely, that cuticular transpiration has no effect on the horn index, so that any movement of the index

[1] A paper by Francis Darwin, F.R.S., read at the Royal Society, June 16.
[2] I also use the epidermis of a *Yucca*—a material which I owe to the kindness of Mr. Thiselton-Dyer.

must depend on a stomatal transpiration. The hygroscope indicates well the gradual "closure"[1] of the stomata that occurs as a plucked leaf withers. It is generally stated that marsh and aquatic plants do not close their stomata under these circumstances. I find that, although the phenomenon is much less marked than in terrestrial plants, yet that, in many species, partial closure of the stomata undoubtedly occurs in the aquatic class.

The most interesting fact observed in withering leaves is that in many cases the "closure" of the stoma is preceded by temporary opening, which may occur almost simultaneously with the severance of the leaf from the plant. Thus the hygroscope readings rise at first, and subsequently sink to zero. The interest of this fact is the demonstration of the interaction between the guard cells and the surrounding epidermis. The phenomenon is best seen in plants with milky juice, but is not confined to this class. The preliminary opening of the stomata occurs in the early morning, but not in the evening—a fact which is of importance in relation to the mechanism of the nocturnal closure of the stomata.

A diminution of the stomatal transpiration can also be brought about by compressing the stem of the plant in a vice, a process which is known to diminish the water supply (F. Darwin and R. Phillips, *Camb. Phil. Soc. Proc.*, 1886). The stomatal closure is here probably an adaptive response to the lowering of the water-supply of the leaf, but this is not quite certain.

A series of experiments were made on the comparative effect of moist and dry air, from which it is clear that the stomata "close" before any visible signs of flaccidity occur in the leaf. When leaves are exposed to air dried by H_2SO_4, "closure" is preceded by a remarkably prolonged opening of the stomata—a phenomenon which requires further investigation.

Baranetzky (*Bot. Zeitung*, 1872) showed that slight degrees of disturbance affect transpiration. The hygroscope gives no evidence of increased transpiration when the disturbance is slight. When the plant is violently shaken the leaves become flaccid and the stomata "close," and in some cases the closure is preceded by increased transpiration, no doubt due to temporary opening of the stomata, induced by the guard cells being released from epidermal pressure before they have lost their own turgor.

N. J. C. Müller (Pringsheim's *Jahrbücher*, vol. 8, 1872) showed that stomata may be closed by electric stimulation; my experiments show that while a strong shock narrows the stomata, a weaker one opens them, no doubt owing to the temporary loss of epidermal pressure.

Some experiments on poisonous gases and vapours were made. Chloroform and ether slowly "close" the stomata, which finally reopen in a normal atmosphere. Pure CO_2 also slowly closes the stomata.

The hygroscope is well fitted to demonstrate the fundamental facts in relation to light. The fact that the stomata are widely open in sunshine is well known; the difference between bright and less bright diffused light is not so well known, nor the fact that in dark stormy weather the stomata may be nearly closed by day, even in summer. The effect of difference of illumination is well shown in certain leaves having stomata in both surfaces, *e.g. Iris*, *Narcissus*, and the phyllodes of *Acacia cyclopis*. In these the stomata on the illuminated surfaces are much wider open than on the less brightly illuminated sides; and when the plant is reversed in position in regard to light, the stomata rapidly accommodate themselves to the change in illumination.

The most interesting fact in regard to the effect of artificial darkness is that it is more effectual in producing closure in the afternoon than in the morning; and, conversely, illumination opens closed stomata more readily in the morning than later in the day. These, together with other observations, tend to show a certain amount of inherent periodicity in the nocturnal closure of the stomata. Another fact of interest is that in darkness prolonged for several days the stomata gradually open. This last observation is used in the section on the mechanism of the stoma as an argument against the prevalent view that the stoma closes in darkness, because in the abeyance of assimilation the osmotic material, on which the turgor of the guard cells depends, ceases to be manufactured.

Schellenberger (*Bot. Zeitung*, 1896) has striven to uphold this view by showing that in the absence of CO_2 the stomata close as though they were in darkness. My experiments on plants deprived of CO_2 lead to absolutely contrary results, namely, that the stomata remain perfectly open even during prolonged deprivation of CO_2.

It is a vexed question (Leitgeb, *Mittheilungen aus dem Bot.*, Inst. zu Graz, 1886) whether or no the majority of plants close their stomata at night. My conclusion is that in terrestrial plants (excluding nyctitropic plants) a great majority show some closure at night; the horn hygroscope stands at zero on the stomatal surface of by far the greater number of ordinary plants. On the other hand, the hygroscope shows widely open stomata on most aquatic plants at night. Stahl (*Bot. Zeitung*, 1897) concludes that nyctitropic plants are remarkable for not closing the stomata at night; this fact I somewhat doubtfully confirm; but the question is not so simple as it seems, owing to the varying behaviour of the stomata at night in different temperatures.

Since the hygroscope gives numerical readings it is possible to represent graphically the daily opening and closing of the stomata. The curve begins to leave the zero with the morning light; it rises rapidly at first, and afterwards more slowly. In some cases it runs roughly horizontally until a rapid fall begins in the evening. In other cases there is a slow rise up to the highest point, which occurs between 11 a.m. and 3 p.m. The hygroscope generally sinks to zero within an hour after sunset.

The effect of heat has not been fully studied, but enough has been done to confirm previous observers who find that heat opens the stomata. As regards the visible spectrum, I find that the red rays are decidedly most efficient, but I am not able to find any evidence of a secondary maximum in the blue, such as Kohl (*Bieblatt zur Leopoldina*, 1895) describes.

The biology of the nocturnal closure is a subject which can hardly be discussed in a condensed manner. It is suggested that the gaseous interchange of assimilation may require widely open stomata, whereas respiration may be carried on with comparatively closed apertures. If this is so, the stomata might be to a great extent shut at night, and an economy in the use of water effected, without detriment to metabolism. Observations are given to show that quite another effect is brought about by nocturnal closure. As long as the stomata are open, the transpiring leaf is considerably cooler than the dry-bulb thermometer, but at night it has almost the temperature of the air. In this way a saving of heat is undoubtedly effected—but it is not easy to say whether it is sufficient to be of much practical importance to the plant. I am inclined to believe, from Sachs' (*Arbeiten*, 1884) experiments on the depletion of leaves, that all saving of heat must be valuable, by preventing the checking of translocation which he observed.

The mechanism of the stoma is another subject which does not lend itself to condensed treatment. I have tried to point out that the stoma has been neglected in the modern reorganisation of plant physiology from the point of view of irritability. Some observers insist on the preponderant influence of the guard cells, while Leitgeb in the same way exaggerated the importance of epidermic pressure, whereas the two factors should, as far as possible, be considered as parts of a whole and as correlated rather than opposed in action. I have also attempted to show how the stoma, like other parts of the plant, may be supposed to react adaptively to those signals, which we usually call stimuli. The attempt which I have made to rank the problem among the phenomena of irritability, is very tentative in character. I have ventured to put it forth because I am convinced that it is in this direction that advances will be made.

[1] I use the word "closure" to mean such a narrowing of the stomatal aperture as corresponds with zero on the hygroscope.

A NEW PHOTOGRAPHIC PRINTING PAPER.

ACTING as agents for the Nepera Chemical Co., New York, Messrs. Griffin and Co., of Garrick Street, have for some time been issuing a new sensitised paper under the name of "Velox," which for ease of manipulation and perfection of results promises to take a firm hold on public favour. From its advent, something more than a year ago, there has been ample opportunity to test the most desirable quality of a photographic paper, viz. its permanence under varying conditions, and, at the least, it can be relied on as much as any *silver* sensitised paper.

Full instructions for the manipulation of the paper for various purposes are given with it, and they do not greatly differ from those employed in the use of other bromide papers. The special advantages claimed for this paper is that the several difficulties involved in the working of ordinary papers are removed. The chief simplification is in the fact that a dark room may be entirely dispensed with, all operations being performed in an ordinary room lit in the usual manner. The paper is described as being coated with a chloro-bromide emulsion, and it is owing to the extreme slowness of this that a special non-actinic illumination is unnecessary. Of course, care is wanted, and *direct* light should not be allowed access to the print; but in an ordinary room, lit by two windows at middle of day, perfectly clean whites may be obtained by turning the back to the window, and developing in the shade thus produced.

Again, no great amount of apparatus is required, not even a printing frame; development is very efficiently performed on a sheet of glass, applying the developer with a pledget of cotton-wool or a mop camel-hair brush.

The exposure for contact printing from an average negative varies from 1-3 seconds for diffused daylight, to 30-120 seconds to a gas-burner at 6 inches distance. A point that might with advantage be added to the instructions for use, is the great convenience of magnesium ribbon as an illuminant. This is being brought forward by many leading plate and paper makers, and deservedly so. The light of burning magnesium is one of the most intense illuminants at present known; and as a great part of the light is concentrated in the blue and violet regions of the spectrum, the parts most effective on a silver emulsion, this gives the light a high efficiency. From 1-3 inches of ribbon, burnt at from 8-12 inches distance, will be found to give satisfactory exposures. Another point in favour of using magnesium is the ease of firing it, all the extra articles needed being a box of matches.

It might be worth while to make the gelatine, &c., which forms the basis of the emulsion, more insoluble than it appears to be from the samples tested, as many people find it convenient to dry prints quickly, and if the paper has not been specially treated, there is danger of blisters or of complete melting of the film. The paper is obtainable in several varieties of surface and suitability for different purposes.

Another suggestion, not mentioned in the circular issued, may perhaps be made as likely to extend its popularity. It is that the paper may be toned with any of the usual toning baths for bromide paper, the one made with copper sulphate and potassium ferricyanide, giving reddish-brown tones, being very suitable.

One of its good qualities is the ease of maintaining pure whites; and this will no doubt lead to its extensive use for copying purposes, as both the negative and positive may be made on the paper. For scientific workers, as well as pictorial photographers, the paper will doubtless prove a great boon.

From its extreme simplicity of manipulation, moderate price, and general high quality, the paper ranks high among silver emulsion printing papers.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. RICHARD ABEGG, privat-docent in physical chemistry at Göttingen, has been promoted to the rank of professor; Dr. Oswald Lohse, observer in the Potsdam Astrophysical Observatory, has also been promoted to a professorship; Dr. Böhmig, privat-docent in zoology at Gratz, has been appointed assistant professor; Prof. Kalkowsky, of the Technical High School in Dresden, has been appointed director of the geological and prehistoric museum there.

ON Wednesday in last week, the Duke of Devonshire opened the new Christie Library at the Owens College, Manchester, and laid the foundation of the Whitworth Hall, another addition to the college buildings. The library is the gift of Mr. R. C. Christie; and the expense of erecting the Whitworth Hall will be met by the sum of 50,000*l*. received by Mr. Christie as one of the residuary legatees of the estate of the late Sir Joseph Whitworth, and since paid by him to the Treasurer of Owens College.

IT is but rarely that an issue of *Science* appears without the announcement of one or more gifts to educational and scientific institutions in the United States, or for the advancement of learning. The following are among the donations recently announced:—By the will of the late Dr. Elizabeth H. Bates, of Port Chester, N.Y., the University of Michigan will receive 125,000 dollars, the income from which is to be used in establishing a chair for the diseases of women and children, to be known as the Bates professorship.—The will of the late Mrs. Annie S. Paton, of New York, leaves 100,000 dollars to Princeton University, subject to an interest for life of her two sons. The bequest is to found a fund for an endowment for Paton lectureships in ancient and modern literature.—It is said that Mrs. Phœbe Haarst will erect a building for mining engineering for the University of California at a cost of 300,000 dollars.—A building for the College of Agriculture of Ohio State University has been completed during the present year at a cost of 70,000 dollars.—The will of the late Mr. Felix R. Bonnet, of Pittsburg, Pa., provides that, upon the death of his widow, 300,000 dollars shall go to the Western Pennsylvania University for the endowment of scholarships.—A donor, whose name is withheld, has subscribed 25,000 dollars for Barnard College in case the 100,000 dollars needed to liquidate the debt on the College are subscribed by October 3. 23,000 dollars had previously been subscribed.—Hobart College, Geneva, N.Y., has received 6000 dollars for a scholarship by the will of Mrs. Augusta M. Williams.—Mr. Philip D. Armour has given an additional endowment fund of 500,000 dollars to the Armour Institute of Technology, Chicago. He had previously given the Institute an endowment of 1,500,000 dollars.—Mr. Washington Duke has given 100,000 dollars to Trinity College, Durham, N.C., which makes the total amount of his gifts to the College 425,000 dollars.—Dr. D. K. Pearsons, who has assisted so many smaller colleges, has offered to give the Salt Lake College, of Salt Lake, Utah, 50,000 dollars, on condition that its officers raise 100,000 dollars more within a year.—Dr. George W. Hill has been appointed lecturer in celestial mechanics in Columbia University, Miss Catherine W. Bruce having given 5000 dollars for this purpose.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 26.—"On the Kathode Fall of Potential in Gases." By J. W. Capstick, M.A., D.Sc., Fellow of Trinity College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

Hittorf and Warburg have shown that when an electric current passes through a tube containing a gas at a pressure of a few millimetres, the fall of potential along the greater part of the tube varies with the pressure of the gas and the current strength, but in the immediate neighbourhood of the kathode there is a fall which is constant in amount provided the negative glow does not cover the whole electrode, or extend to the walls of the tube. It seems likely that this kathode fall will prove to be connected with other constants of the gas, and the aim of the present investigation was to find such a connection by measuring the kathode fall in a compound gas and its constituent elementary gases. The gases used were water vapour, ammonia, and nitric oxide and their constituents.

No difficulty was experienced in measuring the fall in the elementary gases, and the separate readings for any one gas showed good agreement. It proved, however, a very difficult matter to get a constant current to pass through the compound gases. Many months were spent in a fruitless attempt to find what conditions determine the constancy of the current, and since the kathode fall is not constant when the discharge is intermittent, very few measurements could be made on the compound gases.

The values in volts ultimately found for the kathode falls were as follows:—

Hydrogen	298
Nitrogen	232
Oxygen	369
Water vapour	469
Ammonia	582
Nitric oxide	373

Warburg had previously determined the fall in hydrogen and nitrogen. For the former, he found 300. For atmospheric nitrogen containing argon, he found 232. The present experiments were made on nitrogen prepared from ammonium nitrite, whence it appears that the presence of argon does not affect the kathode fall.

The value found for nitric oxide is of very doubtful validity. The appearance of the discharge showed that the gas is rapidly decomposed, and the fact that the kathode fall is nearly the same in nitric oxide. air and nitrogen with a trace of oxygen, points to the oxygen being the sole carrier of the electricity in each case.

If we leave nitric oxide out of account, it appears that the kathode fall is an additive quantity, and hence a property of the atoms rather than of the molecules.

Assuming that the conduction in gases is electrolytic, the analogy of the electrolysis of liquids suggests the possibility that the kathode fall is a measure of the heat of dissociation of the gas. If this be the case, the experiments might be taken to support J. J. Thomson's view that the carriers of the current are provided by the disintegration of the atoms into much smaller particles.

June 9.—"Experiments on Aneroid Barometers at Kew Observatory and their Discussion." By C. Chree, Sc.D., LL.D., F.R.S.

The paper deals with two species of data. The first consists of particulars derived from the records of Kew Observatory as to the errors in aneroid barometers subjected to the ordinary Kew test, which consists in lowering the pressure to which the aneroid is exposed inch by inch to the lowest point required, and raising the pressure in a corresponding way to its original value. Readings are taken at each inch of pressure during both the fall and the recovery, and a table of corrections is obtained by reference to a mercury gauge.

The second group of data are the results of special experiments made at Kew Observatory during the last three years.

The aneroid is an instrument exhibiting elastic after-effect. When pressure is lowered and then maintained constant, the reading continues to fall, and when pressure is restored to its original value, the aneroid reads at first lower than it did originally, but exhibits a tendency to recover. The most characteristic features were discussed thirty years ago by Dr. Balfour Stewart. They have also been the subject of a pamphlet by Mr. Edward Whymper, who gives the results of a number of interesting long period experiments.

The present paper treats of how the differences between the readings with pressure descending and ascending in a normal pressure cycle, such as the Kew test, varies throughout the range, and how the sum of these differences varies from one range to another. It investigates how the error, as pressure is reduced, varies with the rate of fall of pressure (when uniform), how the fall of reading at a low stationary pressure increases with the time, depends on the pressure, and varies with the rate of the previous fall of pressure, and how the recovery after a pressure cycle progresses with the time, and is modified by the nature of the previous pressure changes. The influence of subsidiary stoppages is investigated, and experiments are discussed showing the influence of temperature.

The opportunity is taken of considering the secular change of zero, and also changes in the elastic and the after-effect properties.

Algebraic and exponential formulæ are obtained for such phenomena as the variation of the differences of the descending and ascending readings throughout a pressure cycle, the dependence of the sum of such differences on the range, the fall of reading at the lowest pressure and the final recovery. A theory, to some extent empirical, is built up, leading to mathematical results, depending on only three arbitrary constants, for the behaviour of an aneroid in the ordinary Kew test over any range.

The large differences brought to light between different aneroids show that the means of markedly raising the average are already at the makers' disposal. The present inquiry shows clearly how the effects of tentative improvements may be ascertained.

Physical Society, June 24.—Mr. Walter Baily in the chair.—Prof. Carus-Wilson exhibited an apparatus to illustrate the action of two electric-motors coupled in such a way as to admit of their rotating at different speeds. The two shafts are placed in line, and each is fitted with a bevel-wheel, gearing into an intermediate wheel. The axis of the intermediate wheel is at right angles to the line of the motor-shafts, and is free to rotate in a plane at right angles to that line. The motors can be made to rotate at different speeds by altering the strength of the magnets of either or both. The motion of the intermediate wheel depends upon the difference of the two speeds, or upon their mean, according to their relative directions of rotation. A simple graphic construction enables the action to be predetermined for any given load on the intermediate wheel. Calling the two motors A and B, and the intermediate wheel C, lines can be drawn on a base of current to represent the speeds and the torques for each motor. If the motions of A and B are in the same direction, the load or torque is the same on each, and of similar sign. Hence, as the load on the wheel C is increased, the speeds of A and B tend to become equal (if A had been running faster than B); and for a certain load on C the speeds of A and B will be equal. If the load on C is further increased, B will run faster than A. Also, there will be a certain value for the load on C at which the motion of A will reverse. A further increase of the load on C will bring C to rest, A and B then rotating at equal speeds in opposite directions. When the load on C is nothing, let the motors rotate in opposite directions, A running faster than B. The motion of C now depends upon the difference of speeds of A and B. When a load is put on C, the motion of A is retarded, while that of B is assisted, hence B takes less current, and A takes more. The torques on the two motors, due to the load on C, are now of equal amount, but of opposite sign. As the load on C is increased, the speed of A is reduced, and that of B increased, until the two are equal, and C comes to rest. B is now acting as a generator, and sending current into A. If the load on C is simply that due to friction, the process cannot be carried further. But if the load on C is reversed, the speed of B becomes greater than that of A, and the motion of C is reversed. In the steering gear designed by the Union Electricitäts Gesellschaft, the intermediate wheel is made to actuate a rudder by differential action. The motion is reversed by making the speed of one motor greater or less than that of the other.—Mr. Quick then exhibited Weedon's apparatus for the measurement of the expansion of solids. This method is claimed to be independent of knowledge of optics on the part of the student. The expansion is read directly by means of a pair of micrometers. Precautions are taken to prevent errors due to radiation. Mr. Lehfeldt asked what precautions were taken to prevent the movement of the micrometer supports. Mr. Stansfield described a form of apparatus in use at Chelsea Polytechnic; it was a simple contrivance, in which changes of length were measured by a micrometer. Mr. Quick, replying, thought the instrument referred to by Mr. Stansfield pre-supposed a knowledge of optics.—Mr. Lehfeldt then read a paper by Dr. Donnan on the theory of the Hall effect in a binary electrolyte. In 1883 Roiti investigated the subject of a possible Hall effect in electrolytic solutions. He failed to obtain any positive result. Recently the question has been examined by Bagard, who noticed certain effects in aqueous solutions of zincic and cupric sulphates. Meanwhile, negative results have been observed by Florio. The author therefore discusses what effect might be expected by theory, on somewhat the same lines as those of Van Everdingen, jun., taking a more general case. So far as the present discussion goes, the author's theory is wholly in favour of the negative results of Roiti and Florio. It would appear that Bagard measured a phenomenon not contemplated by the theory as stated in the present treatment. Van Everdingen originally supported the positive results of Bagard; but his work, unfortunately, was rendered incorrect by the accidental omission of a numerical factor. He has since discovered the slip in his calculations, and now agrees with the author's conclusions.—The Chairman proposed votes of thanks to the authors, and the meeting adjourned until October, this being the last of the session.

Linnean Society, June 16.—Dr. A. Günther, F.R.S., President, in the chair.—Prof. J. B. Farmer and Mr. W. G. Freeman demonstrated the action of germinating peas, cress, and barley in causing the deoxidation of a watery solution of methylene blue to a colourless liquid on shaking up the latter with air, while on adding a drop of hydrogen peroxide the blue colour was restored. Green plants placed in the solution were found to act in a manner precisely similar to the seedlings, though the action may be modified by assimilation in sufficient light (see p. 185).—Mr. F. Enock exhibited and made remarks on the eggs of an hemipterous insect containing living parasites (*Prestwichia aquatica*), of whose life-history and habits he gave a detailed account (see p. 175).—Prof. Herdman, F.R S., exhibited some dissections, microscopic preparations, and drawings to illustrate the presence of modified pedal muscles in the oyster. It was shown that there was reason to believe that these muscles, the insertion of which into the shell had been noticed in the American oyster by Ryder and Jackson, were the representatives of the *protractor pedis* of other Pelecypoda. But, as the oyster has no foot in the adult, the muscles have been modified in their distribution and have acquired a new function.—Mr. Miller Christy read a paper entitled "Observations on the seasonal variations of elevation in a branch of a horse-chestnut tree."—A paper was read by Mr. G. W. Carpenter on *Pantopoda* collected by Mr. W. S. Bruce in Franz-Josef Land, in which he recorded the existence of eleven species, one of which he described as new. Of this, *Nymphon piliferum*, a detailed description was given, as of a new variety *Nymphon piliferum* var. *abbreviatum*.—A paper was read by Mr. J. E. Duerden on the morphological relationship of the Actiniaria and Madreporaria.—Dr. C. Forsyth-Major communicated a paper on some fossil Leporines, an abstract of which was given by Prof. Howes. The author's investigations are based on the description of Miocene fossils collected by himself in Sardinia, France and Italy, and on specimens preserved in the Museum of Natural History.

PARIS.

Academy of Sciences, June 20.—Centenary of the foundation of the Conservatoire des Arts et Métiers, by M. Laussedat.—Actinometry in experimental balloons, by M. J. Violle.—On the study of the upper atmosphere, by M. L. Cailletet. An account of an experimental balloon ascent of June 8. The balloon was fitted with self-recording instruments, the lowest reading of the barometer, 118 m.m., corresponding to a maximum height of 13,700 metres.—On the boiling point of liquid ozone, by M. L. Troost. The temperature was determined by means of an iron-constantin couple, previously standardised in ice, boiling methyl chloride, nitrous oxide, ethylene, and oxygen. Several measurements were taken, the ozone always boiling steadily at − 119° C.—Preparation of crystallised calcium, by M. Henri Moissan. After a historical review of previous work on the subject, two methods are described which furnish calcium in white, hexagonal crystals (see p. 209).—On the classification of the Tunicates, by M. Edmond Perrier.—New gases in atmospheric air, by MM. Ramsay and Travers. An account of the discovery of neon and metargon.—On the Rubiaceæ of the Madagascar flora, by M. Emm. Drake del Castillo.—Comet discovered at the Observatory of Nice, by M. Giacobini.—Provisional elements of the Perrine comet (June 14, 1898).—Observations of the Coddington comet, Perrine comet (June 14), and the Giacobini comet, made at the Observatory of Toulouse with the Brunner equatorial, by M. F. Rossard.—Observations of the new Perrine comet (June 14) made at the Observatory of Paris, by MM. G. Bigourdan and G. Fayet.—Observations of the Coddington comet (June 11, 1898) made with the large equatorial at the Bordeaux Observatory, by M. L. Picart.—Application of interference fringes to the study of micrometers, by M. Maurice Hamy. A half-silvered lens of very slight curvature is fixed to the body of the micrometer, and a mirror to the moving portion of the instrument, the whole is illuminated with monochromatic light, and the method of fractional excess applied to the Newton's rings thus produced.—The equivalence group and kinematic bases, by M. Jules Andrade.—On the stability of equilibrium, by M. L. Lecornu.—On an apparatus called the anemotrope, by M. Maillet.—An optical method for measuring lengths up to several decimeters, by MM. A. Perot and Ch. Fabry.—Influence of tempering upon the electrical resistance of steel, by M. H. Le Chatelier. The resistance of steel is not influenced by tempering at temperatures below 710°, the temperature of recalescence. The resistance after tempering at 850°–1000° is about double that of the untempered metal. Some chrome and tungsten steels were also studied. At high temperatures chromium exaggerates the increase of resistance produced by tempering. Tungsten makes practically no difference.—On the rectification of alternating currents, by M. P. Janet.—On the paradoxical multiplication of a discharge derived from a condenser, by M. R. Swyngedauw.—Electrical resistance of the human body, by M. Dubois. The body acts as a condenser with liquid dielectric, of a capacity of about 0·165 microfarad. Under the action of continuous currents the resistance of the body may fall from 51,500 to 3030 ohms. But at any stage of this variable state, if the resistance be measured by a condenser method, with discharge through a ballistic galvanometer, the resistance is found to be invariable, about 400 ohms.—On the thioantimonites of the metals of the alkaline earths, by M. Pouget. The thioantimonites of barium, strontium, and calcium, of the form $R'_3.Sb_4S_9$, are described.—Pyridine bases, by M. Marcel Delépine. Thermochemical data are given for pyridine, piperidine, chloropiperidine, dipiperidine and δ-amidovaleraldehyde.—On some bases derived from piperidine, by M. G. André.—On some bromine derivatives of morphine, by M. H. Causse.—On some new aromatic diurethanes of piperazine, by MM. P. Cazeneuve and Moreau.—Action of chlorine upon ethylene chloride in presence of aluminium chloride. Chlorination of acetylene, by M. A. Mouneyrat. Ethylene chloride heated alone with $AlCl_3$ gives acetylene and hydrogen chloride. If chlorine is passed into the mixture, $CHCl_2.CHCl_2$ and $CH_2Cl-CCl_3$ can be isolated from the product. Chlorine and acetylene combine together quietly if all traces of oxygen are excluded.—Synthesis of symmetrical tetramethyl glutaric acid, by M. E. E. Blaise.—On a crystalline compound of acetylene with cuprous chloride, by M. Chavastelon.—On the cuticle of the palm of the hand and its evolution, by M. A Cannieu.—Classification of the Molgulideæ, by M. Antoine Pizon.—On the proboscidian nervous system of the Glyceræ, by M. Ch. Gravier.—On the first origin and development of nephridia in Annelids, and on the parallelism of their regenerative and embryonic ontogeny, by M. A. Michel.—On the buccal apparatus of the Acarina, by M. A. Brucker.—Study of the defensive glands in some Coleoptera, by M. L. Bordas.—On the oligocene formations occurring in Algeria (Constantine), by M. E. Ficheur.—The micro-organisms of lignite, by M. B. Renault. Micrococci are found in abundance in lignites.—On the use of manures in horticulture, by MM. Alexander Hébert and G. Truffaut. Plants treated with suitable manures showed on analysis the same composition as similar plants grown without the addition of fertilising materials, but the final weight in the former case was double that in the latter.

CONTENTS.

THURSDAY, JULY 7, 1898.

MUSEUMS.

Essays on Museums and other Subjects connected with Natural History. By Sir William Henry Flower, K.C.B., &c. Pp. xv + 394 (London: Macmillan and Co., Ltd., 1898.)

SIR WILLIAM FLOWER'S name is so intimately associated with the subject of museum management and organisation, that all naturalists who have been accustomed to look to him as their guide in this direction will be glad to have his writings collected into one volume for reference. The fact that the twenty essays and the four biographical notices have already been published elsewhere in no way detracts from their value, since the utterances of acknowledged leaders always possess historical interest, apart from the influence which they may have exerted upon contemporary thought.

Although the present volume deals with museums in the first place, there are altogether four sets of essays—the first treating of museums, the second of general biology, the third of anthropology, and the fourth consisting of biographical sketches of Rolleston, Owen, Huxley and Darwin. This arrangement, although upsetting the chronological order in which the various essays appeared, is very convenient for the reader and to some extent—but not wholly—compensates for the absence of an index, an omission to which we feel bound to call attention in these days of overwhelming scientific literature, when writers on scientific subjects are expected as a solemn duty to the reading public to give every facility for reference to the contents of their volumes. We are afraid, moreover, that the author himself is likely to suffer from this omission; for there is so much in his writings that one desires to remember and to quote, that unless notes are made as the pages are perused, the busy worker in science is likely to be put to endless trouble in endeavouring to find a passage which may have struck him at first reading as worthy of selection for future use. It is true that the various essays have their contents set forth at the commencement of the volume, but it is generally admitted that such tables of contents are very poor substitutes for a good index. In calling attention to this defect we are in reality paying the author the compliment of recording the opinion, which will be generally endorsed, that his writings have more than an ephemeral interest.

Of the leading ideas which run through Sir William Flower's essays on museums, the importance of such establishments as educational institutions is more than once dwelt upon and cannot be too strongly emphasised. At the present time, especially when County Council Technical Instruction Committees are wavering in their policy with respect to the endowment of museums, it is of interest to read the following passage given in an address to the Museums Association in 1893:—

"One cannot help considering how much might have been done if only a moderate portion of that large sum of money obtained a few years ago by the tax on brewers, and handed over to the County Councils to spend in promoting technical education, had been used for erecting museums, which might have taken a permanent place in the education of the country. Every subject taught, in order to make the teaching real and practical, should have its collection, and these various collections might all have been associated in the county museum under the same general management. The staff of teachers would assist in the curatorial work, and thus a well-equipped central college for technical education might have been formed in every county, sending out ramifications into the various districts in which the need of special instruction was most felt, and being also the parent of smaller branch museums of the same kind wherever they seem required" (pp. 34-35).

Some few of the counties have assisted in maintaining their local museums, but these are exceptions. In districts which are rural and agricultural, and where such institutions would be particularly valuable, little or nothing has been done. Those counties which have adopted the frittering-down policy of decentralisation have left themselves without adequate funds for the purpose. It may be doubted whether the sporadic instruction in those hardy perennial subjects of cookery, dressmaking and ambulance, which come sufficiently near the definition of technical instruction to entitle local committees to claim their share of the beer money, is ever likely to be of such lasting value to the welfare of the country as the foundation of educational museums. At any rate the present writer has no doubt on this point, whatever the attitude of County Councillors may be, and it is tolerably certain that in the present state of public opinion no auditor would be likely to challenge the expenditure of the technical instruction grant for such a purpose.

Another idea which Sir William Flower constantly urges is the importance of competent curatorship. Again and again has he insisted, during many years, upon the necessity for high scientific attainments on the part of those entrusted with the care of museums. In 1893, for example, in the same address as that from which we have already quoted, he told the museum curators then assembled that they were not, as a class, properly appreciated by the public. As to the qualifications he said:—

"Now, a curator of a museum, if he is fit for his duties, must be a man of very considerable education as well as natural ability. If he is not himself an expert in all the branches of human knowledge his museum illustrates, he must be able to understand and appreciate them sufficiently to know where and how he can supplement his own deficiencies, so as to be able to keep every department up to the proper level. His education, in fact, must be not dissimilar to that required for most of the earned professions" (p. 35).

Again, in the third essay of the present volume, based on statements made in 1891 and 1895 on the subject of local museums, he says:—

"You might as well build a church and expect it to perform the duties required of it without a minister, or a school without a schoolmaster, or a garden without a gardener, as to build a museum and not provide a competent staff to take care of it.

"It is not the objects placed in a museum that constitute its value so much as the method in which they are displayed, and the use made of them for the purpose of instruction" (p. 55).[1]

1 In this essay Sir Wm. Flower, speaking of the desirability of preserving, as an interesting survival, the parish stocks where they are still in existence, says that he knows of only one—in the village of Dinton, near Aylesbury. The writer knows of others at Brading (Isle of Wight), and Abinger, near Dorking.

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Closely connected with the high qualifications which should be possessed by curators is the question of their remuneration and the inducement which such a career offers to men of scientific training. The author's remarks on this point may appear despondent, but they are, unfortunately, only too justifiable.

"In a civilised community the necessities of life, to say nothing of luxuries (which we do not ask for), but the bare necessities of a man of education and refinement, who has to associate with his equals, and bring up his children to the life of educated and refined people, involve a certain annual expenditure, and the means afforded by any occupation for this necessary expenditure give a rough and ready test of the appreciation in which such occupation is held" (p. 35).

Judged by this standard the museum curator stands very low in public estimation. Some consolation, however, may be derived by this class of scientific workers from the consideration that their position is not very different from that of the scientific enthusiast who devotes his life to research in any branch of pure science which has no immediate market value. The consolation is confessedly a very poor one, but the person with the necessary "scientific qualifications" who accepted the munificent stipend of 50*l.* per annum (with rooms, coal and gas) as resident curator, meteorological observer and caretaker of the museum and library in a certain town—of which the only redeeming feature appears to be that it was less wealthy than another town which offered 125*l.* to its museum curator—may find his case paralleled by looking at the advertisements for science teachers which occasionally appear in these columns or elsewhere, where men having an expert knowledge of several branches of science are invited to accept appointments in technical institutes, where their duties are irksome and heavy and their responsibilities great; where their time is taken up in drudgery which crushes enthusiasm and destroys originality, and for which they are offered a stipend that many a butler in a wealthy family would look at with contempt. The position of museum curators is all of a piece with the position of other workers in pure science; and until the so-called "practical man," in whose hands the administration of the technical instruction money has been placed, has been educated off the face of this country or superseded by legislation, there is very little hope of amelioration. It is instructive to note that in 1853 Prof. Edward Forbes said of museums[1]:—

"In most cases they are unassisted by local or corporate funds, and dependent entirely upon the subscriptions of private individuals. Indeed, any attempt to favour the establishment of public museums and libraries through the application of local funds is opposed with a horrible vigour more worthy of a corporation among the Cannibal Islands than within the British Empire. The governing bodies of too many of our towns include no small proportion of advocates of unintellectual darkness."

The writer could put in evidence certain local newspapers—published in a town not thirty miles from London—where an attempt to found a public museum and library was met, only last year, in the very same spirit which Prof. Forbes described in the above paragraph nearly half a century ago. So little have we advanced in this direction in fact in the rural districts, and even in many of the provincial towns, that the remarks on local museums made by Forbes in 1853 read like the precursors of Sir William Flower's observation on the same subject in the volume under notice:—

"It so happens, however, that the value and excellence of almost every provincial museum depend upon the energy and earnestness of one, two, or three individuals, after whose death or retirement there invariably comes a period of decline and decay" (Forbes, 1853).

"Voluntary assistance is, no doubt, often valuable. There are many splendid examples of what it may do in country museums, but it can never be depended on for any long continuance. Death or removals, flagging zeal, and other causes, tell severely in the long run against this resource" (Flower, 1895).

The history of too many local museums is unfortunately comprised in these paragraphs, and the writer has vividly in mind some very pregnant remarks in this strain made by Sir William Flower at Chingford in 1895, at the opening of that excellent little local museum founded by the Essex Field Club. We can only add that every one of the seven essays on museums reprinted in the present volume deserves most careful perusal, and all who are interested in the subject will do well to study them.

The eight essays on general biology, which follow those on museums, abound with interesting topics. Although, no doubt, many readers of these columns are quite familiar with these addresses, it is refreshing to have brought before us again the views of the author on the development of the Ungulata (Royal Institution lecture, 1873), his remarks on classification and nomenclature (Address to Section D, British Association, 1878), and the two lectures on whales delivered, respectively, at the Royal Institution in 1883 and at the Royal Colonial Institute in 1895. Throughout all these biological essays runs the leading idea of evolution, of which doctrine Sir William Flower has always been a consistent and temperate advocate. The perusal of some of these essays induces feelings akin to those with which the old soldier recounts his past campaigns. The arguments with which hostile criticism had to be met in the early days may now have lost their point, but the younger reader must never forget that the great battle of evolution has been fought and won since Sir William Flower entered the field, and a calm consideration of the contents of the present volume will show that no insignificant part in this struggle has been borne by its author. In fact, one of the most prominent episodes in the history of the spread of the new doctrine beyond the circle of workers in science was the memorable address on "Recent Advances in Natural Science in relation to the Christian Faith," given at the meeting of the Church Congress at Reading in 1883, and reprinted as the ninth essay of the present volume. If the consideration of these biological essays calls forth any feeling of regret on the part of those who are now actively engaged in carrying on the work of research, it must be that their distinguished author was unable by virtue of his official duties to enter into the later controversies which have divided the school of evolutionists. Sir William Flower's essays read like very "orthodox" Darwinism; yet there are few whose opinions on such topics as heredity and

[1] "The Educational Uses of Museums." (Introductory lecture, Session 1853–54; Museum of Practical Geology.)

the transmission of acquired characters, and the bearing of the teachings of Prichard, Galton and Weismann on the original theory of Darwin and Wallace would have been of greater value to the present generation of workers. On one point which has from time to time been raised in connection with the theory of evolution, viz. the rate of modification of organisms in past time, the author has recorded his view in the following terms :—

"There is no proof whatever that the laws of variation and natural selection, if such be the laws which lead to the introduction of new forms and the extinction of old ones, were ever more potent than they are at present" (p. 109).

The section on anthropology comprises five essays of which the last, "Fashion in Deformity," is familiar to our readers as one of NATURE Series. There are two presidential addresses to the anthropological section of the British Association, viz. York, 1881, and Oxford, 1894. The presidential address to the Anthropological Institute on "The Classification of the Varieties of the Human Species" was delivered in 1885, and the lecture on "The Pygmy Races of Men" at the Royal Institution in 1888. It is now familiar history that Sir William Flower was among the pioneers who in this country helped to raise anthropology to its present position among the natural sciences. It is strange that the science of man should have made less progress than that of the other subjects dealt with in these essays. The author says in the preface :—

"Upon the third subject, the main point of which is the advocacy of a more systematic study of Anthropology in this country, there has been, as it seems to me, less advance than in either of the other two ; and in putting forth its claims for greater recognition I felt for a long time as one crying in the wilderness."

Among recent signs of progress the author notes with satisfaction the establishment of a professorship of anthropology in the University of Oxford, a fitting place for such a chair being that University which gave a home to the first systematically arranged anthropological collection brought together and presented by another great pioneer in this field of research, General Pitt-Rivers.

In concluding this notice we can only say that while giving expression to the widely felt regret that the author should have been compelled to withdraw temporarily from active administrative duties, it is a matter of congratulation that he has been enabled to turn his enforced leisure to such useful account as the publication of the present volume. R. MELDOLA.

CLERK MAXWELL'S INFLUENCE ON MODERN PHYSICS.

James Clerk Maxwell and Modern Physics. By R. T. Glazebrook, F.R.S. Pp. viii + 224. The Century Science Series. (Paris and Melbourne: Cassell and Company, Ltd., 1896.)

THE sketch of Clerk Maxwell's life and work which Mr. Glazebrook has written well illustrates the immense influence which Maxwell has exerted on modern physics. Of his work it can be said, in a truer sense than of much that has been accomplished, that it lives after him. Its vitality is apparent in all kinds of ways, and in nearly every region of physical inquiry. In a certain measure the developments of his great scientific generalisation, though they do not yet lie in perspective before us in the same way, recall those of Newton's theory of gravitation. There is the same kind of power of intuition displayed in arriving at the general theory, the same kind of partial development, by the methods most ready to hand, of its consequences, and, to a certain extent at least, the same kind of presentation of the whole subject by methods which were not quite those of discovery. Now we have other workmen with tools of keener edge and finer temper, perhaps, adding here and taking away there to improve its symmetry and remedy its occasional want of logical consistency, and, what is of far more importance, extending the scope of its results, until electric wave-theory and experiment threatens to become a subject almost too great for any single investigator to intelligently follow in all its ramifications.

It is remarkable how quickly, sometimes, the natural philosophy of a science is built up, when observation and classification have been carried sufficiently far. At the right moment, when in a sense everything has been prepared, the genius arrives, and the chaotic elements spring into relation with each other and to life at his touch. Not that there is nothing really to be done ; on the contrary, the task is one which only genius could accomplish. Much has been achieved by other workers, who have spent laborious lives in research ; indeed, the actual toil by which the data have been collected and classified, and their relations traced, has been spread over centuries, and the actual work of those who unite all in a general theory is small in comparison. But how great the result is, is immediately made known by its fruits.

The present state of the science of electricity and magnetism is due to advances of this kind made by a close succession of men of genius, of whom one of the greatest is happily still with us. The natural philosophy of electricity, which may be said to have begun with Oersted and Ampère, is due in no small measure to the experimental researches and truly philosophical ideas of Faraday. The first consistent statement of it was given by Thomson, who expressed in mathematical language Faraday's ideas of lines of force, and deduced by a dynamical process the consequences of Faraday's experimental discoveries. Thomson's theory was at bottom one of action in a medium, and from it he obtained by deduction and experimental verification important discoveries of his own. Upon this quantitative philosophical discussion Maxwell to a great extent based his form of the theory, the essence of which is its dynamical character, and its explicit transference of the phenomena from the conductors and magnets and circuits to the electromagnetic field. The theory of light, though far from being the end, is the crown of the whole work.

The manner of scientific progress was traced very clearly by Comte, but the distinction between the observational and classificatory stage of a science and its natural philosophy stage, and the importance of the latter, have not been so well appreciated by other writers. It was said, as many people know, by a celebrated philosopher, that the theory of gravitation was really contained in the laws of Kepler, to whom therefore, and not to Newton, the discovery of gravitational attraction was due. The utterance was a remarkable one for a philosopher who always contended that the object of philosophy was, as no doubt it is, to find unity in diversity. It only shows that even divine philosophy does not always suffice to lift a man above national iealousy and prejudice. The law of gravitation was the one uniting principle, the unity which explained the whole range of planetary motions, brought into one view the motion of the moon and the fall of a stone, enabled the motions of the heavenly bodies to be computed, and the places of the bodies predicted for a long range of future time, and gave the keynote for those great investigations of the future and the past of the solar system, and of our own terrestrial system within it, which have been carried out since Newton's time by his followers. Some of the greatest of these researches —we may well be proud of the fact—have been carried out by scientific men of our own country, whom this age has either seen or still possesses.

Like Maxwell's electrical theory the Newtonian gravitation raised, as does every really science-making theory, questions which it did not answer. There is the further problem of the *rationale* and mechanism of gravitation, and questions of its application to close aggregates of particles, and our minds are suddenly turned from the stars in their courses to the structure of molecules and the nature of inter-molecular action. The new problems bristle with difficulties far greater than those which have been surmounted, the new standing ground attained has only disclosed steeper heights to be scaled.

So it has been in the electromagnetic theory of light. The conception of a plane wave of light as a propagation of a disturbance in which there is electric, and at the same time magnetic, intensity varying as a simple harmonic function of the time, and its minute verification by Hertz and his pupils, and by others, has opened whole vistas of problems we cannot hope to solve for many a day. There are the primary questions, whether the theory of the ether, according to which light vibrations are transmitted as waves of distortion in a medium for which the ratio of the rigidity modulus to the density is enormous, has any foundation in fact, and, if so, what is the relation of the varying electric and magnetic forces to the material vibrations; how do these electric and magnetic forces arise, and how are they maintained in the ether: in short, how does matter act upon ether and ether uopn matter. In these are involved others of perhaps a more limited or special nature, the mode of localisation of energy in fields in a steady state, and the mode of flow of energy in cases of transference. The complete solution of these would yield the secret of voltaic action, and, it might be, reduce the voltaic cell to a magneto-electric machine, and tell us in what magnetic and electric induction themselves consist.

That Mr. Glazebrook's book can be of great interest, even to those who are more or less familiar with Campbell and Garnett's life of Maxwell, we can fully testify. It is true that most of the early reminiscences given in the biographical sketch are to be found in the life; but there are personal recollections of Mr. Glazebrook's, and several other touches here and there, which give this part of the work a charm and value of its own. This is followed by one or two specimens of the verses which Maxwell from time to time threw off, sometimes in a serious mood, sometimes in a gay, but always with a grace of expression and originality (and at times a quirkiness amounting almost to caprice) of thought peculiarly his own. The specimens chosen are the inimitable parody in verse of Tyndall's Belfast Address, the verses on "Molecular Evolution," written on the same occasion, the verses addressed "To the Committee of the Cayley Portrait Fund," and the song of the Rigid Body. A few more might have been included without giving too much illustration of this side of Maxwell's versatile nature. The rapidity and ingenuity of his verse composition were extraordinary. The writer well remembers seeing on a sheet of the article "Elasticity," written by Lord Kelvin for the ninth edition of the "Encyclopædia Britannica," a copy of verses which Maxwell had jotted down before returning the proof. It began:

> "Vex not my ears, ye crystal spheres,
> Your harmony's insipid, O.
> But play again that tuneful strain,
> My parallelepiped, O."

And so on,

> "Finding great fun in twenty-one
> Elastic moduluses, O!"

for six or eight verses, with marvellous rhymes for the numerous, and for purposes of verse somewhat intractable, technical terms with which a mathematical discussion of the elasticity of an æolotropic solid abounds.

His letters also were very beautiful, and serve as a comforting reminder that if letter-writing is a lost art, it survives still in some men of playful fancy and lightness of touch as a natural gift. Of these only a few specimens are given by Mr. Glazebrook, and hardly more could have been included within the limits of space at his disposal.

The rest of the book consists of a sketch of Maxwell's work in Colour Vision, Molecular Theory of Gases, and Electricity. This we need not review. Suffice it to say that it is thoroughly clear and trustworthy, and will well repay perusal by the physicist already acquainted with later developments of Maxwell's work. Mr. Glazebrook has also found room for a valuable concluding sketch of the work of Hertz and his followers, which was founded on Maxwell's theory, and afforded its experimental verification.

There are one or two misprints. At p. 68, the Don referred to oddly enough turns a *watch*; and there is another, near the beginning of the foot-note on p. 131. The biographical reference to George Green, of Nottingham, on p. 158, is not quite accurate.[1]

[1] It is strange that the ninth edition of the "Encyclopædia Britannica" should contain no biography of Green. He was undoubtedly a great genius, and made an impression, not merely on mathematical physics, but on pure analysis, which will never be effaced. It has been said in jest, but with considerable truth, that applied mathematics is made up of continual applications of Green's theorem. Of this enormously powerful theorem a more lately discovered relation, which is very fundamental in the theory of functions of a complex variable, and which is generally quoted as Riemann's theorem, is only a particular case.

Green's career was certainly very remarkable: but Mr. Glazebrook is in error as to his original occupation. Up to the year 1829 he assisted his father, who was in business first as a baker in Nottingham, and afterwards as a miller in the neighbouring village of Sneinton. In that year, when Green was thirty-six years of age, his father died, and not long after Green

Mr. Glazebrook is to be congratulated on having produced an attractive and useful book. The only fault of the sketch is that it is too small for the subject, but for that the author is not responsible. And after all the time has hardly yet come for a complete appreciation of Maxwell's influence on modern science. A. GRAY.

FUNAFUTI.

The Atoll of Funafuti, Ellice Group: its Zoology, Botany, Ethnology, and General Structure, based on Collections made by Mr. Charles Hedley of the Australian Museum, Sydney, N.S.W. (*Memoirs Australian Museum, Sydney*, No. iii. Parts 1–6, 1896–1898.)

THE Pacific Ocean is divided into basins by a series of island chains and submarine ridges. The most conspicuous chain begins in Malaysia, crosses New Guinea, and, sweeping round parallel to the eastern coast of Australia, runs past New Caledonia and Lord Howe Island to New Zealand. The islands of this chain all rise from the Melanesian plateau, and they are continental both in structure and in the characters of their recent and fossil faunas. Outside this series is another, which Hedley calls the Marshall-Austral chain, including the Ellice, Phœnix, Marshall, Gilbert and Samoan archipelagoes, and perhaps represented still further to the south-east by the great Patagonian platform that projects north-westward from the coast of South America. All but one of the members of this chain are oceanic in structure and inhabitants; the exception is Samoa, where the chain crosses the line of elevation that passes from the Tonga Islands, through Samoa, and on northward towards the Sandwich Islands. In the angle between this line and that of the Austral-Marshall series is one of the deep open basins of the Pacific. A belt of apparent subsidence lies on each side of the Tonga-Sandwich line, marked amongst other points by the decreasing size of the atolls as the two belts are approached. It is the atolls that border these two belts of subsidence that offer the best chance of settling the great coral island controversy. Funafuti, as one of the easternmost of the Ellice Islands, is in as good a position for a test boring as could be selected; for it is near the depression between the Ellice Archipelago and the Tonga-Sandwich Island line, and is on the south slope of one of the deep open basins of the Pacific. The mechanical difficulties, however, proved too serious at the first attempt. But the expedition of 1896 was valuable not only from the lessons taught as to the methods of boring in coral reefs, but as it afforded the opportunity for a detailed study of the island. Captain Feild worked out the submarine contour, and the naturalists collected materials for a detailed study of the fauna and ethnology. Monographs of various types of Indo-Pacific islands are greatly to be desired before the primitive characters have been lost. We must therefore welcome the valuable monograph on Funafuti, based on the extensive and systematic collections of Mr. Hedley, which have been promptly worked out by the officials of the Sydney Museum. Six parts of the monograph have been received, amounting to 368 pages, and illustrated by twenty-two plates. Mr. Hedley contributes a general introduction, in which he clearly states the geomorphological position of the island, and describes its geological structure and its people. It is interesting to notice that, in spite of the slight depth reached by boring in 1896, Mr. Hedley infers from the general characters of the atoll that its structure supports the Darwinian theory. Mr. Hedley also contributes a series of most interesting notes to the other articles, and shows in them that he is as competent a naturalist as he is a keen collector.

The second part begins the description of the fauna with the account of the insects and Arachnida by Mr. Rainbow, of the Crustacea and Echinodermata by Mr. Whitelegge. The third part contains Mr. Waite's report on all the Vertebrates except the birds, which are described by Mr. J. North in the first part, and also some of the Alcyonaria and Enteropneusta. The accounts of these two groups are concluded in the fourth part, which also contains the report on the sponges. Mr. Hedley himself contributes the ethnological section, which forms the fifth part. The sixth section, the last we have received, contains one of the contributions of most interest at the present time—Mr. Whitelegge's account of the corals. Mr. Hedley tells us that the chief impression the coral reefs of the island made upon him was their poverty both in individuals and species. More genera and species can be collected, he tells us, in a single tide on the reefs of Queensland, New Guinea and New Caledonia than he could find at Funafuti in several weeks' search. Nevertheless, Mr. Whitelegge finds forty-seven species in Mr. Hedley's 170 specimens, and divides into distinct species corals which Mr. Hedley had especially collected to illustrate different forms of the same. But Mr. Whitelegge only adds two new species, which for corals is an unusual act of moderation.

In a series of memoirs such as this, it is of course inevitable that the standard varies. One factor that has a marked influence on the merit of the articles is the size of the group concerned. Mr. Waite's note on the indigenous mammal is a complete monograph, and its accuracy is apparently unimpeachable; but when we come to the sections on the Arthropods we find that Mr. Rainbow has to describe all the insects, including representatives of the orders Coleoptera, Hymenoptera, Lepidoptera, Diptera, Hemiptera and Orthoptera, and also that he has to describe the Arachnida. It is therefore Mr. Rainbow's misfortune, not his fault, that his determinations cannot hope for the same degree of finality as those of his colleagues who deal with smaller groups. But Mr. Rainbow's contribution is no less useful; only it must be judged as one of those preliminary descriptions which record the general constituents of a fauna, and thus sort it out ready for criticism and revision by the specialists. The specialists are few and insects are many. The specialist monographers cannot keep pace with the collectors. Hence if the work had waited until the

disposed of the business in order to obtain more leisure for his studies and researches. His entering at Gonville and Caius College in 1833 at the age of forty, and his obtaining the fourth place in the mathematical tripos of 1837, the year of Griffin, Sylvester and Gregory, are better known facts. His University career, whatever else it may have done, apparently did not tend to make his earlier work more generally known, and he died in 1841 without that scientific recognition which was his due. That came later when William Thomson (Lord Kelvin), who was the first to recognise the tremendous importance of Green's work, obtained in 1850 the republication in *Crelle's Journal* of the famous "Essay on the Application of Mathematical Analysis to the Theories of Electricity and Magnetism" [*Crelle* 40, 44, 47 1850, 1852, 1854)], originally published in 1828.

collection had been distributed and described by the experts, the account of the arthropod fauna would not have been available until the present interest of Funafuti had passed.

OUR BOOK SHELF.

Weather Lore. A Collection of Proverbs, Sayings and Rules concerning the Weather. By Richard Inwards, F.R.A.S. Third edition. (London: Elliot Stock, 1898.)

MR. INWARDS is to be congratulated on the fact that his industry, exhibited in the collection of quaint sayings concerning the weather, has been rewarded by the demand for a third edition of his book on weather lore. If this popularity indicates a greater taste for an acquaintance with unscientific rules to be applied for the purposes of weather prediction over long periods, than an appreciation for the forecasts made on sound principles but for shorter intervals, it would imply a retrograde movement in meteorological education; but we imagine the demand for the book arises rather from the curious information it contains, and the old-world wisdom it exhibits, than from its scientific teaching and character of guide to weather prophecy. This edition is apparently much increased in size, and some features of a distinctly scientific value have been added. We notice a frontispiece in which the typical forms of cloud are well illustrated, and the average height at which these clouds float is marked by the marginal introduction of well-known mountain summits, calculated to bring home to us a correct notion of the elevation at which these clouds circulate. Cloud study is deserving of much more attention than it generally receives, and we welcome any attempt to induce more regular examination of the forms and motions of the familiar spectacle clouds present.

Then the section on the average dates for the first flowering of plants and appearance of migratory birds, which is either new or has been enlarged, should lead to more accurate observation of familiar phenomena. Such sections interest us much more than the proverbs and sayings which go to make up the bulk of the book. The arrangement of these proverbs seems to be much the same as in the first edition. Of the value of these, apart from their literary character, perhaps it is as well to say nothing. We follow the author or compiler in calling these rules proverbs, but the term is scarcely a happy one. A proverb has been defined as the wisdom of many and the wit of one, but in some cases, here preserved, it is difficult to recognise either the wit or the wisdom. They may give some evidence of national customs or of local manners, and sometimes display shrewd observance on the part of the authors; but this mass of endless detail, collected by many generations of weather-wise people, may become somewhat wearisome if taken in large doses. Yet, if we understand Mr. Inwards correctly, he implies that the persevering labour and continuous observation bestowed on weather signs have resulted in securing some insight into meteorological phenomena, and he recommends us to imbibe the general spirit of these rules and adages, and try to find where similar results have followed similar indications. This would lead to the detection of a number of coincidences no doubt, but it is not easy to see how true science would be advanced thereby.

First Stage Magnetism and Electricity. (The Organised Science Series.) By R. H. Jude, M.A., D.Sc. Pp. 350 + xv. (London: W. B. Clive, 1898.)

ALTHOUGH there are several books on these subjects prepared specially to cover the syllabus of the elementary examination of the Science and Art Department, the one before us has some peculiarities which renders the treatment different in many respects. The chief difficulty which the author has attempted to overcome is the conception of electrical potential, which so often forms a stumbling-block to the beginner. This he has introduced much earlier than usual, leading appropriately up to it. In this, the first part of the book, the author has further expounded in a simple manner the conceptions of the ethereal theory, thus bringing it within reach of the beginner. The second two parts deal with magnetism and electrodynamics, the main points of treatment being the emphasis of fundamental principles, the omission of the disputed points in the theory of the voltaic cell, and, as the author states, "a liberal use of the conception of potential gradient." Numerous illustrations are inserted in the text, and a great number of examples and examination questions are added.

As a first course on magnetism and electricity the book should prove serviceable.

Problems of Nature. Researches and Discoveries of Gustav Jaeger, M.D. Selected from his published Writings. Edited and translated by Henry G. Schlichter, D.Sc. Pp. ii + 261. (London: Williams and Norgate, 1897.)

THIS small volume has been formed by collecting together a number of Jaeger's brief essays on various important subjects. They are classified under three headings as Zoological, Anthropological, and Varia. The essays are highly ambitious, and lay down the law upon matters of the deepest difficulty with commendable brevity. Thus the fourteen zoological essays range from "The Origin and Development of the First Organisms" and "The Origin of Species" to "Inheritance," "The Animal Soul," and "The Development of the Vertebrate Type," and altogether occupy eighty-three pages. The essays classed as anthropological deal chiefly with the author's pronounced views on physiological processes, infection, immunity, constitutional strength, &c.

The author is apparently a man with an active original mind and a great respect for his own opinion. Subjects of such intricacy and difficulty are not to be handled so boldly except by those who have not been able to study, or have not cared to study all that has been said about them. Allowing for the dictatorial and peremptory style of the author, much that is suggestive and interesting will be found in many of the essays, as indeed we should expect from the writings of a man who was one of the first, if not the first, to suggest the continuity of the substance of the germ cells of parent and offspring as the biological basis of heredity. A letter, written to the author by Charles Darwin in 1869, and a second in 1875, are printed, and the latter also reproduced in facsimile. Both are very characteristic in their high appreciation of the work of another.

The book is well translated and edited. The printing is good, but the few illustrations are not well executed, the representation of a nerve-cell (after Max Schultze) on p. 9 being especially bad. E. B. P.

Medical Missions in their Relation to Oxford. By Sir Henry W. Acland, Bart., K.C.B., F.R.S. Pp. 92. (London: Henry Frowde, 1898.)

THIS is an address, with a series of notes, delivered by Sir Henry Acland to the Oxford University Junior Scientific Club at the beginning of last December, with the object of showing the valuable work which can be accomplished by men with scientific knowledge acting in connection with foreign missions, either as coadjutors or as appointed religious teachers, as medical practitioners, or as health officers. The needs of India for such men are especially referred to, and it is shown that the prevention of disease, or the care of the public health among various races under different conditions of climate, life, and character, as well as the treatment of disease under the same conditions, should be an essential object of foreign missions. The establishment at Oxford of a department where the complicated subjects bearing on the public health of India can be taught is warmly advocated.

It was with the idea of securing such means of study that Sir Henry Acland resigned his office into the hands of the Regius Professor of Medicine, Prof. Burdon-Sanderson, but, unfortunately, the University is not able to carry out the scheme, and it remains for some wealthy person to grasp the great importance of the various questions involved in the public health of India, and assist the University to provide the means required.

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.*]

Protective Mimicry.

I HAVE read, with special interest, both Sir George Hampson's remarks on certain cases of pseudo-mimicry and Mr. Ed. Poulton's answer to the same (NATURE, vol. lvii. pp. 364 and 389).

Now, as I am the person that was consulted on the subject by one of Sir G. Hampson's correspondents in India, I think myself entitled, and in a way even bound, as far as possible to remove some of the misgivings that seem to have crept into Mr. Poulton's appreciation as to the true bearing of the facts under discussion.

Though he agrees, on the one hand, with Sir G. Hampson as to the fact that "this and other like cases of mimicry are quite destructive of any interpretation of resemblance based on Bates' theory," he yet maintains, on the other, that "they do not similarly affect the Müllerian theory."

But this is precisely what I contend is contradicted by the facts in question. To make this clear, I shall only use Mr. Poulton's own statements and admissions.

"The Müllerian theory," he says, "supposes that a common type of appearance among distasteful insects in the same locality acts as a common advertisement to enemies, so that the loss of life which must ensue during the time in which each generation of enemies is being educated to avoid the owners of a particular type or pattern and colouring is shared between the species instead of being borne by each independently."

The theory, thus understood, seems to Mr. Poulton to be rather exemplified and confirmed than contradicted by the facts in question, and he therefore continues: "It is probable that *Teracoli* are on the whole avoided by birds; and if this is also true of the *Abraxas*, the resemblance may well be advantageous, in spite of the difference in station, even granting that the 'good round sum' of 6000 feet is an absolute barrier to the *Teracoli* below and the *Abraxas* above. But future investigation may show that they approach much nearer than this."

First of all this reasoning, which is openly all about admitted facts, looks rather as a running away from those facts to some wished-for possibilities. Besides Mr. Poulton grants, after all, that unless both types occur in the same locality and be exposed to the same enemies, no possible training of young birds can be conceived, and consequently no advantage can be supposed to accrue.

But what are the facts? For here, of course, I do not pretend to discuss what might take place in any possible supposition, nor even to find fault with the logical slip so very common among natural selection evolutionists, which consists in so confounding the simple admission that similarity of colour exists, or even is useful, as to conclude from it that it is therefore the result of usefulness.

Now, so long as we keep to facts, whether we consider the two species of butterflies themselves or their respective enemies, the conclusion is the same, and they both require distinct climatic conditions and distinct "habitats."

Willingly or not, we must resign ourselves to see the "good round sum" of 6000 feet, or rather the difference in climatic conditions and other "surroundings" represented by this difference in elevation in our regions of Southern India remain as an insuperable barrier between the above-named species of butterflies, and to much the same extent also between their enemies.

Far from coming into contact, therefore, they are thus kept by their habits apart from one another, and put under conditions quite different from those required for the possible application of even the Müllerian theory.

Finally, both from the evidence of these and many like facts and, as Mr. Plateau has so well demonstrated, from the trifling importance of colouring in the selection of insects by their enemies, it is, to say the least, difficult to see how the facts of similarity in colour, shape, &c.—which for shortness sake we may even call "mimicry"—can be interpreted or explained by any possible theory based on simple natural selection. And I would, in conclusion, remark that I distrust all such theories not, as Mr. Poulton seems to believe, "on the ground that the evidence is not demonstrative," but because, far from offering an intelligible and possible explanation of facts, they simply stand in contradiction with them and mislead us as to their real meaning.

J. CASTETS, S.J.

St. Joseph's College, Trichinopoly, India, June 8.

I DO not propose to deal with Mr. Castets' objections to natural selection in general. They have often been met before. As to the special case under discussion, he feels that his knowledge of the distribution of the two species is exhaustive enough to give him safe warrant for the assertion that they are invariably separated by a height of 6000 feet. If this conclusion is well founded, it is an important contribution to the facts of the case under discussion. Nevertheless neither this nor the climatic differences need affect the Müllerian theory if the barrier which separates the one form from the other is crossed by the enemies of both. The *Teracolus*-like appearance of the moth is remarkable, and separates it very sharply from its allies. It occurs on an elevated district surrounded by lower country in which the *Teracolus* abounds. The approximation is sufficient to render the Müllerian theory a probable explanation in view of the immense number of similar relationships accompanying a closer approximation in other parts of the world, and considering the complete absence of any other explanation; unless, indeed, Mr. Castets intends to imply, by so constantly dwelling upon one aspect of the environment, that the *difference* in climate is responsible for the *agreement* in appearance.

Oxford, June 30. E. B. POULTON.

Epidemics among Mice.

REFERRING to a paragraph in your issue of June 23 (p. 179), relative to the discovery by Dr. Issatschenko of a new microbe pathogenic to rats, I would call attention to some articles by Prof. F. Loeffler on epidemics among mice, &c., in the *Centralblatt für Bacteriologie und Parasitenkunde*, Band xi. pp. 129–141 (February 10, 1892), and Band xii. pp. 1–17 (July 5, 1892), which will be found translated in a Blue Book entitled, "Report of the Departmental Committee appointed by the Board of Agriculture to inquire into a Plague of Field-Voles in Scotland, with Minutes of Evidence and Appendices and a copy of the Minute appointing the Committee" (1893). Translations of the above papers form Appendix vi. of this Report; and Prof. Loeffler's second paper relates his successful efforts to employ the "Bacillus typhi murium" to destroy field-voles in Thessaly.

It would be interesting to know whether the microbe discovered by Dr. Issatschenko is the same as that described by Prof. Loeffler, or a different species. W. F. KIRBY.

Chiswick, June 25.

Remarkable Hailstones.

ON Sunday, June 26, a district to the south of Manchester was visited by a thunderstorm, which was remarkable for its accompaniment of heavy hail. The storm came from the same quarter as the cool surface wind, viz, north-east, and reached its height about 2.15 p.m.

Preceded by a lull in the heavy rain, hail, accompanied by lightning, began to fall, and continued to do so for five minutes.

The most noticeable fact was the peculiar shape of the hailstones. These were conical in shape, about $\frac{1}{2}$ inch long, and $\frac{3}{8}$ broad in widest part. In longitudinal section they showed (*a*) opaque white bands; (*b*) clear, colourless bands; (*c*) semi-opaque bands, dotted with more opaque portions.

All of those examined agreed in possessing transparent portions at the *vertex* and *base*. On making a transverse section through one of the opaque bands, it was seen to consist of (*a*) narrow clear channels intersecting the surface; (*b*) opaque masses, many of an uniform size, separated by the above-mentioned clear, transparent channels.

The general appearance of this transverse section inclined one to regard the stone as built up of a number of conical spicules, with their vertices pointing towards the vertex of the stone.

This was confirmed by the fact that one of the stones, whilst melting, was squeezed between the thumb and finger, and immediately fell apart into three distinct spicules.

Samuel N. Player.

126 Burton Road, West Didsbury, Manchester.

Dendritic Patterns caused by Evaporation.

I was glad to see the note (with illustrations) published in Nature (June 23) on this subject. Among the specimens which I did not mention in my paper are two microscope slides similar to those described by Prof. G. H. Bryan. They are botanical slides from the collection in my laboratory at Bedford College, and as they were bought specimens, I was not certain that they had been mounted in glycerine jelly, although I believed it was probably the medium used. I therefore laid them aside for future work, and am now pleased to find the probability confirmed. I wished also to make further experiments on the relation of the structure to the included specimen.

I should like to point out, however, that although the medium does not contain recognisable particles in suspension, we may look upon the jelly as representing material in an extremely fine state of division, as it were, so that the principle of formation may be similar to that in the other slides described.

July 1. Catherine A. Raisin.

Solar Halo of July 3.

In case it may interest your readers, I write to say that there has been a magnificent halo round the sun, lasting almost without interruption from 4 p.m. to 6 p.m.

It varied in intensity during the time of its visibility, and also in colour. When at its best it was distinctly bluish at its outer margin, shading through yellow to red; the more decidedly green and pink tints of the rainbow seemed to be wanting. But the most conspicuous feature of the apparition was the comparative darkness of the sky within the ring. The halo appeared as if fringing a dark storm-cloud; but that this was not really the case, was evident from the sun's appearance.

All day, in fact for several days past, the sky has been exceptionally much decorated with fantastic cirrus clouds, and this afternoon, at the time of the halo, veils of cirrus concealed almost all the blue; while a lower layer of cumulus clouds drifted up from the west and gradually obscured the sun, halo and all, for a time.

I do not know if the halo formed a complete ring round the sun, as trees partly concealed my view; but I was able to trace it for fully three-quarters of its circumference.

Bradfield, Reading, July 3. Catharine O. Stevens.

A Monochromatic Rainbow.

A curious rainbow was observed here on Friday evening last. Heavy rain falling in a dark southern sky formed the lower portion of one limb of a bow, extending about 10° directly towards the zenith. The red band alone was visible, and lasted *after sunset* (which occurred at 8.40 for our horizon, and some ten minutes earlier below the Howgill Fells), for a full quarter of an hour. A. J. K. Martyn.

Sedbergh, July 3.

CAST METAL WORK FROM BENIN.

Among the spoils, interesting to ethnologists, brought back from Benin by the punitive expedition under Admiral Rawson, was a large number of elaborately carved elephant's tusks, some of them of remarkable length; various smaller objects in ivory; profusely ornamented wooden panels forming doors and looking-glass frames, and hundreds of objects of great multiplicity of design cast in metal, both in the round and in high relief. The wonderful technical skill displayed in the construction of the metal objects, their lavish ornamentation, much of which is deeply undercut, and in nearly every case the high artistic excellence of the completed subject, have been a surprise and a puzzle to all students of West African ethnology. If they have now begun to recover from their surprise that work of such excellence, indicating skill born of long experience, should have come to light from among so barbarous a race, and that no whisper of its existence should have reached Europe, notwithstanding its great abundance (as attested by the numerous pieces exposed in London and provincial auction rooms, in addition to the hundreds of plaques and figures sent to the British Museum); there has, at all events, been as yet no elucidation of the mysteries—who were its manufacturers, where and when was it executed, and whence did they derive the knowledge of this art?

Although the city has been described as being, in the middle of the seventeenth century, "of greater civility than to be expected among such Barbarous People," none of the travellers who, within the past two or three hundred years, have left accounts of their visits to Benin, have described this metal work as a special feature of interest there. If the amount that has already found its way to Europe had been displayed in the king's or chiefs' houses, or in their public buildings, it could not surely have failed to attract attention and remark. The artificers and their appliances for the manufacture of works, on so large a scale, could hardly also, one would suppose, escape notice, or be passed over in silence, if observed. More than one traveller mentions seeing blacksmiths at work and turning out good workmanship, "considering the appliances they have"; but no foundry work or modellers in clay or wax are referred to.

Tusk-holders in the form of human-headed vases have certainly been alluded to; and the nearest approach to a description of the plaques is the "melted copper whereon are Ingraven their Warlike Deeds and Battels, kept with exceeding curiosity," mentioned in Ogilby's collection of African travels. Few, however, if any, of the plaques brought to Europe display warlike deeds or battle scenes. The accompanying illustrations are taken from examples lately acquired by the City of Liverpool, and described by Dr. Forbes in vol. i. No. 2 of the *Bulletin* of the Liverpool Museums—a recently established periodical, intended to make known the contents of the Derby (or Zoological) and the Mayer (or Ethnological) Museums, and the results of the investigations carried on in the laboratories attached to them.

Fig. 1 represents a small plaque, used as a lid of a box, or perhaps as a pendant, in which the king or some high personage is shown, supported by two slaves; while in Fig. 2, is illustrated one of the human-headed vases which sat on the altar in the king's principal Juju-house, supporting a carved elephant tusk. The head-dress of this figure is a network of coral strings with pendants, set off on both sides by rosettes of larger beads of a different sort. Encircling the neck as high as the lower lips are thirty-one coral ropes, forming the collar, which is the insignia of a high dignitary.

On the face may be observed his tribal marks, consisting of three raised weals over the outer corners of each eye, and of two long perpendicular lines running down the front of the forehead above each inner corner. These last probably represented ordinary tattoo marks on the brow, as they are represented by bands of iron, ingeniously let into the metal during the casting. In the same way the pupils of the eye are formed by round discs of iron. The whole figure has been very carefully chiselled over; and when it was newly finished, there is little doubt that the steel-blue tattoo lines and the glistening pupils gave to the face and eyes a very life-like appearance.

The projecting circular flange of the base has depicted on it a series of most interesting symbolic and fetish emblems. From its centre in front, the different symbols follow each other in the same order round both halves of the circumference. The central symbol is a bullock's head; then, in succession, a stone neolithic celt; an arm excised at the shoulder (with a tripod-like ornament covering the termination, and in its hand a three-pointed object); a frog; a fish, with protruding eyes, which seems to resemble more nearly than any other the curious mud-hopping *Periophthalmus koelreuteri*, so common on the brackish margins of West African rivers, or, possibly, it may be intended for—though very unlike—the electric fish (*Malapterurus*), which is a powerful fetish on different parts of the coast, because of the "quaking and trembling it produces in the arm"; then follows another bullock's head, which, with a second neolithic stone axe, completes the series.

The bullock's head, which occupies the central position among the symbols, is doubtless a fetish emblem. The

FIG. 1.

Beni have large herds of black and white cattle, as described by Burton; and bullocks form one of the chief sacrifices, human beings being the other, when the king is making "country custom" for his father and dead ancestors. The same emblem was much in evidence also in Dahomey, when, "during the customs," as Commander Forbes records, "a party carrying the fetish gear is headed by a man in a huge coat of dry grass, wearing a large bullock's head. As he passes, all the boys follow crying 'Soh, soh!' This is the representative of the god of thunder and lightning." One of these actual masks formed part of the Benin loot, and is now in the National Collection.

The next emblem to this, on each side, is the representation of an undoubted neolithic celt. These implements, which occur in the ground in many parts of Africa, are, among the Yorubas, considered to be "thunderbolts which Shango or Jakuta, the thunder god, cast down from heaven, and are venerated as sacred relics. Among the negroes in Tobago, in the West Indies, where they disinter similar neolithic axes, from time to time, in digging holes for sugar-canes, the stone is often boiled, and the water drunk to cure various kinds of ailments. The tusk-holders that have been secured for the Liverpool Museum must be of great antiquity, for they are overlaid with a very rich patina, the result of long exposure.

The little statuette (Fig. 3) is very interesting. It represents a native soldier or hunter, standing with a flint-lock in his hand. The upper part of his body is clothed in a garment ingeniously made of the two halves of a headless leopard's hide. A short pleated kilt-like garment encircles his loins. He wears a bandolier, a short sword, a hunting-knife, and a powder-flask made

FIG. 2.

of elephant tusk. The most interesting detail of this statuette is undoubtedly the flint-lock, as it serves to fix the period anterior to which this casting could not have been made, *i.e.* 1630 to 1640, the date of the invention of flint-locks.

The elaborate details on the plaques, statuettes and tusk-holders prove that whoever the artist was who designed these objects, he was, or had become, well acquainted with the religious or fetish feelings and ideas of the people, their ceremonies and customs, and with the minutest details of their various garments, ornaments and accoutrements, and was no passing visitor. His skill and patience are beyond question.

The material of which these various objects is composed is not bronze, as has been generally stated in most of the accounts of them, but a copper-lead-zinc compound, in which the proportions of the three elements vary very much. Its analysis has consequently thrown little light on the source whence the metal was obtained.

The process of manufacture was undoubtedly that known as *Cera perduta*, in which the object is first modelled in very fusible wax. The model is then overlaid with finely levigated clay, and built up to a sufficient thickness. Through an orifice, afterwards made in the clay, the wax is melted out, and the molten metal run into the vacuity. By this process each article requires a model for itself, and only one casting can be made from one mould.

FIG. 3.

As the present natives of Benin are incapable of producing, at the present day, any works approaching these plaques and statuettes, it may be that the art was brought to the West Coast Hinterland by some European trader, prisoner or resident, who, observing the skill of these people in the modelling of clay figures, such as the Fantee women fashion, may have instructed them how to do the same in wax, and how by overlaying the model with clay to finally reproduce it in metal.

It is possible, on the other hand, that their knowledge of founding was derived from purely African sources. The ancient Egyptians knew how to cast in bronze, in which there was, however, no zinc. The Benin upper classes are not negroid, their features are regular, and their skin olive-coloured. It seems not improbable, therefore, as another explanation of the presence of such high works of art in Benin, that many centuries ago the city may have been occupied by an offshoot of the same central Soudan race, with the leaven of Abyssinian or Egyptian influences among them, as now occupies Nupe, a few hundred miles further north; but that through intercourse with the debased coast tribes, they became demoralised and degenerated into their present low civilisation. The metal work discovered in the city may, therefore, be the relics of a former higher civilisation; or they may, as Commander Bacon has suggested, have been the spoils of some campaign, kept as fetishes. When, however, their full history is elucidated, an interesting and unsuspected chapter in the history of West Africa will undoubtedly be brought to light.

THE PROPOSED UNIVERSITY FOR BIRMINGHAM.

THE movement started in Birmingham fifteen years ago for the establishment of a University in the Midlands has been growing so steadily in energy and in volume that the promoters feel justified in taking definite steps for the accomplishment of their object. The first stage of operations was reached last year, when the College founded by Sir Josiah Mason in 1880 was incorporated by Act of Parliament under a new constitution, and received the new name of "Mason University College." An important step forward was taken last week, July 4, when the first public meeting in favour of the proposal to create a University was held in the Council House, under the chairmanship of the Lord Mayor of Birmingham, and was attended by Mr. Joseph Chamberlain, M.P., and an influential gathering. The proceedings must have been in the highest degree satisfactory to the promoters, for not only were some interesting speeches delivered and much enthusiasm displayed, but a very substantial proof of the earnestness with which the scheme is being taken up by the inhabitants was afforded by the announcement of promised donations to the requisite funds of about 96,000*l*. The next step will be the issue of a public appeal for further donations; and it is confidently expected that the sum of 250,000*l*., which it is estimated is necessary to complete the equipment of the College, to found new chairs, to supply additional buildings, and to provide for the administrative machinery of the University, will before long be subscribed.

The proceedings at the recent meeting included the resolution, "That in the opinion of this meeting it is essential that in the interest of the city and the Midland district generally, a University shall be forthwith established in Birmingham." Mr. G. H. Kenrick, who moved this resolution, is a manufacturer at West Bromwich, employing a large number of men; and is himself a donor of 10,000*l*. to the fund. He has for many years taken a prominent and honourable part in promoting elementary and technical education in the city; and his opinion on such a question, whether as a man of business or as a school manager, is entitled to respectful attention from his fellow citizens. After referring to the influence which the existence of the University would have upon the training and education of teachers, Mr. Kenrick went on to give his view as to the intimate relation which must be established between the University and the industries of the district; and it is to be hoped that both parties, the professors on the one hand and manufacturers on the other, will be careful to note the very sensible observations of the speaker upon this topic.

No man can now stand up and say that industry can get on very well without science. That idea has been almost given up, but a more dangerous one has arisen in its place.

Some manufacturers know quite well that their industries are dependent upon scientific knowledge; but they have got into the way of saying that they do not want people around them knowing too much, and that when they want a scientific man they can send for him. But a man of science called in on such occasions is not always able to prescribe the exact remedy for the particular disease concerning which he is consulted. This is not to be wondered at, considering that industry has done her best so long to keep science at a distance, that science has pursued her own path independently with small direct reference to the needs of industry.

Prof. Tilden seconded the resolution, and took the opportunity of pointing out that, though in the past there had been much prejudice in the minds of British manufacturers against a University training, because they had been disposed to regard it as all very well for clergymen and schoolmasters, but useless in practical affairs; nevertheless a University rightly organised and rightly conducted might be made a most practical kind of thing.

He urged upon the meeting the importance of noting what is being done in other countries, especially the United States of America and Germany, and pointed to the fact that in these countries not only are Universities numerous, but are influential and richly endowed; while the directors, managers, and even foremen in manufacturing concerns are almost entirely men who have received a complete scientific education, and have taken a degree in one of the Universities, or if not in the University in one of the polytechnics or technical schools. The polytechnics of London and the municipal technical schools in this country are institutions which have done, and are doing, good service; but there are indications that the public do not realise how different they are from their prototypes on the Continent, partly in consequence of the inferior quality of the teaching staff, and partly by reason of the fact that the instruction given in such institutions in this country is only partial, and does not demand the devotion of the whole time and energy of the student. As to the influence of the Universities in England, it was obvious that the ancient Universities, though perhaps partly alive to the question, are incapable of providing what is wanted by industry. A great opportunity is now at hand for creating a University of a new type, in which all that is best of the old and the new can be associated together; not merely a large public school, but a place for men and women, a place for study and also eminently a place for research, and a place where that predominance of examinations which unfortunately prevails so generally in most British universities would be got rid of. In constituting her University Birmingham would do well to emphasise the claims of science in its application to industry by establishing a faculty of "technics" in which "applied science" should be put on an equality, so far as honours and rewards are concerned, with the faculties of arts and of pure science. Mr. Chamberlain supported the motion in a speech which passed in review the course of events which had led up to the movement then inaugurated, and made a strong and effective appeal to local patriotism which had done so much in the past, which had made Birmingham what it was, and which he believed would now set the crown upon their educational work.

The Bishop of Hereford, in moving for the formation of a general committee, made an interesting speech which was listened to with all the more attention that the Bishop of the diocese had endeavoured to throw cold water on the scheme by pointing to the spiritual destitution of the district, and indicating his opinion that this ought to be remedied before other schemes were brought forward. The Bishop of Hereford, however, pointed out that not only was it impossible to put a stop to a great tidal movement which arose out of civic patriotism, but that the work in which they were engaged was actually more likely than any other to help the growth of that spirit in every denomination in the city which would never rest till the spiritual needs of the community were adequately supplied. The Bishop in concluding referred to Bristol and its University College, of which he is President.

At one time it seemed probable that the Birmingham project would take the shape of a federation of colleges among which Bristol would be included. That idea seems now to be abandoned. But the success of movements of this kind seems to be dependent chiefly upon financial support; and if Birmingham brings her scheme to completion it may be hoped that this will serve as a stimulus to other cities to follow her example, so that at some future, not far distant, time, not only will London have a University worthy of her great position, but every large centre of population will be occupied by a seat of learning at once the guide and helper of local industry and a focus of the light and culture of the world.

THE NATIONAL MUSEUM OF NATURAL HISTORY.

THE imminent retirement of Sir William Flower after his long and extremely efficient service as Director of the Natural History Museum, is an event of very serious importance to the progress of natural science in England. At one time the national collection, like any little country museum, was a jumble of curiosities and antiquities, the stray result of capricious generosity. As knowledge grew, the various departments became specialised, and in the middle Victorian period, thanks to the prescience of Owen, and the active interest of the Prince Consort, a prodigious dichotomy was effected. The collections relating to what are called by a well-known if illogical term, the Natural Sciences, were separated from the sculptures of Assyria and Greece, from the papyri and coins, the remains of the arts and manufactures of earlier civilisations, and were lodged in the magnificent palace in South Kensington. They were placed under the care of a small army of specialists—zoological, botanical, geological and mineralogical—and these were directed by a single controlling general, directly responsible to the nation through the Trustees and the Treasury. The great abilities of Owen, and the coordinating genius of Sir William Flower, rapidly made the British Museum of Natural History an institution of world-wide importance. Scientific men from provincial England, from Scotland and Ireland, from the Colonies and from other nations, came to regard it more and more as the greatest of centres for the elaboration of all knowledge in natural science depending on the presence, classification, and display of material specimens. As the reputation of the Museum has grown, so also has grown the work done and to be done in it. Collectors from all parts of the world lavish on it or offer to it for sale the best of their specimens; naturalists bequeath to its care their treasured collections from a thousand sources, and so material for scientific work accumulates. The members of the staff become specialists of extraordinary knowledge; many of them, junior and senior, are experts of European reputation in their own departments. Among all the activities of our great nation, the scientific activity of the Natural History Museum takes a great and increasingly great place.

It is obvious that as this organism grows in activity and specialisation, the position of its Director becomes more arduous and important. The Director of the Natural History Museum should be the leader of the natural sciences in the Empire. He has the opportunity of influencing both society and the Legislature by personal contact and intercourse. He should be the channel through which the scientific workers of the nation make known their needs and aspirations. He should have attainments of the widest possible description, and scientific sympathies that are wider than possible attainments. Not only is such a man advisable for the general advancement of science—he is necessary for the particular post. An almost inevitable association with specialisation is limitation of outlook, and as the various members of the staff of the museum become more efficient in their own departments, they require more and more the assistance of a controlling and coordinating chief. Precisely as they become more distinguished in their own branches of exact knowledge, it becomes more necessary that an officer in whose wide powers they have the fullest confidence, and for the dignity and responsibility of whose post they have the highest respect, should be at their head.

There is no possible mode by which the election of a person with these high qualifications may always be secured, but at least it is certain that he should be sought for in the widest field. Britain and the Colonies, the whole Empire should be passed in review before choice is made of one to hold this arduous, dignified and supreme post. We need not doubt that the Trustees will rise to the level of their responsibilities, and we are glad to know that the President of the Royal Society is numbered among them.

NOTES.

IN honour of the centenary of the establishment of the Physical and Agricultural Society at Königsberg, Dr. Walter Simon has given the Society the sum of four thousand marks to be offered as a prize for a work on the subject of plant or animal electricity, presenting either fundamentally new aspects, or dealing with the physical cause of organic electricity, or its importance upon life in general, or upon certain functions. The competition is open to every one. The works presented may be printed or written in German, French, English, or Italian, and must be sent in before December 31, 1900. Works which are published before the end of next September will not be admitted to the competition, as the intention is to give the prize for works which are comparatively recent at the time of the award. Should no work of sufficient merit be presented the prize may be withheld, or two prizes of five hundred marks each may be awarded. The Committee appointed to make the award consists of Profs. W. Pfeffer, B. Frank, W. Kühne, E. Hering, and L. Hermann, with power to add to their number. Further information concerning the prize may be obtained from the President, or the Secretary, of the Physikalisch-ökonomischen Gesellschaft, Königsberg.

THE fourteenth annual general meeting of the Marine Biological Association was held on June 28; Prof. E. Ray Lankester, F.R.S., President, being in the chair. The Report of the Council dealt largely with the work done at the Plymouth Laboratory during the year. Reference was made to Mr. Garstang's investigations of the habits and migrations of the mackerel, to Mr. Holt's researches on the reproduction and development of fishes living in the neighbourhood of Plymouth, and their distribution at different ages, as well as to the experiments with floating bottles for determining the surface drift in the English Channel, and to the systematic investigation of the dredging and trawling grounds between the Eddystone and Start Point. Twenty-two naturalists and eight students were reported as having worked at the Laboratory since the last annual meeting, in addition to the members of the regular staff. The following were elected members of Council for the year:—President, Prof. E. Ray Lankester; Hon. Treasurer, J. A. Travers; Secretary, E. J. Allen. Council: F. E. Beddard, Prof. Jeffrey Bell, G. C. Bourne, Sir John Evans, G. H. Fowler, S. F. Harmer, Prof. Herdman, Prof. Hickson, J. J. Lister, Sir John Murray, P. L. Sclater, D. H. Scott, Prof. C. Stewart, Prof. W. F. R. Weldon.

ON June 30 the Senate of the Dublin University conferred the honorary degree of Sc.D. on Mr. R. H. Scott, Secretary to the Meteorological Council. In a humorous Latin speech the Public Orator referred to the fact that many people believed the recipient to be not only the interpreter, but also the author of the weather. Last year the French Government conferred on Mr. Scott the Order of Officer of the Legion of Honour, in recognition of valuable services rendered during many years to the French Marine, by the transmission of timely notices of impending bad weather.

MR. JOHN MILNE, writing from Shide, Isle of Wight, says:—At 6h. 48m. 37s. p.m. on June 29, preliminary tremors with a duration of nine minutes heralded the commencement of a large earthquake. The movements extended over three hours. The maximum change in inclination of the surface of the ground was between nine and ten seconds of arc. From an open diagram the period of the E.W. movements which were the most pronounced was thirteen seconds. Assuming a velocity of 2·5 km. per sec., then the length of the earth-waves would be about 32 km., and their height about 30 cm. Records were obtained at Kew, Laibach, and probably at all observing stations in the world.

THE annual general meeting of the Society of Chemical Industry will be held in Nottingham on July 13-15.

THE latest *Verhandlungen* of the Berlin Geographical Society (1898, Nos. 5 and 6) contain the addresses delivered at the special meeting held at the end of May to celebrate the seventieth anniversary of the foundation of the Society. The medals presented at the meeting were as follows:—The Humboldt medal to Dr. Nansen; the Karl Ritter medal to Dr. E. von Drygalski, for his work in Greenland and the monograph upon it; the gold Nachtigal medal to Dr. G. Schweinfurth, for his explorations in Africa; and the silver Nachtigal medal to Captain Ramsay, for his geodetic and cartographic work in German East Africa. Prof. W. M. Davis, Prof. G. K. Gilbert, M. A. de Lapparent, and Prof. Mohn were elected honorary members; and the following were elected corresponding members of the Society:—Dr. Sven Hedin, Lieut. Johansen, W. Obrutschew, Dr. Fritz Sarasin, Dr. Paul Sarasin, Captain Sverdrup, and Dr. Eduard Freiherr von Toll.

FOR several years the Royal Geographical Society, latterly in co-operation with the Royal Society, has been making strenuous efforts to influence the Government to equip an expedition for the exploration of the Antarctic, the greatest unknown area on the face of the earth. It will be within the recollection of our readers that at an enthusiastic meeting held at the Royal Society last February, at which Dr. Nansen and Prof. Neumayer, besides many distinguished British men of science, were present, the great value of the results to be derived from an Antarctic expedition was clearly explained. Previous to this, in October last, the President of the Royal Geographical Society wrote to the Prime Minister urging that an Antarctic expedition should be undertaken either by Her Majesty's Government or with the aid and sanction of the State. The President pointed out in strong terms that it was the duty of England to undertake the further exploration of the greatest unknown region of the globe, and so complete the work done by Ross fifty years ago. The reply received at the time was sympathetic and gave reason to hope that the final reply, which was to be sent at a later date, would be favourable. The final reply has just been received from Lord Salisbury, and in it "his lordship expresses his regret that he is unable, under existing circumstances, to hold out any hope of Her Majesty's Government embarking upon an undertaking of such magnitude." Moreover, it is stated in the reply that at the recent conference of Premiers held at Melbourne in March last, it was resolved that the Australasian Colonies should take no joint action in the matter of Antarctic exploration. In these circumstances, the Council of the Royal Geographical Society have decided to endeavour to obtain the funds for an expedition to be sent out under the Society's auspices. They have authorised the President to take steps to obtain subscriptions to the amount of not less than 50,000*l.*, and the Society itself will contribute 5000*l.* It is much to be regretted that the Government has been unable to give practical support to the enterprise, both in the interests of science and from the point of view of our national credit, but it will be still more lamentable if the expedition has to be abandoned altogether on account of want of funds. The amount required to equip and despatch the expedition is not excessive, and we trust it will soon be raised, so that the Antarctic area may be efficiently surveyed from many scientific aspects.

THE proposed removal of the Museum of Practical Geology from Jermyn Street to South Kensington, recommended by the Committee of the House of Commons on the Museums of the Science and Art Department, has met with adverse criticism from geologists and others. A circular inviting signatures to a memorial to the President and Council of the Geological Society, setting forth the reasons against the transference of the Museum to South Kensington, was recently sent to all Fellows of the Society resident in Great Britain and Ireland. The memorial pointed out that the Museum at present occupies a convenient central position, easy of access for engineers, architects, and others who make use of its collections, in proximity to most of the learned societies, and adjoining the offices of the Geological Survey. The Council of the Geological Society was therefore asked "to impress upon Her Majesty's Government that the suggested discontinuance of occupation and removal of the collections would seriously impede the progress of science, especially on its economic side." The memorial has been signed by about five hundred Fellows of the Society and was presented to the Council, a resolution passed at the recent meeting of the South-Eastern Union of Scientific Societies, and having the same object, being considered at the same time. Though the Council did not see their way to comply with the request of the memorial, they expressed the opinion that the question of the removal required more consideration than it appeared to have received. The memorial and the facts of the case were then brought to the notice of Lord Salisbury, who has promised to give attention to the whole question. There the matter at present stands, but it is to be hoped that no final decision will be arrived at until it has been given most careful consideration and more evidence taken with reference to it than has yet been laid before the Select Committee, in whose report the removal of the collections is suggested.

IT has already been announced that the Society of Arts' Albert Medal for this year has been awarded to his Excellency Dr. Robert Bunsen, the veteran professor of chemistry at the University of Heidelberg. At the annual meeting of the Society held on Wednesday of last week, the work of this eminent investigator was referred to by the Council in the following words:—Amongst the numerous and important scientific discoveries which have rendered the name of Bunsen famous wherever science is valued, perhaps the most striking is the one in which he was associated with his distinguished colleague, Prof. Kirchhoff, viz. spectrum analysis, a discovery which has shed a new and unexpected light on the composition of terrestrial matter, and has enabled us to obtain a distinct knowledge of the chemical composition of sun and stars. The contributions which Bunsen has made in the application of chemistry and physics to the arts and manufactures are of the utmost value, and their importance may be measured by two out of many instances. The Bunsen battery was, until the introduction of the dynamo, the cheapest source of electricity; the Bunsen gas-burner, by which a non-luminous, smokeless, but highly heated flame is obtained, is now not only indispensable in all laboratory work, but is used for heating purposes in thousands of houses and manufactories, and for illumination, by the incandescent system, in millions of lamps. Beyond these Bunsen's contributions to the sciences of chemistry and physics have been of the highest importance; but, perhaps, the greatest benefit which he has conferred through a long life devoted to the advancement of science, has been the influence which he has exerted as a teacher.

THE Paris correspondent of the *Chemist and Druggist* makes the following announcement:—"The gift of 2,000,000 francs (80,000*l.*), made by Baroness Hirsch some time ago to the Pasteur Institute, or rather about two-thirds of it, is to be devoted to building and fitting up a large model biological institute in the rue Dutot, Paris, opposite the Pasteur Institute. The interest of the balance of the money will be devoted to working expenses, though additional money will be required for the latter purpose. The ground on which the new building is to be erected was left as a legacy to the Pasteur Institute by another lady a few years ago. The plans for the Biological Institute have been drawn up by the directors and professors of the parent establishment with the aid of their architect. A hospital will be attached to it, where patients attacked by maladies to which Dr. Roux gives special attention will be treated. M. Duclaux will be the director of the new institute, in addition to that bearing Pasteur's name, while the laboratories of biological chemistry will be under the care of M. Gabriel Bertrand. It is hoped to have the building ready by 1900, and most likely the lectures, &c., connected with biology will in due course be transferred to the rue Dutot from the Sorbonne."

IT has been agreed by the Executive Committee that ladies attending the fourth International Congress of Zoology at Cambridge in the company of a member may become Associates on the payment of 10*s.* This payment will entitle them to attend the general and sectional meetings, and the receptions held during the meeting of the Congress at Cambridge.

THE septic treatment of sewage, to which reference was made in NATURE of November 4, 1897, has so far received the sanction of the Local Government Board, that they have authorised the borrowing of the money required for extending the experimental tanks at Exeter. The Board, however, do not yet seem to be satisfied that this system is capable of producing a thoroughly satisfactory effluent, as it has been required that the minimum area of land usually allowed shall be provided for the completion of the purification. From an article in *The Engineer* of June 17 it appears, however, that this system has been in successful operation in this country for several years, and that for an original outlay of 300*l.* and an annual cost of 50*l.* the sewage from the town of Winsford, in the Salt District, containing 12,000 inhabitants, has been sufficiently purified to flow into the river Weaver without causing any pollution. Under all the existing systems that are in operation, one of the chief difficulties is the disposal of the sludge which is left in the settling tanks, but under the septic treatment this difficulty disappears. The process at Winsford is simplicity itself. The works were constructed about twenty years ago, and have been in continuous operation ever since. They consist of a series of tanks containing about seven feet of ashes and clinkers, through which the sewage flows. Each set of tanks is used for a week, and then allowed a rest. The sludge settles in the first tank, and, owing to the action of the microbes, the residue, when taken out and placed on the banks, cannot be distinguished from ordinary soil. The quantity is so small that, although none has been removed, there is no accumulation at the present time. The water in the river Weaver, into which the effluent flows, has from time to time been analysed, but no traces of pollution have been detected, and there is no discoloration.

THE Deutsche Seewarte, in connection with the Danish Meteorological Institute, has issued daily synoptic weather charts for the North Atlantic Ocean and adjacent continents, for a year ending November 1893. These charts give a complete representation of the state of the weather existing at 8h. a.m. each day, and clearly show the movements of the low-pressure areas and the positions of the barometric maxima, compiled from all available data from land and sea. Synoptic charts for the above district have now been regularly issued (including those for the same district, issued by our own Meteorological Office for 1882–3) since the latter part of 1873, and contain the most necessary materials for elucidating weather changes and for improving weather predictions. The charts are accompanied by a separate *Quarterly Weather Review* explaining the various conditions, and illustrated by charts relating specially to each period during which any particular system was maintained, and clearly exhibiting the tracks of the various storms or low-pressure areas from west to east, or north-east. Great credit is due to the German and Danish Institutes for the persistency with which this most important work is carried on, as, although some copies are sold, there must be a considerable expense thrown upon them, both as regards the production of the charts and their subsequent discussion; but the value of the work to meteorological science is beyond question.

THE Director of the Madrid Observatory, Sr. M. Merino, has published the results of the meteorological observations made there during thirty-five years (1860–94). The tables, which have been very carefully prepared and arranged by Sr. F. Cos, show *inter alia* the monthly and yearly values of all the principal elements and the daily means for each five years. This long and laborious work is the continuation of that published in 1893, which contained the results of thirty years' observations. The absolute maximum temperatures of the various years range from 98°·6 to 111°·7, and the absolute minima from 25°·5 to 9°·5. The average yearly rainfall amounts to 16·5 inches, but the quantity varies very considerably in different years.

THE study of the mathematical theory of electricity would appear to be becoming popular in Japan, to judge from the *Kiji* of the Tōkyō Mathematico-Physical Society. In two numbers now before us (vol. viii. parts 1, 2) we find no less than three papers on this subject: one by H. Nagaoka, on the strain of an iron ring by magnetisation; one by E. Sakai, on the distribution of electricity on two excentric cylinders; and finally an essay by Dr. S. Kimura, on the magnetisation by induction of a rotating sphere or spheroid under a solenoidal distribution of magnetic force.

"THE disruptive discharge in air and liquid dielectrics' forms the subject of a dissertation by Mr. T. W. Edmondson, of the University of New York (*Physical Review*, vi. 2). From experiments with different sized spheres immersed in different liquids, Mr. Edmondson finds that the curves representing the relation between the potential difference and the sparking distance are in general approximately hyperbolas becoming practically straight lines for spark-lengths of over 3 mm. While a smaller difference of potential is necessary to produce a discharge through a given distance for large spheres than for small ones when the spheres are close together, for longer distances the dielectric is electrically stronger for large than for small spheres. Mr. Edmondson gives a table of the dielectric strengths of various substances; those for air, obtained with spheres, being considerably higher than that obtained by Macfarlane for planes. Both electrostatic and alternating discharges are considered.

A USEFUL summary of the present state of knowledge of the properties of Becquerel rays, in relation to Röntgen rays, is given by Mr. Oscar M. Stewart in the April number of the *Physical Review*. With reference to these radiations from various chemical substances, it is concluded: "As these rays can be reflected, refracted and polarised, there can be no reasonable doubt that they are transverse ether waves. Interference alone is left to be established to confirm this, but owing to the extreme feebleness and short wave-length it is doubtful whether it can be shown. . . . These rays, like X-rays, are not homogeneous. They have all the properties that X-rays possess, such as photographic action, exciting fluorescence, making gas conductors, and exciting thermo-luminescence. . . . The similarity in the behaviour of the X-rays and Becquerel rays certainly presents a strong argument in favour of the theory that X-rays are short transverse ether waves." In connection with this subject, it should be mentioned that the articles which have appeared on the subject of the discharge of electrified bodies by X-rays are briefly reviewed by Mr. Clement D. Child in Nos. xxiii. and xxix. of the *Physical Review* (1897), and supplemented with some results of his own upon the effect on the rate of discharge produced by a variation in the density of the air surrounding the electrified body.

PAPERS on miscellaneous results of recent work of the Division of Entomology of the U.S. Department of Agriculture appear in *Bulletin* No. 10 (new series). The articles are of interest to economic entomologists, and of importance to agriculturists and fruit-growers. Among the general notes is one on a lead-boring insect. Examination of a lead tank which had leaked showed that the metal had been pierced with holes by the larvæ of some species of beetle of the genus Lyctus. This is the third case which has come under Dr. L. O. Howard's notice of insects which bore into lead. In one case a Cossus larva bored its way through a large leaden bullet, which was embedded in an oak tree in which the larva was living; and in another, a coleopterous larva bored its way through a piece of lead piping.

AN important memoir, containing the results of a detailed craniological investigation, has just been published in the *Transactions* of the Wagner Free Institute of Science of Philadelphia (vol. v.). The memoir is the last of the late Dr. Harrison Allen's many contributions to the knowledge of organic forms and their modifications, and entitled "A Study of Hawaiian Skulls." The concluding remarks express clearly the scope of the contents; they are as follows:—"In the study just completed I have described a new graphic method of collating measurements. I have endeavoured to establish the proposition that the difference between the crania called here the 'cave and the coast crania' are not due to race but to methods of living, and in some degree to differences of mental strength in individuals. The cave series represents the dominating and superior type, and the coast series the weak and conquered type. I have suggested that some of the contrasts that obtain in the proportions of the face of the crania after European contact may be traced to the impress made upon the individual by the action of the exanthematous diseases. I remain of the opinion that the interest attached to the study of the human skull is not confined to attempting to limit race, but to the study of the effects of nutritive and even morbid processes upon the skull form." Dr. D. J. Brinton prefixes a short appreciative note to the memoir, and points out that the conclusion as to the influence of methods of living in producing differences between crania is most important.

"A CATALOGUE of Earthquakes on the Pacific Coast, 1769 to 1897," by Dr. E. S. Holden, forms No. 1087 of "Smithsonian Miscellaneous Collections," vol. xxxvii. In compiling this catalogue, Dr. Holden had in view the determination of the general facts as to distribution of earthquake shocks, as to topographic areas, as to time, intensity, &c., and also the characteristics of particular shocks. The result is a history of earthquakes on the Pacific Coast, the disturbances being arranged chronologically and briefly discussed in an introduction. As many of the earthquakes of California are very local phenomena, which depend upon local causes for their production, no very definite conclusions can be found with reference to them. An arrangement of the shocks according to seasons shows that for California, Oregon, and Washington at large, shocks occur with about equal frequency in the wet and in the dry seasons. The records indicate, however, that in San Francisco and San José shocks are more frequent in the rainy season than in the dry. Dr. Holden suggests that, in any future study of California earthquakes, special regions ought to be selected for examination, with the object of determining the origin of the local shocks. The data he has obtained seem to indicate that the greater number of California earthquakes have been the result of faulting in underlying strata, rather than due to volcanic causes directly. With regard to damage to life and property caused by the earthquakes recorded, it is concluded that the earthquakes of a whole century in California have been less destructive than the tornadoes or floods of a single year in other parts of the States.

WE have received the Summary Report of the Geological Survey of Canada for 1897, by Dr. George M. Dawson, Director, and it is interesting to note that there is a great and increasing demand for the Survey publications. It is, of course, not surprising to learn that the report on the Yukon district is practically exhausted, and that the text and maps will be revised and reprinted. Gold mining was first attempted in the Yukon region in 1880, and in 1887 Dr. Dawson conducted an exploration of it; his forecast of the mining prospects has been amply verified by the recent discoveries in the Klondike district. The work of the Survey has so increased that there is great need of new, fireproof, and more spacious quarters; but at present the economic and scientific value of the collections and records does not appear to be fully appreciated by the Canadian Parliament. A quotation is made from an article in NATURE, written by a geologist who attended the meeting of the British Association in Toronto, and this pointed out how well the work of the Survey is appreciated by the people for whom it is primarily intended. The results of experimental borings carried out by the Survey in Northern Alberta in search of mineral oils are duly recorded. There are useful notes on the occurrence of corundum, and of observations on it by Mr. W. F. Ferrier. Coal, peat-bogs, building-stones and various metals come in for a share of attention, as well as the soils and agricultural prospects. Various analyses and assays have been made. The purely scientific aspects of geology are by no means neglected, and we have accounts of the igneous origin of fundamental gneiss, and of various formations of all ages up to the glacial drifts and recent accumulations. Reports on the palæontologica work are furnished by Mr. Whiteaves. During the year nineteen new maps were published; so it is evident that the Survey is prosecuted with vigour and enthusiasm, and we only hope that Dr. Dawson's desire for a more appropriate establishment may be granted.

THE seventeenth annual Report of the United States Geological Survey, recording in full the work done under the direction of Mr. C. D. Walcott during the period 1895–96, has lately reached us. It is divided into three parts, which are published in two bulky and two smaller volumes, and together these comprise lxviii and 2998 pages of letter-press. The information, as usual, is of the most varied character. There is the general report of the Director; an account of magnetic declination in the United States, by Henry Gannett; further contributions to the geology of the Sierra Nevada, by H. W. Turner; a geological reconnaissance in North-western Oregon, by J. S. Diller; and a discussion of the faunal relations of the Eocene and Upper Cretaceous on the Pacific Coast, by T. W. Stanton. In addition there are reports on the coal and lignite of Alaska, on the Uintaite or Gilsonite (a variety of asphalt) in Utah; on the brick-clays of Rhode Island; on the gold-quartz veins of Nevada city; on the geology of Silver Cliff and the Rosita Hills of Colorado; on the Tennessee phosphates; and on various underground and artesian waters. The mineral statistics are full and elaborate, and it is interesting to note that Fuller's earth has been discovered in Florida, Georgia, Virginia, and South Dakota. The illustrations are many, and include figures of Eocene and Upper Cretaceous Mollusca, maps, sections, pictorial views, and plates showing structure of ores, eruptive and metamorphic rocks.

THE following important additions to our knowledge of the flora of the American continent and of Australia have reached us:—Contribution No. 3 to the coastal and plain flora of Yucatan, by D. C. F. Millspaugh, from the Field Columbian Museum, Chicago; Contributions from the Gray Herbarium of Harvard University (No. 13), by Mr. B. L. Robinson, comprising a revision of the North American and Mexican species of *Mimosa* (67 species), and of the North American species of *Neptunia*; five instalments of Contributions to the flora of Queensland, by Mr. F. M. Bailey (these, not being numbered, are difficult of reference).

TOURISTS who are contemplating a visit to the north of Ireland should procure a copy of the Official Guide to the Belfast and Northern Counties Railway, Giant's Causeway, and Antrim Coast. The volume is a handy and exceptionally interesting guide-book, containing, in addition to the usual information, a section upon scenery and geology in County Antrim, by Prof. G. A. J. Cole, botanical notes by Mr. R. Lloyd Praeger, notes on the antiquarian remains of Antrim, by Mr. W. Gray, and numerous reproductions of photographs.

THE initiation ceremonies of natives of Australia have in recent years received the attention of a number of anthropologists. The latest paper upon the subject deals with the initiation ceremonies of the Arunta tribe, Central Australia, and is by Prof. Baldwin Spencer and Mr. F. J. Gillen. (*Proceedings* of the Royal Society of Victoria, vol. x., issued May 1898). It may be recalled that an account of the Engwurra ceremony as performed by the Arunta tribe appeared in NATURE a year ago (vol. lvi., p. 136). The Engwurra is not passed through until probably the native has reached the age of at least twenty-five or even thirty; but this final and impressive ceremony is preceded by others, beginning at about the age of ten or twelve, through which practically every Australian native has to pass before he is admitted to the secrets of the tribe and regarded as a fully-developed member of it. It need hardly be pointed out that authentic records, such as are given in the present paper, of ceremonial rites of aboriginal tribes are of increasing scientific value, even though the significance of the rites is not understood. Among other subjects of papers in the volume of *Proceedings* referred to above are:—Entropy meters, a method of determining the specific heat of a liquid; the geology of Coimaidai, with appendices on the marsupial bones of the Coimaidai limestone and the graptolites of the district; the structure of an Australian land leech (*Philæmonpunge*, n.s.); and a catalogue of the marine shells of Victoria.

IN the current number of the *Berichte*, J. H. Aberson describes a very interesting substance, which appears to be a new isomeride of malic acid. This compound occurs in many species of Crassulaceæ, and has the composition, molecular weight and chemical composition of malic acid, $C_4H_6O_5$, but differs from this very markedly in its behaviour when heated. Ordinary malic acid under these circumstances yields water and fumaric acid or maleic anydride, whereas the new isomeride is converted into a volatile double anhydride or malide, $C_8H_8O_8$, formed from two molecules of the acid, small quantities of fumaric and maleic acids and other products being also formed. The new acid is, moreover, more strongly dextro-rotatory than ordinary malic acid, and yields salts which differ from the malates in several important particulars. The author considers that the new compound is geometrically isomeric with ordinary dextro-malic acid, but that in it the free rotation of the two carbon atoms has in some way been arrested, so that the atoms and groups attached to these are not in that "most favoured" position, by the aid of which Wislicenus has been able to formulate so clearly the production of fumaric and maleic acids from the ordinary acid. It has not, however, been hitherto found possible to convert the new acid into the better-known modification, although the author promises to describe at an early date a method for its synthetical production. If this new form of the acid really has the configuration assigned to it, further research will no doubt reveal the corresponding lævo-rotatory and inactive (racemic) acids, the number of isomeric malic acids being thus brought up to six.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by the Lady Tichborne; a Pig-tailed Monkey (*Macacus nemestrinus*, ♀) from Java, presented by Mr. J. Ratillon; two Rhesus Monkeys (*Macacus rhesus*, ♂ ♀), a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by the Parks Committee, Tynemouth; a Lioness (*Felis leo*) from Somaliland, presented by Mr. Henry S. H. Cavendish; a Mouflon (*Ovis musimon*, ♂) from Corsica, presented by Mr. H. Brinsley Brooke; a Jackal Buzzard (*Buteo jacal*) from South Africa, presented by Mr. J. E. Matcham; a Royal Python (*Python regius*) from West Africa, presented by Mr. W. G. Woodrow; a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, a Brush Turkey (*Talegalla lathami*) from Australia,, a Glaucous Macaw (*Anadorhynchus glaucus*) from Paraguay, a Yellow-crowned Penguin (*Eudyptes antipodum*), a Thick-billed Penguin (*Eudyptes pachyrhynchus*) from New Zealand; six Argentine Tortoises (*Testudo argentina*) from Patagonia, a Nilotic Trionyx (*Trionyx triunguis*) from North Africa, a White-throated Monitor (*Varanus albigularis*) from South Africa, four Wagler's Terrapins (*Hydraspis wagleri*) from Brazil, deposited; a Lesser Koodoo (*Strepsiceros imberbis*, ♂), a Beisa Antelope (*Oryx beisa*, ♂), two Hagenbeck's Jackals (*Canis hagenbecki*) from Somaliland, three Japanese Teal (*Querquedula formosa*, ♂ ♀ ♀) from North-east Asia, two Black-winged Pea-fowl (*Pavo nigripennis*) from Cochin China, a Rufous Rat Kangaroo (*Æpyrymnus rufescens*, ♂) from New South Wales, purchased; two Bennett's Wallabies (*Macropus bennetti*, ♂ ♀), a Brush-tailed Kangaroo (*Petrogale penicillata*, ♀), a Japanese Deer (*Cervus sika*, ♀), born in the Gardens, five Upland Geese (*Chloephaga magellanica*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET PERRINE (JUNE 14).—The following is a continuation of the ephemeris from last week. The comet is rapidly decreasing its northern declination and becoming brighter.

1898.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	log r.	log Δ	Br.
July 7	5 44 14	+48 16·7			
8	49 48	47 28·6			
9	55 18	46 38·4	9·8958	0·1744	4·02
10	6 0 45	45 45·8			
11	6 9	44 51·0			
12	11 30	43 53·9			
13	6 16 49	+42 54·5	9·8435	0·1585	5·51

LATITUDE VARIATION IN A RIGID EARTH.—In an article contributed to the *Physical Review* (vol. vi. No. 3), Prof. Henry Crew discusses the movements of the earth's axis in terms of elementary dynamics, and calls attention to the "beautiful, but much neglected, top which Maxwell first spun at Edinburgh some forty years ago." Besides giving an excellent illustration of the top itself, Prof. Crew adds also an account of the adjustments that are necessary for its accurate working, and describes the various phenomena which it will illustrate, such as nutation and precession, statical stability and dynamical instability conferred by rotation, variation of latitude, and effect of polar ice-caps. In the mathematical treatment above referred to, Prof. Crew recalls the fine illustration employed by Maxwell, that the motion of the earth is practically that of a circular hoop rolling, but not slipping, on a stick of circular cross section, the word "practically" being used as the earth, in sections parallel to the equator, is not circular but elliptical. The theory here expounded shows that this hoop does represent the motion of a freely rotating rigid solid fixed at its centre of mass. Prof. Davidson's extensive and accurate series of observations (*Astr. Journal*, No. 323) receive here due attention.

CONFERENCE OF ASTRONOMERS AT HARVARD.—In consequence of the great success of the conference of the astronomers held last year at the Yerkes Observatory, it is proposed to hold a second meeting this year, and further to continue them annually. As the American Association for the Advancement of Science will meet in Boston on August 22, on the occasion of the fiftieth anniversary of its foundation, it has been decided to hold the conference at the Harvard College Observatory on August 18, 19 and 20. The circular, which we have received from Prof. E. C. Pickering, tells us that the proposed plan will enable visiting astronomers to attend this meeting, and those who are members of the Association can avail themselves of the special rates which have been obtained from hotels and railroads. Those who intend to go are requested to send in their names, and titles of papers if they intend to read any. Besides showing the work of the various departments of the observatory, excursions will be planned to various neighbouring scientific institutions, including the Blue Hill Meteorological Observatory, the Massachusetts Institute of Technology, the laboratories of Harvard College, &c.

A FINE COLLECTION OF METEORITES.—There has just been published a most interesting and valuable catalogue and guide to the collection of meteorites in the Paris Natural History Museum. Prof. Stanislas Meunier, who occupies the chair of Geology, tells us in his preface that in 1861 they only possessed 64 meteorites, and the first published catalogue comprised 86 falls. In 1864 the number rose to 160, and in 1889 the list consisted of 367 distinct meteorites. Since that date the museum has obtained possession of numerous new additions, and the present catalogue deals with 463 distinct falls. The catalogue itself is very well arranged. We have first a list of the different types which up to the present are known and exhibited in the museum, sections of which are copiously illustrated; we next come to the arrangement of the individual meteorites, followed by an excellent bibliographical index. The final list is arranged chronologically, and gives the date and locality of fall, type, weight, and other interesting data.

THE AMERICAN ASSOCIATION.

THE preliminary programme of the fiftieth meeting of the American Association for the Advancement of Science, to be held at Boston August 22–27, has just been issued by the local committee.

Some changes have been made in the officers of the Association by death and resignation. The revised list is:—President: Frederick W. Putnam. Vice-Presidents: Section A (Mathematics and Astronomy): Edward E. Barnard. Section B (Physics): Frank P. Whitman. Section C (Chemistry): Edgar F. Smith. Section D (Mechanical Science and Engineering): Mortimer E. Cooley. Section E (Geology and Geography): Horace L. Fairchild. Section F (Zoology): Alpheus S. Packard. Section G (Botany): W. G. Farlow. Section H (Anthropology): James M. Cattell. Section I (Social and Economic Science): Archibald Blue. Permanent Secretary: Leland D. Howard. General Secretary: James McMahon, to fill vacancy caused by the death of David S. Kellicott. Secretary of the Council: Frederick Bedell.

The meetings will be held at the Massachusetts Institute of Technology, the Harvard University Medical School, and the Boston Society of Natural History. Association headquarters will be at the Rogers Building of the Institute of Technology (named after Prof. Wm. B. Rogers, last president of the Society of American Geologists and Naturalists, from which the American Association was organised fifty years ago). The hotel headquarters will be at the Copley Square Hotel.

The general programme begins with the meeting of the Council on August 20. The first general session of the Association will be held on Monday, August 22, at 10 a.m., at Huntington Hall in the Rogers Building. The retiring president, Prof. Wolcott Gibbs, will introduce the president-elect, Prof. F. W. Putnam, of Harvard University. Addresses of welcome will be delivered by Governor Roger Wolcott, of Massachusetts; Mayor Josiah Quincy, of Boston; and President James M. Crafts, of the Massachusetts Institute of Technology. President Putnam will reply. The several sections will then commence their sittings.

The addresses of the several vice-presidents will be given on Monday afternoon as follows:—

At half-past two o'clock: Vice-President Whitman, before the section of physics, "On the Perception of Light and Colour"; Vice-President Cattell, before section of anthropology, on "The Advance of Psychology"; Vice-President Farlow, before section of botany, on "The Conception of Species as affected by Recent Investigations on Fungi."

At half-past three o'clock: Vice-President Barnard, before section of mathematics and astronomy, on "Development of Astronomical Photography"; Vice-President Blue, before section of social and economic science, on "The Historic Method in Economics"; Vice-President Packard, before section of zoology, on "A Half-century of Evolution with Special Reference to the Effects of Geological Changes on Animal Life."

At half-past four o'clock: Vice-President Smith, before section of chemistry (subject to be announced); Vice-President Fairchild, before section of geology and geography, on "Glacial Geology in America"; Vice-President Cooley, before section of mechanical science and engineering (subject to be announced).

The address of the retiring president, Prof. Wolcott Gibbs, on Monday evening, will be "On some Points in Theoretical Chemistry," after which will be a reception to the Association and invited guests.

The meetings of the several sections for the reading of papers will be held on Tuesday and Thursday, morning and afternoon; and some sections will also hold meetings at Cambridge on Friday. Sections F and H will meet on Tuesday evening at the Harvard Medical School, when Dr. Thomas Dwight will lecture on "Variations in Human Bones."

Wednesday will be "Salem Day," and will be devoted to an excursion to Salem, where the museum of the Association is located. On the return, in the evening, lectures will be given in Huntington Hall on the Boston Park System and the Metropolitan Water Supply and Sewerage System.

Friday, Cambridge Day, will be spent at Harvard University, and an address will be made in the evening at Sanders Theatre by President Charles W. Eliot.

The general closing session will be held on Saturday morning at 10 o'clock; and the concluding meetings and adjournment of the sections in the evening.

Besides the excursions to Salem and Cambridge, an excursion will be made on Tuesday afternoon, under the auspices of the American Forestry Association, to Middlesex Fells; on Thursday afternoon to the Arnold Arboretum and the Blue Hill Meteorological Observatory; and on Saturday a choice between (*a*) Wellesley College, (*b*) Concord and Lexington.

On the following Monday, August 29, excursions will start to the following places:—White Mountains, Plymouth, Provincetown (ocean excursion to Cape Cod), Wood's Holl (the Marine Biological Laboratory and the United States Fish Commission), Newport, Clinton (the new Metropolitan Water Supply), Lawrence Experiment Station (of special interest to chemists, biologists and students of public hygiene).

The foreign guests at the Boston meeting will be entertained by the City of Boston. The officers of the committee on foreign invitations are Dr. Henry P. Bowditch, chairman; Mr. A. Lawrence Rotch, secretary.

The local secretary for the Boston meeting is Prof. H. W. Tyler, of the Massachusetts Institute of Technology, to whom all correspondence should be addressed.

Meetings of affiliated societies will begin on August 18, including American Forestry Association, Geological Society of America, American Chemical Society, Society for the Promotion of Agricultural Science, Association of Economic Entomologists, Botanical Club of the Association, American Mathematical Society, Society for the Promotion of Engineering Education, American Folk-Lore Society, National Geographic Society, Botanical Society of America, and conference of Astronomers and Physicists.

FOLK-MEDICINE IN ANCIENT INDIA.

"THE most primitive witchcraft," says Sir Alfred Lyall, "looks very like medicine in the embryonic state." This is pre-eminently the case in ancient India, where it is not difficult to trace the history of medical science—such as we find it in scientific works on medicine, like the *Charaka* or *Susruta*—back to its early beginnings in the charms and witchcraft practices of the *Atharva-veda*, the most ancient compendium of sorcery.

In India, as elsewhere, the general doctrine of disease prevails that all abnormal and morbid states of body and mind are caused by *demons*, who are conceived either as attacking the body from without, or as temporarily entering the body of man. The consequence is that primitive medicine consists chiefly in chasing away or exorcising these hostile spirits. This is done, in the first instance, by *charms*. The spirit of disease is addressed with coaxing words and implored to leave the body of the patient, or fierce imprecations are pronounced against him, to frighten him away. But these charms, powerful as they are (in fact, there is nothing more powerful to the primitive mind than the human *word*, the solemn blessing or curse), are yet not the only resource of the ancient physicians or magicians.

From the earliest times people had become aware of the curative power of certain substances in nature, especially of herbs. This knowledge was first gained by experience, and, after it had once been obtained, people began to ascribe similar curative power to plants, as well as to animal and mineral substances for various other reasons. Analogy or association of ideas serves to explain not only many of the practices of primitive medicine, but also accounts in many cases for the belief in the curative power of certain substances. The principle that *similia similibus curantur* prevails throughout the whole range of folk-medicine. Thus dropsy is cured by water. A spear-amulet is used to cure colic, which is supposed to be caused by the spear of the god Rudra. The *colour* of a substance is of no small importance in determining its use as a medicine. Thus turmeric is used to cure jaundice. Red, the colour of life-blood and health, is the natural colour of many amulets used to secure long life and health. A black plant is recommended for the cure of white leprosy. But even the *name* of a substance was frequently a reason for ascribing to it healing power. One of the most powerful medicinal or magical plants is called in Sanskrit *apāmārga* (*Achyranthes aspera*), and it owes its supposed power essentially to its etymological connection with the verb "apamarj," meaning "to wipe away," and in Hindu charms the plant is constantly implored to wipe away disease, to wipe out demons and wizards, to wipe off sins and evils of all kinds.

To wipe a disease away, is a very common and a very natural means of getting rid of it. This seems to be the meaning also of that ancient method of curing disease by *the laying on of hands*, which is already mentioned in the *Rig-veda*, though it is also possible that it was intended to press the disease down by means of the hands, in order to make it go out of the body. Some of the charms used with the laying on of hands point to still another explanation. As the priest had to *touch* the person for whom he was offering prayers and sacrifices, so it was thought that the imprecations could only have effect on a person if there was an actual connection between the medicine-man and the patient. There is a striking similarity between this ancient Hindu custom and the modern practices of faith-healing, in which, after all, prayer has merely been substituted for the ancient charms.

The two chief resources of folk-medicine, then, are charms and magic rites, the principal object of the latter being to bring the body into contact with some supposed curative substance. These substances are frequently applied in the shape of amulets or talismans.

The most ancient collection of charms is that found in the *Atharva-veda*, an excellent translation of which, with extracts from the ritual books, has just been published by Prof. Bloomfield in the "Sacred Books of the East" (vol. xlii., 1897). In the medical charms of the Atharva-veda the diseases are always personified. It is only our way of speaking when we say that diseases are supposed to be *caused* by demons. As a matter of fact the diseases themselves are addressed as personal and demoniacal beings. Thus *Fever*—"the king of diseases," as it is called in the "Susruta," the great work on Hindu medicine—is addressed as a demon who makes men sallow and inflames them like a searing fire. He is implored to leave the body, threatened with destruction if he does not leave it, and yet at the same time worshipped as a superhuman being. "Having made obeisance to the Fever, I cast him down below." This is a very characteristic way of dealing with evil spirits, which we find among all primitive people. The healing power, too, is addressed as a supernatural being, and invoked to destroy the demon of disease. Thus the plant Kushtha (*Costus speciosus*), which was always considered by the Hindus as one of the most potent remedies against fever, leprosy, and other diseases, is addressed with such words as: "O plant of unremitting potency, drive thou away the Fever that is spotted, covered with spots, like reddish sediment." In some of the charms against fever, we meet with vivid descriptions of all the symptoms of malarial fever. We read in one charm: "When thou, being cold, and then again deliriously hot, accompanied by cough, didst cause the sufferer to shake, then, O Fever, thy missiles are terrible: from these surely exempt us!" And the Kushtha plant is again implored: "Destroy the Fever that returns on each third day, the one that intermits each third day, the one that continues without intermission, and the autumnal one; destroy the cold Fever, the hot, him that comes in summer, and him that arrives in the rainy season!"

The frequency of fever during the rainy season probably accounts for the belief that lightning is the cause of fever, as well as of headache and cough. A very symbolical cure of fever consists in making the patient drink gruel made of roasted grain, the dregs of the gruel being afterwards poured from a copper vessel over the head of the patient into fire, which must be taken from a forest-fire. A forest-fire is supposed to have originated from lightning, and that the cure of a disease is effected by that which causes it, is an almost universal belief. Both the roasted grain and the copper vessel are symbolical of the heat of fever. Here we have the rudiments of homœopathy. Another magic rite is intended as a remedy against cold fever. By means of a blue and a red thread a frog is tied to the couch on which the patient reclines, and a charm is recited in which the fever is invoked to enter into the frog. The frog represents the cold element, and the cold fever is expected to pass into the cold frog. A very similar charm is met with in Bohemia, where the peasants, in order to cure chills of fever, catch a green frog, sew it into a bag, and hang it around the neck of the patient.

The cure of a disease by making it enter into some animal, is one of the most general devices of medical witchcraft both in India and elsewhere. According to Jewish law, a living bird is "let loose into the open field with the contagion of leprosy." Jaundice is cured, in parts of Germany, by making it pass into a lizard. In ancient India, jaundice was cured by seating the patient on a couch beneath which yellow birds were tied. The yellow disease was expected to settle on the yellow birds.

The principle of curing a disease by something similar to its cause or symptoms is also apparent in the cure of excessive discharges by means of water. Dropsy—the disease sent by *Varuna*, the god of the sea and of the waters—is naturally cured best by the use of water. A very simple cure of dropsy consists in sprinkling water over the patient's head by means of twenty-one (*three times seven*) tufts of sacred grass (*Poa cynosuroides*), together with reeds taken from the thatch of a house. The water sprinkled on the body is supposed to cure the water in the body.

But there must have been many other reasons, too, which pointed to *water* as a great healing power. To the present day the Hindus look upon rivers as divine beings, or as the abode of spirits. And we may credit even the ancient Hindus with a certain knowledge of medicinal springs. Nor is it surprising that in a tropical climate the rain waters were hailed as "divine physicians." And it may be that actual experience of the beneficent influence of water on health suggested the eulogy found in a Vedic charm: "The waters verily are healing, the waters chase away disease, the waters cure all diseases."

That dropsy is ascribed to Varuna, one of the great gods of the Hindu pantheon, is quite exceptional. For, as a rule, diseases are caused by godlings rather than by gods. More especially, all such diseases as mania, fits, epilepsy, convulsions, &c., are ascribed to possession by Rakshas (devils) and Pisāchas (goblins). Even in the scientific works on medicine, *e.g.* in the "Charaka-samhitā," assaults of evil spirits and possession by demons are enumerated among the causes of disease. In the *Atharva-veda* we find a special class of charms, the so-called "driving-out charms," which are considered as most effective remedies against possession.

But the most powerful enemy and destroyer of all devils is the *Fire*. "Slayer of fiends" is one of the most common epithets of Agni, the god of fire. Hence we find that Fire is invoked in charms against mania to free from madness him who has "been robbed of sense by the devils." Sacrifices to the god of fire, burning of fragrant substances, and fumigation are among the principal rites against possession by demons.

Besides the Rakshas and Pisāchas (devils and goblins) whose special province it is to cause all kinds of mischief, we find in ancient India also the world-wide belief in *incubi* and *succubi*, who pay nocturnal visits to mortal men and women. These are the Apsaras and Gandharvas of Hindu mythology, who correspond to the elves and nightmares of Teutonic belief. They are really godlings of nature. Rivers and trees are their natural abodes, which they only leave in order to allure mortals and injure them by unnatural intercourse. To drive these spirits away the fragrant plant *ajasringi* "goat's horn" (*Odina pinnata*) is used, and certain charms are pronounced. According to Teutonic belief also fragrant herbs (*e.g. Origanum antirrhinum*, *Hypericum perforatum*, and especially thyme) are excellent means for frightening away devils and witches, as well as nymphs and elves.

That the spirits of trees and waters are occasionally identified with the spirits of disease, may to some extent account for the healing power ascribed to water and trees. In fact, the far-spread custom of transferring diseases to trees seems to have originated from a desire of infecting the *spirit* of a tree with a disease which may have been caused by the same or an allied spirit. Amulets as a protection against diseases, hostile sorcery, evil eye, and other calamities are frequently taken from trees. Thus, an amulet consisting of splinters from ten kinds of holy trees was considered by the ancient Hindus as a potent remedy against hereditary disease, and also against possession by demons. Nine kinds of wood are used for a similar purpose in German folk-medicine.

As these malevolent spirits are the sworn enemies of mankind, it is only natural that they should be most anxious to injure the new-born infant, and even the embryo. Numerous, therefore, are the charms and rites concerned with the protection of mother and child against the attacks of evil spirits. Hence the custom of keeping a fire or a light burning in the lying-in room—a custom found among tribes of the Malay Peninsula, prescribed in the sacred books of the Parsis, and still practised in Germany, as it was in ancient Rome. In ancient India, the rule was to keep a fire burning near the door of the lying-in room, in which mustard-seeds and rice-chaff were sacrificed every morning and evening for ten days. Visitors, too, were requested to throw mustard-seeds and rice-chaff into the fire before entering the room.

The chapter of children's diseases is as large in medical witchcraft as in modern medical science, and in the Hindu charms we find numerous names of demons to whom the various diseases of children are ascribed. One of these demons is called the "Dog-demon," and is said to represent epilepsy (though the barking dog would remind us rather of whooping-cough). When a boy was attacked by the dog-demon he was first covered with a net, and a gong was beaten, or a bell rung. Then the boy was brought into a gambling hall—not, however, by the door, but by an opening made in the roof; the hall was sprinkled with water, the dice cast, the boy laid on his back on the dice, and a mixture of curds and salt poured over him, while again a gong was beaten. To drive evil demons away by means of loud noises, such as the beating of a gong, was a device frequently resorted to in ancient Hindu rites, and bells and drums are still used in India as scarers of demons. Interesting is the practice of bringing the child into the hall through an opening in the roof—that is, *not by the door*. To enter a house by any other opening but the door seems to be a means of escaping the demons who are haunting the threshold. Thus, according to a German superstition, it is conducive to the health of a child to lift it out of the window when it is taken to church to be baptised.

Of course, the ancient Hindus knew that some maladies and derangements of the human body were not caused by any mysterious power; they knew that wounds were inflicted by weapons—they knew something about the effects of poison, and had an idea that certain diseases were caused by animals, such as *worms*. But in ancient India, as well as in German folk-medicine, the term "worms" includes all kinds of reptiles, and snakes and worms are not kept very distinct. Moreover, all kinds of diseases were ascribed to worms. And both worms and snakes are actually considered as a kind of demoniacal beings. The imprecations against worms are, therefore, not much different from the charms against the demons. Thus we read in a charm against worms in children: "Slay the worms in this boy, O Indra, lord of treasures! Slain are all the evil powers by my fierce imprecation. Him that moves about in the eyes, that moves about in the nose, that gets to the middle of the teeth, that worm do we crush." This fierce imprecation is accompanied by a rite symbolical of the destruction of worms in the patient. An oblation of black lentils, mixed with roasted worms and with ghee, is offered in the fire. Then the sick child is placed on its mother's lap, and, with the bottom of a pestle heated in the fire and greased with butter, the palate of the child is warmed by thrice pressing upon it. Then a mixture of the leaves of a horse-radish tree and butter is applied, and twenty-one (*three times seven*) dried roots of *Andropogon muricatus* are given to the child upon whom water is poured.

The words of the charm leave no doubt that not only intestinal diseases, but also pains of the head, the eyes, &c., are ascribed to worms. Thus, German folk-medicine knows of a "finger-worm" as the causer of whitlow (*Panaricium*), and even spasm in the stomach is ascribed to a worm, the so-called "heart-worm" (*Herzwurm*). As the Hindu charm mentions a worm "that gets to the middle of the teeth," so worms are believed to be the cause of toothache almost in every part of the world. "If a worm eat the teeth," says one of the prescriptions in an English "Leech Book," "take holly rind over a year old and root of carline-thistle, boil in hot water, hold in the mouth as hot as thou hottest may." In Madagascar the sufferer from toothache is said to be "poorly through the worm."[1] In a French charm against toothache it is said: "Si c'est une goutte de sang, elle tombera, si c'est un ver, il mourra." In Germany a sufferer from toothache will go to a pear-tree, walk three times round it, and say: "Pear-tree, I complain to thee, three worms sting me, the one is grey, the other is blue, the third is red—I wish they were all three dead." A young Hindu friend of mine (now a student at Oxford) tells me how he remembers the witch coming to his father's house (in Calcutta) to cure persons suffering from toothache, and how after some hocus-pocus she would point to some cotton threads she held in her hand, saying: "Look, here are the worms which I have taken out from your teeth."

In the Buddhist scriptures we read of an extremely clever physician, Jīvaka, who performed many marvellous cures. Once upon a time, we are told, there lived in the capital of Magadha a rich merchant who had been suffering for seven years from a disease in the head. Many renowned physicians came to see him, received much money, and went away without effecting a cure. At last the physicians agreed that the merchant must die; some said on the fifth day, others on the seventh day. Now Jīvaka, the physician in ordinary to the King of Magadha, was sent for, and he promised to cure the merchant if he would give him a good fee. "All that I possess shall be yours, doctor, and I will be your slave," said the merchant. "Well, my good householder, will you be able to lie down on one side for seven months?" asked the doctor. The merchant said he would. Would he be able to lie down on the other side for seven months, and on his back for another seven months? The patient thought he would be able to do so. Upon this the doctor ordered him to lie down, tied him fast to his bed, cut through the skin of the head, drew apart the flesh on each side of the incision, pulled *two worms* out of the wound, and, showing them to the people, said: "See, sirs, these two worms, a small one and a big one. The doctors who said that the patient would die on the fifth day had seen the big worm, those who said he would die on the seventh day had seen the small worm." Then he stitched up the skin of the head, and anointed it with salve. But after seven days the merchant said he could not lie down any longer on one side. Jīvaka ordered him to lie down on the other side for seven months. Again, after seven days, the patient said he could not bear it any longer. The doctor ordered him to lie down on his back for seven months, but he could bear this for seven days only. Then the doctor told him that he was quite well now, and that he knew beforehand the patient would be well in *three times seven*[1] days, but if he had told him so at the outset he would never have lain down even for so short a time.

This Jīvaka was a respectable man, an esteemed friend of Buddha himself, and a pious Buddhist. That the science of medicine had reached a comparatively high stage of development at the period when the Buddhist scriptures were compiled (say about 350 B.C.) is proved by the chapter on medicaments found in the "Vinayapitaka,"[2] and by the various stories told of Jīvaka. Yet there are traces even in these stories showing that physicians were considered as a class of uncanny creatures. "The physicians are cunning people," says King Pajjota, one of Jīvaka's patients. In the ancient Hindu, *i.e.* Brāhmanic, law-books, a very low social position is assigned to the physicians. They rank with temple-priests (who are in attendance to some popular idol), sellers of meat, hunters, usurers, women of bad character, outcasts, thieves, and eunuchs. They are not admitted to funeral meals and sacrifices, they receive no hospitality from members of the highest castes, and no orthodox Brāhman is allowed to accept food from a physician.

This degraded position of the medical profession in ancient India is, no doubt, due to the fact that in India, as in other countries, the physician is the direct descendant of the wizard and sorcerer. And although I do not believe that Sir Alfred Lyall[3] has succeeded in proving witchcraft to be "the aboriginal and inveterate antagonist of *religion or theology*"—the witchcraft practices of the ancient Hindus, and of all primitive people, rather prove an intimate connection between witchcraft and popular religious belief—yet I think he would be right if he had said only "*theology*" instead of "*religion or theology*." Witchcraft is always opposed to theology, and there is a natural rivalry between the wizard and the priest. And, as in India, the Brāhmans, the professional theologians, became the most dominant class, their antagonists—the wizard and his descendant, the physician—were naturally degraded and excluded from the higher ranks of society.

This antagonism between witchcraft and theology is the same as that between science and theology in more recent times. For the witch who depends not merely on supernatural agencies, but on actual observation of natural phenomena and on some sort of reasoning (which may not be *logical*, but can always be justified on *psychological* grounds) is, after all, the humble precursor of the man of science. To quote again Sir Alfred Lyall, "he is just touching, though he may only touch and let go, a line of thought which points, albeit vaguely and most crookedly, towards something like mental independence." It is this historical connection between witchcraft and science that gives an intrinsic scientific interest to the study of folk-medicine.

M. WINTERNITZ.

[1] See W. G. Black, "Folk-Medicine," p. 32 *seq.*

[1] Compare the importance of this number in the witchcraft practices mentioned above.

[2] See "Sacred Books of the East," vol. xvii. p. 41 *seq.*

[3] "Asiatic Studies," 1884, p. 76.

GUTTA-PERCHA AND INDIA-RUBBER.

BOTANISTS who are interested in the cultivation of *Sapotaceæ* on a commercial scale, are beginning to realise the consequences of the careless methods that have denuded the Indo-Malayan regions of Taban trees. Cable-manufacturers complain very seriously of the great falling-off in quality of gutta-percha during the past few years, and the small hope of obtaining better supplies in future. This degeneration of the cultivating industry is beginning to make itself felt in the Treasury Reports of the gutta-percha producing countries; not so much in the quantity annually shipped, as in the prices paid for a given weight each year.

For instance, the Sarawak (Borneo) Treasury Report of revenue and expenditure for 1897 gives comparative figures relating to the condition of supply and demand of gutta-percha and india-rubber; the following table, drawn up from the Report, shows the fall in prices of gutta-percha during the four years 1894–1897, inclusive, and indicates a corresponding degradation of quality. (The "picul" is, for our purpose, taken as 133⅓ lbs., and the Sarawak dollar as 1*s.* 11*d.*)

Gutta-percha exported from Sarawak.

Year.	Quantity.		Value.		Average price per picul.	
	Piculs.	Tons.	$	£ s. d.	$	£ s. d.
1894	1937	115·3	162,233	15,547 6 7	83·75	8 0 6¼
1895	2782	165·6	194,120	18,603 3 4	69·77	6 13 8¾
1896	2820	167·9	190,939	18,298 6 5	67·70	6 9 9
1897	2867	170·7	185,532	17,780 3 0	64·71	6 4 0½

With this may be compared the increased demand for, and steady value of india-rubber throughout the same period.

India-rubber exported from Sarawak.

Year.	Quantity.		Value.		Average price per picul.	
	Piculs.	Tons.	$	£ s. d.	$	£ s. d.
1894	1259	74·9	85,775	8,220 2 1	68·12	6 10 6¾
1895	1392	82 8	95,493	9,151 8 3	68·60	6 11 5¾
1896	1624	96·7	108,813	10,427 18 3	67·00	6 8 5
1897	2130	126·8	146,229	14,013 12 3	68·65	6 11 7

From another source we are able to give the total weights of gutta-percha landed in England, from all gutta-percha producing countries, since 1895.

Total Weight of Gutta-percha landed in England.

Year.	Tons.
1895	716
1896	318
1897	396
January to April 1898	626

The present year shows a very marked rise in the demand for gutta-percha; this is more apparent when it is remembered that the 626 tons was all landed between January 1 and April 30, and that the quantity landed in April alone was 149 tons.

We may sum up the condition of the gutta-percha cultivation industry in a few words: there is an increasing demand, a degeneration of quality, and an almost total disregard of the future. Experimental efforts have, we believe, been made to produce a steady supply of high-quality gutta-percha, but so many years are required to establish the scheme on a profit-earning basis, that it is almost beyond the powers of private enterprise to make it a success.

TREATMENT OF THE SURFACE OF MEDALS.[1]

SILVER.

IN this country medals have been issued for centuries with the tables or flat surfaces smooth and mirror-like, while a more or less frosted texture has been given to the portions in relief. This is especially the case in medals which have been struck as specimen pieces, for after highly-polished dies have been used for a certain time the difference between the appearance of the tables and the parts in relief becomes less and less marked. As is well known, medals with polished surfaces rapidly tarnish, and even blacken, by exposure to the ordinary atmospheric influences. In France a different system has long been adopted concurrently with the one just described. Unpolished dies are employed, and care is taken to impart to the medals struck from them a dead or frosted surface by rubbing them with fine pumice. Recently, at the French Mint, medals have been subjected to the process known as "sand blasting" by the aid of an appliance which projects against the surface of the medal a small jet of air, carrying with it fine sand, and having a velocity of about 180 feet per second. When thus treated the surface of the medal becomes minutely granular or frosted, and may then be further treated in several ways. Sometimes the surface is darkened by exposure to an aqueous solution of a sulphide, followed by rubbing with very fine pumice, which removes the dark layer of sulphide from the portions in high relief, and leaves dark lines in the more deeply-cut recesses. It is, however, preferable to cover the medal with a layer of platinum, and this is effected by immersing it in an alcoholic solution of chloride of platinum until a blackened surface is produced. Subsequent rubbing with a brush and very fine pumice changes the blackened surface to a delicate grey; and if this operation is conducted skilfully, graduated shadows may be left wherever the artist considers their presence to be desirable. The beauty of medals so treated, and the fidelity with which the details of the design are revealed, are beyond question; but it may be doubted whether the surface of the medal is permanently protected. A medal with a frosted platinised surface has, however, a great advantage over one with a polished table, as the platinised medal is merely deepened in tone by exposure to the atmosphere, and, unlike medals which have been struck in the ordinary way, does not become disfigured by blotches of tarnish. The frosted platinised medal may be restored to almost its original freshness by careful rubbing with a soft leather; while a polished silver one cannot be so renovated, as the tarnish attacks the surface and destroys the polish.

During the past year, for the first time in the history of the Mint, medals have been issued with frosted and platinised surfaces. More than 27,000 large silver medals were platinised by a slight modification of the above method. It became necessary, therefore, to provide an appliance for producing the sand blast, and this, together with a small 1 H.P. motor for driving it, has been fitted up in the basement of the Assay Department.

BRONZE.

Medals of bronze differ considerably from those of silver, as their surfaces are far more liable to be influenced either by the slow operation of the constituents of the atmosphere or by the more rapid action of chemical agents. Ancient silver coins, for instance, which have been long buried in the earth, do not show anything like so wide a range of colour in their patina or crust, as is revealed on coins of brass, bronze or copper, which have been hidden in the same way. This is due to the fact that silver is far less affected than copper by the chemical action of the constituents of soils, or by atmospheric influences. The patina acquired by an ancient coin or medal often constitutes no small part of its value. "You would laugh at me," said Philander, in Addison's charming dialogues upon the usefulness of ancient medals, "should I make you a learned dissertation on the nature of rusts; I shall only tell you that there are two or three sorts of them which are extremely beautiful in the eye of the antiquary, and preserve a coin better than the best artificial varnish." The object of the medallist is accurately expressed in the above sentence, for he endeavours to protect the surface of all medals in which copper is the main constituent, by a patina or film of oxide, so as to preserve the medal from further change. This may be effected in various ways. The medals of the Italian Renaissance were not struck, but cast by the method of *cera perduta*, already described in these Reports,[1] and much of the beauty of the medal was due to the "skin" or pellicle of oxide which the medal acquired during casting. The skill of the artist in arranging the composition of the bronze, and fixing the temperature at which it was cast, was revealed in the texture of the medal's surface.

In modern times most medals to which the name of bronze is given are really of copper, "bronzed" or coloured artificially on

[1] From a memorandum by Prof. Roberts-Austen, C.B., F.R.S., in the Twenty-eighth Annual Report of the Deputy Master and Comptroller of the Mint, 1897.

[1] Sixteenth Report (1886), pp. 24, 49; Seventeenth Report (1886), p. 15.

the surface. The process by which this colouring is effected has long been employed, and is thus described in an old receipt. Apply with a brush to the surface of the medal common crocus powder, jewellers' rouge, previously made into a smooth paste with water. When dry, expose the medal over a clear fire for about one minute; lastly, when the medal is sufficiently cold, polish it with a plate brush. The exact composition of the superficial layer of oxide which is formed, has, I believe, never been ascertained; but it is well known that the tint varies greatly from light brown to deep chocolate, according to the particular variety of oxide of iron which is used.

With a view to ascertain whether this old method could not be replaced with advantage, it was natural to turn to the work of Japanese artists, who are masters in the art of giving protective surfaces of varied tints either to copper in its pure state or to copper alloys. I have shown elsewhere[1] that in conducting such operations the Japanese employ dilute boiling solutions of certain salts of which verdigris and sulphate of copper are the more important.

The following solution[2] has been found to answer fairly well, even when the ordinary European verdigris, which is a basic acetate of copper, is employed:—

Verdigris	87 grains
Sulphate of copper	437 ,,
Nitre	87 ,,
Common salt	68 ,,
Sulphur	233 ,,
Water	1 gallon

In Japan, however, "verdigris" is made by the action of plum-juice vinegar on plates of copper which contain certain metallic impurities. Such native verdigris has consequently a very complex constitution. It is called "Rokusho," and cannot be procured in this country; but I am indebted for a sample of it to Mr. W. Gowland, formerly technical adviser to the Japanese Mint at Osaka. He obtained it from a famous maker of verdigris at Osaka, who persistently refused to give any information respecting its mode of manufacture. Mr. Gowland also gave me an elaborate description of the method of employing this verdigris in the colouring of copper medals, a method which has only been adopted in Japan as the result of a long series of experiments. Guided by an analysis which was made of this "Rokusho," a mixture was compounded which produced quite as fine patina on copper as the native "Rokusho," though its action was less certain and less rapid. The series of tints which may be obtained by slight variations in the composition of the "Rokusho" is truly remarkable. These tints range from golden yellow through deep brown to bright red, the colour mainly depending on the relative amounts of malate, urate, and chloride of sodium which are present.

The quality of the copper also exerts a very great influence on the tint of the patina; the difference, for instance, between ordinary "best select" copper of the smelter and "electro" copper, is very marked, as the former becomes dark brown and the latter golden yellow when boiled in the same solution of "Rokusho." Since the close of the year 1897, over 5000 medals have been treated by the method which has just been described. Apart from the mere tint of the medal, the Japanese artists attach much importance to producing a sheen or damascening which shows through a transparent patina. This is effected by developing the crystalline texture of the copper by a preliminary treatment of the medal before it is boiled in the solution of "Rokusho."

In France, medals of true bronze containing much zinc are struck, and although the colour is heightened by superficial oxidation, produced by gentle heating, no true patination is effected.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

By the will of the late Mr. Edward O. Bleackley, the Owens College, Manchester, receives 500*l.* for "Bleackley Scholarships."

We have more than once in these columns called attention to the views expressed by Prof. Meldola and others concerning the futility of occasional instruction in miscellaneous subjects as carried on at great cost to the county by many Technical Instruction Committees, more particularly in rural districts. An advocate of these views has now been found in the person of the Countess of Warwick, who, acting on the advice of Prof. Meldola, has established a small school of science at Bigods, near Dunmow in Essex, on her own estate. The school at present contains about sixty pupils of both sexes, and by way of a beginning it is proposed to select twenty of the most highly qualified for instruction under the "School of Science" curriculum of the Science and Art Department. Lady Warwick deserves every encouragement in this praiseworthy effort to bring systematic instruction within the reach of a class of the community more in need of such assistance even than the inhabitants of large towns, and we learn that the Essex County Council has wisely determined to co-operate in the movement. The experiment is one in every way deserving of success, and the results will be watched with interest all over the country. One of the weakest points in modern technical education schemes has been the lack of such institutions in the thinly-populated agricultural districts, and the county of Essex has done well in taking part in an experiment which cannot but lead to results of the greatest importance. Mr. E. E. Hennesey, of the Royal College of Science, has been appointed principal of the school, which is provided with laboratories, lecture and class rooms, a workshop and laundry, garden plots, &c., and is situated in a most pleasant and secluded corner of the county, about a mile and a half from Dunmow railway station. The mansion adjoining the school has been handed over by the Countess for the use of the staff and of boarders, and the neighbouring farm is available for field demonstrations.

SCIENTIFIC SERIAL.

Symons's Monthly Meteorological Magazine, June.—Lightning conductors, by A. W. Preston.—The author refers to a theory put forth by some architects that old churches which have never been struck by lightning do not require conductors, as the probability is they never will be struck. The editor of the *Magazine* will be glad to receive any evidence upon the subject.—Results of meteorological observations at Camden Square, London, for forty years. These show that the mean of all the highest readings was 78°·1, and of all the lowest 33°·8; the average rainfall is 1·92 inches, against 2·26 inches in the present year.—Summer rainfall, by A. B. MacDowall. Based upon the rainfall at Greenwich Observatory since 1841, the author finds (1) that in the first five years after sunspot minimum years, there have always been more dry summers than wet, and (2) that in each group of five consecutive years ending with a sunspot minimum year, there have been (with one exception) more wet summers than dry. These facts point to a tendency for a wet summer this year.—This number contains a long, if not unique, well record, containing the approximate height (in feet above Ordnance datum) of the top of the water in Mr. L. Wood's well at Chilgrove, near Chichester, since 1836.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 9.—"On the Heat dissipated by a Platinum Surface at High Temperatures." By J. E. Petavel, 1851 Exhibition Scholar. Communicated by Lord Rayleigh, F.R.S.

The first part of the paper refers to the emissivity of a bright platinum surface in air, hydrogen, carbon dioxide, and in other gases.

In the case of each of the above gases the values of the emissivity are given at three distinct pressures; namely, 6, 76, and 228 centimetres of mercury.

The temperature measurements are based on the researches of Callendar and Griffiths, confirmed by the recent determinations of Heycock and Neville. To check the calibration of the thermometers at higher temperatures, the melting point of palladium was used. In all cases observations were made from a temperature of 100° C. to temperature of 1200° C., and a number of the curves are extended to 1779° C. by a direct

[1] A paper "On the Use of Alloys in Art Metal-work." (*Journal* of the Society of Arts, June 13, 1890.)

[2] A similar solution for heightening the colour of gilded metals is described by Benvenuto Cellini in his "Trattato dell' Oroficeria in Fiorenza, 1568."

measurement of the emissivity of platinum and palladium at their melting points.

The platinum wire, which served at the same time as radiator and thermometer, was 0·112 cm. in diameter. It was placed in the axis of a vertical glass cylinder, which formed the enclosure.

The effect produced by a change in the size, shape, material, and temperature of the enclosure and in the position and diameter of the wire are also studied.

The temperature is expressed in degrees Centigrade, and the emissivity in C.G.S. units.

Part ii. consists of a bolometric study of the radiation emitted by platinum at temperatures ranging from 500° C. to the melting point of the metal. It is shown that for theoretical reasons the true rate of change of the total radiation with temperature lies between the values obtained by measuring the heat lost by the radiating body and those deduced from the readings of any form of bolometer or thermopile.

By comparing the observations of Dr. J. T. Bottomley and Schleiermacher, based on the first method, with those of F. Paschen and of the author, made by the second method, a criterion is obtained by which to test any formula intended to express the law of thermal radiation.

The formulæ of Dulong and Petit, of Stefan, and of Rosetti fail when tested in this manner; whilst Weber's formula, from 400° to 800° C., gives results in close agreement with the true rate of change of total radiation with regard to temperature.

The second part of the paper also contains a description of some points of interest in the design of the bolometer which was used during this work.

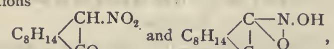
Part iii. refers to the variation of the intrinsic brilliancy of platinum surface with temperature.

The results may be expressed by the following formula:—

$$(t - 400) = 889 \cdot 6 \sqrt[6\cdot 9]{b},$$

where t is the temperature in degrees Centigrade, and b the intrinsic brilliancy in candle power per square centimetre. The constant 400 is taken as the temperature limit at which the visible radiation falls to zero.

Chemical Society, June 16.—Prof. Dewar, President, in the chair.—The following papers were read:—Preparation of a standard acid solution by direct absorption of hydrogen chloride, by G. T. Moody. The author prepares an accurately standardised solution of hydrogen chloride by determining the increase in weight consequent on absorbing the pure gas in water.—Researches on the terpenes. III. Halogen derivatives of fenchene and their reactions, by J. A. Gardner and G. B. Cockburn. An α- and a β-chlorofenchene hydrochloride are obtained by treating fenchene with phosphorus pentachloride; both readily yield a crystalline chlorofenchene $C_{10}H_{15}Cl$, which can be converted into a chlorofenchenephosphonic acid.—Researches on the terpenes. IV. On the oxidation of fenchone, by J. A. Gardner and G. B. Cockburn. Fenchone is very slowly oxidised by hot nitric acid with formation of isocamphoronic acid, dimethyltricarballylic acid, dimethylmalonic acid, isobutyric acid, acetic acid, and nitrofenchone.—Nitrocamphor and its derivatives. Part I. Isodynamic forms of nitrocamphor, by T. M. Lowry. Although solutions of nitrocamphor show multirotation the author has not been able to isolate the isodynamic forms of the constitutions



yet the corresponding forms of π α′-bromonitrocamphor seem to exist.—Cannabinol, by T. B. Wood, W. T. N. Spivey and T. H. Easterfield. Cannabinol is a mixture which yields a liquid and a crystalline acetyl-derivative, $C_{21}H_{26}O_2$.—An improved form of gas-analysis apparatus, by W. A. Bone.—Preliminary note on the action of light on acetylene, by W. A. Bone and J. Wilson. On exposing acetylene to sunlight a greasy brown deposit is formed which is still under examination.—Reversible zymohydrolysis, by A. C. Hill.—The solubility of isomeric substances, by J. Walker and J. K. Wood. The authors find that the rule that the order of solubility of isomerides is independent of the solvent is not strictly applicable.—Note on nitration and substitution in nitro-compounds, by A. Lapworth and C. Mills.—Hydroxydibromocamphorsulphonic acid. A correction, by A. Lapworth and F. S. Kipping.—Enantiomorphism, by F. S. Kipping and W. J. Pope.—Azobenzene derivatives of chrysin, euxanthone, gentisin and morin, by A. G. Perkin. Chrysin yields a disazo-derivative of the composition $C_{15}H_8O_4(N_2Ph)_2$; similar compounds have been prepared from other analogous colouring matters.—Constituents of the Indian dyestuff "waras," by A. G. Perkin. Waras, a purplish powder covering the seed pods of *Flemingia congesta*, contains flemingin, $C_{12}H_{12}O_3$, homoflemingin and two resins $C_{12}H_{12}O_3$ and $C_{13}H_{14}O_3$; it dyes silk a golden yellow shade.—Note on the oxidation of charcoal by nitric acid, by G. Dickson and T. H. Easterfield. By a process involving oxidation with fuming nitric acid and potassium chlorate, charcoal may be made to yield one-fourth of its weight of crystalline ammonium mellitate.

Zoological Society, June 21.—Dr. W. T. Blanford, F.R.S., Vice-President, in the chair.—Mr. J. Graham Kerr exhibited some specimens of *Lepidosiren* collected by him in the Gran Chaco of Paraguay during 1896–97. The adult males exhibited the characteristically varying appearances of the hind limb in the periods before, during, and after the breeding season. Mr. Kerr also exhibited specimens of the young of *Lepidosiren*, illustrating especially the external gills and sucker, the disappearance of these organs, and the change in the colour of the animal associated with the surrounding conditions of light or darkness. A small collection of Teleostean fishes collected in the same swamps in which *Lepidosiren* was found, and identified by Mr. Boulenger, was also exhibited.—The Secretary called the attention of the meeting to the arrival in the Society's Gardens of four living specimens of the Australian Lung-fish (*Ceratodus forsteri*), deposited by Mr. D. O'Connor, who gave an account of the mode in which he had obtained them and brought them to England.—Mr. G. A. Boulenger, F.R.S., exhibited specimens of the remarkable fish *Polypterus lapradii*, from the Lower Congo. They were provided with highly-developed external opercular gills, the presence of which, he remarked, was not dependent on age, as had been heretofore supposed, because they were retained for a long period, if not, in some cases, throughout life.—Mr. R. E. Holding made some remarks on some interesting animals he had observed during a recent visit to the Zoological Gardens at Belle Vue, Manchester.—Prof. Howes exhibited, on behalf of Mr. E. W. L. Holt, a specimen of a new British fish (*Argentina silus*), obtained eighty miles south-west of the Scilly Islands.—Mr. Abbott H. Thayer, of New York, explained his method of demonstrating, by actual experiments, the underlying principle of protective coloration in animals, and invited the members present, and their friends, to witness an exhibition of his demonstrations which (as arranged with the Secretary) would take place in the Society's Gardens next day.—Mr. G. A. Boulenger, F.R.S., read a memoir on the collection of fishes made by Mr. J. E. S. Moore in Lake Tanganyika during his expedition in 1895–96. Twenty-six new species were described, of which eight were made the types of new genera.—Mr. R. I. Pocock read a paper on the scorpions, spiders, and *Solifugæ* collected by Mr. C. S. Betton in East Africa between Mombasa and Uganda. Of the seven species of scorpions, six species of *Solifugæ*, and thirty species of spiders represented in the collection, five of the *Solifugæ* and twelve of the spiders were described as new, one species of the latter, viz. *Eucratoscelus longiceps*, being made the type of a new genus.—A communication was read from Mr. J. Stanley Gardiner containing an account of the fungoid corals collected by him in the Central Pacific. Twenty-one species were treated of, of which six were described as new. It was proposed to absorb the genus *Tichoseris* into *Pavonia*, and the genera *Maeandroseris*, *Coscinaraea*, and *Plesioceris* into the genus *Psammocora*.—On behalf of Dr. A. Dugès, Mr. G. A. Boulenger communicated the description of a new genus of Ophidia, proposed to be called *Geatractus*, for the reception of *Geophis tecpanecus*, recently characterised by M. Dugès.—Dr. G. H. Fowler presented three papers relating to the surface and midwater collections made by him on H.M.S. *Research* in the Faeroe Channel in 1896 and 1897. The first of these, by Mr. I. C. Thompson, dealt with the *Copepoda*; the second, by Mr. E. W. L. Holt, treated of the collection of fish-larvæ, and included an account of the larval ontogeny of *Scopelus glacialis*; and the third, by Dr. Fowler, contained a description of his new midwater net, and a discussion on the general features of the midwater fauna.

Geological Society, June 22.—W. Whitaker, F.R.S., President, in the chair.—Post-glacial beds exposed in the cutting of the new Bruges canal, by T. Mellard Reade. The following beds, enumerated in descending order, were found in this cutting: (5) Argile des polders supérieure; (4) *Cardium* (*edule*)-sand; (3) Argile des polders inférieure; (2) *Scrobicularia* (*plana*)-clay; (1) Peat with the remains of trees.—High-level marine drift at Colwyn Bay, by T. Mellard Reade. This paper describes a mound of sand capped by boulder clay, which occurs 1 mile south by west of Colwyn Bay Station. It measures about 90 yards on the longer axis, which runs north-east, 50 yards on the shorter axis, and is situated 560 feet above O.D. Among the pebbles and boulders in the drift, and scattered about in the sandpit, were granites from Eskdale and the south of Scotland, small flints, and local and Welsh rocks identified by Mr. Ruddy as derived largely from the head of the Conway valley. The base of the sand is not exposed, but the author has no doubt that it is geologically above the grey till with Welsh boulders.—Observations on the geology of Franz Josef Land, by Dr. Reginald Kœttlitz. This paper opens with a detailed description of the geography and geology of various portions of the archipelago. The basaltic rocks occur in tiers from 10 to 70 feet high, and range to a height of 1300 feet above sea-level. The associated and interbedded rocks consist of shale, sandstone, and basaltic tuff. The stratified rocks are not appreciably altered by the heat of the basalt, which is often vesicular both at the base and summit of the tiers. From this and other evidence the author concludes that many of the sheets are contemporaneous flows, and that as the fossil plants and ammonites are of Jurassic age, some of the lavas date back to Jurassic time. Dykes, sills, and necks are also described. The Jurassic rocks consist of shales and sandstones; they have yielded ammonites and belemnites, a portion of a specimen of *A. Lamberti* having been found embedded in "basaltic tuff." Pebbles of radiolarian chert have also been found embedded in these rocks, and a granite-block, mentioned by Payer as having been seen embedded in an iceberg, is believed to have come from the same source The raised beaches are very numerous, and occur at various heights, from just above sea-level to 287, 310, 340, and even 410 feet, drift-wood and bones of seals, walrus, and whales having been found on them. On Cape Mary Harmsworth twelve beaches are seen in a series one above another. The entire skeleton of a seal was found on the summit-plateau of Cape Neale, together with waterworn stones, at a height of 700 feet above sea-level. The highest waterworn pebbles noted were found at 1111 feet on Cape Flora. In some cases floe-ice at sea-level becomes covered over and preserved by gravel heaped upon it by the sea; and some of the raised beaches seem to consist of a similar mixture of ice and gravel, as is proved by the formation of pitfalls in them where the ice melts. Ice-masses are also sometimes preserved under taluses, avalanches, and slips. The "ice-cap" is probably not so thick as is generally supposed, and it has little downward movement. It forms domes on the summits and plateaux, but it seems to be a mere mantle on the terraced slopes, as it is rigid and dimpled, and during warm seasons raised beaches and terraces are thawed-out under the ridges. Comparatively few evidences of glaciation were met with. Roches moutonnées and rounded hills are absent, and only in the two valleys separating Cape Flora from Cape Gertrude were the rocks planed, scratched, and polished. Some of the landscape-features, including the separation of the group into individual islands, are attributed to marine action following lines of fault. The paper concludes with observations on soundings, the temperature of glaciers, the size of icebergs, and the finding of reindeer-antlers by Mr. Leigh Smith and the members of the Jackson-Harmsworth Expedition.—Notes on rocks and fossils from Franz Josef Land brought home by Dr. Kœttlitz, of the Jackson-Harmsworth Expedition, in 1897, by E. T. Newton, F.R.S., and J. J. H. Teall, F.R.S. In this communication an analysis of the basalt is given, which compares closely with those of basalts from Iceland. The silicification of the rocks, presumably by geyser action, the presence of a black analcime, pebbles of radiolarian chert, and crystals of selenite, probably formed *in situ* in shale, are also described. Notes are given on some of the fossil plants, on the drift-wood, and on apparently new species of *Inoceramus* and *Belemnites*.—On the Corallian rocks of Upware, by C. B. Wedd. The opinion usually held that the "Coralline Oolite" of the northern quarry at Upware is of older date than the "Coral Rag" of the southern quarry, gains support from the work detailed in this paper, although the results of recent excavation show that a rock of different lithological character from that of the northern quarry probably underlies the rocks of the southern quarry. A list of the fossils found in the lowest beds of the southern quarry includes eleven species not yet found in the "Oolite" of the northern quarry; a second list comprises the fossils found just below the "Rag" in the "Oolite" of the southern quarry. Both these faunas are intermediate between those o the "Rag" of the southern and the "Oolite" of the northern quarry. From the results of excavation and other evidence, the author considers that the "Oolite" can hardly be less than 40 feet thick, and that this rock is geologically below the "Rag" of the southern quarry.

EDINBURGH.

Royal Society, June 20.—Sir William Turner in the chair.—In a paper on steam and brines, Mr. J. Y. Buchanan discussed the relation of the concentration and the rise of boiling point of various solutions of salts, and instituted a comparison between the effect of pressure and the effect of concentration in producing this rise.—Dr. W. Peddie read a paper on torsional oscillations of wires, experimental and theoretical. In previous papers a relation of the form $y^n(x + a) = b$, where n, a, b are constants in any one experiment, was found to connect y the range of oscillation with x the number of oscillations. In the present paper five experimental results were given. (*a*) When the wire is subjected to great fatigue, n and b are independent of the magnitude of the initial range of oscillation; also n becomes unity when the fatigue is great. (*b*) Both log nb and log b may be regarded as linear functions of n in each of the series of experiments made, though both cannot be strictly so simultaneously. (*c*) In all of the series the linear function is such that, when n is unity, b has an absolutely constant value. This indicates a quantity which depends only on the nature of the material of the wire. (*d*) The period of oscillation has no observable effect on the results. (*e*) The time of inward oscillation over a given range exceeds that of outward oscillation. In the theoretical part of the paper a simple molecular theory of the action was investigated and was found to be in accord with observed facts, such as—the result (*e*) given above; the deviation from Hooke's law; the lessening of this deviation (as observed by Wiedemann) when an oscillation is stopped just short of zero, and again increased positively; and the relation between torsion and set.—Drs. Milroy and Malcolm read a paper on the metabolism of the nucleins under physiological and pathological conditions. It was found that the effect of nucleins and nucleic acid was to increase the number of the leucocytes in the blood, and also the amount of phosphorus excreted in the urine. Part of this phosphorus must have been derived from the tissues. On the other hand, metaphosphoric acid had no effect either on the leucocytes or on the phosphorus-holding tissue. An examination of pathological conditions in which leucocytosis was present showed that in leucocythæmia (spleno-medullary) the phosphorus excretion was diminished both absolutely and relatively to the nitrogen, while in plumbism the conditions varied only slightly from the normal. Emphasis was laid on the great caution required to be observed in drawing conclusions from the amount of alloxuric bodies secreted in cases where increased breaking down of the white blood corpuscles is suspected.

PARIS.

Academy of Sciences, June 27.—M. Wolf in the chair.—General formulæ giving the values of D for which the equation $t^2 - Du^2 = -1$ is resolvable into entire numbers, by M. de Jonquières.—On the new Giacobini comet, by M. Perrotin.—Report on a memoir of M. Lecornu, entitled "On the equilibrium of an ellipsoidal envelope submitted to a uniform internal pressure."—Observations on the Coddington comet made at the Observatory of Algiers with the 188 mm. equatorial, by MM. Ch. Trépied and J. Renaux.—Elements of the Giacobini comet, by M. I. Lagarde.—Determination of a surface by its two fundamental quadratic forms, by M. L. Raffy.—On the principle of correspondence, by M. H. Burkhardt.—On the mixing of gases, by M. Van der Waals. Remarks on a note by M. Daniel Berthelot.—Reply to the preceding, by M. Daniel Berthelot. The justification for the assumption criticised by M. Van der Waals is to be found in the close agreement between the results theoretically deduced by its aid and those of experiment.—On gaseous mixtures, by M. A. Leduc. Remarks on a note by M. D. Berthelot.—On the specific heat of air at constant pressure, by M. A. Leduc. Remarks on an error overlooked by M. Regnault in his determination of this constant. The neglect to fully correct for the expansion in the calorimeter, causes a systematic error in the final result of 0·6 per cent., the value being raised from 0·2375 to 0·239.—On the radiation of incandescent mantles, by MM. H. Le Chatelier and O. Boudouard. In the opinion of the author, there is no need to construct a special hypothesis to explain the action of the Welsbach burner. The emissive power is not greater that one, but the proportion of blue, green, and yellow radiations far surpasses that of red; and consequently the proportion of the energy given out as luminous radiations is very great. The absolute value of the luminous energy thus given out is, however, less than that which would be emitted by a black body at the same temperature.—Action of hydrogen upon silver sulphide, and the reverse reaction, by M. H. Pelabon. If the two systems, hydrogen-silver sulphide, and silver-hydrogen sulphide, are heated to the same temperature, the final state is the same in each case provided that the temperature be about 350° C. The velocity of the reaction is much accelerated by rise of temperature. The same state is finally reached if the starting system be sulphur, silver, and hydrogen.—On the heat of formation of lithium carbide, by M. Guntz. The value 11·3 calories was found by dissolving in water pure lithium carbide, details being given of the precautions necessary for the preparation of the latter.—On the combination of certain organic substances with mercuric sulphate, by M. G. Denigès. The mercuric sulphate reagent gives insoluble compounds when heated for a short time with fatty ketones, ordinary acetone giving an almost quantitative yield.—On a general method of preparation of mixed carbonic ethers of the fatty and aromatic series, by MM. P. Cazeneuve and Albert Morel. The carbonates of the phenols are heated either with the sodium alcoholate, or better, with an alcoholic solution of certain organic bases, such as pyridine.—On the nitro-derivatives resulting from the action of nitric acid upon ouabaine, by M. Arnaud. A mono- and a di-nitro derivative were isolated.—On the acids of the essential oils of geranium, by MM. Flatau and Labbé. An isomeride of myristic acid was isolated from the Indian essence.—Action of cyanamide upon chloranil in presence of potash, by M. H. Imbert. The reaction is similar to that already described for bromanil.—Contribution to the search for manganese in minerals, vegetables, and animals, by M. P. Pichard. Manganese appears to be very widely distributed. A list is given of natural orders of plants in which manganese has been found.—On the development of *Acmæa Virginea*, by M. Louis Boutan.—On the lakes of Roche-de-Rame (Hautes-Alpes), du Lauzet (Basse-Alpes), Roquebrussane, and Tourves, by M. André Delebecque.—On a method of measuring the area of the heart by radiography, by MM. G. Variot and G. Chicotot.—Improvement in the tubes employed in radiography, by M. L. Bonetti. The bulb is furnished with a sealed-in platinum wire, which can be heated by an external current.

NEW SOUTH WALES.

Linnean Society, May 25.—Mr. Henry Deane, Vice-President, in the chair.—On a myxomycete new for New South Wales, by D. McAlpine.—A preliminary study of the *Membracidæ* described from Australia and Tasmania, by Dr. F. W. Goding. The author has in contemplation the preparation of a monograph on the homopterous family *Membracidæ*, the Australian and Tasmanian species of which have not received much attention.—Further notes on Australian shipworms, by C. Hedley. A fresh-water shipworm from Fiji, first brought under notice by Mr. T. Steel at the Society's meeting in August 1895 is described and illustrated, under the name *Calobates fluviatilis*. *C. saulii*, Wright, in which *Teredo fragilis*, Tate, is included, is also dealt with. This species has now been traced from Adelaide, through Bass Straits to Sydney, where a second species, *C. edax*, flourishes, now first recognised as destructive to wharves in Port Jackson.—Descriptions of new mollusca, chiefly from New Caledonia, by C. Hedley. A remarkable new *Placostylus* from Dr. Cox's collection, aberrant alike geographically and structurally, is described; with further considerations on the range of the genus, dwelt on in a previous communication. Several molluscan novelties obtained during a visit to New Caledonia are made known, including a new *Teinostoma*, a *Diplommatina*, and an *Ischnochiton*.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Adressbuch für die Deutsche Mechanik und Optik, Band i. (Berlin, *Der Mechaniker*).—Stanford's Compendium of Geography and Travel (new issue): North America. Vol. 2. The United States: H. Gannett (Stanford).—Food Supply: R. Bruce (Griffin). The Making of a Daisy: E. Hughes-Gibb (Griffin).—Logic, Deductive and Inductive: C. Read (Richards).—Iowa Geological Survey, Annual Report, 1896 (Des Moines).—The Alpine Guide. The Western Alps: John Ball, new edition, by W. A. B. Coolidge (Longmans).—The Doctrine of Energy: B. L. L. (Paul).—Practical Organic Chemistry: G. George (Clive).—Wealth and Progress of New South Wales, 1896–97: T. A. Cogblan (Sydney).—Notes on Volumetric Analysis: A. Thornton and M. Pearson (Longmans).—A Short Course in Inorganic Qualitative Analysis: Dr. J. S. C. Wells (Chapman).—A Laboratory Guide in Qualitative Chemical Analysis: Prof. H. L. Wells (Chapman).—A Course of Practical Chemistry: W. G. Valentin, 9th edition, edited and revised by Prof. W. R. Hodgkinson (Churchill).—Hydrographical Surveying: Rear-Admiral Sir W. J. L. Wharton, 2nd edition (Murray).—Régularisation du Mouvement dans les Machines: L. Lecornu (Paris, Gauthier-Villars).—Müller-Pouillet's Lehrbuch der Physik und Meteorologie, Neunte Auflage, Zweiter Band, Zweite Abthg.: Drs. Pfaundler and Lummer (Braunschweig, Vieweg).—A First Year's Course of Practical Physics: J. F. Tristram (Rivingtons).—Facts about Bookworms: Rev. J. F. X. O'Conor (Suckling).

PAMPHLETS.—Additions to the Fungi on the Vine in Australia: D. McAlpine and G. H. Robinson (Melbourne)—Copenhagen (Danish Tourist Society, Copenhagen).—Publications of the Smithsonian Institution available for distribution, April 1898 (Washington).—Das Fernobjektiv im Porträt, Architektur und Landschaftsfache: H. Schmidt (Berlin, Schmidt).—Der Gummidruck: J. Gaedicke (Berlin, Schmidt).—Introduzione allo Studio dei Silicati: Prof. E. Ricci (Milano, Hoepli).—Tours in North of Ireland (Belfast, Baird).

SERIALS.—Journal of the Chemical Society, June (Gurney).—Economic Journal, June (Macmillan).—Journal of the Royal Microscopical Society, June (Williams).—An Illustrated Manual of British Birds: H. Saunders, 2nd edition, May and June (Gurney).—Field Columbian Museum Publications. Anthropological Series, Vol. 2, No. 2; Zoological Series, Vol. 1, Nos. 9 and 10 (Chicago).—Tufts College Studies, No. 5 (Tufts College).—Longman's Magazine, July (Longmans).—Chambers's Journal, July (Chambers).—Good Words, July (Isbister).—Sunday Magazine, July (Isbister).—American Journal of Mathematics, July (Baltimore).—Monthly Weather Review, March (Washington).—Natural Science, July (Dent).—Johns Hopkins University Studies, Ser. xvi. No. 6 (Baltimore).—Humanitarian, July (Duckworth).—Century Magazine, July (Macmillan).—Proceedings of the Royal Society of Victoria, Vol. x. (new series), Pt. 2 (Melbourne, Ford).—Contemporary Review, July (Isbister).—Fortnightly Review, July (Chapman).—Reliquary and Illustrated Archæologist, July (Bemrose).—National Review, July (Arnold).—Journal of the Royal Agricultural Society of England, Vol. 9, Part 2 (Murray).

CONTENTS.

THURSDAY, JULY 14, 1898.

EVOLUTION OF THE MORAL INSTINCT.

The Origin and Growth of the Moral Instinct. By Alexander Sutherland, M.A. Two vols. Pp. xiii + 461, and vi + 336. (London: Longmans, Green, and Co., 1898.)

MR. SUTHERLAND'S work is thoroughly Darwinian, being based on a huge mass of observations which he has selected without apparent bias, marshalled well, and handled judiciously. Few books written since Darwin's time on the evolution of the human mind, are so thorough and comprehensive and well deserving of study. Its chief merit lies in the solid treatment by which the writer confirms and extends the masterly sketch drawn by Darwin in the fourth and fifth chapters of his "Descent of Man," but it is also extremely original in many particulars; and though somewhat diffuse here and there, is interesting throughout. Mr. Sutherland resides in Australia, where it must have been more difficult to obtain that ready access to books and authorities which European students enjoy, and to obtain skilled help in his experiments; he is therefore entitled to a proportionate increase of praise and to much excuse where he is open to criticism.

The main argument and the general results of his inquiry may be stated in a few words, but the fulness of their significance will be imperfectly realised without carefully reading the whole of his book. They are, that a progression in complexity of organisation and faculty is closely associated with the duration of growth, including both the embryonic stage and that of immaturity. Next, that the duration of growth is closely correlated with parental care. It is shown that in the earlier stages of evolution of a species, the parental care is small, but as higher stages of evolution are reached, the amount of parental care successively increases until it grows into parental sympathy, and he argues that it is directly or indirectly from parental sympathy that all morality proceeds. The first of these three steps might rank as a corollary to Von Baer's law, namely that the successive stages in the history of each race are hurried through during the embryonic life of each individual in it. Consequently as the number of stages increases, the length of time required for individual development tends to increase also, though not in the same proportion because the rate of passing through them may and does to some extent become more rapid. The author shows by a large array of evidence that the above presumption is true, and that this essential basis of his further argument may be accepted without hesitation.

Leaving insects aside as creatures of an entirely different mental constitution to our own, and as evolved along different lines from vertebrates, he begins by tracing in detail the first appearances of the parental instinct in various species of fish. He finds—

"Of species that exhibit no sort of parental care, the average of forty-nine gives 1,040,000 eggs to a female each year; while among those which make nests or any apology for nests the number is only about 10,000. Among those which have any protective tricks, such as carrying the eggs in pouches, or attached to the body, or in the mouth, the average number is under 1000; while among those whose care takes the form of a uterine or quasi-uterine gestation which brings the young into the world alive, an average of fifty-six eggs is quite sufficient.

"It must hence be very evident how much better are a few that are tended than a great crowd left without care. And the first link in the chain of reasoning of this book is that in the struggle for existence an immense premium is placed upon parental care, and that not until this has been developed can the higher nervous types become possible."

There is another well-known way, as he points out, by which the life of the young is rendered more secure, namely by assuming mimetic characters and thereby escaping the observation of enemies. But successful mimicry leads to nothing further, and therefore does not enter into the plan of the present work.

He next examines into the case of amphibians and concludes that—

"Among all the non-parental species for which I have obtained information the number exceeds 800 eggs, yet the average of nine species that show parental care is only twenty-seven. Among the viviparous species the number of offspring declines to ten or less in the year."

Up to this point he considers that the story of evolution contains no indication whatever of the existence of real affection, but the true parental sympathy, which is destined to play a most important part in the survival of the nobler species, arises during the next stage.

Birds and mammals are understood to be developed from different points in the scale of reptile life, and the character of the protection they respectively give to their young differs accordingly. Some reptiles incubate their eggs, and birds carry on this process of incubation; other reptiles bring forth their young alive, and mammals follow that method. As their respective types advance in the scale of intelligence and affection, he shows that both birds and mammals present a lengthening period of parental protection, but the mammalian method reaches far ahead of that of the birds. It leads to the monkey, to the savage and to civilised man; the other seems to reach its acme in the bower bird.

In discussing birds, he divides them into three classes of progressive intelligence. The lowest contains the ostrich, emu, &c., which annually lay on the average twelve or thirteen eggs; the medium class includes partridges, petrels, coots, plovers and pigeons, these lay, on the general average, seven or eight eggs; the highest class includes birds of prey, parrots, woodpeckers, sparrows and finches, these lay, on a general average, four or five eggs a year. All birds of the higher grade

"hatch out young ones of abject helplessness, and the continuance of each species is absolutely dependent upon that parental love which is poured out in floods of unmeasured self-sacrifice. Among these birds the gracious charm of family life is first made fully known, and it is no mere chance that, concomitant therewith, comes that delight in throbbing melody which proclaims the fullest tide of joyous life. In all these genera, with their multitudinous species, male and female unite in their care for the tender brood, and show, as a rule, a steady attachment each for the other. Sometimes the male and female brood on the eggs alternately; while one is sitting the other is not far off; but this occurs only in twenty-eight per cent. of the genera, and these are on the whole of somewhat inferior type. In sixty-five per cent. the female alone undertakes the brooding, but the male is, throughout, her faithful attendant, feeding her assiduously, driving away intruders, and cheering her with the joy of his tumultuous song. In accordance with the teachings of economics, we must regard this division of employment as a sign of progress." . . .

"That family life, which T. H. Green, in his 'Prolegomena to Ethics,' so justly regards as the ultimate basis of moral ideals (p. 257) . . . is faintly seen in a few fish; it is not wholly absent among reptiles, but it is for the first time distinctly observable among the lower birds, increasing ever as the type advances, till we find the nest-life of one of these higher birds to be marked by many graces of an indubitably moral character. The conjugal tenderness of the mated pair, and their unwearied self-sacrifice in ministering to the wants of their offspring, are ethically beautiful. Where these appear in an equal degree in the human couple, we reckon them as a solid fundamental element of goodness. Much else is required of man and woman, but it is no slight praise to say 'he was a kind husband and a devoted father,' or that 'she was a tender wife and a mother of unwearied love and self-sacrifice.'

"The family life, which we see so beautifully developed in these birds, is like the seed, enclosing within itself the full potentiality of all the ethic good to be developed in yet later stages, wherein a growing intelligence makes the young always more and more dependent upon family and social union."

Similarly in mammalian species, the number of offspring decreases with each successive stage of increasing intelligence and parental sympathy. It not only does so in the four orders of monotremes, marsupials, deciduate and non-deciduate placentalia, taken as wholes, but also when they are severally analysed in much detail. It is impossible to go further into this subject within the space at our disposal.

The portion of the book thus far noticed, is but a small part in bulk of the whole, but it will be of superior interest to those who are disposed to argue in a lazy offhand way, that after parental instinct had attained the level reached in the lower savages, its further evolution would be merely a matter of time and of favourable conditions. This was, however, by no means the feeling of the author, for he has taken very great pains and given much anthropological research to trace its actual steps. It is only possible here to give extracts from his summary.

"The process of moral development, as I see it, has been a slow dawning of parental sympathy, whence arises a simple and natural morality which is strengthened by the growth of the sense of duty and other accessory developments of sympathy. Out of the morality thus engendered springs whatever is moral in law, though, fundamentally, law is not moral but retaliatory."

One of the most interesting parts in the later portion of the book relates to the evolution of the sense of chastity. In the course of that discussion he treats lucidly and with great fairness many vexed questions concerning marriage in early times. He is in full concurrence with and gives important contributions to the present reaction against the excessive but clever dogmatisms of McLennan about the universality of marriage by capture, endogamy and exogamy, and the rest. But it is impossible to cope in a short article with the wide range of careful inquiry contained in this really remarkable book. Yet extensive as it is, some additional chapters have been written and afterwards omitted, as the author informs us. Others, too, might have been inserted; for instance, it would be very interesting to trace and describe the origin and purport of superstitious fears in human nature and their bearing on moral instinct.

F. G.

THE ANIMALS OF ESSEX.

The Mammals, Reptiles, and Fishes of Essex. By H. Laver. Essex Field Club Special Memoirs, Vol. iii. Small 8vo. Pp. viii + 138, illustrated. (Chelmsford: Durrant, 1898.)

In respect of physical conditions Essex is one of the most favourably situated of the eastern counties of England for the possession of a large local fauna, its inland districts presenting variety of station, while it has a large sea-board, forming an estuary into which discharge several more or less important rivers. Indeed, were it not for the pollution of the Thames, the fish-fauna of the county would be even larger than is at present the case, and would reckon among its constituents the lordly salmon itself. Among other special advantages from a naturalist's point of view the county includes Epping Forest, which under its present excellent administration forms a sanctuary for wild creatures of many kinds. And in addition to its natural advantages, Essex is fortunate in possessing a Field Club which includes on its working roll many naturalists of high capacity. It is to a member of this club that we owe the present contribution to a knowledge of the fauna of the county.

So far as numerical completeness is concerned, the author seems to have done his work thoroughly; if he errs at all, it is in mentioning certain species which have admittedly been introduced into the county. The scientific importance of local faunistic works is not, however, to be reckoned by the number of kinds of stray cetaceans and other wanderers they record; but by pointing out the reason why particular species are restricted to particular districts, and in what respects the local representatives of each species recorded differ from their kindred in other districts. In both these respects the work before us fails to come up to modern requirements; since it completely ignores these portions of the subject, and merely gives general notes of little or no value on the animals mentioned. The work may be, and probably is, of considerable interest to the residents of Essex, but can lay no claim to a position of any scientific importance. It may, however, be useful as a foundation on which to build a more important superstructure, when the naturalist arises who will treat the Essex fauna from a broader standpoint.

It is somewhat unfortunate that the work appeared too soon after Mr. Thomas's revision list of the nomenclature of British mammals to admit of the author following the new light. In some cases, such as the retention of *Arvicola* for the voles, and of *Lepus timidus* for the common hare, the author is obviously behind the times. It may be uncongenial, but the sooner amateur naturalists take to follow the lead of their professional brethren in nomenclatural questions (always reserving the "*Scomber scomber*" principle) the better it will be for all parties. The change is bound to come, and it may as well be accepted gracefully. In making a family "*Arvicolidæ*," the author departs from all authority; and the adding of the name of its founder to each family and order of fishes is an unnecessary redundancy.

The volume is illustrated with several photogravures, all of which are excellent from an artistic point of view, while several afford interesting glimpses of local scenery. If it be regarded merely as a stepping-stone towards fuller treatment, the work may be welcomed as indicating the recognition of the importance of treatises on our local British faunas.

R. L.

THE AMERICAN EXCAVATIONS IN MESOPOTAMIA.

Nippur; or, Explorations and Adventures on the Euphrates. By J. P. Peters. Vol. i. pp. xvi + 375; vol. ii. pp. x + 420. (London: Putnam's Sons, 1897–98.)

THOSE who take an interest in Mesopotamian excavations, and in the building up of the history of the ancient empires which flourished in the land "between the two rivers" by means of almost undecipherable cuneiform documents, will welcome the appearance of Dr. Peters' volumes. We must, however, warn the reader that he is not to expect a thrilling narrative like that which the late Sir Henry Layard gave us in his "Nineveh and Babylon," and "Nineveh and its Remains," both of which works were published nearly forty-five years ago, and he is not to look out for vivid tales of the uncovering of the palaces of mighty kings in the presence of hundreds of wondering and enthusiastic natives, nor for anything of the kind. No Mesopotamian traveller can ever hope to attract the attention of the reading public as thoroughly as did Sir Henry Layard, for there is, unfortunately, no second Nineveh to "discover"; though, by the way, its site was not only never lost, but was thoroughly well known. Moreover, the reader must not expect from Dr. Peters a scientific work like Dr. Oppert's "Expédition Scientifique en Mésopotamie," the first part of which appeared in 1859, for the work which he undertook to do in Babylonia and Assyria was not on all-fours with that which the eminent French man of science was called upon to perform. Sir Henry Layard's want of knowledge of Assyrian was made up for by the possession of considerable skill in writing an easily read and popular account of his travels and works; in the early days of the science of Assyriology when he wrote, he was able to put forward theories which in subsequent years scholars like Sir Henry Rawlinson and Dr. Oppert were unable even to mention. Dr. Peters starts, of course, with much better equipment than any one of the three Mesopotamian explorers whose names we have mentioned, for he has all their experience to help him, and an enormous mass of archæological facts, which have been heaped up by several workers, at his free disposal. Notwithstanding these advantages, his work is not a scientific exposition of the results obtained from the excavations by the expedition of which he was the director, nor is it a very readable popular story, interesting by reason of the personal details which it contains. His two volumes are well printed and very fairly illustrated, and they have maps, an index, appendices, &c. Dr. Peters must have given much time and attention to the work before us, and those who are able to wade through some hundreds of heavily-written pages will, of course, thank him for it. It is not our intention to discuss "Nippur" in detail, for many of the results obtained from the excavations carried on at the city of this name by Dr. Peters, and by his distinguished successor Mr. Haynes, have already been made known by Prof. Hilprecht; our object is only to call attention to the excellent work which the Americans have done by establishing a Consulate at Baghdad, and by systematically working through a site.

Just as England owes its unrivalled collections of Babylonian and Assyrian antiquities in the first instance to the private initiative of the British Ambassador at Constantinople about the year 1845, so the fine collections of inscribed tablets and other antiquities which America now possesses are due to the private enterprise of some of the principal citizens of Philadephia. The American expedition was inaugurated by Mr. E. W. Clark, a leading banker of that city, and the scheme was adopted with great vigour and good-will by Dr. W. Pepper; other public-spirited men joined them, and their efforts have been crowned with such success that up to the present time nearly fifteen thousand pounds sterling have been expended by America on archæological researches in Mesopotamia. The chief site of the work of the Americans was at Nippur or Niffer, a city which was situated about fifty miles to the south-east of Babylon, and was the centre of a great and flourishing civilisation some seven thousand years ago. Some of the early explorers had ascertained that the mounds which marked the site of the old city contained remains of buildings, inscribed tablets, &c., but the work of digging them out seriously did not begin until Dr. Peters and Mr. Haynes arrived on the scene. Dr. Peters toiled for several weeks at Niffer in 1891 and 1892, and succeeded in clearing out part of the great Temple of Bel, and in finding a large number of inscribed tablets; the two volumes before us deal practically with the results of his labours. In 1893 Mr. Haynes took over the work, and was so fortunate as to light upon a "find" of thousands of tablets, seals, and other important documents; he was also enabled to lay bare the ruins of the greater part of the ancient city and its temple in such a way that we are now able to understand the plan upon which an ancient pre-Babylonian city was arranged and built. Many tablets and other precious objects had, according to the terms of the agreement between the Ottoman Museum authorities and the Americans, to be sent to Constantinople; but we are glad to learn from Prof. Hilprecht's publications that a substantial number have been allowed to cross the Atlantic as a reward for the money and labour expended by the Americans at Niffer. It is to be hoped that copies of all such documents may be made available for scholars as soon as possible, and that other cuneiform experts in America will follow the example which Prof. Hilprecht has set them. Meanwhile it is to be hoped that a successor to Mr. Haynes and Dr. Peters has been found, and that a good work so well begun may be continued.

OUR BOOK SHELF.

A Manual on General Pathology for Students and Practitioners. By W. S. Lazarus Barlow, B.A., B.C., M.D., M.R.C.P. Pp. xi + 795. (London: J. and A. Churchill, 1898.)

THE book before us is a treatise on general pathology, from which morbid anatomy is practically excluded. To the readers of Cohnheim this subject is familiar; the author has done well to take such a book as a model, and to, so to speak, bring it up to date.

The relation between morbid anatomy and disease has never been doubted. The study of a dead, dilated, hypertrophied and valvularly diseased heart has always been held to be of immense value to the student of medicine. It must be admitted, however, that it bears the same relation to disease as a scratched rock does to the action of a glacier. Both are the more or less permanent records of a process. However valuable such records may be, it must be admitted that the demonstration of the behaviour of a heart under conditions more or less exactly imitating disease is also of great value. It is to be regretted that while teaching in morbid anatomy is all-sufficient, instruction in experimental pathology is most often conspicuous by its absence. A careful perusal, however, of Dr. Barlow's work will in no small measure make up for this deficiency, and the student of medicine who wants to do something more than get qualified in a minimum time, will find it very helpful. Although the book is ostensibly written for practitioners, the reviewer is afraid that its contents will only appeal to a relatively small circle of medical practitioners, at any rate at present.

It would be impossible in a short notice to even enumerate the subjects treated by Dr. Barlow. The chapter on osmosis will perhaps appeal most to the general physiological reader; in it is to be found a description of the author's own work in this field of research, and also a fair account of the work of those who hold different views with regard to the function of the epithelium cells involved. The pathology of the circulation is well handled, but contains little of special interest. Under inflammation, chemiotaxis and its relation to phagocytosis are discussed. The author devotes a chapter to the "Pathology of Heat Regulation," at the conclusion of which fever, and tissue change in fever is fully considered. Under shock and collapse, which are viewed in the light of the recent experiments of Roy and Cobbet, transfusion is treated in an original manner. Chapter xii. forms an interesting monograph on the pathology of nutrition, which is dealt with exhaustively. Chapters on morbid secretion and excretion, and the pathology of respiration follow, and the book concludes with a miscellaneous appendix, in which, *inter alia*, ptomaine poisoning is briefly considered.

The book is eminently readable, and although the range of subjects covered by it is very wide, is not wanting in thoroughness. Its value is enhanced by the carefully compiled bibliography which concludes each chapter. It is somewhat to be regretted that it should appear so soon after almost similar subjects have been treated either in Allbutt's "System of Medicine" or in Prof. Schäfer's "New Text-book of Physiology," but this is obviously no fault of the author's. F. W. T.

A Text-Book of Entomology, including the Anatomy, Embryology and Metamorphoses of Insects, for use in Agricultural and Technical Schools and Colleges. By Prof. Alpheus S. Packard. Pp. xvii + 729. (London: Macmillan and Co., Ltd. New York: The Macmillan Co., 1898.)

DR. PACKARD has undertaken in this text-book to review and epitomise the vast literature relating to the structure of insects. For such a task special qualifications are necessary; among the rest, unflinching industry, a sound judgment, and a first-hand, practical knowledge of the subject. These qualifications our author exhibits on every page. He has worked long and hard as an investigator; he has a candid mind; and he has spared no pains either upon the collection or the elucidation of his materials. The critic who tries to be wholly impartial may feel compelled to point out a certain slowness to draw general conclusions, which is particularly evident in the concluding section on the causes of metamorphism. This reserve is natural, perhaps laudable, in the writer of an encyclopædic work. Dr. Packard's book will be of the greatest service to students of insect-anatomy, and almost indispensable to future writers on the subject. It is a great store of well-sifted and carefully arranged information, which will guide the naturalist to many a special research which he might easily have passed by in ignorance of its very existence. We must not leave the impression that Dr. Packard has done nothing but condense into a text-book the work of other men. He has made out for himself many interesting and valuable facts, and in no part of this treatise does he find himself altogether remote from his own published researches. The book before us is handsomely printed, profusely illustrated, and furnished with copious bibliographical lists. Together with the very dissimilar treatise by Dr. Sharp in the "Cambridge Natural History," it puts the student of scientific entomology into a far better position than he occupied a year or two ago. Dr. Packard's book, like Dr. Sharp's, should find a place in every library which includes comparative anatomy, and both should be the constant companions of all who occupy themselves with the structure and life-histories of insects. L. C. M.

The Mathematical Theory of the Top. Lectures delivered on the occasion of the Sesquicentennial Celebration of Princeton University. By Felix Klein, Professor of Mathematics in the University of Göttingen. Pp. 74. (New York: C. Scribner's Sons, 1897.)

THE four lectures constituting this little book are worthy of the great occasion which called forth their delivery. Prof. Klein uses the particular dynamical problem of the top as an illustration of the advantages that may be gained by utilising the modern theory of functions in applied mathematics. Instead of being content with analytical processes, he strives to the utmost to give a geometrical form to his formulas, and to make the solution intuitive. He passes beyond the parameters of Euler and Rodrigues to apply to dynamics a system of coordinates which Riemann introduced forty years ago in the discussion of certain geometrical problems. Using also Riemann's method of conformal representation, he gives an insight into the inner nature of elliptic functions, and shows that his new parameters are what he calls "multiplicative elliptic functions"—they miss being doubly periodic by being affected by an exponential factor when t (the time) is increased by a period. By means of these parameters the author attains to a clearer, neater and more complete solution of the problem of the motion of a body about a fixed point than had hitherto been reached, and justly claims that he has resolved the problem into its simplest elements. He also deals with Jacobi's famous theorem, that the motion of the top may be represented by the relative motion of two Poinsot motions (or rotations of a body about its centre of gravity which is fixed).

In generalising to the full the problem under discussion the author deals with the case when the time, t, by being supposed complex, becomes capable of two degrees of variation. In order to get a geometrical representation, he is led to consider the motion of a rigid body in hyperbolic non-Euclidean space.

The last lecture deals with a top whose point of support is no longer supposed fixed, but movable in a horizontal plane. The hyper-elliptic integrals of this more general problem are interpreted in a similar way to the elliptic integrals of the previous discussion. From the nature of the case, in these lectures, an outline sketch of a large subject is all that can be given, but the lines are traced by the hand of a master; and for filling in the details we must look to the author's treatise, "Ueber die Theorie des Kreisels," which is now in course of publication by Teubner.

William Stokes, his Life and Work (1804–1878). By Sir William Stokes. *Masters of Medicine.* Pp. 256; plate i. (London: T. Fisher Unwin, 1898.)

THE memoir before us is an interestingly written account of a man whom all physicians respect. Stokes was a master of medicine, and the inclusion of his biography in this series shows the wisdom of the editor. The name and work of Stokes are perhaps not as well-known to the modern student of medicine as they ought to be; this is probably due to the fact that not sufficient time has passed for us to appreciate his work, or rather for us to estimate its great value. He worked and taught at the time when exact methods of physical diagnosis were beginning to be applied by the clinician. Pathological chemistry and bacteriology were practically non-existent, and clinical thermometry was in its infancy. The work of Laennec on the stethoscope had attracted the attention of medical Europe, and opened up the enormous field of the correlation between physical signs and symptoms. It is in this particular field that the work of Stokes was done, and his treatise on the diagnosis and treatment of diseases of the chest still remains a classic. With the exception of Laennec's work, which it considerably amplified, this book must be regarded as one of the most noteworthy upon this subject which had until then been written.

To turn from his professional to his private life, the letters which are given us in this biography show us Stokes as a cultured Irish gentleman, forming the centre of a wide circle of friends. The biography is carefully written, and will appeal to all those who are interested in that epoch of the history of medicine to which its subject belongs. F. W. T.

Practical Organic Chemistry. By George George, F.C.S. Pp. 94. (London: W. B. Clive.)

THERE is no date on the title-page of this book, but the preface bears the date May 1898. No scientific book should, however, be published without the year of publication being printed upon the title-page.

The book is intended "for the elementary and advanced examinations of the Science and Art Department." It contains a few experiments on the detection of common elements in organic compounds, on melting and boiling points, organic acids, alcohols, sugars, &c., notes on the methods of examination of mixtures containing organic compounds, and on the preparation of some reagents used in organic analysis. The volume will thus make the student acquainted with the reactions of, and the tests for, common organic bodies.

Food Supply: a Practical Handbook for the use of Colonists and all intending to become Farmers Abroad or at Home. By Robert Bruce. With an Appendix on Preserved and Concentrated Foods, by C. Ainsworth Mitchell, B.A. Pp. xvi + 159. (London: Charles Griffin and Co., Ltd., 1898.)

THIS is the second volume of the "New-Land" Series, edited by Prof. G. A. J. Cole. It is a concise and soundly practical manual of farming in which the fundamental principles of successful agriculture, and of the selection and management of live-stock, are described. It is only paying a compliment to the author to state that the book contains the kind of information published by the Department of Agriculture of the United States, and in such official publications as the *Agricultural Gazette* of New South Wales and the *Agricultural Journal* of the Cape. As we are at present without a central office for supplying information to British farmers, it is the more necessary that the means of education in the science and practice of agriculture afforded by such books as the one under notice, should be widely known. The volume deals with the fundamental principles of most branches of farming, and will prove of service in any part of the world. The forty-nine half-tone reproductions of photographs of representative animals, illustrating the chief breeds of live-stock, will be of particular interest to farmers.

Royal Gardens, Kew. Bulletin of Miscellaneous Information, 1897. Pp. 437 + 68. (London: H.M. Stationery Office, 1897.)

THE well-known *Kew Bulletins* afford the best of evidence of the valuable work done at the Royal Gardens in advising upon possible developments of the natural resources of our Colonies and dependencies. Each *Bulletin* contains a number of plain statements of attempts made to introduce new and commercially profitable plants in suitable districts, of improved methods of cultivation, and of work that men trained at Kew are doing in the various parts of the world to which they have gone from the Royal Gardens. The *Bulletins* issued in 1897 are collected in the present volume, and together they make a worthy contribution to economic botany. Among the contents is a long list of publications issued from Kew during the years 1841–95. This record of accomplished work is an eloquent testimony of the important part which the Gardens take in botanical research, and in developing the resources of the Empire. Several papers on botanical exploration and enterprise are included, and sixty-three pages are devoted to the report of the Royal Commission appointed to inquire into the condition and prospects of the West India Colonies.

LETTERS TO THE EDITOR

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

The Spectrum of Metargon.

WE have delayed in replying to Prof. Schuster's letter in your issue of June 30 in order that we might make further experiments on the subject. We have had the kind assistance of Prof. Schuster, who demonstrated to us the close similarity between the group of green lines in the metargon spectrum and the spectrum of the blowpipe flame. We subsequently satisfied ourselves regarding the similarity of the metargon spectrum and the "Swan" spectrum, shown by carbon monoxide in a vacuum tube. At first sight, Prof. Schuster seems justified in attributing that spectrum to the presence of carbon or of one of its compounds. Yet we think that careful consideration of the following facts will necessitate a suspension of judgment:—

(1) The sample of metargon was mixed with twice its volume of oxygen, and sparked for two hours in presence of caustic soda. This sample, introduced into a vacuum tube after removal of oxygen, still showed the same spectrum.

(2) A little oxygen was introduced into the gas, and the mixture was then admitted to a vacuum tube. Oxygen lines became visible, but no bands of the so-called "carbonic oxide" spectrum. On removing the oxygen by means of phosphorus, the original spectrum appeared with its customary brilliancy.

Thinking it possible that the ordinary spark may not have had a sufficiently high temperature to decompose an imaginary stable carbon compound, a jar and spark-gap were introduced, and sparks passed through a mixture of metargon with twice its volume of oxygen, standing over caustic soda, for six hours. No contraction occurred, and the spectrum of the gas was unaltered, after removing oxygen.

(3) An artificially made mixture of carbon monoxide and argon —about equal volumes of each—was mixed with oxygen. It was sparked and exploded. It was then further sparked over soda for a quarter of an hour. On introducing the gas into a vacuum tube, after removal of oxygen, no carbon lines or bands were seen, but only the spectrum of pure argon.

The bands in the green of metargon are exceedingly brilliant, and the spectrum is by no means of the character of a subsidiary one. It does not appear to be possible to enfeeble them relatively to the rest of the spectrum.

We have found it possible, in hundreds of cases where it was necessary, to remove traces of carbon compounds from gases evolved in heating minerals—chiefly helium—to remove the carbon bands by "running" the tube, *i.e.* by increasing the intensity of the current until the aluminium pole melted. The green and red bands, under these circumstances, slowly disappear, and the spectrum of helium or of argon, as the case may be, shines out "clean-cut," and shows as bright lines on a black background. This process is impossible with metargon; no change is produced even after long "running."

We must again call attention to the facts that this gas shows the ratio of specific heats 1·66; that it possesses sensibly the same density as argon; and that it is a solid at the temperature of liquid air, boiling under atmospheric pressure.

Although, therefore, we are the first to admit that the spectrum of this gas requires further investigation, yet, from what we have observed, we provisionally adhere to our original view that it possesses the characteristics of a definite chemical individual.

We would take this opportunity of correcting a misprint in the *Comptes rendus*, cxxvi. p. 1762, where the wave-length 5849·6 is attributed to metargon, instead of to neon.

W. Ramsay.
M. W. Travers.
Edward C. Cyril Baly.
University College, London, Gower Street, W.C.

Liquid Hydrogen.

Prof. Dewar's letter in your last issue is such a pronounced personal attack on me, that I feel I ought to deal with the remarks to my prejudice which it contains, though I will try to avoid imitating its tone.

(1) He refers to the statements on which I base my claim to the invention of the self-intensive method as matter which "has already been refuted." I should be glad to know when and by whom. They are clearly numbered 1, 2, 3, 4, in my last letter, and form the substance of my first. At the Society of Chemical Industry Mr. Lennox, though he was present and heard the statements repeated, with every opportunity of contradicting them, did not do so. Prof. Dewar, far from refuting statements 1 and 3, did not even deny them; and his attack on the second (respecting the novelty of the invention) resulted in strengthening it, since it showed that he was reduced to building up an anticipation by taking material from several different sources, having been unable to find any account of the combination before my proposal in November 1894. The fourth statement had not then been made, as hydrogen had not been liquefied. Where then has the refutation taken place? In both his letters to you Prof. Dewar keeps all four statements at a very respectful distance.

(2) Prof. Dewar uses the words "accusations which he was compelled to withdraw when he met me face to face," and "when brought to book at the Society of Chemical Industry." It is quite untrue that I withdrew anything at all. On the contrary, I said that "I had nothing to withdraw," and that my assertions were "a simple and direct statement of historical facts," repeating more frequently than is shown in the printed report that the facts were exactly as I had stated them. As to what took place between Prof. Dewar and his assistant it is obvious that, not having been present, I could have no knowledge; and I can only publish what I know of my own knowledge, or can prove by conclusive evidence. Deductions from the facts must be made by every one for himself, and I reminded Prof. Dewar that as I had published no such deductions I could not withdraw them.

(3) I was not, at the time of my communications to Mr. Lennox, "convinced of the general dishonesty of Royal Institution methods," as Prof. Dewar suggests. I regarded the Royal Institution as one of the temples of science, and Mr. Lennox as its chief acolyte, who might, perhaps, when my offering had been examined and found worthy of acceptance, introduce me to the favourable notice of higher authorities.

(4) What I am "to be understood as saying in the letters you have published," is so clearly set forth in my four numbered statements in your issue of June 23, that Prof. Dewar's doubts on the point cannot be so puzzling as his question implies.

(5) Prof. Dewar's acquaintance with patent-law cases involving a host of partisan expert witnesses and costly counsel is too extensive and familiar to leave him in any doubt as to the reason why a man without means does not begin a prosecution for infringement. I could, however, warn the infringers; and this I did. The protest having been made, I am still free to prosecute when circumstances render it possible and advisable to do so, and the present prospects of low-temperature work make it by no means unlikely that action may yet be taken.

(6) Prof. Dewar's admission, referring to Dr. Linde's method, which he had just heard described, "that the practicability of such a mode of working had never struck him," was made in the opening sentences of his remarks, without any limiting qualifications, but with express inclusion of both "the mechanical ingenuity and knowledge of thermodynamics" involved; so that its only fair interpretation is with reference to the description that had just been given of Dr. Linde's combination, which is, except in details, the same as mine. The force of the admission is not lessened by quoting a subsequent passage which refers to one part of the combination. Dr. Linde and I had invented a combination which made it possible to liquefy air without using any other refrigerant than water. Prof. Dewar admitted that he had never thought out the whole combination. Whatever therefore he and others had done with some parts of it, when the combination came out he ought to have recognised its novelty, instead of endeavouring to piece it together out of old patents and experiments.

(7) Neither M. Solvay nor Prof. Onnes claims to have invented a combination by which continuous free expansion from a nozzle is able, without using other refrigerants, to liquefy air: so that Prof. Dewar misleads his less instructed readers by putting those gentlemen forward as my rivals on the ground that they claim to have used parts of the combination.

My communications to Prof. Dewar's assistant were, however, of earlier date than any publication of Dr. Linde's process. This is the fact of which, with its corollaries, I had hoped to obtain a frank admission from Prof. Dewar, and I would have much preferred that the discussion in your columns had been confined to the points raised in my first letter. Prof. Dewar, however, instead of frankly admitting my claims, as other prominent scientific men have done, or discussing the statements on which they are based, has seen fit to give his attention almost entirely to the more personal elements in the controversy. In two letters he has called my action "dubious" and "not straightforward," and has said that either I am "a singularly dull person" or am consciously imposing "upon the credulity of the world," that I contradicted myself "when brought to book," and that I "was compelled to withdraw accusations" which in fact I explained that I had never made, while refusing to withdraw anything at all. Under these circumstances I think that few of your readers will blame me for asserting the justice of my claims, though I regret that so much of your valuable space should have been occupied by matters of this nature. W. Hampson.

July 1.

The Distribution of Prepotency.

No numerical estimate appears to have been made of the frequency with which different grades of prepotency are distributed. Breeders are familiar with the fact that certain animals are peculiarly apt to impress their personal characters upon offspring, but how frequently and to what extent this tendency occurs has never, I believe, been investigated. The following attempt is therefore of interest, though not free from objection in minor details. In *Wallace's Year Books* of the American Trotting Horses, lists are given (1) of the sires of offspring, any one of which has succeeded in trotting one mile in 2 minutes and 30 seconds or less, or who has "paced" (= ambled) the same distance in 2 minutes and 25 seconds or less; (2) of the dams of at least two such offspring, or else of one such offspring and one such grandchild. A selection was made from lists (1) and (2) of sires and dams who were themselves foaled before 1870 and who therefore were, or would have been, at least 25 years old at the date of the last *Year Book* in my possession, which is for 1896. This is practically a sufficient allowance, giving say 5 years to the foals in which to make their record, and 20 years as the limit of the breeding age of either parent. My selection from list (1) contained 716 sires, and that from list (2) contained 494 dams. Reducing to percentages, the distinguished offspring (standard performers) to 100 sires and to 100 dams from these lists respectively, are tabulated below, disregarding decimals. Thus out of each

Distribution of the Parents of Standard Performers.

	Number of standard performers produced by a single parent, sire or dam.											Total parents.
	1	2	3	4	5	6 to 10	11 to 20	21 to 30	31 to 40	41 to 50	51 and above	
Sires ...	46	17	10	7	3	9	4	1	1	1	1	100
Dams ...	50	35	10	3	1	1	—	—	—	—	—	100

100 selected sires, we see that 46 produce only one standard performer, 17 produce two, 10 produce three, 7 produce four, and 5 produce three. Thus far the distribution of prepotency is not particularly abnormal, and we might have guessed that there would be about 3 cases more, none of which would contain more than from seven to eight standard performers, but the facts are surprisingly otherwise. Although the frequency of the successively larger families decreases with fair regularity, the rate of their diminution is far too slow to be compatible with the normal law of frequency. Instead of the expected 3 cases, each containing six, seven or eight standard performers, we find 17 cases of far higher contents. Thus in the list of 716 sires, the number of distinguished offspring are,—60 to *Blue Bull*, 71 to *Strathmore*, 83 to *George Wilkes*, 92 to *Happy Medium* and 154 to *Electioneer*. Making full allowance for the tendency of breeders to send the best mares to the best horses, the prepotency of the sires just named is enormous, that of *Electioneer* superlatively so. The same results are indicated by the produce of the dams, though the figures are less striking owing to the relative fewness of their offspring. A sire produces some 30 foals annually, a dam only one, while the period of production is presumably longer for the sire than for the dam. Consequently out of the list of 494 dams, the three mares *Emeline* (*sic*), *Minnehaha* and *Green Mountain Maid*, who produced respectively 7, 8 and 9 standard performers, seem as phenomenal as the five horses mentioned above. Again, prepotency is as we should have expected, heritable in a marked degree; thus all of the above five sires except *Blue Bull* are sons of "*Hambletonian* 10," and one of the three mares, *Green Mountain Maid*, was dam of *Electioneer*.

My conclusion is that high prepotency does not arise through normal variation, but must rank as a highly heritable sport, or aberrant variation; in other words its causes must partly be of a different order, or else of a highly different intensity, to those concerned in producing the normal variations of the race. In a sport, the position of maximum stability seems to be slightly changed. I have frequently insisted that these sports or "aberrances" (if I may coin the word) are probably notable factors in the evolution of races. Certainly the successive improvements of breeds of domestic animals generally, as in those of horses in particular, usually make fresh starts from decided sports or aberrances, and are by no means always developed slowly through the accumulation of minute and favourable variations during a long succession of generations.

FRANCIS GALTON.

Zoology as a Higher Study.

THE following, necessarily condensed, comments on Prof. Ray Lankester's criticisms may be permitted.

(1) Prof. Lankester's views on the citation of authorities in text-books have been published before. To the best of my belief "authoritative public opinion," if it had expression, would favour the side of common sense in this matter. A text-book, adapted to the needs of the elementary student, in which the "historical method of exposition" should be followed, and each discoverer awarded his due meed of recognition, is an impossibility, within reasonable limits of size and cost. Our reasons for omitting all references to authorities really were those given in the preface, which I invite Prof. Lankester to re-peruse, not those which he ungenerously ascribes to us.

(2) Where the names of the original authors of figures have not been quoted, and the proximate source from which the block was borrowed or the figure copied has alone been given, the name of the original author is, in most instances, a matter of no consequence whatever. In a very few cases the omission is regrettable.

(3) The main responsibility for the "most astonishing" of the errors which Prof. Ray Lankester has noticed in the text-book, viz. the statement that ossification occurs in the skeleton of Elasmobranchs, rests with me, and not with the two sons of W. Kitchen Parker. The most astonishing thing to the initiated onlooker will doubtless be Prof. Lankester's evident confidence that this is an error.

(4) The "error" with regard to the nephrostome of Lumbricus is Prof. Lankester's. If he will read over that part of the "Text-book" as it would be read by a student, taking the description of *Nereis* as the foundation, he will understand what I mean. "Corresponding segment" is not "same segment."

(5) The criticism of the statement regarding cœlome and hæmocœle in Peripatus would have lost all its apparent cogency had Prof. Lankester quoted only three lines more (see "Text-book," vol. i. p. 561).

WILLIAM A. HASWELL.

The Nature and Habits of Pliny's Solpuga.

I READ with much interest Mr. Pocock's article on "Solpuga" (NATURE, vol. lvii. p. 618). It may be worthy of note that a species of Galeodes is met not infrequently in Southern California, and is one of the few Arthropodous animals that is bold enough to attack and devour the honey-bee. It enters the hive and seizes the bee, worker as well as drone, and soon makes away with it. Were these Arachnoids as abundant as the Robber-flies (Asilidæ), they would be nearly as serious enemies of the bee-keepers of Southern California as are those insects. They are not, however, sufficiently numerous to do any serious mischief, and so are not feared or dreaded.

A. J. COOK.

Claremont, Cal., May 12.

The Weather of this Summer.

IN your notice of Symons's *Met. Mag.* this week, I seem to be credited with (discredited by?) the announcement that this summer will probably be wet. May I point out that it is one thing to announce this, and another to say that in the five years ending with the next sunspot minimum year (say 1901, or thereabouts), there will probably be more wet summers than dry? Further, the two rules cited in the notice are based on data extending from 1816, not merely from 1841.

July 8.

ALEX. B. MACDOWALL.

THE NATURAL HISTORY MUSEUM.

THE following memorial has been addressed to the Trustees of the British Museum:—

Sir, My Lords, and Gentlemen,—We, the undersigned, being persons interested in the science of Natural History, venture to address to you the following observations suggested by the retirement of Sir W. H. Flower from the post of Director of the Natural History Museum (British Museum).

It is, in our opinion, of great importance to the welfare of Natural History that the principal official in charge of the national collections relating to this subject should not be subordinate in authority to any other officer of the Museum. The Natural History Collections are in a part of London remote from the National Library and the other departments of the British Museum; the supervision of these collections and the direction of the large staff entrusted with the care of them are sufficient to tax the whole energies of any one entrusted with those duties. For the purpose of facilitating this task and avoiding possible friction, it seems to us necessary that the Directors should meet the Trustees and represent them before Her Majesty's Treasury as the responsible head of a department, and not as a subordinate.

A position such as we have described was held, to the great satisfaction of the scientific world, by Sir William Flower, who succeeded Sir Richard Owen; to abolish it now would involve a great change of policy. We believe that the existing system has given satisfaction to the staff of the Museum and to the public. Under it the collections have been so administered as to serve the needs of national education and of scientific research in a very efficient manner.

It may be pointed out that the interests presided over by the principal Librarian are totally different from those under the charge of the Director of the Natural History Museum, and that the same man cannot be expected to understand or to represent adequately the needs of two departments so complex and so distinct from one another. The progress which has been made in the Natural History Museum under its present organisation, especially in regard to its development as an instrument of public instruction and enjoyment, would have been difficult under the old system, in which the Head of the Natural History Collections had not a position of independence and freedom. In this connection it is important to remember that the support given to the institution by Parliament must be largely dependent upon public sympathy and approval. Further, it must not be forgotten that while the Natural History Museum has been developed as a place of public interest it has increased its reputation as an institution of first-rate scientific importance in Europe, both by the magnitude and organisation of its collections, and by the researches carried on by the staff within its walls.

This statement has already been signed by—

Dr. G. J. Allman, F.R.S.
Dr. J. E. T. Aitchison, F.R.S.
Dr. John Anderson, F.R.S.
Lieut.-Col. H. H. Godwin Austen, F.R.S.
H. H. Armstead, R.A.
Sir Benjamin Baker, K.C.M.G., F.R.S.
Prof. J. Bayley Balfour, F.R S.
Prof. Sir Robert Ball, F.R.S.
The Rev. S. A. Barnett.
Right Hon. Lord Battersea.
Prof. Lionel Beale, M.B., F.R.S.
F. E. Beddard, F.R.S.
The Duke of Bedford.
The Rev. G. C. Bell, Master of Marlborough College.
Sir Walter Besant.
Dr. W. T. Blanford, F.R.S.
Edward Bond, M.P., late Chairman of the Technical Education Board, L.C.C.
Prof. T. W. Bridge.
T. Brock, R.A.
Dr. Horace T. Brown, F.R.S.
Sir James Crichton Browne, M.D., F.R.S.
Dr. T. Lauder Brunton, F.R S.
G. B. Buckton, F.R.S.
R. Brudenell Carter, F.R.C.S.
Prof. W. Watson Cheyne, F.R.S.
Dr. W. J. Collins.
Prof. John Cleland, F.R.S.
Sir John Conroy, Bart., F.R.S.
Sir Martin Conway.
Prof. D. J. Cunningham, F.R.S.
Sir William Crookes, F.R.S.
Prof. W. Boyd Dawkins, F.R.S.
Prof. James Dewar, F.R.S.
F. V. Dickins, Registrar of London University.
H. E. Dresser, Author of "The Birds of Europe."
Prof. J. C. Ewart, F.R.S.
Dr. Robert Farquharson, M.P.
Prof. J. B. Farmer.
Sir Joseph Fayrer, M.D., F.R.S.
Michael Foster, M.D., Sec. R.S.
Sir E. Frankland, K.C.B., Foreign Secretary R.S.
Right Hon. Sir Edward Fry, F.R.S.
A. B. Freeman-Mitford, C.B.
E. Onslow Ford, R.A.
Prof. A. R. Forsyth, F.R.S.
Francis Galton, F.R.S.
Sir Douglas Galton, K.C.B., F.R.S.
Sir Alfred B. Garrod, M.D., F.R.S.
Prof. Francis Gotch.
H. Rider Haggard.
Prof. W. D. Halliburton, F.R.S.
S. F. Harmer, F.R.S.
Prof. W. A. Herdman, F.R.S.
Prof. S. J. Hickson, F.R.S.
M. D. Hill, Science Master, Eton College.
Sir Joseph D. Hooker, G.C.S.I., F.R.S.
Prof. G. B. Howes, F.R.S.
Dr. E. Hull, F.R.S.
Right Hon. Lord Kelvin, G.C.V.O., F.R.S.
Prof. W. P. Ker.
Sir John Kirk, G.C.M.G., K.C.B., F.R.S.
O. H. Latter, Science Master, Charterhouse School.
Prof. G. D. Liveing, F.R.S.
Sir Norman Lockyer, K.C.B., F.R.S.
Sir Leonard Lyell, Bart., M.P.
Prof. A. Macalister, F.R.S.
Sir W. MacCormac, Bart, Pres. R.C.S.
Dr. Maxwell T. Masters, F.R.S.
The Right Hon Sir Herbert Maxwell, Bart., M.P., F.R.S.
Prof. W. C. McIntosh, F.R.S.
Prof. R. Meldola, F.R.S.
Prof. L. C. Miall, F.R.S.
P. C. Mitchell, Lecturer on Biology, London Hospital.
Dr. St. George Mivart, F.R.S.
Prof. C. Lloyd Morgan.
Sir John Murray, K.C.B., F.R.S.
J. T. Nettleship.
Captain Sir A. Noble, K.C.B., F.R.S.
The Rev. Canon A. M. Norman, F.R.S.
Prof. W. Odling, F.R.S.
H. F. Pelham, M.A., Camden Professor of History, and President of Trinity College, Oxford.
Prof. W. M. Flinders Petrie.
Prof. G. V. Poore.
Prof. Sir F. Pollock, Bart.
T. C. Porter, Senior Science Master, Eton College.
Prof. E. B. Poulton, F.R.S.
Sir William O. Priestley, M.D., M.P.
M. R. Pryor.
Dr. P. H. Pye-Smith, F.R.S.
The Right Hon. Lord Reay, G.C.S.I.
Sir W. Richmond, K.C.B., R.A.
The Most Hon. the Marquis of Ripon, K.G., F.R.S.
Dr. Briton Rivière, R.A.
Prof. W. C. Roberts-Austen, C.B., F.R.S.
Sir William Roberts, M.D., F.R.S.
Sir Henry Roscoe, F.R.S.
The Hon. Walter Rothschild.
Prof. A. W. Rücker, Sec. R.S.
Right Hon. Sir B. Samuelson, Bart., M.P., F.R.S.
Dr. Dukinfield H. Scott, F.R.S.
R. H. Scott, F.R.S.
A. Sedgwick, F.R.S.
Prof. C. S. Sherrington, F.R.S.
A. E. Shipley.
Sir John Simon, K.C.B., F.R.S.
Dr. H. C. Sorby, F.R.S.
The Right Hon. Earl Stanhope.
Sir Herbert Stephen, Bart.
Marcus Stone, R.A.
Prof. Sir George Stokes, Bart., F.R.S.
Lieut.-General Sir Richard Strachey, G.C.S.I., F.R.S.
J. W. Swan, F.R.S.
J. J. H. Teall, F.R.S.
Sir Richard Temple, Bart., G.C.S.I., F.R.S.
Sir Henry Thompson, F.R.C.S., M.B.
Sir Richard Thorne Thorne, K.C.B., F.R S.
Hamo Thornycroft, R.A.
Dr. T. E. Thorpe, F.R.S.
Everard F. im Thurn, C.M.G.
Prof. J. W. H. Trail, M.D., F.R.S.
The Rev. Canon H. B. Tristram, F.R.S.
Prof. Sir William Turner, F.R.S.
Prof. S. H. Vines, F.R.S.
Prof. C. Waldstein.
Dr. Alfred Russel Wallace, F.R.S.
Prof. H. Marshall Ward, F.R.S.
Prof. R. Warington, F.R.S.
Prof. F. E. Weiss.
Prof. W. F. R. Weldon, F.R.S.
Prof. T. Westlake, Q.C.
Edward Whymper.
Sir John Williams, Bart., M.D.
Sir H. Trueman Wood, Secretary of the Society of Arts.

At a meeting of the Standing Committee of the Trustees of the British Museum, held on the 9th inst., the following letter was directed to be sent to Sir William Flower. It is signed by the Chairman of the meeting, Lord Dillon.

"*British Museum, July* 9, 1898.

"DEAR SIR WILLIAM FLOWER,—With profound regret the Trustees accept the resignation of the Directorship of the Natural History Museum which, owing to failure of health, you have been unhappily compelled to submit to them. They had hoped that the remaining term of years which you might have spent in their service would have enabled you to perfect the arrangement of the collections so admirably planned and so systematically developed by you during your fourteen years of office, and they cannot but regard your retirement at this moment as a real misfortune to the Museum.

"They wish to record their high appreciation of your services.

"The rare combination of wide scientific knowledge with marked administrative ability and a sympathetic appreciation of the requirements of the uninstructed public has carried you through a most difficult task. Under your hands the Natural History collections of the British Museum have fallen into the lines of an orderly and instructive arrangement which no one, whether man of science or ordinary visitor, can examine without admiration.

"To you, as a worthy successor of Sir Richard Owen, will attach the honour of having organised a Museum of Natural History which now occupies a pre-eminent position among all the Museums of the civilised world.

"For these devoted services the Trustees thank you. In your retirement you carry with you their lasting gratitude and their sincere good wishes.

"Believe me, Dear Sir William Flower,
"Yours very truly,
(Signed) "DILLON."

ANIMAL INTELLIGENCE: AN EXPERIMENTAL STUDY.[1]

MANY are the writers on animal intelligence, but few have made comparative psychology a subject of scientific investigation by the methods of careful observation and of experiment under conditions allowing of some control. Right welcome, therefore, is Mr. Thorndike's experimental study, of which a brief preliminary notice appeared in NATURE a few weeks ago (vol. lvii. p. 372).

This careful research goes far to confirm the conclusion, to which the present writer has been led, that the method of animal intelligence is one of undiscriminating trial and error, of profiting by chance experiences, and one which depends on the establishment of direct associations—a conclusion which is in close accord with that reached by Prof. Wundt. Mr. Thorndike is, however, somewhat severe in his criticisms of previous writers in the same field, complains that they have made no observations of their own, and says that most of the books do not give us a psychology, but rather a eulogy of animals. "They have all been about animal intelligence, never about animal stupidity." One of the previous writers has, however, said: "And then, as Mr. P. G. Hamerton well remarks, we have to take into account the immensity of the ignorance of animals." Ignorance and stupidity are, of course, by no means synonymous. But it is the former rather than the latter that is so abundantly exemplified in animal life.

In many of his experiments Mr. Thorndike's method was as follows. Very hungry kittens were shut up in box-cages, 20 inches long by 15 broad and 12 high, and food was placed outside within the animals' sight. To get out the kitten had either to pull down wire loops placed in different positions in different cages, or turn a broad button, or press an ordinary thumb-latch, or push down a small platform, or simply pull a string stretched across the roof. These devices (each in its separate cage) were so arranged that on the fitting push or pull the door opened; and fish was the reward of success. In other cages two or three distinct actions on the part of the kitten were required before the door opened. In yet other experiments the kitten was released and fed directly she either licked herself or scratched herself. The object of the investigation was to watch and record the establishment of associations; and the results are plotted in curves, giving the time-intervals between imprisonment and escape in successive experiments.

The curves are far from smooth, as is indeed to be expected where the internal factors are necessarily somewhat inconstant, and where the difficulties to be overcome by the subjects are different in different cases; but they bear out the contention that the method of animal intelligence is to profit by chance experience, and is dependent on the gradual establishment of direct associations. I have endeavoured to extract from some of Mr. Thorndike's carefully plotted data a mean curve for the method of trial and error, and though it does not come out very well, it does serve to indicate that *gradual* sweep towards rapid and assured success, which would theoretically result on this method. In contradistinction to this the curve of rational procedure is quite different. I plotted some curves of this type a few months ago, after reading Dr. Lindley's dissertation on "A Study of Puzzles" (*Amer. Journ. of Psych.*, vol. viii. No. 4). They were for ordinary wire-puzzles, and show a *sudden* leap from failure to success when the trick of the puzzle was discovered and *understood*, and after that some slight improvement in rapidity of success as the manipulative details were mastered.

[1] "Animal Intelligence: an Experimental Study of the Associative Processes in Animals." By Edward L. Thorndike, A.M. (Monograph Supplement to the *Psychological Review*, June 1898.)

Passing reference may here be made to Dr. Lindley's interesting study above mentioned. He finds by observation that the method of the young child is largely that of the animal. Trial and error, chance success, and direct association are predominant. In older children, who are beginning to generalise the results of their experience, rational procedure based on a considered scheme or plan, makes itself more and more felt. Further observation on similar lines will serve to link such results as Mr. Thorndike's with the human psychology of the text-books.

To return to Mr. Thorndike's research. The conditions of his experiments were perhaps not the most conducive to the discovery of rationality in animals if it exist. The sturdy and unconvinceable advocate of reasoning (properly so-called) in animals may say that to place a starving kitten in the cramped confinement of one of Mr. Thorndike's box-cages, would be more likely to make a cat swear than to lead it to act rationally. And he may further urge that where the string passes out of sight and the bolt is hidden from view, the opportunities of understanding the situation are excluded. All the kitten could think would be: here's something loose and unnecessary to the normal constitution of a box; I'll try that on chance. But although I do not deem Mr. Thorndike's method so conclusive for the anti-rationalist view as observation under more natural, and, I may add, more sympathetic conditions, yet the form of his curves affords no particle of evidence for reasoned behaviour.

We may pass over his experiments on dogs and chicks with the barest mention. They serve to support the same conclusions with some differences of detail.

When we come to his psychological explanation of the nature of the associations involved, I find much to agree with but somewhat to dissent from. Where he argues that animals form no free ideas, I am heartily with him. I have myself contended that they are incapable of analysing a situation. And if in interpreting the facts of observation one's language may seem to imply that the sight of an object and its taste are analysed out and then associated, this is due to the inevitable analytic form which the use of words entails. Animals, in my opinion, do not analyse in this way, and do not form "free" ideas. The utmost that we can allow is that certain elements in a complex situation may, under given circumstances, predominate in consciousness over others; and this, not through any process of abstraction, but from the interplay of the nature of the animal and the circumstances of the case.

But when Mr. Thorndike says that "the groundwork of animal association is not the association of ideas, but the association of idea with impulse," I for one, as at present advised, am not prepared to follow him. "Impulse," he defines as "the consciousness accompanying a muscular innervation apart from that feeling of the act which comes from seeing oneself move, from feeling one's body in a different position, &c." Now in the first place this involves the assumption that physiological innervation is accompanied by a specific form of consciousness here termed "impulse." The question is still *sub judice*. But there is, at any rate, much to be said in favour of the view that consciousness is directly stirred only by *afferent* nerve-currents, and that the innervation process is itself unconscious, though its effects are communicated to consciousness by an afferent back-stroke from the motor organs as they move. This alternative view should, I think, have been mentioned, at all events in criticising one who provisionally holds it. On this view the efferent impulse (apart from its effects) cannot be psychologically associated with anything, since it is physiological and unconscious. In the second place, to suppose that one who holds the impulse as such to be purely organic, holds also that "an animal whenever it thinks of an act can supply an 'impulse' to do the act," savours, to say the least of it, of improbability. In any case I do not recognise it as my own view. I hold as strongly as Mr. Thorndike that the efferent impulse (as an organic link) is a *sine quâ non* in every case of association in animal psychology, and that no animal can supply it "at will."

A very interesting series of experiments were made with a view to extracting an answer to the question, Do animals imitate? The question is not so easy to answer as it looks. No one with adequate experience can doubt that young birds and mammals perform actions which, from the observer's point of view, are imitative. The sight of an animal performing some simple action is the stimulus which prompts to the performance of a similar action. This I have termed "instinctive imitation." And this Mr. Thorndike would not deny to animals, though he would, I take it, deny (and not without psychological justification) its right to be spoken of as imitation, properly so-called. On this basis are founded the numerous cases of imitation by suggestion where the sight of an action performed is the stimulus to the performance of a similar action. A more complex case is that of the bird which, hearing certain sounds, is not only stimulated to make sounds itself (like a laughing jackass to which one whistles), but gradually to make its own sounds resemble those which afford the stimuli (like the parrot which "draws a cork"). Here it seems that the resemblance itself gives satisfaction—in any case the factor of experiential selection is introduced. In these cases imitation by suggestion is supplemented by a tendency to more exactly reproduce the sound which affords the stimulus—a tendency which seems to be based upon the innate satisfaction which accompanies the act of reproduction. Thus far, in my opinion, animals can certainly go; but even this, it may be urged, is only pseudo-imitation. True imitation is seen only where a being of set purpose copies a given model, not only reproducing, but intending to reproduce. And it is the presence of true imitation of this type which Mr. Thorndike's experiments were designed to test. They afford, however, no evidence of it. Cats were allowed to see others do the trick of the box-cage. But they themselves, when placed in the cage, took the usual time to effect their escape. Their exit was no quicker from seeing others get out by the performance of certain clawings or pushings. The experiments do not carry complete conviction to my mind, though I regard the conclusion to which they lead as probably correct.

Mr. Thorndike thinks it likely that the primates stand at a higher level in this respect than dogs or cats. "If it is true," he says, "that the primates do imitate acts of such novelty and complexity that only this out-and-out kind of imitation can explain the fact, we have located one great advance in mental development. Till the primates we get practically nothing but instincts and individual acquirement through impulsive trial and error. Among the primates we get also acquisition by imitation, one form of the increase of mental equipment by tradition." My own observations on imitation in monkeys are too few and inconclusive to justify more than a very guarded expression of opinion. I lean to the view, however, that there is, even in them, little evidence of true imitation of the higher psychological type; and that the observed facts may be accounted for by a great extension of "instinctive imitation" suggestion, and behaviour directly founded thereon. I hope Mr. Thorndike will put the matter to the test of well-devised experiment.

Several interesting problems connected with the psychological interpretation of animal behaviour are briefly discussed, but can only be mentioned here. Mr. Thorndike accepts the conclusion that in animals "memory" is simply what has been termed "reinstating," and involves no true localisation in time or space. "The animal's self is not a being looking 'before and after.'" "Memory in animals, if one still chooses to use the word, is permanence of associations, not the presence of an idea of an experience attributed to the past." This is precisely the conclusion to which the present writer has been led. On the question whether animals are aware of the pleasure or pain that others are feeling, he says that the conduct of animals "would seem to show that they do not. For it has given us good reason to suppose that they do not possess *any* stock of isolated ideas, much less any abstracted, inferred or transferred ideas. These ideas of others' feelings imply a power to transfer states felt in oneself to another, and realise them as there." As thus stated I think his conclusion is correct, though he quotes me in an opposite sense. In my later discussion ("Introduction to Comparative Psychology," p. 320) I expressly exclude any such ejective transference.

In conclusion, some apology is perhaps demanded for reference to my own observations and conclusions in the same field of study. But it is well to preserve historical continuity in a topic, and it so happens that Mr. Thorndike's work has carried further and extended some of my own; and that his leading conclusions are in the main confirmatory of those which I have reached. In the general trend of our opinions we are perhaps more essentially in accord than, in some cases, he seems to suppose. Even our illustrations are sometimes closely similar; both utilising, for example, the consciousness of a man when he is playing tennis as illustrating the probable subjective condition of the conscious but not yet self-conscious animal. And this substantial agreement is not a mere personal matter. Were it such there would be no justification for drawing attention to it. It shows that the method of observation and experiment, on different but parallel lines, has led two independent investigators to results which are on the whole harmonious; and it affords some ground for the hope that comparative psychology has passed from the anecdotal stage to the higher plane of verifiable observation, and that it is rising to the dignity of a science. In any case Mr. Thorndike's research is one of no little value, and will, I trust, be supplemented by further investigations.

C. Lloyd Morgan.

THE FLORA AND FAUNA OF BRITISH INDIA.

NO portion of the earth's surface surpasses the British Empire in India in the wealth and importance of its vegetable and animal life. Not only is there no other equally large tropical area that has received the same amount of exploration from naturalists, but the territories and dependencies of British India comprise regions with a marvellous variety of climates, from tropical islands like the Andamans and hot plains like the Carnatic, to the snows of the Himalayas and the frigid plateaus of Tibet; whilst the rainfall varies from the "record" 600 inches or more on the Khasi hills to the meagre supply that occasionally damps the arid sands of the Sind desert, where, frequently, for years in succession, rain is unknown. The remarkable antiquity of the Indian peninsula, the greater part of which appears to have been land from the earliest geological times, adds greatly to the scientific importance of the fauna and flora.

Under these circumstances it is not surprising that the variety of plants and animals occurring in India should be very great. There is no other large tropical region with which comparison is possible, because, as already mentioned, there is none of which the natural productions are as well known. Europe (3,800,000 square miles) has more than twice the area of India (1,750,000 square miles), but it has a far poorer flora and fauna, only about 9500 flowering plants being known to occur against 14,500 Indian species; whilst British India and its dependencies contain more than twice as many species of mammals, nearly three times as many birds, considerably over four times as many batrachia, and about eight times as many reptiles as the whole of Europe. The moths known to be found in Europe are 3040 in number, those of India 5600; and in this case there is no doubt that the Indian list is far from complete.

The interest attaching to the botany and zoology of India makes the circumstance noteworthy that two important works published by order of the Government of India, and at its cost, have been completed within the last six months. These works are the "Flora of British India" and the vertebrate section of the "Fauna of British India." In neither case is the work exhaustive, but each deals with the most important group of plants or animals respectively, the "Flora" containing descriptions of all flowering plants, and the "Fauna" accounts of all vertebrate animals. It is scarcely necessary to say that flowering plants form a much larger proportion of the whole flora, than vertebrate animals do of the entire fauna; but some progress has already been made with an addition to the "Fauna" as originally planned, and with the description of the huge mass of Indian Invertebrata. Except that the plants of the Malay peninsula are included in the "Flora," whilst the animals are omitted from the "Fauna," the British India of the two works is the same, and includes all India proper with the Himalayas, Ceylon, Assam, and Burma.

The "Flora of British India" is a work to which Sir J. D. Hooker has devoted many years of his life, and it is chiefly written by him, portions having been contributed by other botanists, amongst whom are Mr. Thiselton-Dyer, Mr. C. B. Clarke, Dr. Maxwell T. Masters, Mr. J. G. Baker, and the late Dr. T. Thomson and Dr. T. Anderson. The undertaking may be said to have commenced originally by the publication of the first (and only) volume of Hooker and Thomson's "Flora Indica" in 1855; but the present work, which is on a smaller plan, has been brought out in parts, of which the first appeared in 1872, and the last, containing the index, in November 1897. The whole consists of seven thick octavo volumes, comprising altogether over 5000 closely printed pages, and containing descriptions of 14,520 species.

The "Fauna of British India" is on a different plan, and the completed portion, containing the Vertebrata, consists of eight octavo volumes and of over 4100 pages. Of the eight volumes, one contains the Mammals (402 species), four the Birds (1626), one the Reptilia (534) and Batrachia (130), and two the Fishes (1418). The whole is edited by Mr. W. T. Blanford, who is also the author of the volume of Mammals and of two volumes of Birds, the remaining two volumes of the latter being the work of Mr. E. W. Oates; whilst Mr. G. A. Boulenger has contributed the part containing the Reptilia and Batrachia, and the late Dr. F. Day wrote the account of the Fishes. The first part appeared in 1888, and the last volume of Birds has just been issued from the press.

As already mentioned the "Fauna," as originally projected, was intended to contain an account of the Vertebrata alone, and this is now complete. But some years ago the Government of India authorised an extension of the work, on the same plan and under the same editor, to certain Invertebrate groups, with the result that up to the present time four volumes on Moths, by Sir G. F. Hampson, have been published, with descriptions of 5618 species; and one volume on Bees and Wasps, by Colonel C. T. Bingham, containing descriptions of 995 species. Thus at present the series of the Fauna comprises thirteen volumes. No intimation has been given of any additional parts being in preparation. It may be hoped, however, that further additions will be made, and that, so far as is practicable, both the Flora and Fauna may be completely described. A thorough knowledge of the productions of India is as important for economic reasons as for scientific inquiry.

A. KERNER VON MARILAUN.

WE regret to announce that Dr. Anton Kerner von Marilaun, Professor of Botany in the University of Vienna, died suddenly on June 21 in that city from apoplexy. He was born at Mautern, Lower Austria, on November 13, 1831. He acquired at a very early age a considerable knowledge of the flora of his native province, and had already a good reputation as a botanist when still a student of medicine in the University of Vienna. After having taken his degree as Dr. Med. et Chir., he practised for a short time in one of the Vienna hospitals; but finding the medical career not to his taste, he accepted a professorship in the Josef's Polytechnicum at Ofen, Hungary. In 1861 he was called to the chair of Botany in the University of Innsbruck, which he occupied till 1878, when he succeeded Eduard Fenzl as Professor of Botany and Director of the Botanic Garden and Museum at Vienna, in which position he remained up to his death. In 1875 he was elected a member of the Imperial Academy of Science of Vienna; he received the order of the Eiserne Krone in the following year, in recognition of his achievements as a teacher and man of science, and was knighted in 1877, when he added the title "von Marilaun" to his name. When Eichler, the eminent morphologist, died, the University of Berlin invited him to the vacated chair; but Kerner, who had always been a staunch Austrian, declined.

Kerner's principal claims as one of the most prominent botanists Austria has produced, rest chiefly on his researches in phyto-geography and biology—this term to be understood in the narrower sense, in which it is so often used in Germany. Trained from early youth to observation in the field, thoroughly familiar with the Central European flora, gifted with a keen eye for the salient features of vegetation and, at the same time, with an analytic mind ready to break up the general aspect in which a given vegetation presents itself into its elements, he was eminently fitted to develop that particular branch of phyto-geography which deals with the association of plants in so-called plant-formations. This doctrine had just then assumed a definite shape through Grisebach's investigations, although it may well be traced back to Alexander Humboldt. In his book, "Das Pflanzenleben der Donauländer" (1863), Kerner applied with great success the new method to the vegetation of the Eastern Alps and a large part of Hungary, which he had explored in numerous excursions. In a contribution to "Die Oesterreichisch-Ungarische Monarchie im Wort und Bild," which was published under the auspices of the late Crown Prince Rudolf, he worked out in a general way the distribution of the various floras within the monarchy, their principal subdivisions and their history, and he added soon afterwards an excellent map, under the title "Florenkarte von Oesterreich-Ungarn." If he was early a master of descriptive phyto-geography, he was by no means indifferent to the historical side of the science, as his paper, "Beiträge zur Geschichte der Pflanzenwanderungen" (1867), in which he sided with Forbes and against Grisebach and his creation theory, an interesting essay, "Studien über die Flora der Diluvial-Zeit in den östlichen Alpen" (1888), and several more show. Of his biological researches the most remarkable are those dealing with the relations of flowers and insects.

His splendidly illustrated book, "Schutzmittel der Blüthen gegen unberufene Gäste" (1876), was translated into English ("Flowers and their unbidden Guests"), and, no doubt, gave a powerful impetus to the development of one of the most fascinating chapters in biology. In fact, I believe, nothing appealed more to his constitution of mind than investigations of this kind; for he was endowed with a wonderful amount of imagination which, in that inexhaustible field, found ample opportunity for asserting itself—now divining the explanation of some puzzle, now losing itself in fanciful flights. Among his other papers of this category, I may mention, as more widely known, "Können aus Bastarden Arten werden?" and "Parthenogenesis einer angiospermen Pflanze" (1876). The latter referred to *Antennaria alpina*, and the correctness of the construction he put on the facts observed has been doubted for a long time; but a paper by Dr. Juel, of Upsala, published just a week previous to Kerner's death, must have given him great satisfaction if it reached him, as the author confirmed fully the disputed points by independent observation and careful microscopical investigation. Among his papers concerning systematic botany may be mentioned one under the title, "Abhängigkeit der Pflanzengestalt von Klima und Boden" (1868), which contains a valuable and highly philosophical essay on the section Tubocytisus of Cytisus; further, his "Monographia Pulmonariarum" (1878), and a very great number of critical notes, which are scattered through his "Vegetations-Verhältnisse des mittleren und östlichen Ungarns und angrenzenden Siebenbürgens" which, began in 1867, run through thirteen volumes of the *Oesterreichische Botanische Zeitschrift*, however, without having been completed. Numerous similar notes are also contained in the "Schedae ad Floram Exsiccatam Austro-Hungaricam," a beautifully prepared collection of Austrian and Hungarian plants, the issue of which proceeded to Century xxii. In his investigations into subjects of systematic botany, Kerner hardly ever ventured beyond the boundaries of his special domain, *i.e.* Austria-Hungary and the adjoining districts. This, perhaps, was partly the cause of his strong tendency towards "Jordanism," or the excessive subdivision into species, of his occasional one-sidedness, such as is often found in strictly local botanists, and of the almost complete absence of any attempt at dealing with groups of a higher order and from a broad standpoint. The only time he tried a problem of this category, namely in the chapter on the "Stämme des Pflanzenreiches," or the phyla of the vegetable kingdom, in his "Pflanzenleben," he was rather unfortunate, and he wisely omitted it in the second edition.

His great work, "Pflanzenleben," well known to the English public from the translation by Prof. F. W. Oliver ("The Natural History of Plants") was in many respects the crowning result of his life-long labours. When he undertook to write the book, which was to be one of a series of popular treatises on natural history, published by the Bibliographische Institut of Leipzig, his plan was to incorporate all his own experiences and observations, many of which were only laid down in rough notes, to assimilate those of other authors, and to produce a standard work which would treat homogeneously all the various phases of plant-life. It was a tremendous task, and must have heavily taxed his constitution, which was not over-strong, although he was scarcely yet past the prime of life when he commenced it. The work is known for its lucid, nearly always fascinating and often classic style, its beautiful illustrations, few of which are not original, its fulness of suggestive matter, its occasional quaint mixture of truth and fiction—of course, unconscious fiction—and its independent conception, and little need be said about it in this place. It is the very embodiment of the genius of its author, and it reflects equally well his strong and his weak points. Measured by it, Kerner might appropriately be called the poet-botanist.

Kerner was an excellent lecturer, who raised the subject of his lecture high above the ordinary level by enlivening the purely morphological and otherwise dry details by constant references to the relations which exist between form and function, and also by his bold and highly artistic draughtsmanship. He was a man of refined culture, but naturally nervous; he came not rarely into collision with others, from the effects of which he, no doubt, ultimately suffered most. Many of his smaller papers are so scattered or buried in all but inaccessible periodicals, and even daily papers, that a careful selection and reissue of those amongst them which are really valuable is very desirable.

OTTO STAPF.

NOTES.

The Cambridge Anthropological Expedition to Torres Straits arrived at Thursday Island on April 22. The Hon. John Douglas, C.M.G., the Government Resident, did all in his power personally and officially to advance the aims of the expedition, as did also the other Government officials and many others. The Hon. C. T. J. Byrnes, Chief Secretary, sent a cordial telegram of welcome and offers of assistance on behalf of the Government. After a week's delay a start was made for Murray Island, and owing to unfavourable weather it took another week to traverse the hundred and twenty miles between the two islands. The Murray Islanders gave Dr. Haddon a very cordial reception; they appear to understand the main objects of the expedition, and many of them are assisting in various ways. A deserted mission-house is occupied as a dwelling, and it has been converted into a temporary anthropological and psychological laboratory, photographic studio, surgery and dispensary. All the members of the expedition are in good health, and work has commenced in earnest.

The French Société d'Encouragement has awarded the grand prize of 12,000 francs to M. Moissan for his numerous researches in chemistry; the prize of 2000 francs for the experimental study of the properties of metals and alloys to M. C. E. Guillaume; the prize of 1000 francs for an investigation of albuminoids to M. Fleurent; a prize of 2000 francs to M. Cord for his work on the agriculture and geology of the soils in the department of Lozère; an *encouragement* of 500 francs to M. Capredon for his work on metallurgical chemistry; of 500 francs to M. A. Bigot for his work on enamels; of 1000 francs to M. Pagès for his work on the agriculture of the Cantal Department; and 500 francs to M. Mazel for his work on the agriculture of the Vivarais district.

The Committee appointed in 1895 to examine and report upon the various monographs submitted in competition for the Loubat prizes to be awarded in 1898 have issued their report to President Low, of Columbia University. The monographs that were formally submitted for examination were the productions of eight different authors; of these the committee consider as being the most meritorious, and as most fully complying with the conditions prescribed for the competition, the treatise on "Stone Implements of the Potomac Chesapeake Tide-water Provinces," by Mr. William Henry Holmes, Curator of the Department of Anthropology in the National Museum at Washington, and to this author therefore the committee recommend the awarding of the first prize, value 1000 dollars. In the opinion of the committee the second prize, value 400 dollars, should be given to Dr. Franz Boas, of the Metropolitan Museum of Natural History of New York City, for his monograph entitled "The Social Organisation and Secret Societies of the Kwakiutl Indians." Special mention is also made in the report to a work by Mr. Alfred P. Maudslay, of London, dealing with the archæology of Central America. This work was not submitted for competition, and is not yet in a complete state, but its great merit is such as to be considered worthy of special mention by the committee.

Science states that the New York City Board of Estimates and Apportionment has authorised the reissue of 375,000 dollars in bonds for the construction of buildings for the botanical garden in Bronx Park. Work on the museum building is being carried forward, the contract calling for its completion early next year.

PROF. VON RÖNTGEN has been awarded the Elliot-Cresson medal of the Franklin Institute of Philadelphia.

SIR GEORGE STOKES, Bart., F.R.S., will deliver his presidential address before the Victoria Institute at the annual meeting on Monday, July 18.

As we go to press the annual meeting of the Society of Chemical Industry is being held at Nottingham, under the presidency of Dr. F. Clowes. During the meeting the Society's medal will be presented to Dr. W. H. Perkin, F.R.S.

THE French Botanical Association has elected M. G. Rouy of Asnières as its president for the year. The annual meeting will be held from August 3 to 12, and will be devoted to an exploration of the environs of Gap, Brianson, and du Lauteret.

SIR JOSEPH FAYRER, Bart., K.C.S.I., F.R.S., &c., has been elected a governor of Wellington College.

THE U.S. Commission of Fish and Fisheries has made arrangements for a biological survey of Lake Erie. The work will be under the direction of Prof. Jacob Reighard of the University of Michigan, with whom will be associated Dr. H. B. Ward, of the University of Nebraska, Dr. H. S. Jennings, of the Montana College of Agriculture and Mechanical Arts, Dr. J. Shaw, of Ann Arbor, Mr. A. J. Pieters, of the U.S. Department of Agriculture, and a number of other assistants. Experimental work will be a prominent feature of the survey, and among other problems to be considered are the rate of growth of fishes; the food of young fishes reared from the egg, and the changes in their regimen during growth; the source of food of aquatic rooted plants; the life-histories of food fishes reared in aquaria or ponds, and of certain aquatic insects and other invertebrates; the rate of increase of the plankton as a whole, and of its individual constituents. There will also be systematic studies of the habits, migrations, distribution and food of the fishes and other organisms of the lake. At the beginning of the work Prof. Reighard and Dr. Ward will devote a considerable amount of time to plankton problems, especially the perfection of methods and apparatus; Dr. Snow will carry on experimental work on the algæ; Dr. Jennings will undertake experimental researches on the protozoa, and Mr. Pieters will pursue studies of the aquatic flora. The summer headquarters of the survey will be at the Government hatching station at Put-in-Bay, South Bass Island, Ohio. Lake Erie affords an excellent field for work of this character, on account of its varied fauna, diversified physical features, extensive fishing interests, and the recent serious depletion of the supply of certain valuable food fishes. The investigations, it is stated, may ultimately be extended to some of the other Great Lakes.

THE fourth International Congress of Agriculture will be held at Lausanne from September 12 to 17 next, under the patronage of the Swiss Department of Agriculture. The work of the Congress will be divided into the following sections:—Rural economy, agricultural education, forestry, dairying, stock breeding, agricultural industries, viticulture, protection of birds, insect and other pests. Those who desire to join the Congress as members (subscription 20 francs) are requested to send in their names to M. S. Bieler, Director of the Agricultural Institute, Champ de l'Air, Lausanne, before the 15th instant. Copies of the preliminary programme may be obtained in this country on application to Sir Ernest Clarke, Secretary of the Royal Agricultural Society, at 13 Hanover Square, W.

AS has already been announced, the autumn meeting of the Iron and Steel Institute will be held in Stockholm on Friday and Saturday, August 26 and 27. An interesting and varied programme has been prepared by the local committee, and seven papers have been promised, two being by Swedish metallurgists. Mr. Richard Ackerman, Director-General of the Swedish Board of Trade, an honorary member of the Institute, and a Bessemer gold medallist, will read a paper on the development of the Swedish iron industry, whilst Prof. G. Nordenström, of the School of Mines, Stockholm, will submit a communication on the most prominent and characteristic features of Swedish iron ore mining. Mr. C. P. Sandberg will discuss the danger of using rails of too hard a nature, whilst Prof. W. C. Roberts-Austen, C.B., F.R.S., will describe the action of explosives on the tubes of steel guns. The chemical side of metallurgy will be represented by three papers. The first will be by Mr. J. E. Stead, on brittleness in steel produced by annealing; the second by Prof. J. O. Arnold, of University College, Sheffield, on the micro-chemistry of cementation; whilst the subject of the third paper will be the influence of metalloids on cast iron, by Mr. Guy R. Johnson, of Tennessee, U.S.A. An excursion of twenty days' duration will follow the meeting.

AN exhibition of the manufacturing and mineral wealth of the various States and Colonies of South Africa is to be opened at Grahamstown on December 15. It will be divided into five groups or sections dealing respectively with raw materials, manufactures, mining and machinery, natural history and science, and fine arts. The exhibition will remain open until January 21.

IT will be remembered that a few weeks ago Dr. T. E. Thorpe, F.R.S., and Dr. Oliver, of Newcastle-upon-Tyne, were appointed by the Home Secretary to inquire, as experts, into the causes and prevention of lead-poisoning in the Potteries. These two gentlemen have now been invited by the same authority to undertake a similar inquiry into the dangers incidental to lucifer match-making, and have been commissioned to visit some of the factories on the continent.

THE *Electrician* states that the International Submarine Telegraph Memorial Fund has now been closed, and the following amounts have been applied to the objects named: University College, Gower Street, London, to endow the Pender Electrical Laboratory, 5000*l.*; Glasgow and West of Scotland Technical College, to continue annual John Pender Gold Medal, 210*l.*; Glasgow University, to provide annual bursary for student of Glasgow and West of Scotland Technical College who proceeds to Glasgow University, 1650*l.*; marble bust of Sir John Pender, by Mr. E. Onslow Ford, R.A., to be placed temporarily in the Board-room of the Eastern Telegraph Company, and for replica, which has been placed in the reading-room of University College, Gower Street, London, and pedestals for same, 461*l.*

AN electrically-worked underground tubular post for letters and parcels has been designed by Dr. Alfred Brunn and Mr. Viktor Takács, of Budapest, and submitted by them to the Hungarian postal authorities. It has been decided to lay down a trial line from the eastern to the western stations of Budapest, and, if a year's working proves successful, the postal authorities will take over the line, and a scheme for connecting twenty-three offices on both sides of the Danube will be carried out.

THE doctors of Portugal are evidently very much in earnest about the medical and sanitary well-being of their country, as is shown by the number of resolutions carried by them at the close of the recently held National Congress of Medicine at Lisbon on various subjects which, in their opinion, are of pressing public importance. One resolution called on the Government to give effect to the vote of the Chamber of Deputies, that vaccination should be made compulsory in Portugal. Another series of resolutions had reference to the repression of tuberculosis. The Congress urged that permanent committees should be appointed for the purpose of diffusing a knowledge of the means of prophylaxis against that scourge. It further recommended that all tuberculous patients admitted to general hospitals should be placed in special wards. It was also decided to appoint a committee to study the question of the establishment of sanatoria for the treatment of tuberculosis in Portugal. With regard to leprosy, the Congress called upon the Government to organise a system of careful study of the disease, and regular teaching of the means of dealing with it; to take a census of the population; to establish agricultural colonies of lepers, in connection with each of which there should be places where all the means of combating the disease should be taught; to place legal hindrances in the way of marriages between lepers and the descendants of lepers; and to educate the poor to correct notions as to the hereditary and contagiousness of the disease.

THE *Times* of Saturday last contained a report of an address delivered on Thursday before the German Society for Public Hygiene by Prof. Koch on the subject of the plague, in which he dealt especially with his discovery of a plague centre in the Hinterland of German East Africa, whither the disease had been introduced from Uganda. After referring to the plague centres of Hu-nan, Tibet, and the west coast of Arabia, in the vicinity of Mecca, the lecturer went on to lay claim to a fourth centre in Equatorial Africa. It had been found that a devastating disease prevailed at Kissiba, in the extreme north-west corner of German East Africa, close to the Victoria Nyanza. Suspecting that it was the plague, Prof. Koch proceeded from India to East Africa in order to make investigations. With the help of Dr. Zupitza, who made a special expedition to Kissiba, he had been enabled to identify the disease as the bubonic plague. In the case of five persons who had died from the disease anatomical preparations were obtained, and the blood and lymphatic glands of plague-stricken patients were bacteriologically examined. All the ordinary features of the bubonic plague were present. Nine out of ten of those who were infected died. The disease was communicated to rats and to monkeys. It was found that an outbreak of the plague among rats frequently preceded a human epidemic, and, in fact, the rat plague might always be regarded as a warning. A further observation had been made, which was of importance. The inhabitants of Kissiba lived almost entirely on bananas. The banana groves were so thick that they admitted neither light nor air, and were perfect breeding places of the bacillus. It would be most interesting if physiologists could investigate the processes of nourishment and metabolic change which attended an almost exclusive diet of bananas. It had been discovered, however, that Kissiba was not an original plague centre, but that the disease had been introduced from Uganda, as the reports of missionaries who resided there showed. It had existed for a long time in Uganda, but it had recently moved in the direction of Budu. Its introduction to Kissiba had been traced to a native who had visited a friend in Uganda. He returned home and died of the plague, and of a large number of natives who attended his funeral many were infected and perished. It was a favourable circumstance that for the present Kissiba lay somewhat out of the ordinary caravan route.

DR. CAMPBELL MCCLURE, of Glasgow, describes in the *Deutsche Medicinische Wochenschrift* a bacillus which he discovered while making examinations of milk in the laboratory of Dr. Piorkowski in Berlin. In the agar plate cultures it formed brown granular colonies, which also grew well in glycerine agar at 37° C., presenting a white appearance, confluent in the middle and punctate at the margins, and becoming yellow and slimy in three or four days. Milk treated with the bacillus and kept at 37° C. for 48 hours was coagulated and had a strongly acid reaction and an acetous smell. The appearance of a bouillon culture kept for 24 hours at 37° C. was constant and typical, the fluid being slightly turpid with a considerable flocculent deposit on the bottom and sides of the tube. The bacillus could be stained with the ordinary aniline colours, but not with Gram's solution. Cover-glass preparations stained with methylene blue showed a great similarity to the diphtheria bacillus and the pseudo-diphtheria bacillus of Löffler and von Hofmann respectively.

THE current number of the *Lancet* has a note interesting to the vast army of cyclists. After a "spin" along a more or less dusty road the cyclist sometimes experiences a dry and subsequently sore and inflamed throat. Headache and depression often follow, and the symptoms generally simulate poisoning of some kind. When the bacteriology of road dust is considered, these effects are hardly to be wondered at. Hundreds of millions of bacteria, according to the nature of the locality, are found in a gramme weight of dust, and the species isolated have included well-known pathogenic organisms. Indeed, there can be no reason for doubting the infective power of dust when it is known that amongst the microbes encountered in it are the microbes of pus, malignant œdema, tetanus, tubercle, and septicæmia. The mischief to riders as well as to pedestrians would probably be largely averted if, as nature intended, the respirations were rigidly confined to the nasal passages, and the mouth kept comfortably though firmly shut. As investigators have shown, the microbes in the air seldom pass beyond the extreme end of the nasal passage, and consequently never to the larynx or bronchial surfaces. A useful precaution, therefore, in addition to exclusively breathing through the nostrils, would be to douche the nasal cavity, after a dusty run or walk, with a weak and slightly warm solution of some harmless antiseptic.

THE Berlin correspondent of the *British Medical Journal* calls attention to the prevalence of trachoma in the eastern provinces of Prussia, where it often assumes an epidemic character, especially among children in the lower schools. The authorities are at last fully alive to the gravity of the matter, and have determined to spare neither pains nor expense in order to stamp out the disease effectually. Thus the city of Königsberg has for the last six months employed ten ophthalmic surgeons especially for the purpose, and the report of their work just published is most satisfactory and hopeful, showing as it does by figures the results already accomplished. In October 1897, of 17,553 school children examined, 5568 were found to be suffering from trachoma; of these, 1763—10 per cent. of those examined—were serious cases. These latter were treated, some in the hospital, some in their own homes, and some in special trachoma classes. By the middle of February the number of cases had gone down to 1218, of which 345 were serious in character. At the date to which the report extends—that is, the end of April—there were only 826 cases, with 223 serious ones. The number of special oculists has therefore been reduced to six.

THE Photographic Convention of the United Kingdom was held at Glasgow last week, and we are glad to find, from the report of its proceedings in the *British Journal of Photography*, that so much attention was paid to the scientific side of photography. The President (Mr. John Stuart), in the course of his very interesting opening address, said concerning photography: "It has made the astronomer more than ever master of the heavens. By its aid he has mapped out the starry firmament, and been apprised of the existence of stars the most powerful telescopes had failed to show. In the investigations into the composition of the sun and its corona photography has been an invaluable agent. In the registration of storms in the body of the sun it plays a very important part. In the registration also of the barometric and thermometric variations it is in daily use. . . . Its utility in microscopic work has been abundantly proved of late; bacterial science has made rapid strides by its assistance, and every day seems to produce a more startling discovery than the day before. . . . In the medical profession photography promises to become one of the most beneficent agents science has as yet placed at the service of the healing art. The X-rays, or radiography, are now an indispensable adjunct in every well-equipped medical school. A flourishing society has been started to specialise in this hopeful field, and already developments are daily taking place almost beyond our conception." During the meeting a large number of slides illustrative of solar, lunar, and stellar photography, radiography, and slides in colours by various methods were shown, and everything done tended to bring home to those present the almost universal application of photography to art and science.

WE are glad to learn from *Nature Notes* that the Guildford Natural History and Microscopical Society have practically achieved the object of their memorial to the War Office on the making of Wolmer Forest a sanctuary for the preservation of birds, the War Office having adopted the opinion previously expressed by the Commissioner of Woods and Forests, to which reference has already been made in these columns. The forest came under the management of the Aldershot Game Preserving Association in 1895, since which time all birds have been strictly protected; no birds, except game birds, have been allowed to be shot, and hawks, owls, and other birds have been carefully preserved as far as possible. The heronry has gradually increased from one nest a few years ago to about twenty nests now, and nearly fifty young herons flew from the nest in 1897; foxes are also strictly preserved. The Secretary of the Association states, however, that to make the preservation a success a large area round the outskirts of the forest should be included in the scheme for protection, as at present the destruction of birds and animals is still carried out on private land round the forest.

THE Kew Gardens authorities have many problems submitted to them to solve in the course of a year. Many they succeed in unravelling, but occasionally they are baffled. The June number of the *Bulletin* places on record one of the most curious of the tasks brought before the authorities, and one that they have had but little success with. The specimens referred to in the following letter, which was received from Mr. Kenneth Scott, of Cairo, were carefully examined by Dr. D. H. Scott, of the Jodrell Laboratory, who could only conjecture that they were fragments of the paleæ of some grass. "For some time now malingering Egyptian soldiers have been sent in to the Kasr-el-Aini hospital under my care, suffering from extreme œdema and intense inflammatory injection of the conjunctiva of one or both eyes; the *cornea unaffected*. No discharge from the eye. The condition is entirely unlike that which they also produce by putting in the juice of Euphorbia, slaked lime, seed of 'melocheeya' (*? Corchorus olitcrius*) and other things. I obtained the specimens sent you by covering the eye with a thick collodion dressing so as to completely seal it up. The man at the end of five days had evidently feared the inflammation might subside, and therefore raised the dressing and renewed the baneful application, part of which I found on the face of the dressing lying against the eye. I have been entirely unsuccessful in obtaining here any information on the matter, nor have I been able to obtain further quantities of the leaf. The patient either began to fear the consequences of the affair, or his stock of the drug became exhausted, as he in no way interfered with the next collodion dressing which was applied, the eye being quite cured, and the dressing intact after a period of five days."

MR. J. BURTT DAVY has recently presented to the Kew Museum the ingredients of a Chinese prescription purchased by him at China Town, San Francisco, particulars of which, as far as their identification can be made out, may be of interest. The ingredients include fruit-heads of an *Eriocaulon*, apparently *E. cantoniense*. This plant has a reputation in China for various diseases, such as ophthalmia, especially in children, as a styptic in nose-bleeding, and in affections of the kidney. Spiny hooks from the stems of the Gambier plant (*Uncaria gambier*, Roxb.), which have astringent properties, and are mostly used in infantile complaints. Some very thin transverse sections of the stem of *Akebia quinata*, a climbing berberiadaceous plant, also occur in small quantities, as well as the bark of *Eucommia ulmoides* known as the "Tu Chung." Tonic and invigorating properties are ascribed to the latter, and its cost is therefore considerable. Among other ingredients which have not been identified, are crushed flower-heads of a composite plant, and slices of a slender, twig-like stem, probably a willow.

THE *Times* of July 11 states that the sum appropriated by Congress for the service of the United States Department of Agriculture for the fiscal year ending June 30, 1899, shows an increase of 326,300 dollars over that for the fiscal year just ended, the principal additions being for the Weather Bureau and the Bureau of Animal Industry. Under the Weather Bureau provision is made for the establishment of sixteen new stations, and the erection of a small building on the Government reservation at Sault Saint Marie (popularly known as "the Soo").

Engineering has the following interesting note on the most ancient steam engine in existence:—"The oldest engine in the world is in the possession of the Birmingham Canal Navigations, this engine having been constructed by Boulton and Watt in the year 1777. The order is entered in the firm's books in that year as a single-acting beam engine, with chains at each end of a wood beam, and having the steam cylinder 32 inches in diameter with a stroke of 8 feet, and erected at the canal company's pumping station at Rolfe Street, Smethwick. During the present year (1898) this remarkable old engine, which has been regularly at work from the time of its erection to the current year, a period of, say, 120 years, was removed to the canal company's station at Ocker Hill, Tipton, there to be re-erected and preserved as a relic of what can be done by good management when dealing with machinery of undoubted quality. It is worthy of note that the Birmingham Canal Navigations favoured Boulton and Watt in 1777 with the order for this engine, and in 1898, or 120 years afterwards, the company have entrusted the same firm, James Watt and Co., Soho, Smethwick, with the manufacture of two of their modern triple-expansion vertical engines, to be erected at the Walsall pumping station, having 240 horse-power and a pumping capacity of 12,713,600 gallons per day.

ACCORDING to the *Pharmaceutical Journal*, a fresh use for seaweed is claimed to have been discovered by a Norwegian engineer, who exhibited an invention at the Stockholm Exhibition for producing paper-glue, dressing-gum, and soap from seaweed. The first establishment for this branch of manufacture was, according to his statement, to be erected in the district of Stavanger, but, up to the present, nothing appears to have been done in this direction.

THE total number of chemical works registered in all parts of Germany, according to the latest trustworthy statistics, is 6144, the total number of persons employed by them being 125,440. Amongst the industries of the Hamburg Consular district which have attained to the greatest importance are those for manufacturing various chemical products, such as nitrates, sulphuric and nitric acid, sulphates, boracic acid, artificial manures, pharmaceutical products, dyeing and tanning extracts, essences, and more particularly different kinds of explosives. The factories in that district now employ altogether some 4000 workmen as compared with about 1300 ten years ago, a fact demonstrating once more the rapid strides made throughout Germany by most branches of chemical industry during recent years.

BOG iron ore is worked in the province of Quebec, Canada, and arrangements are being made (says the *Engineer*) to extract manganese from bog ore deposits in the province of New Brunswick. The ore is a soft, wet stuff, containing 50 per cent. of water, and is covered by a thin coating of vegetable earth. The depth of ore varies from 5 feet to 30 feet. When dried the residuum is a fine black powder, too fine to be treated in the blast-furnace, and this has therefore to be made into briquettes, as is done with the fine dust from blast-furnaces and the finely-divided iron produced from low-grade ores by the Edison electrical process. The cementing material used is kept secret. An analysis of the dried ore at 212° F. is given as follows: metallic manganese, 48·240 per cent.; metallic iron, 5·700 per cent.; sulphur, 0·096 per cent.; phosphorus, trace; silica, 1·88 per cent.

THE office of the Bureau of Mines at Toronto has issued a notice to the effect that the first discovery of corundum in Ontario was made late in the year 1896, and exploration work carried on under direction of the Government in 1897 shows that the corundum-bearing lands have an aggregate area of about 50,000 acres. The mineral rights over nearly the whole of this tract are held by the Crown, and they have been withdrawn from sale and lease pending a report on the occurrence of the mineral and the methods of treating it, undertaken by the professors of the Kingston School of Mining. Meantime the attention of prospectors, miners, and capitalists is invited to the district, and, with a view to its development and the establishment of industries in the province for treating and utilising the corundum ore, proposals will be received by the Dominion Commissioner of Crown Lands until the first day of September next.

PROF. KIENITZ-GERLOFF criticises, in the *Biologisches Centralblatt*, Prof. Plateau's attack on the hypothesis that the bright colour of flowers is the principal agent in attracting insects for the purpose of cross-pollination. He maintains that the facts support the conclusions of Darwin, Müller, and Lubbock much more than those of Plateau, the general results of whose observations he sums up as follows: "The new is not true, and the true is not new."

THE U.S. Weather Bureau has published a *Bulletin* (No. 22) on the climate of Cuba, with a note on the weather of Manila. The work has been somewhat hastily compiled by Dr. Phillips, in charge of the section of climatology at the Bureau, and is very useful as showing what information exists, and by giving references as to where it is to be found. There appears to be very little precise meteorological data obtainable for Cuba, excepting for Habana. Observations were begun there by the late Prof. A. Poey, about 1850, and since 1859 have been regularly continued at Belen College. During the ten years 1888–1897 the highest yearly mean temperature was 77°·2, and the lowest 76°·1. The warmest month is July, with an average temperature of 82°·4, and the coldest month is January, with an average of 70°·3. The highest temperature recorded was 100°·6, and the lowest 49°·6. The greatest rainfall occurs in October and June; the yearly average for thirty years was 51·73 inches, but the amount varies considerably in different years. The greatest annual fall was 71·40 inches, and the smallest 40·59 inches. Thunderstorms are of almost daily occurrence in the West Indies, but little damage results from them. Meteorological observations have been made for many years at Manila Observatory. From tables compiled by Prof. Hazen it appears that the average annual temperature is 80°. The hottest month is May, with an average of 84°, and December and January are the coolest months, each with an average of 77°. The highest temperature recorded was 100°, and the lowest 74°. The mean annual rainfall is 75·43 inches, of which more than 80 per cent. falls between June and October. Departures from the average are in some instances remarkable, the extremes varying from 121 to 35·6 inches, while the fall of 61 inches in one September, and only 2 inches in another September is still more remarkable.

PROF. KLEIN, of Göttingen, contributes to the *Nachrichten der K. Gesellschaft der Wissenschaften in Göttingen* a statement of the arrangements that have been made to complete the publication of Gauss's works, consequent on the death of Prof. Ernst Schering, who up till lately has undertaken the work. The remaining unpublished papers on Astronomy are to be edited by Prof. Brendel; those dealing with Theory of Numbers and analysis are taken over by Prof. Fricke, of Brunswick; for Gauss's geometrical investigations Prof. Stäckel, of Kiel, has been secured; Profs. Börsch and Krüger, of the Geodetic Central Institute in Potsdam, have promised their assistance for papers on geodesy; and Prof. Wiechert, recently appointed Director of the Gauss Magnetic Observatory, is to deal with Gauss's papers on mathematical physics. It is proposed to issue three further volumes and a supplementary index-volume; vol. vii. will be devoted exclusively to astronomy; vol. viii. will consist of matter supplementary to previous volumes, especially theory of numbers, analysis, geometry and geodesy; and vol. ix. will be reserved for biographical matter.

A DETAILED report on the growth of sugar-beet, and the manufacture of sugar in the United Kingdom, is contributed by Sir J. B. Lawes and Sir Henry Gilbert to the *Journal* of the Royal Agricultural Society. Reviewing the whole of the facts that are adduced in the paper, both as to the climate and other conditions essential for the production of sugar-beet in sufficient quantity, and of sufficient quality, the authors are disposed to think that, so far as the production of the roots is concerned, it could only be a success over comparatively limited areas, and not throughout the agricultural districts of Great Britain generally. As to the profits of the sugar factories, if established, the cost of roots of good quality would probably be so high as to make it doubtful whether, with the present price of sugar in the market, adequate profits from the manufacture could be expected. In conclusion the authors think that if the sugar-beet industry is to be established with any prospect of success, great caution should be exercised in the choice of the locality or localities, and that the undertakings should, in the first instance, be limited in number and confined to the most suitable localities.

THE latest issue of the *Izvestia* of the Russian Geographical Society (1897, iv.) contains a valuable paper, by Prof. Mushketoff, on the glaciers of Russia in 1896. The plan of the Russian Geographical Society is to obtain every year, if possible, accurate measurements of the state of a number of glaciers, especially in the Caucasus, so as to know with accuracy whether they increase in bulk, or decrease, and to which extent. For eight glaciers the measurements extend already for the past eight to ten years, and they show that these glaciers have been steadily decreasing, their lower ends having retreated at an average speed of from 9 to 38 metres every year. Taking the northern and the southern slope of the Caucasus separately, the average speeds of retreat are 22 metres a year for the former, and 25 metres for the latter. Several new glaciers were discovered in 1896 by the botanists Bush and Schukin. In Turkestan, the expedition of Lipskiy and Barschevskiy discovered in the Hissar Range a great number of large glaciers, formerly unsuspected, the biggest ones lying at the headwaters of the Yagnob River. Their lower ends descend to altitudes of from 10,500 to 11,000 feet, and their *névés* lie at altitudes of 13,000 feet and more. They are all much smaller now than they have been formerly, as may be seen from the moraines and débris with which they are surrounded. Photographs of the Zerafshan glacier, which were procured in 1896 by Maslovskiy, show that it has considerably decreased since 1881. In Siberia, a number of formerly insufficiently-known glaciers was described by Prof. Sapozhnikoff; the main ones, much greater than the well-known Berel, belong to the system of the Byelukha mountain—the Katuñ glacier consisting of two branches, 3½ and 4¾ miles long. The Altai glaciers reach by their lower ends the 6600-feet level. Three big ones were discovered at the headings of the Bukhtarma, and one in the Kimas Range of the South Altai. All are much smaller now than they were formerly.

THE Fauna of the Neocomian Belemnite Beds of Baluchistan is described (in the "Palæontologia Indica") by Dr. Fritz Noetling. Two plates suffice to illustrate the species, which include only *Gryphæa Oldhami* (n.sp.), and four well-known Neocomian Belemnites. A further contribution to the Palæontology of Baluchistan, by Dr. Noetling, is entitled "Fauna of the Upper Cretaceous (Maëstrichtien) Beds of the Mari Hills." As remarked by the author, the species described are of special interest, inasmuch as they shed quite a new light on the geographical distribution of the Upper Cretaceous fauna. Seventy-seven fossil forms have been obtained at present from the strata, and of these sixty-six have been described specifically—of the others only the genus could be determined. Twenty-three plates are devoted to their illustration. No less than twenty-four of the species have been identified with forms previously described, and these naturally are the more interesting. They include *Hemipneustes* (two sp.), *Ostrea acutirostris*, *Gryphea vesicularis*, *Pecten* (*Vola*) *quadricostata*, *Corbula harpa*, *Nautilus sublævigatus*, &c. The author concludes that the strata ("Hemipneustes beds") are of Upper Senonian age, and most probably represent the "Étage Maestrichtien." The fauna bears hardly any resemblance to that of similar age in southern India or northern Africa; it belongs rather to the European province of the Upper Cretaceous sea. This sea was most probably divided by a comparatively narrow land-barrier from the sea in which lived the Upper Cretaceous fauna of southern India, a view first expressed by Dr. W. T. Blanford.

THE Cephalopoda of the Lower Trias of the Himalayas are described by Dr. Carl Diener in a recent memoir of the Geological Survey of India ("Palæontologia Indica"). The fossils figured, in twenty-three plates, as in the above-mentioned monograph, are mostly Ammonites, together with a few species of Nautilus, and one Orthoceras. Among the forms described are *Prosphingites nala*, *Hedenstroemia Mojsisovici*, *Nannites hindostanus*, *Xenaspis* (*Vishnuites*) *Pralambha*, *Ophiceras Sakuntala*, *Koninckites Yudishthira*, *Kingites Varaha*, and *Lecanites sisupala*. The work bears evidence of great care, minute study, and research; but it seems a pity that generic or sub-generic names coined on a more uniform system should not be adopted, even for the sake of the palæontologist who confines his attention to the Order of "Ammonea," to which all the before-mentioned forms belong. Dr. Diener also describes the Permian fossils of the *Productus*-shales of Kumaon and Gurhwal. These shales are intimately connected with the lowest Triassic deposits in the Niti area of the Himalayas, and they rest on an eroded surface of Upper Carboniferous rocks; nevertheless, they contain species of *Productus* of late Carboniferous or Permian type. The fossils are figured in five plates, and they include the well-known European form *Athyris Royssii*.

THE Gasteropoda of the Trias of Halstatt form the subject of a well-illustrated and important monograph by Dr. E. Koken (*Abhandl. der K.K. geol. reichanstalt*, Band xvii., Wien). Twenty-three plates are devoted to the illustration of the fossils, and they include species of *Pleurotomaria*, *Murchisonia*, *Trochus*, *Natica*, *Chemnitzia*, and other genera; and multitudes of sub-genera (as most geologists would prefer to regard them), but the names of these, which are legion, can only be appreciated by the specialist.

RECENT researches on metallic lithium have shown that this metal cannot be distilled in either hydrogen or nitrogen gases, vigorous combination occurring in both cases. The metals of the alkaline earths would appear to behave similarly; so that if it should be necessary to heat these substances in an indifferent gas, argon or helium must be employed. In the current number of the *Comptes rendus*, M. Moissan shows that if pure calcium be heated in hydrogen, the metal takes fire and burns energetically, forming the hydride CaH_2, a transparent crystalline substance which is stable at a high temperature. It behaves as a strong reducing agent, and is violently decomposed by cold water, giving off one-seventh of its weight of pure hydrogen gas. It differs from the corresponding lithium hydride in that nitrogen is without action upon it at a red heat.

THE Cambridge University Press announce a series of monographs upon material obtained by Dr. Arthur Willey, Balfour Student of the University of Cambridge, from New Britain, the Loyalty Islands, and other islands of the South Pacific during the years 1895-97. The work, which will be illustrated, will embody the zoological results of the expedition, and will, it is expected, be completed in five or six parts. The first part (to be published in August) will contain the following contributions: (1) On the anatomy and development of *Peripatus novæ-brittanniæ*, by Dr. Arthur Willey; (2) on a little-known sea-snake from the South Pacific, by G. A. Boulenger; (3) account of the Phasmidæ with notes on the eggs, by D. Sharp; (4) *Metaprotella sandalensis*, n. sp., by Dr. Paul Mayer; (5) report on the Millipedes and Centipedes, by R. I. Pocock; (6) report on the Arachnida, by R. I. Pocock.

THE series of "Museum Hand-books" issued by the Manchester Museum has been added to by a paper on "The Nomenclature of the Seams of the Lancashire Lower Coal Measures," which was read before the Manchester Geological Society in January last by Mr. Herbert Bolton. Many students will doubtless be glad to have the paper in its present handy form.

FROM time to time we have noticed papers, chiefly of local interest, dealing with the Hereford earthquake of December 17, 1896. We understand that Dr. Davison's detailed report will shortly be published by Messrs. Cornish Bros., Birmingham, provided that a sufficient number of subscriptions be obtained to defray the cost of printing.

WE have received from Messrs. H. W. Cox, Ltd., their price list of induction coils and apparatus for producing X-rays. In it is to be found full particulars as to the prices and capabilities of the specialities of this firm.

THE current number of the *Journal* of the Society of Arts contains the first of the series of Cantor lectures, by Prof. Noel Hartley, F.R.S., on "The Thermo-Chemistry of the Bessemer Process."

THE additions to the Zoological Society's Gardens during the past week include two Vervet Monkeys (*Cercopithecus lalandii*) from Natal, presented by Mr. W. Champion; a Great Wallaroo (*Macropus robustus*) from South Australia, presented by Miss W. Jackson; two —— Hedgehogs (*Erinaceus*, sp. inc.) from North Africa, presented by Sir Harry Johnston, K.C.B.; a European Pond Tortoise (*Emys orbicularia*), European, presented by Mr. A. H. Cocks; an Algerian Tortoise (*Testudo ibera*) from Algeria, presented by Mr. G. H. Gude; a Sulphurous Snake (*Phrynonax sulphureus*), a Deadly Snake (*Lachesis atrox*), a Centipede from Trinidad, presented by Mr. R. R. Mole; a Lataste's Viper (*Vipera latasti*) from Algeria, presented by Mr. Carl Hagenbeck; two Yellowish Finches (*Sycalis luteola*) from Brazil, presented by Mr. F. L'hoest; an Arabian Baboon (*Cynocephalus hamadryas*) from North Africa, a Grey Parrot (*Psittacus erithacus*) from West Africa, a Swainson's Lorikeet (*Trichoglossus novæ-hollandiæ*), two Pennant's Parrakeets (*Platycercus elegans*) from Australia, a Thick-necked Tree Boa (*Epicrates cenchris*), a Corais Snake (*Coluber corais*) from Trinidad, deposited; a Giraffe (*Giraffa camelopardalis*, ♂) from Senegal, eight Lateral White-eyes (*Zosterops lateralis*) from New Zealand, two Indian Tantalus (*Pseudotantalus leucocephalus*) from India, two Spotted Pigeons (*Columba maculosa*), a Burmeister's Cariama (*Chunga burmeisteri*) from Argentina, four Wandering Tree Ducks (*Dendrocygna arcuata*) from the East Indies, purchased; a Puma (*Felis concolor*), two Barbary Wild Sheep (*Ovis tragelaphus*), a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMETARY NEWS.—In the *Astronomische Nachrichten* (Nos. 3501 and 3504) we find the ephemeris for both of Perrine's comets, namely March 19 and June 14. The former, which is situated in the northern part of Auriga and is visible for the greater part of the night, is gradually receding from the earth and becoming faint. Its ephemeris for the present week is:—

12*h*. *Paris M.T.*

1898.	R.A. h. m. s.	Decl. ° ′ ″	Br.
July 16	5 28 46	+53 48 47	
17	30 46	44 17	0·08
18	32 44	39 48	
19	34 40	35 21	
20	36 33	30 55	
21	5 38 25	+53 26 32	0·08

Perrine's comet, discovered on June 14, is, however, rapidly increasing in brightness and is getting near the sun, rendering observation somewhat difficult towards the end of this month. Its ephemeris for the week, as calculated by Dr. Berberich, is—

12*h*. *Berlin M.T.*

1898.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	Br.
July 14	6 8 45	+44 38·7	2·98
15	13 7	43 52·7	
16	17 25	43 5·6	
17	21 40	42 17·3	3·36
18	25 52	41 27·8	
19	30 0	40 37·1	
20	34 5	39 45·4	
21	6 38 7	+38 52·3	3·96

Wolf's comet, which is situated in Taurus, is gradually increasing in brightness and moving eastwards. This body will approach Mars very closely on July 19, their positions differing in R.A. and Declination by only 1·9m. and 0′·0 respectively, as computed by Herr Thræn. Its ephemeris is as follows:—

1898.	R.A. h. m. s.	Decl. ° ′	Br.
July 14	3 38 1	19 51·8	2·2
15	40 56	48·5	
16	43 50	44·8	
17	46 44	40·9	2·2
18	49 37	36·6	
19	52 31	32·1	
20	55 23	27·5	
21	3 58 15	+19 22·7	2·3

Comet Giacobini, though moving rapidly northwards as regards declination, is becoming now a faint object, being one-half the brightness it was at the time of its discovery.

STARS HAVING PECULIAR SPECTRA.—In a recent *Harvard College Circular* (No. 32) Prof. Pickering publishes a list of stars the spectra of which are described as peculiar. Most of these have great southern declinations, so we give below a short list of the few that can be observed in these latitudes. The stars were all discovered by Mrs. Fleming in her regular examination of the Draper Memorial photographs.

Designation. °	R.A. 1900. h. m.	Dec. 1900. ° ′	Magn.	Description.
−12 1500	6 23·7	−12 59	7·7	Type I. Hβ bright.
+ 5 1267	6 25 2	+ 5 57	7·1	" " "
− 8 1467	6 28·1	− 8 48	8·5	Peculiar. Variable with small range.
+ 6 1309	6 32·0	+ 6 14	6·5	Type I. Hβ bright.
" "	7 13·9	−13 3	"	Type V. Gal. long. 195° 30′, lat. + 1° 11′.
−11 1941	7 22·4	−11 31	8·9	Peculiar. Variable.
− 4 3199	11 59·6	− 5 13	8·7	Type II. Variable.
− 8 5858	22 16·5	− 8 7	8·5	Type III. Hyd. lines bright? Variable.

Two other stars with great southerly declinations, A.G.C. 14145 and 14686, show spectra with bright and dark hydrogen lines. In the former Hβ and Hγ are variable. On June 2, 1893, they were bright and superposed on a broad dark band. On April 17, 1895, and March 17, 1896, these lines, like the other hydrogen lines, were dark. In the latter star the hydrogen lines were also variable. On May 20, 1892, Hβ, Hγ and Hδ were dark. On April 3, 1895, Hβ was bright, and on April 21, 1895, Hβ and Hγ were bright. Hζ and Hη were dark with the edge of greater wave-length apparently bright.

A careful study of the spectra of some of the bright southern stars has enabled Miss Cannon to increase the number of stars containing the additional hydrogen lines first seen in ζ Puppis. Thus in A.G.C. 17572, 3925, 4027, 4202 and 4544 are present and dark. In A.G.C. 8631 and 22763 the lines 4027, 4202 and 4544, and the bands 4633 and 4688 are present and bright. In the stars A.G.C. 10863, 22748 and 22843, the hydrogen lines 3925, 4027, 4202 and 4544 are present and dark, and the bands 4633 and 4688 are bright. In the last two mentioned stars, and also in A.G.C. 9311, 26 Canis Majoris, the band 4633 is described as being double.

THE CONSTANT OF ABERRATION AND STELLAR MAGNITUDES.—In determining the constant of aberration by stars of different magnitudes, using the well-known method of Talcott, Prof. Doberck finds (*Astr. Nachr.*, 3504) that the values decrease as the magnitudes decrease. Thus, using stars averaging 4·4 in magnitude, the value of the constant he obtained was 20″·639 ± 0″·075, with stars averaging 5·4 it was 20″·430 ± 0″·063, and with those of 6·4 magnitude the value was 20″·385 ± 0″·066. Prof. Doberck suggests that perhaps this fact may explain differences in the values obtained at different observatories, such differences being always in excess of their probable errors.

THE ECLIPSED AND UN-ECLIPSED SUN.—In the *Bulletin de la Société Astronomique de France* (for July), M. Deslandres gives an account of the methods he adopts in photographing the entire chromosphere of the sun. As this beautiful method has been previously published, we need only draw attention to the very fine phototypes which illustrate the magnificent results that he has so successfully obtained. *Knowledge* for the same month contains two reproductions from Prof. Campbell's negatives of the solar corona obtained in India this year.

Although these do not give us the details as seen by the unaided eye, or as photographed on a small scale, they serve to show the structure of the lower corona. It is difficult, however, for reproductions such as these to do justice to the original negatives, as much of the fine detail is lost in the process. Prof. Campbell, it will be remembered, was stationed at Jeur, and his chief instrument was a large photographic telescope of 5 inches aperture and 40 feet focal length, the instrument being fixed, and the photographic plate made to follow the sun.

THE PLANKTON OF LAKE MENDOTA.

THE natural history of small lakes has long offered a most promising field for research in an important department of biology, viz. the inter-relations of species of plants and animals in the struggle for existence, and the dependence of both upon the physical factors of their environment. As compared with the majority of land and sea areas, a small lake constitutes a relatively perfect "unit of environment," the different elements of which can be determined with an accuracy impossible in most other cases. It is on this account, we suppose, that the detailed study of lake plankton has rapidly gained so many votaries since the lines of quantitative investigation were laid down by Dr. Zacharias and his pupils. In America, especially, the investigation of lacustrine plankton has been taken up with zeal by a considerable army of workers, the vast network of lakes in the basin of the St. Lawrence and the upper reaches of the Mississippi providing unrivalled opportunities for the most diversified inquiries. The latest[1] contribution upon this subject is at least as interesting as its predecessors, and we propose here to give a short account of Prof. Birge's principal results.

Lake Mendota is a sheet of water 6 miles in length by 4 in width, of moderately uniform depth, varying from about 18 to 24 metres, and without any large affluent. During the winter the lake is usually frozen over for three or four months. In the present memoir Prof. Birge gives an account of the Crustacea of the plankton of this lake. He deals firstly with the seasonal and annual changes in the frequency of the Crustacean constituents of the fauna, and secondly with the horizontal and vertical distribution of the total Crustacean population and of the individual species. In each case he discusses the nature and influence of the various factors which operate in the production of the observed changes. Serial observations and collections were made during a period of two and a half years.

Neglecting isolated individuals, the Crustacean fauna of Lake Mendota consists of eight well-represented species, which may be grouped as (*a*) perennial and (*b*) periodic. The perennial group includes three species of Copepoda (*Diaptomus Oregonensis*, *Cyclops brevispinosus* and *C. Leuckartii*), and two species of Cladocera (*Daphnia hyalina* and *Chydorus sphæricus*). The periodic group consists entirely of Cladocera (viz. *Daphnia pulex*, *D. retrocurva*, and *Diaphanosoma brachyurum*).

Prof. Birge shows by an elaborate series of curves and figures that the Crustacean population undergoes a cycle of seasonal changes which is regularly repeated in successive years—three periods of increase alternating with three periods of decrease in the course of each year. The maxima occur in spring (May), midsummer (July), and autumn (September and October); the minima in winter (December to April), early summer (June or early July), and late summer (late July or August).

The spring maximum is by far the greatest, and is due mainly to the rapid and preponderating increase of *Cyclops brevispinosus*. The summer depression is due to a subsequent rapid decline in the numbers of this species. Renewed reproductive activity on the part of other perennial species leads to the midsummer maximum, which is succeeded by a slow decline, reaching a point of greatest depression towards the end of August. During this period of decline most of the periodic species are introduced, but their numbers do not, as a rule, compensate for the falling off in the number of the permanent species. In this respect Lake Mendota appears to be peculiar, for it often happens in other lakes that the periodic forms are the dominant members of the summer population. The September rise is caused chiefly by the multiplication of *Daphnia* of all species and of *Cyclops*. The rapidity of the subsequent decline to the winter minimum is dependent on a number of different conditions, such as the abundance of the periodic forms present, the rate of fall of temperature, storms, &c. It varies therefore in successive years. But while the absolute number of Crustacea present, and the rapidity of the seasonal changes themselves, vary considerably in successive years, it is undoubtedly an interesting fact, clearly established by Prof. Birge's researches, that the general character of the vicissitudes of the floating population of the lake is remarkably constant from year to year.

The principal factors which determine the numbers of Crustacea in different years are, according to Prof. Birge, (1) food supply, both quantity and quality, (2) temperature, and (3) competition. It would appear that of these factors, the temperature of the water exerts a greater control over the number of Crustacea than does the food, since the number of Crustacea falls off in autumn while food is still abundant. The influence of temperature is felt through its effects upon the reproductive powers of the Crustacea, increased warmth favouring rapid multiplication.

So far as the food supply of the Crustacea is concerned, Prof. Birge assures us that the actual quantity of microscopic plant-life in Lake Mendota is almost always in excess of the demands of the Crustacea. A scarcity of food is brought about by changes in the quality rather than in the quantity of the algæ present, since some forms are more available than others as food for particular species or stages of Copepods or Cladocera. For example, young Crustacea are quite unable to eat *Ceratium* on account of its large size and its hard shell; consequently the regular predominance of *Ceratium* in the late summer is one of the principal causes which brings about the annual decline in the number of Crustacea at this season of the year. The Cladoceran *Chydorus* remains scarce while diatoms or *Ceratium* are the predominant algæ, but abounds when the place of these algæ is taken by Schizophyceæ or *Anabæna*. In seasons when the inedible filaments of *Lyngbya* predominate, there is a marked reduction in the numbers of all Crustacea present, except *Diaptomus*, which manages to maintain its numbers by combining great locomotive powers with effective means of catching food.

Equally interesting is Prof. Birge's account of the vertical distribution of Crustacea in the lake at different seasons. In winter, corresponding with the homothermous condition of the water, the Crustacea are uniformly distributed; but in summer the formation of the "thermocline" (or boundary between the upper stratum of warm, and the lower stratum of cold water) leads to a distinct stratification of the lake into layers inhabited by different types. The layers undergo changes in thickness as the thermocline descends, and these changes affect the distribution of the Crustacea to a marked degree. Moreover the layer of cold water below the thermocline becomes largely exhausted of oxygen by the decomposition of dead plants and animals which sink into this stagnant zone; and it is on this account, rather than on account of the difference in temperature, that the layer below the thermocline becomes largely destitute of Crustacean life. Insect larvæ, however, such as *Corethra*, may nevertheless be found in considerable number below the thermocline, obviously because they can carry a stock of air in their breathing tubes.

Space will not admit of further references, but we have perhaps extracted enough from this excellent memoir to justify our opening remark that the careful study of lake plankton is well worth the expenditure of time and labour such as the author of the memoir before us has clearly devoted to it. W. G.

[1] "Plankton Studies on Lake Mendota. II. The Crustacea of the Plankton, July 1894–December 1896." By E. A. Birge, Ph.D., Sc.D., Professor of Zoology, University of Wisconsin. (*Trans. Wisconsin Acad. Sci.*, xi., 1897, pp. 274 to 448.)

DESTRUCTION OF THE FRENCH OBSERVATORY IN MADAGASCAR.

AN interesting account of the destruction of the French Observatory in Madagascar is contributed by M. E. Colin to a recent number of *Cosmos*.

In October 1895, after the rupture between the Governments of France and Madagascar, the colonists and missionaries of the former country were requested to leave Antanánarivo. The observatory of Ambohidempona, belonging to the French Catholic Mission, was entrusted to the care of the Prime Minister by the priest Mgr. Cazet, together with all the instruments. The two natives, who acted as computers, were instructed to continue the series of observations commenced in 1889. Matters went well and quietly for a time; but after about nine months had elapsed a rumour was circulated by an Indian, a British subject, to the effeot that the French before leaving had hidden a lot of war materials in the cellars of the observatory. After a thorough inspection an electric battery was found in the cellars. However, the absence of instruments of destruction did not allay the suspicions, especially as the story was told at the time the French soldiers were approaching Antanánarivo.

In August, the Madagascan Government sent M. Ramarosaona to make a complete search over the observatory. He found in the north tower six cases with the following inscription on them: "Produits chimiques et photographiques, Brewer Frères, Paris," and at once concluded that this was the ammunition, deciding that the two copper-mounted telescopes were the cannons, and he announced his discovery to the Prime Minister with much pride. The Prime Minister, however, knew that the instruments were really telescopes and not cannons, and expressed the wish to look through one. On seeing how clearly distant objects could be observed, he at once concluded that the instruments were used for watching the manœuvres of the French soldiers. All suspicious instruments and boxes were then taken to the palace; inspectors were frequently sent to the observatory to try and find the hidden war material, but to no effect.

Finally, in September an order was issued from the Queen that the inhabitants of the neighbouring villages were to take the instruments and furniture of the observatory to the college at Ambohipo, and to destroy the observatory, in order that the French, who were advancing on the town, should not find a single shelter. With all possible speed the two men in charge dismounted as many instruments as possible, and packed them ready for transport. The inhabitants, however, were already in the buildings breaking down windows and doors, so that many instruments were broken, and others disappeared. The meteorological observations were continued up to the last moment, and much credit is due to the two assistants, who were indefatigable in their efforts to save as much as possible.

Soon after the destruction of the observatory, of which only a few feet of the walls were left, the French arrived, and an engagement followed between them and the Madagascans; and the position of the latter became so bad that they had to escape to Antanánarivo, leaving behind them their cannons and ammunition, which were afterwards used by the French to bombard the palace.

The next day an inspection was made of the instruments at the college, but most of them were found to have been damaged in transport; so much so, that it was either a case of sending them to France to be mended, or of replacing them by new ones. Most of the other instruments that were taken were returned, and in some cases money was sent to compensate for damages.

The observatory had been at work for a little over six years, and during that time very important observations in meteorology, astronomy, magnetics and geodesy had been made. A subscription is now open for a new observatory and for the College of France at Antanánarivo, and in all probability the new observatory will be dedicated to the memory of the soldiers killed in Madagascar.

TIDES IN THE GULF AND RIVER ST. LAWRENCE.

WE have received a copy of a paper[1] read before the Royal Society of Canada, giving a general description of the results of the tidal observations which are being carried out in the St. Lawrence under the direction of the Canadian Government. In NATURE of April 22, 1897, an account was given as to the origin of this survey and the manner in which the operations were being conducted by Mr. Bell Dawson, the officer in charge of the work, under the direction of the Marine Department of the Dominion. One of the principal objects of the survey is to obtain, by means of self-recording tide-gauges, data for computing trustworthy tide-tables for the use of the navigation.

Tide-tables for two of the stations—Halifax and Quebec—have been issued for the last two years, and for St. John for the present year. Owing to the great variation of the rise and time of the tides at different parts of the Gulf, the pamphlet affords an extremely interesting study of tidal conditions. The regularity with which the tide proceeds to Quebec after it has once entered the mouth of the river is in great contrast with its character while in the Gulf.

The variation in the period of time which the tidal undulation occupies in crossing the open Gulf is twice as great as the variation in the period between Anticosti and Quebec, where the distance is double. The main set of the tide is along the deep-water channel of 100 fathoms, which continues up the river to the mouth of the Saguenay, 130 miles below Quebec. Along the 240 miles from St. Paul Island in Cabot Strait to Anticosti the tide is propagated at the rate of 43 miles an hour; whereas over the 450 miles from Anticosti to Quebec the rate is 82¼ miles an hour. The variation in the range of the tide at different parts of the Gulf and river is even more varied. At some of the stations and in the Atlantic the range is from 4 to 5 feet. At Magdalen Island, in the middle of the Gulf, and also in parts of Northumberland Strait, the rise is almost imperceptible; while at Quebec and St. John the range is 26 and 32 feet. The wind is also found to have a material effect on the range and time of the tides, which are delayed or advanced from 1½ to 2 hours in some parts of the Gulf, according to its direction and force. The pamphlet is accompanied by a map of the Gulf and several tidal diagrams.

[1] "Character and Progress of the Tides in the Gulf and River St. Lawrence, as ascertained by Simultaneous Observations with Self-registering Tide-Gauges." By W. Bell Dawson, M.A., Assoc. M. Inst. C.E. (Ottawa: J. Durie and Son. London: Bernard Quaritch, 1897.)

THE DUKE OF DEVONSHIRE ON UNIVERSITY EXTENSION.

A CONFERENCE on University Extension was held in Cambridge last week, and on Thursday, the second day of the proceedings, the Duke of Devonshire presided, and delivered an address, portions of which, taken from the *Times* report, we reproduce:—

LOCAL EXTENSION COLLEGES.

The most important outcome of University extension during the last few years has been the light which it has thrown on the possibility of coordinating, where the circumstances are favourable, various forms of adult education. A few weeks ago his Royal Highness the Prince of Wales opened the new buildings of the University Extension College at Reading, and the presence of a large and distinguished body of representatives of the University of Oxford showed the deep interest taken by the sister University in this new institution, which is the direct result of the University extension movement aided and supported by municipal contributions, local generosity, and the subsidies of the neighbouring County Councils. Special local circumstances and the encouragement given by the Board of Agriculture have given a particular character to the organisation of the Reading College; but the essential fact in its rapid and striking growth has been the part played by the representatives of the University in organising and stimulating local effort and in educing out of various elements a new type of educational institution which associates municipal and local activity with University traditions and prestige. The successful growth of the Exeter University Extension College, which stands in a close relation to the University of Cambridge, and largely owes its increasing educational importance to that connection, is another proof the value of the services which the Universities are rendering to this branch of national education. The differences in the organisation of the Reading and Exeter Colleges show how wisely the methods of University extension work have been allowed to adapt themselves to the various conditions of distinct localities. The operations of the University syndicates have been happily marked by a judicious sense of the need for elasticity and freedom in educational organisation, coupled with an earnest care for high aims and for a high standing of teaching. A good beginning has also been made, in close connection with the University of Cambridge, at Colchester, where the new University Extension College will, it may be hoped, render excellent educational service to the municipality and surrounding neighbourhood.

A VINDICATION OF THE EXTENSION MOVEMENT.

Apart from providing guidance and stimulus in studies for those who would otherwise be deprived of them, the University Extension colleges and courses have proved of great advantage to many who desire to keep up their intellectual interests and to refresh their knowledge. Teachers in the various grades of schools, public and private, are among those who have had reason to be grateful for the efforts made by the Universities to extend these educational opportunities. And stimulus given to the teachers reacts most beneficially upon the schools and pupils under their care. In educational as in all work it is necessary to have patience in awaiting results. The best results of an improved system of primary or secondary education are not those which are the first to show themselves. And in course of time it is probable that the number of persons desiring to avail themselves of opportunities for continuing their education within easy reach of their own homes and in the leisure hours of life will steadily increase. In the circumstances of our own country, where momentous issues of Imperial policy constantly turn upon the popular vote, it is of high importance that we should encourage by all the means in our power the growth of educational organisations which are providing dispassionate instruction in the duties of modern citizenship and diffusing that kind of knowledge which is necessary to the formation of a discriminating judgment. We do not believe that it is possible to indoctrinate busy people with a systematic knowledge of a dozen or fifteen subjects, to understand any one of which would require a preparatory knowledge of many years. But it is possible to aid intelligent students in every rank of life to gain the elements, the gist, of liberal culture, and to obtain that insight into the vast complexity of human affairs which is the salutary safeguard of intellectual modesty and the best protection against hurried and partial judgments. It is in training and providing the teachers for this great and difficult work of adult popular education that the Universities are rendering one of their highest services to the country. By equipping and sending out these intellectual missionaries, men of high purpose and of high culture, they are really guiding a national movement. Let us not imagine that great educational enterprises realise themselves mechanically—that the merely fortuitous combinations of County Councils or other public authorities will suffice to secure all that is wanted in the training of citizens for citizenship. Material aid of this kind is indispensable. It is a mark of local interest, it secures the further development of that local interest. But by itself it is insufficient. What is really indispensable is leadership. The man, or group of men, must be forthcoming who, in each centre of population, will take the lead and guide the various forces which are at our disposal into wisely-chosen channels of systematic effort. And it is one of the highest duties of the Universities to train and to send forth such men, to give them moral support in their difficult labours, and to attach to their enterprise the weight of academic prestige.

SOME CONDITIONS AFFECTING GEYSER ERUPTION.[1]

The Influence of Hydrostatic Pressure.

BOTH field observation and experiment have contributed to our present knowledge of the physical causes of geyser eruption. The natural history of geyser regions has been summarised by Weed (*School of Mines Quarterly*, New York, 1890, vol. xi. No. 4, p. 289), and the experimental work by Andreæ (*Neues Jahrbuch für Min. Geol. und Pal.*, 1893, Bd. ii. p. 1). Weed concludes that geysers occur only in acid volcanic rocks, and along natural drainage lines where meteoric waters accumulate for discharge. The source of heat is conceived to be escaping hot vapours from slowly cooling lavas, the only known geysers occurring in regions of recent volcanic activity. New geysers originate by the opening of new waterways along fissure planes in the rock, and such new orifices of overflow are continually forming to compensate the diminution in activity of older vents. The cause of the intermittent spouting which distinguishes the typical geyser was originally stated by Bunsen (Tyndall: "Heat as a Mode of Motion"; Appleton, 1888, p. 168); the boiling-point of water rises with increased pressure, hence decreases from the lower end of a water-filled tube upward. If water of a lower stratum, nearly, but not quite, at the boiling point, be lifted by the entrance of steam from below to a level of less pressure and lower boiling point, "the heat which it possesses is in excess of that necessary to make it boil. This excess of heat is instantly applied to the generation of steam: the column is lifted higher, and the water below is further relieved. More steam is generated, and from the middle downwards the mass suddenly bursts into ebullition. The water above, mixed with steam-clouds, is projected into the atmosphere. . . ." (Tyndall, *l.c.*, pp. 169–170).

The accuracy of Bunsen's theory was early confirmed by experiment; and the only mechanism necessary to produce geyser eruption is a tube filled with water, open above and heated below. Many further experiments have been made, however, with a view to explaining the variations observed in the period and interval of geyser eruptions, the relative amount of steam and water, and the effect of artificial stmulants in hastening eruption. Andreæ's experiments were directed toward the imitation of Peale's ("U.S. Geological Survey of the Territories, 1884," vol. xii. part 2) types, a classification based on the form of the basins and the relation of the periods of steam and water in the eruption. It is noteworthy that in most of these experiments, the apparatus recommended has an open basin above, which retains the water thrown out and permits it to *flow back* into the geyser tube.

In Peale's classification no mention is made of the nature of the geyser-spring during the interval of quiescence; in some cases there is continuous overflow or discharge, in others there is no overflow except during eruption. As it may be shown that this fact of the presence or absence of hydrostatic pressure at the geyser vent has an important bearing on the conditions of eruption, the writer would suggest a classification based on this very simple distinction; it is a singular fact that in the published descriptions of geysers this point has been frequently overlooked. If geyser waters represent meteoric drainage, they are affected by the laws of hydrostatic equilibrium. In such case a tube continuously overflowing is in a distinctly different class from one which throws off its waters to join the superficial drainage to the sea only during the period of its occasional or intermittent discharge. The first case is represented by such a geyser spring as "Excelsior," in the Yellowstone Park, a violently boiling cauldron in the hill slope, continually discharging vast volumes of water into the pond below, which in turn drains into the Firehole River; the Great Geyser of Iceland, and the Rotomahana Geyser (destroyed by the Tarawera eruption in 1886) of New Zealand are other types of the continually overflowing class. "Old Faithful" is the type of the second class; its waters may be seen in violent ebullition a few feet below the orifice of the vent, but overflow takes place only during eruption.

Any apparatus designed to imitate accurately either of these must be provided with a supply reservoir having subterranean connection with the geyser tube, by which water may siphon in to replace that discharged. Obviously this replacement takes place in nature: if the water, as asserted, is meteoric, and governed by the same laws that determine the loci of springs, the natural method of such replacement is by the action of gravity. In the case of Excelsior, this subterranean compensation is continuous; the effective head of water at the orifice of exit is fairly constant: in the case of Old Faithful the water-column is in equilibrium, and replacement occurs only after each eruption, when this equilibruim has been disturbed by the ejection of the column.

Experimental Demonstration.

A simple device to illustrate this process was described by G. Wiedemann (*Wiedemann's Annalen*, xv., 1882, p. 173) and mentioned by Andreæ (*l.c.*, p. 4). Wiedemann made no geological comparisons, the apparatus having been constructed for class-room illustration in physics; and most of the geological experimenters have used back-flow apparatus, without supply reservoirs. The essential parts of Wiedemann's apparatus are a water-column heated below, and a supply-tube entering this column and connecting it with a reservoir of cooler, superficial waters. When the excess of steam generated has thrown out the main column, cooler water filters in through the supply-tube, and fills the geyser tube to the level of the reservoir. For effective and regularly repeated geyser eruptions, the reservoir level must be maintained a little below the height of the mouth of the geyser tube.

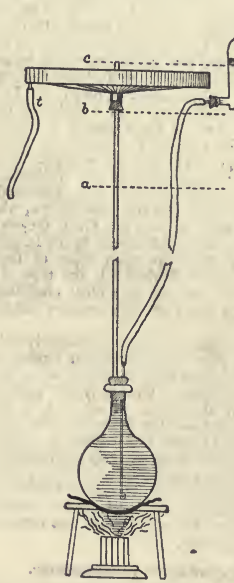
The accompanying figure illustrates Wiedemann's apparatus, as it has been used by the writer. The dimensions are as follows: capacity of each flask, one quart; length of main geyser tube 4 feet, diameter (outside) 5/16 inches; diameter of basin 2 feet; the bottom flares funnel-wise from the centre slightly, and is provided with a ¼-inch outlet tube *t*. The lower flask rests on a sheet of wire-netting over the flame of a

[1] By T. A. Jaggar, jun. (Abridged from the *American Journal of Science*, May.)

four- or six-tube Bunsen burner, and the basin and reservoir bottle are supported above on a wooden frame. The basin is of zinc, and may be raised or lowered so that the mouth of the geyser tube is flush with the bottom of the basin or raised above it as shown. The supply tube is recurved slightly at the bottom of the flask, so that the cold jets which siphon in from the reservoir will not be directed against the glass wall of the flask and break it. The reservoir bottle is connected by rubber tubing with the supply tube, so that the bottle may be freely raised or lowered to various levels indicated by the dotted lines *a*, *b* and *c*.

Experiment 1.—"*Old Faithful*" *Type.*

When heat is applied below, the reservoir level being at *a*, fter about 14 minutes an eruption takes place, characterised by violent ebullition in the flask below, ejection of the water-column to a height of about 4 feet and of a mixture of steam and water for a few seconds longer; then the water-level in the reservoir is seen to fall suddenly, a stream is seen to be flowing into the lower flask from the curved tip of the supply-tube, the cooling of the base of the column is accompanied by ondensation of steam and downward suction, the water rises



to level *a* again and a period of repose fellows. It should be noted that if the level of the cooler water in the reservoir is at *a*, the expanded warmer water in the geyser tube is somewhat above *a*. The process described is repeated at regular intervals of about 1½ minutes, the duration of each eruption being about 20 seconds. If the water in the reservoir be not renewed, it gradually becomes warmer and the intervals are of shorter duration. In this case, or with the reservoir level somewhat higher, as at *b*, and the geyser mouth raised above the basin, as shown in the figure, we have in miniature the conditions of "Old Faithful."

Experiment 2.—"*Excelsior*" *Type.*

The conditions are altered if we raise the reservoir level to the point shown in the figure, namely, just above the height of the geyser mouth (*c*). In such case there is continuous overflow of the hot water, and if the outlet tube *t* be left open, this will continually flow off; this over-flow must be constantly compensated at the supply tube by cooler water from the reservoir, so that the water in the flask never reaches the boiling point. If the water-level of the reservoir be maintained constant, this circulation will continue indefinitely, and in such case there will be a dome-shaped mass of hot water continually boiling up and overflowing at the geyser's mouth, as in the case of the Excelsior Geyser. Now at this stage, if the water-level in the reservoir be allowed to sink under the drain upon it, it may fall to a level six inches below *c*, without interrupting the continuous overflow; in other words, it may fall back to the *b* level, and yet the geyser will continue to act as a boiling spring, without entering into an eruptive phase. The cause of this is to be found in the differential expansion of the water noted above, and a convectional upflow which acts as a driving-power even against a reversed head, after overflow has once been established.[1] The overflow tube *t* may at this stage be led into the reservoir at the *b* level; this establishes a permanent circulation, the only loss being by evaporation. With the diminution in pressure if the level of the reservoir sinks, there is a tendency towards diminished inflow of cooler water at the supply-tube; this implies rise in temperature of the water at the base of the geyser-column, which tends to augment both volumetric expansion and convectional velocity. Hence there is here a critical point where the hydrothermal and hydrostatic forces are in very delicate equilibrium; if the reservoir is lowered an inch, the overflow decreases, ebullition takes place below, and an eruption of extraordinary violence takes place. The same effect is at once produced by placing the glass stopper in the reservoir bottle, and so checking the atmospheric pressure. When the mouth of the geyser-tube is flush with the bottom of the basin, an eruption may be induced by stopping the overflow tube *t* and permitting the water-level to rise in the basin, thus augmenting the pressure on the geyser-column. Eruptions once started will continue intermittently, if the hydrostatic conditions are maintained constant; if, however, the water-level of the reservoir again rises to a point where continuous overflow is possible at the geyser's mouth, the eruptions will cease and a hot-spring phase will follow.

Field Application of the Results of Experiment.

The two simple experiments described, when compared with the facts of nature, account for the most essential variations observed in the phenomena of geyser eruption. Both are methods of draining the reservoir—the one continuous, the other spasmodic. In the same way the geyser-springs drain off the superficial waters that accumulate from the abundant rainfall of the Yellowstone Plateau. The "Excelsior" cauldron is stated by Hague ("Geol. History of the Yellowstone National Park, *Transactions* Am. Inst. of Min. Eng., vol. xvi., 1888) to discharge constantly into the Firehole River 4400 gallons of boiling water per minute, "and there is no evidence that this amount has varied within the last two or three years (1887)." Weed (*l.c.*) has estimated, on the moderate assumption that one-third of the eruption-column of Old Faithful is water, that 3000 barrels are thrown off at each eruption. Here we have examples of continuous and spasmodic drainage methods, both sending their waters eventually to the Madison River, and re-supplied from a local source.

The geyser basins are topographic hollows, which supply vents for the meteoric waters accumulated in fissures of the decomposed rhyolite. These waters are heated by vapours escaping from the only partially cooled deeper lavas, and are escaping in the form of springs and geysers. In the springs the overflow is occasioned by hydrostatic pressure; in the geysers it is permitted by occasional violent discharge. The transition from one phase to the other may readily be induced, as shown in Experiment 2, by very slight changes in the hydrostatic pressure, *i.e.* variations in the mean level of ground-water (Grundwasserspiegel), or in the local head for any specific case. The head of water may be modified at either the source (supply reservoir) or the orifice of exit; head is diminished by lowering the reservoir through formation of new outlets or through decreased supply, or by building up a cone around the geyser tube. Conversely the head of water may be increased by excessive supply (rainfall) at the reservoir, by clogging of outlets, or by the water finding a new vent at a lower level.

Soaping Geysers.

It has long been known that by artificially confining the steam in small-mouthed geysers of high surface temperature, eruption may be brought about prematurely. In Iceland the Strokr is

[1] Such convection currents gain no momentum without overflow, hence at the *a* level convection played no essential part in the phenomena observed.

thus stimulated by dumping into the neck of the funnel large pieces of turf. In the Yellowstone district, it has been found that a small amount of soap or lye added to the geyser water will frequently hasten eruption. This is explained by Hague ("Soaping Geysers," *Trans. Amer. Inst. Min. Eng.*, vol. xvii., 1889, p. 546) as due to the increased viscosity of the liquid. "Viscosity must tend to the retention of steam within the basin and . . . explosive liberation must follow . . . Viscosity in these hot springs must also tend to the formation of bubbles and foam when the steam rises to the surface, and this in turn aids to bring about the explosive action, followed by a relief of pressure, and thus to hasten the final and more powerful display." Graham (*American Journal of Science*, January 1893, p. 54), as a result of experiments with an artificial geyser, agrees that viscosity has much to do with the confinement of steam, but questions the influence of bubbles and foam.

Experiment 3.—*The Effect of Soap.*

The apparatus was arranged to give regular eruptions as in Experiment 1, with the geyser-tube flush with the bottom of the basin and the water maintained about an inch deep in the basin without overflow. A small quantity of fine shavings of Ivory soap was thrown into the basin: these gradually dissolved and the milky solution was, after several eruptions, sucked into the flask below. The occasional steam-bubbles, which, in pure water, rise rapidly through the geyser-tube and escape at the surface during the intervals between eruptions, were less numerous, very small, and slower in their upward movement through the soapy solution; after five or six eruptions it became evident that the intervals were somewhat shorter (averaging 1 min. 20–30 seconds, instead of 1 min. 30–40 seconds), and the periods very noticeably longer (40–45 seconds, instead of 20 seconds). The ebullition in the flask was more violent than in the case of pure water, and columns of fine bubbles accumulated in the geyser-tube, only to be ejected with a violent sputter and give place to a new accumulation. It was evident that these accumulated myriads of tiny steam bubbles, confined within the tube and adhering to the walls of the tube, formed a cushion opposing considerable resistance to pressure from below.

After the diffusion of the soapy solution had become general, the reservoir (and consequently the geyser-column) was lowered to the level *a*; the intervals were at once shortened to an average of about one minute, in consequence of the rapid accumulation at the surface of the column and *within the tube* of the cushion of steam bubbles. So resistant is this cushion, that as it grows by the addition of new bubbles rising from below, the water column is actually depressed, down to the neck of the flask; here a point is reached where the frictional resistance of the froth cushion and the hydrostatic pressure are balanced. A further accumulation of steam forces up the column of foam, release of pressure permits the water to burst into violent ebullition, and an eruption takes place. From this it would appear that in those geysers where the tube is small, the growth of a cushion of steam soap-bubbles may play a very important part in accelerating the development of eruptive conditions.

Summary.

(1) Geysers and boiling springs are subject to the laws of hydrostatic pressure, in common with other springs.

(2) In a geyser-spring, overflow once established may be maintained by convection even against a reversed head; this leads to a critical point in the spring's mode of discharge.

(3) In this condition, with a constant source of heat, very slight changes in the local head are sufficient to induce a change in the nature of a geyser-spring's mode of action. Such change in the head may be caused by variation in rainfall, by building up a sinter cone by forcing new outlets at lower levels, or by clogging of old conduits.

(4) Geyser basins afford drainage channels for meteoric waters. The drainage takes place by either continuous overflow (hot springs) or spasmodic eruption (geysers). Both types, as well as transitional forms, are represented in the Yellowstone Park.

(5) In general, those geysers which are irregular in their eruptions have continuously overflowing vents; and the most regular geysers have confined waters, which overflow only during eruption. This is explained by the fact that the overflowing vents are under hydrostatic pressure, cooler water from lateral ducts is continually replacing that which flows off, and the ebullition necessary to produce eruption is thus prevented; eruption can only take place in the seasons of minimal inflow of cooler water, when the heat is in excess. Where the water is confined, on the other hand, and the supply of heat constant, cooler water rushes in only after each eruption, and a definite interval is required to bring it to the boiling point at the base of the column. Overflowing and confined springs should be distinguished in any description or classification of geysers.

(6) For the artificial stimulus of geyser eruption, an important effect of the bubble-forming alkalies, in small tubes, is the initial depression of the water-column by the growth of a confined cushion of minute steam bubbles. The release of pressure induced by the final ejection of the froth column causes eruption.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. MERRILL E. GATES has resigned the presidency of Amherst College.

THE following appointments are announced:—Dr. Charles Harrington to be assistant professor of hygiene, and Dr. Franz Pfaff to be instructor in pharmacology and physiological chemistry in Harvard University; Mr. R. A. Emerson to be assistant professor of horticulture at the University of Nebraska.

Science announces the following gifts for educational and scientific purposes:—50,000 dollars, from a source kept secret, to Amherst College, for an academic hall in honour of President Seelye; 20,000 dollars from Mr. H. L. Higginson, treasurer of the J. W. and Belinda Randall Charities Corporation of Monson, Mass., for the erection of a building, or as a permanent fund in connection with the University of Virginia. *Science* also states that two conditional gifts of 50,000 dollars, offered by Dr. D. K. Pearsons, have been secured by the colleges collecting the additional sums required. The endowment of Beloit College is thus increased by 200,000 dollars, and that of Mt. Holyoke College by 150,000 dollars.

THE *Calcutta Gazette* reports that representatives of La Martinière and Doveton Colleges have been appointed to consider the advisability or otherwise of the amalgamation of the two institutions. It appears that for many years these two colleges carried on with efficiency, and at a standard which compared favourably with corresponding schools in England, a large portion of the work of secondary education in Calcutta; but in recent years both La Martinière and Doveton, from causes over which they have had little control, have fallen behind in the race for up-to-date education. Owing to the keen competition of newly-opened hill schools, and the consequent loss of scholars and fees, also owing to heavy reduction in interest on the capital invested in Government securities, these colleges have not been able to keep pace with the requirements of modern education; while, on the other hand, they have been handicapped by heavy expenditure on the up-keep of extensive buildings and the payment of large sums in municipal rates and taxes. To remedy this state of affairs, which every year becomes more serious and pressing, the amalgamation of the two institutions has been suggested, in the hope that the result would be a considerable decrease in expenditure and a consequent gain in discipline and efficiency. It is fully recognised that there are difficulties in the way of the realisation of this scheme, but the Lieutenant-Governor sees no reason to believe them insurmountable. The aims and objects of the two institutions are almost identical, and it is hoped that petty differences of detail may not be allowed to stand in the way of arriving at a common understanding as to some broad scheme of amalgamation on lines which, by uniting the resources of the two colleges, will enable them to provide that standard of European education which it was the intention of their founders to give, but which under existing conditions it is practically impossible that either college alone can supply from its unaided resources.

SCIENTIFIC SERIALS.

THE *Mathematical Gazette*, issued under the auspices of the Mathematical Association, continues to maintain its interesting collection of notes and solutions to problems. The June number, recently issued, contains, in addition to these notes, papers by Mr. H. B. Billups on the connection between the inscribed and escribed circles of a triangle, and by Mr. R. F. Muirhead on relative motion. We should be glad to see more articles in the *Gazette* dealing with questions of general principle, rather than with neat solutions of special problems; such subjects as the methods of teaching "Progressions" in Algebra might well afford interesting material for discussion.

THERE are several interesting papers in the *Journal of Botany* for June and July 1898.—A figure is given of the newest addition to our phanerogamic flora, *Stachys alpina.*—Mr. H. N. Dixon adds also a new moss (from Perthshire) to the British flora, *Plageothecium Müllerianum.*—The "Recent Literature on Algæ," by Miss Ethel S. Barton, contributed from month to month, is a useful feature.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 4.—M. Wolf in the chair.—The Perpetual Secretary announced to the Academy the death of M. Ferdinand Cohn, Correspondant in the Botanical Section.—M. Van Tieghem added a short appreciation of the work of the late Prof. Cohn.—Numerical tables for facilitating the development by interpolation of the disturbance function, by M. O. Callandreau.—On the elastic equilibrium of a dam of masonry of triangular section, by M. Maurice Lévy.—On the maintenance of the motion of a pendulum without disturbance, by M. G. Lippmann. A series of instantaneous impulses is given to the pendulum, equal, but of contrary signs, the algebraic sum of the disturbance being equal to nothing. If the impulses are imparted as the pendulum swings through its position of equilibrium, each separate disturbance also becomes vanishingly small.—New observations on the Zeeman phenomenon, by MM. Henri Becquerel and H. Deslandres. In a very intense magnetic field (35,000 C.G.S. units) the bands of nitrogen and cyanogen (the "carbon spectrum") show no signs of doubling nor enlargement, although the rays of the air spectrum were, under the same conditions, strongly divided. Most of the rays examined undergo the division into triplets announced by M. Zeeman; certain rays, however ($\lambda = 3788{\cdot}01$, $\lambda = 3743{\cdot}45$ in the iron spectrum), split up into five. The distribution of these split-up rays, considered as a function of the wave length, shows signs of periodicity.—On the decomposition of water by chromous salts, and on the use of these salts for the absorption of oxygen, by M. Berthelot. Solutions of pure chromous chloride, free from all trace of free acid, give no trace of hydrogen gas, even after eleven years. In presence of a trace of hydrochloric acid, a minute quantity of hydrogen is evolved, which becomes very appreciable at 250° C. Hence acid solutions of chromous chloride cannot be used for the removal of oxygen in exact work, except in the case of hydrogen.—On the reaction between hydrogen gas and nitric acid, by M. Berthelot. Hydrogen is not absorbed by pure nitric acid, either in the cold or at 100°, even after twenty hours contact.—Preparation and properties of calcium hydride, by M. Henri Moissan (see p. 257).—On apple orchards on pasture land, by M. Ad. Chatin.—Notice on the life and work of M. Paul Serret, by M. Darboux.—Velocity of propagation of discontinuities in media at rest, by M. Paul Vieille.—The relation of metallic envelopes to the Hertzian oscillations, by M. Edouard Branly. The Hertzian oscillations are completely arrested, even by a very thin metallic envelope, if the latter is hermetically closed.—Mechanism of the discharge by the X-rays, by M. G. Sagnac.—Irreversible isothermal transformations of a mixture. Development of the conditional relation of equilibrium, by M. A. Ponsot.—On blue glass with chromium base, by M. André Duboin. Account of some experiments on the production of blue glass. The three glasses, $4{\cdot}5SiO_2.Al_2O_3.3BaO$, $4{\cdot}5SiO_2.Al_2O_3.1{\cdot}5CaO,1{\cdot}5BaO$, and $28SiO_2.9B_2O_3.16BaO.3Al_2O_3$, coloured either with potassium bichromate or chromic oxide, give very fine blue glasses.—On copper selenate and its use in the preparation of selenic acid, by M. R. Metzner. Selenium is converted into selenious acid, and this oxidised in solution with chlorine. Copper oxide is added to this liquid, and evaporation gives fine prisms of copper selenate. Pure selenic acid is obtained from this by electrolysis.—Action of hydrogen upon potassium paratungstate, by M. L. A. Hallopeau. At a low temperature a mixture of the blue oxide with the dioxide of tungsten is obtained. At a higher temperature tungsten bronze ($K_2O.WO_3 + WO_2.WO_3$) is formed.—Volumetric analysis in alkaline solution by a ferrous reducing agent, by M. André Job. The reducing liquid is made by adding an acid solution of ferrous ammonium sulphate to an excess of sodium pyrophosphate. The excess of the iron salt can be exactly determined by standard iron solution. The solution in sodium pyrophosphate is colourless and remains so during the oxidation, and is as energetic in its reducing power as stannous chloride.—Volumetric analysis of a mixture of acid ethyl phosphates and phosphoric acid, by M. J. Cavalier.—On the estimation of phosphoric acid, by M. Henri Lasne. A discussion of the results given by M. Leo Vignon.—On the phenylurethanes of the ethers and nitriles of some oxy-acids, by M. E. Lambling. The urethanes described were the phenylurethanes of ethyl lactate, trichlorolactate, of trichlorolactic nitrile, glycollic ether and nitrile, phenyl glycollic ether and nitrile, and α- and β-ethyl oxybutrates.—On a new combination of acetylene with cuprous oxychloride, by M. R. Chavastelon. By the action of water upon the compound $Cu_2Cl_2.C_2H_2$, previously described, the substance $Cu_2O.Cu_2Cl_2.C_2H_2$ is obtained.—On ethane-pyrocatechol, by M. Ch. Moureu.—On the elimination of chlorides in rickets, by M. Œchsner de Coninck.—Absorption of liquids by textiles, by M. Leo Vignon. Textiles have a specific absorbing power for each liquid, the order of magnitude of this constant being silk, wool, and cotton.—The hematozoa of goitre, by M. E. Grosset. The parallelism between goitre and malaria is shown to be very well marked, and drawings are given of parasitic organisms, hematozoa, always present in the blood of recent cases of goitre.—On the functions of the pancreas in the Squalidæ, by M. Emile Yung.—On the development and structure of the larva of some cheilostomatous bryozoa, by M. Louis Calvet.

CONTENTS.

THURSDAY, JULY 21, 1898.

TECHNICAL MYCOLOGY.

The Utilisation of Micro-organisms in the Arts and Manufactures: a Practical Handbook on Fermentation and Fermentative Processes, &c. By Dr. Franz Lafar, Vienna. With an introduction by Dr. Emil Chr. Hansen, Copenhagen. Translated by Charles T. A. Salter. In two volumes: Vol. i. Schizomycetic Fermentation. With plate, and 90 figures in the text. Pp. xviii + 405. (London: Charles Griffin and Co., Ltd., 1898.)

BEFORE Pasteur published his great work on "Fermentation," most people would have scouted the idea that bacteria could ever play any very important part in technical and trade affairs. But when this work appeared it became evident that, as shown in the description of the processes concerned in brewing and vinegar-making, a new era had been inaugurated. Still it was scarcely, even at that time, anticipated that bacteria would come to play their present important part in the arts. Although it is impossible at first sight to appreciate the immense strides that are now being made, it is manifest when one comes to look over such a volume as that under review, that technical mycology has materially aided, and sometimes in a measure even superseded, much of the work of the chemical laboratory. In the case of chemical work, *results* are merely recognised and set forth, but, from bacteriological work, explanation of the chemical changes are afforded. It is interesting to notice what a successful attempt has here been made to amalgamate the scientific with the practical. Hitherto the scientific part of bacteriology has been looked upon as science pure and simple, except in its relation to the production of disease, and to such conditions as putrefaction and fermentation. Now, however, that the scientific investigator and the practical worker are co-operating, it is evident that the import of bacterial processes is greater than could hitherto have been imagined. It has certainly been one of the greatest gains of bacteriology that the study of the physiology of fermentation and other technical processes should have been undertaken by Pasteur and Hansen. Under their leadership there have been brought together a number of eager workers who have from time to time made valuable contributions to our knowledge of mycology. Most of such work, however, is to be found only in technical or scientific journals, with the result that the technologist has not always had the benefit of the opinion of the scientific expert, whilst on the other hand the scientific expert has too frequently worked unavailingly along lines which at the time appeared to lead to no practical result. In the work before us, and in one or two others, especially those that have come from the Danish laboratories, we have a series of text-books, if one may so speak of them, in which both kinds of investigations have been carefully sifted, analysed, collected, and accessibly arranged. It has too long been the case that in certain of the technical laboratories founded specially for the purpose of bringing bacteriological science to bear on technical work, the scientific worker has been kept too closely to analyses and to work having direct relations to technical processes, with the result that in many cases his work has been dwarfed, and he has had little time to devote to original investigation of any kind.

Hansen, in the preface to the work before us, puts the matter pithily and forcibly in the following words:—

"It is true that an intimate connection with practical conditions sets fresh tasks before the investigator, and exerts on the whole a sufficiently stimulating influence; but on the other hand, the same circumstance gives rise to the danger of diverging into by-paths, and neglecting the strict scientific conditions of investigation. Since these Stations and Laboratories are, as a rule, maintained by a circle of practical men for whom they work, the investigators appointed thereto are often subject to regrettable pressure. Even though, otherwise, a certain amount of freedom is allowed them in these institutions, they labour under the great difficulty of being obliged—whilst engaged in the task of scientific investigation—to be ready at any moment to give assistance—coupled with analyses and any wished-for disclosures—to the parties interested. Still further difficulties arise when practical men foolishly intermeddle in scientific investigations, and especially when results that shall be immediately available for practical utilisation are impatiently demanded—results which, however, are only attainable by scientific investigation, and cannot be forced on at pleasure. . . . The result of these vexed relations between Scientists and practical men has been to call into existence a quasi-scientific literature by which neither Science nor Practice is benefited—a result which every one who has the healthy development of this subject at heart must greatly deplore and endeavour to improve according to his ability. These conditions are, however, in existence, and we must take them into account."

Such being the state of affairs, we welcome most heartily a work which deals in a thoroughly scientific spirit with technical bacteriology, and in the first volume of Dr. Lafar's book we have the part fulfilment of the promise of an exceedingly useful work. Dr. Lafar has given a scientific basis of bacteriology, offering classifications and methods of working which can now be styled classical. But in addition he has drawn up a kind of parallel between the micro-organisms of disease and the micro-organisms that play a part in various technical processes; the whole forming a thoroughly good foundation on which to build up the more technical part which follows. This following part includes a systematic description and classification according to their power of doing work in special technical processes of various groups of micro-organisms. After dealing briefly with the question of spontaneous generation, the author goes on to speak of the various theories of fermentation, and closes the introductory part of the work with a short account of the special organisms that are associated with this process. He then, in the first division of the main body of the book, devotes a section to the schizomycetic fermentations and to the general morphology and physiology of schizomycetes. This is followed by a section on the general biology and classification of bacteria: in this latter section the behaviour of bacteria under the influence of physical agencies is specially dealt with, and mention made of their relation to one another in the various symbiotic, metabiotic, and antagonistic conditions. The account of the various classifications of the bacteria, commencing with that drawn up by O. F.

Müller, and ending with those now generally in use, is excellent; although it is evident from what is here laid down, that our classification of micro-organisms is as yet to a large extent empirical, and that there is great need for a classification constructed on a thoroughly sound and scientific basis. The principles of sterilisation and pure cultivation are given succinctly but very clearly. The section devoted to the heat-resisting bacteria, their place in nature, and their importance in the fermentation and food-stuff industries, is one of considerable interest. The principal organisms in this group are described as the *Bacillus subtilis* and its congeners, the *Clostridium butyricum*, the genus Granulobacter, and various other organisms associated with the butyric acid fermentation, the fermentation of cellulose, the "retting" of flax and hemp, and the production of rancidity of fats.

The relation of the study of the life-history of these various organisms to the preservation of milk, meat, eggs, vegetables and fruit is fairly carefully considered, as are also the lactic fermentation and the allied decompositions, special stress being laid on the production of optically active organic compounds by fermentation, on the artificial souring of cream, the coagulation of milk, and on the importance of the part that various lactic acid bacteria play in the processes of distilling, brewing and vinification; and in the preparation of fodder, the making of brown hay into sweet ensilage and sour fodder. Then the work done by bacteria in tanning, in the manufacture of sugar in the conditions known as "ropiness" in milk, wine, beer, and other liquids are all somewhat fully and interestingly treated. A special section is devoted to the decomposition and transformation of organic nitrogenous compounds; this, of course, constitutes a very important part of the work, and, in conjunction with the section on oxidising fermentation, affords a very large amount of information on the bacterial processes involved in the breaking up of various organic compounds. It is interesting to note how closely these processes are associated with those of fermentation of cheese and of similar proteid substances.

Altogether this volume, the first of two, is an exceedingly interesting and valuable contribution to the study of technical mycology. The work of translation is well done, but there are one or two slips which might with advantage be corrected in future editions: for instance, "typhus" is throughout used for "typhoid," this, of course, being a literal translation of the German *typhus* without the term *abdominalis*, which is always added to indicate our *typhoid* fever. It need scarcely be mentioned that the work will probably be hailed by English workers with gratitude, but we may point out that the term "mycology" will convey to the general reader very little idea as to the scope of the work. Many years ago a work was published in this country to which the title "Pathological Mycology" was given, a work which was largely overlooked because of its title. Since then this same title has been used abroad, where the significance of the word appears to be more fully appreciated. We think the translator would have been wise had he selected some title more generally "understanded of the people" for what, after all, must to a certain extent be a popular work. There will, however, be a considerable demand for this book amongst those who are engaged in pathological and technical bacteriology, who, of course, will appreciate both the title and the work; but the translator must expect to find that some, at least, of his possible readers will pass over this book simply because they do not understand the title.

Messrs. Griffin have done their part in a thoroughly workmanlike fashion, and we congratulate both author and translator in having their work placed so well before the reading public.

PARTIAL DIFFERENTIAL EQUATIONS.

Leçons sur l'intégration des équations aux derivées partielles du second ordre à deux variables indépendantes. Par E. Goursat. T. I. pp. viii + 226; T. II. pp. 344. (Paris: A. Hermann, 1897, 1898.)

A DIFFERENTIAL equation, in its usual form, states an analytical problem with a certain assumption as to the form of the answer. It implies the existence of a dependent variable, capable of being differentiated so far as the order of the equation indicates; and the solution of the equation consists in discovering a relation among the variables, free from differential coefficients, such that the given differential equation may be derived from it. The question at once arises: what is the most comprehensive form of solution? Is it possible in every case to define an integral relation connecting the variables equivalent to the differential equation in the sense that not only is the differential equation derivable from it, but every possible relation consistent therewith is included as a particular case in the integral equation? In the early days of the infinitesimal calculus it was observed that ordinary differential equations could be obtained by eliminating constants; while partial differential equations could be derived by the elimination of constants or of arbitrary functions. In some cases the reverse process of starting with the differential equation and arriving at an integral relation, involving arbitrary constants or functions, or both, was found to be practicable; and it came to be taken for granted that integral relations of this kind always existed, the only difficulty being that of discovering them.

But, with the advance of function-theory, the peculiar difficulties of the subject have gradually become more evident. It is true that, with regard to ordinary differential equations and partial differential equations of the first order, the general form of solution has been established, and the hypothesis of the earlier mathematicians justified; but when we come to partial differential equations of the second and higher orders, the aspect of the problem is radically changed. In most cases it is hopeless to attempt to assign an explicit form of the general integral, or even to prove its existence; and we have to content ourselves with the study of solutions subject to certain special limitations. Thus we have the problem of Dirichlet in the theory of potential; or again the problem of Cauchy, which forms the leading idea of M. Goursat's original and fascinating treatise.

To explain what this means, let us take the case of an equation of the second order with two independent variables, say $\phi(x, y, z, p, q, r, s, t) = 0$, the notation being as usual. Assume x, y, z, p, q functions of a single variable, subject solely to the condition $dz = pdx + qdy$; we thus have a multiplicity of one dimension, which may be called an orientation of the first order. In general by means of $\phi = 0$, the relations $dp = rdx + sdy$, $dq = sdx + tdy$, and those derivable from them by differentiation, it is possible to find a definite expansion for z, which formally satisfies the differential equation and also contains the given orientation: if the expansion is convergent in a certain domain, this defines z as an analytical function of x, y. Geometrically, if we take x, y, z as point coordinates, the assumed orientation consists of an arbitrary curve, with an arbitrary, but continuous, distribution of tangent planes along it, enveloping a developable surface; if we like, we may regard it as a thin ribbon cut out of a developable. The process sketched above is equivalent to finding an integral surface containing the aforesaid ribbon, or in other words containing the given curve, and touching at each point of it the given associated tangent plane. The problem of Cauchy for an equation of the second order is to find a solution capable of being specialised, by the choice of arbitrary constants or arbitrary functions, or both, so as to contain any given orientation of the first order. Such a solution is said to be general in Cauchy's sense, as distinguished, for example, from one that is general according to Ampère's celebrated definition.

It may happen that the orientation of the first order, M_1 say, is such that the relations $\phi = 0$, $dp = rdx + sdy$, $dq = sdx + tdy$ are, for every element of it, equivalent to only two independent equations; in this case Cauchy's problem becomes indeterminate, and there are an infinite number of integral surfaces containing M_1, which is then said to be a characteristic of the first order of $\phi = 0$. It is an exception for an equation of the second order to admit of a multiplicity M_1; since

$$\phi\left(x, y, z, p, q, \frac{dp}{dx} - s\frac{dy}{dx}, s, \frac{dq}{dy} - s\frac{dx}{dy}\right) = 0$$

has to be satisfied identically for all values of s, and this leads to a number of distinct relations, not generally compatible. One of these is always

$$\frac{\partial\phi}{\partial r}dy^2 - \frac{\partial\phi}{\partial s}dxdy + \frac{\partial\phi}{\partial t}dx^2 = 0; \ldots$$

on every integral surface this equation defines a system of characteristic curves.

Throughout the whole treatise the theory of characteristics plays a predominant part. Thus in Chapters i.–iii., which deal with the equation of Monge and Ampère ($Hr + 2Ks + Lt + M + N(rt - s^2) = 0$), it is shown with admirable clearness how the success of Monge's method of integration depends upon finding integrable combinations of the differential equations of the characteristics. The cases of partial or total failure are discussed as well as those of success; and the reader thus becomes familiar with the *rationale* of the process, instead of merely acquiring facility in applying a method which, in some way that he hardly understands, leads (with good luck) to the required solution. Chapter iii., in particular, contains a large number of important applications very fully worked out.

M. Goursat's first volume concludes with an important chapter on the general theory of characteristics and on intermediate integrals. The notion of characteristics is extended to the second and higher orders, and it is shown, among other things, (1) that every equation of the second order possesses in general two distinct systems of characteristics of the second order; (2) that two characteristics of the second order belonging to two distinct systems, and having in common an element of the second order determine one, and only one, integral surface (p. 193). All equations of the second order may be arranged in four classes according as they have (1) two different systems of characteristics, each of the second order (this is the general case); (2) two systems, one of the first order, one of the second; (3) two systems, usually distinct, each of the first order; (4) one system of the first order.

The second volume begins with an account of Laplace's method of treating linear equations, which may be profitably compared with the discussion of the same subject in Darboux's "Théorie des Surfaces." After this come two chapters, of the highest interest and importance, on systems in involution and on Darboux's method of integration. The first of these deals with systems of equations which admit of solutions involving an infinite number of arbitrary constants, and introduces us to ideas of great value and generality which have been developed by various mathematicians, including M. Goursat himself. The chapter is, to a great extent, introductory to the one on Darboux's method, which immediately follows, and which will probably be found the most engrossing part of the work. The leading idea is that of finding integral combinations of the differential equations of characteristics; not necessarily of the first order, as in Monge's method, but of the second, third, or higher order: thus, for instance, Liouville's equation $s = e^z$ is completely integrated by proceeding as far as the characteristics of the second order. M. Goursat very justly remarks that Darboux's method is the most powerful as yet available, and includes most others, for instance those of Monge, Ampère, and Laplace, as particular cases. In order that it may succeed, it is necessary that every integral of the proposed equation should also be an integral of another partial differential equation which has in common with the given equation an infinity of integrals depending on an arbitrary function, while at the same time the second equation must not be satisfied by all the integrals of the first (II. p. 190). The main practical difficulty is that it is generally impossible to say beforehand whether a given equation admits of solution by this method or not. By means of Lie's theory of transformation-groups it is, however, possible to construct a variety of equations to which Darboux's method may be successfully applied.

The next chapter deals with equations of the kind called by Ampère those of the first class; this is followed by one on transformations; and the treatise concludes with a somewhat miscellaneous chapter containing various generalisations of the preceding theory.

A work so attractive as this, and written by an author so well known, is assured of the favourable reception which it thoroughly deserves; taken with M. Goursat's previous work on equations of the first order, and M. Darboux's "Théorie des Surfaces," it will provide mathematical students with an excellent guide to what has been done in this part of analysis. One way, amongst many others, in which M. Goursat's treatises are likely to be very useful is in giving practical illustrations of Lie's methods. Lie's colossal work on transformation-groups is so very abstract and, at the same time, so exhaustive that it must, we fear, repel the great majority of readers; still it is hardly rash to predict that his ideas, as time goes on and they become more familiar, will prove to be of extreme value and fertility, and profoundly affect, not only the theory of differential equations, but almost every branch of analysis. It should be added that M. Goursat points out that Ampère employed contact transformations of a general character more than seventy years ago; and it is, in fact, one of the author's objects to recall attention to Ampère's remarkable memoirs in cahh. 17, 18 of the *Journal de l'École Polytechnique.*

G. B. M.

OUR BOOK SHELF.

Our Weights and Measures: a Practical Treatise on the Standard Weights and Measures in use in the British Empire, with some Account of the Metric System. By H. J. Chaney. Pp. viii + 164. (London: Eyre and Spottiswoode, 1897.)

THE Superintendent of Weights and Measures gives in this book an authoritative account of the present practice in regard to the various weights and measures used in trade or for the purposes of manufacture. The origin and history of ancient systems are briefly traced so far as to show how our present system comes to be what it is, and references are carefully given to other treatises and to Acts of Parliament on all points of importance.

The book is well illustrated. Some of the views are of antiquarian interest: *e.g.* the beautiful pictures showing the interior of the Pyx Chapel at Westminster Abbey, a depository for standards since the Norman period; but most of the illustrations have reference to weights and measures in actual use, and to the arrangements for their inspection and verification. Local inspectors of weights and measures will no doubt look on this book as a very useful and, indeed, indispensable compendium.

Teachers and writers of books on arithmetic would do well to take to heart the remarks on pp. 112-114. Thus not only is a list given of those weights and measures which alone need be taught to the exclusion of various customary and local designations which, from a national point of view, are now obsolete, but it is well pointed out that a few hours' actual weighing and measuring would make the children in schools more at home with standard weights and measures than many hours of bare learning of the tables.

The last section of the work is on weights and measures used for special purposes; it includes, for instance, an account of engineers' gauges and standards, and gives tables of particulars of the Birmingham wire gauge, Whitworth's and Seller's screw threads, the B.A. small screw gauge, and several other standard gauges.

Practicum der Wissenschaftlichen Photographie. By Dr. Carl Kaiserling. Pp. xii + 404. (Berlin: Gustav Schmidt, 1898.)

IN this volume of about 400 pages we have a work which will be read by most photographers, whether amateur or professional, who are familiar with the German language, for, besides covering a great deal of ground, the subject is treated of in much detail. Although portraiture and landscape photography are included in the text, the author presents the subject more especially for those who employ photography as a means of aiding them in their scientific investigations. Thus, for instance, the medical man is enlightened as to the best means of illuminating portions of the human body to get the best effects from his point of view, and to photograph with success anatomical sections for demonstrations or collections. Microphotography is also treated at some length, and is well illustrated by some fine autotypes.

It must not be assumed that the optics and manipulations are here somewhat ignored at the expense of the new lines on which the book has been written. Both of these come in for their full share, and are well discussed and described, besides being copiously illustrated. Most of the new lenses are referred to at some length, and are accompanied by numerous tables for determining the lengths of exposures under different conditions. Methods of obtaining positives and enlargements, stereoscopic photography, Röntgen photography, and photography in natural colours, besides processes for reproduction, are all in their turn dealt with individually; and the reader who wishes to specialise in any one or more of these branches will find ample information in these chapters.

Enough, perhaps, has been written to show that this book is not only a useful *vade-mecum* for the student of science who wishes to obtain the best results in his special line of work, but is a valuable addition to our photographic literature. The illustrations are numerous, and there is, what is often absent from a great many German books, a good index.

Principles of Mechanism: a Treatise on the Modification of Motion by means of the Elementary Combinations of Mechanism, or the Parts of Machines, for use in College Classes, by Mechanical Engineers, &c. By S. W. Robinson, C.E., D.Sc., till recently Professor of Mechanical Engineering in the Ohio State University. Pp. xv + 309. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

THE main value of this work may not unfairly be said to consist in its 350 illustrations of elementary combinations of mechanism (in many cases more curious than useful), and in the descriptions appended thereto. In regard to the scope of the book, and, it may be added, the degree of clumsiness of expression of which the author is capable, we may quote the second sentence of the introduction: "In Principles of Mechanism we find the application to machines, of the principles of kinematics, or cinematics, the elementary combinations of mechanism of which machines, being studied separately."

A good many rules, useful in the drawing office, are exemplified; but the fundamental principles on which they are based are for the most part left unnoticed. Thus in Fig. 297 we have a complicated drawing of the fixed and moving centrodes of certain mechanisms, but we search the book in vain for any demonstration of the method of instantaneous centres on which the construction depends.

In Fig. 301 the curves of velocity-ratio of crank and connecting-rod are shown: the accompanying description identifies them with the fixed and moving centrodes of the motion. There is no appeal to the fundamental principles involved. In fact the book before us, however suitable for reference by an inventor, seems to us quite unfit for a student's text-book.

Introduzione allo Studio dei Silicati. By Dr. E. Ricci. (Milan: Ulrico Hoepli, 1898.)

IN this pamphlet the author seeks to classify the complex group of the mineral silicates, and he claims for his arrangement the merit of simplicity. The distinction between the hydrous and anhydrous silicates is abandoned, and all mineral silicates are grouped in the two primary divisions of orthosilicates and metasilicates. As simple orthosilicates he includes zircon, phenacite, and willemite with the Peridot family (olivine, sepiolite and calamine); and with the double orthosilicates he groups the felspars, the felspathoids, the micas, the garnets, the epidotes, the tourmalines, the zeolites, and the chlorites. Among the metasilicates we find the pyroxenes and amphiboles, with serpentine beryl and the copper silicates. The table of classification given at the end of the work includes most of the common rock-forming minerals, but does not deal with the rarer species. The author finds himself unable to accept Prof. E. Dana's nomenclature of the silicates, and, as will be seen from the foregoing summary, uses the terms orthosilicates and metasilicates for groups having very different limits to those assigned to them by the American mineralogist.

The Blood; how to examine and diagnose its Diseases. By Alfred C. Coles, M.D. Pp. xi + 260. Plates vi. (London: J. and A. Churchill, 1898.)

THE book before us is practically confined to the consideration of morphological methods. The author has endeavoured to collect what is known concerning the morphological changes as determined by staining reagents in the cellular elements of the blood in different diseases. He has further included a description of the methods requisite for the identification of certain parasites, and Widal's method of serum diagnosis in typhoid fever. The information contained in the book is, so far as concerns method, accurate; and those who prefer to have the methods for the examination of the blood in one volume, not under the head of the respective disease, as is done in the larger text-books of medicine, will no doubt find Dr. Coles' work useful. Some of the author's explanations and definitions are, however, not as exact as they should be; for instance, his remarks on chemiotaxis on p. 86, especially on negative chemiotaxis, are certainly original. The terms are not ordinarily used in the sense of the author. More might also have been done in the direction of a fuller bibliography.

F. W. T.

Notes on Volumetric Analysis. By Arthur Thornton, M.A., and Marchant Pearson, B.A. Pp. viii + 80. (London: Longmans, Green, and Co, 1898.)

THE series of twenty-seven experiments described in this book will serve as an elementary course of practical work in volumetric analysis, as they illustrate all the simple processes of neutralisation, oxidation, iodometry, and methods of precipitation. The instructions are clear; and the student who follows them should have no difficulty in performing the experiments, or in carrying out other exercises of the same type, while at the same time he should become skilful in general volumetric work.

A First Year's Course of Practical Physics, adapted for Beginners and Junior Students. By J. F. Tristram, M.A., B.Sc. Pp. 50. (London: Rivingtons, 1898.)

A SERIES of very elementary exercises on measurements of length, area, volume and density are given in this little book. Neither the plan of the book, nor the experiments described, present any novelties; but this will not prevent the volume from being of use in instructing young pupils in the methods of weighing and measuring.

The Doctrine of Energy: a Theory of Reality. By B. L. L. Pp. ix + 108. (London: Kegan Paul, Trench, Trübner, and Co., Ltd., 1898.)

THE argument that the conception of energy embraces and supersedes the conception of matter; that, in fact, the universe is not made up of two real things—matter and energy—but only one, was supported by the author from the standpoint of physical science in a volume published eleven years ago. The question is now presented as viewed from a metaphysical standpoint, and it will doubtless prove as interesting to students of philosophy as it is to students of physics.

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.*]

Solfatara Gases.

WE have for a considerable time been occupied with an extensive study of the gases emanating from the earth in various parts of Italy with the object of detecting the presence of argon and helium, and possibly of other elements they may contain.

The first part of this work has already been published (*Gas delle terme di Abano, Gazzetta Chimica Italiana*).

We are now completing the study of the gases of the Solfatara di Pozzuoli, Grotta del Cane, Grotta ammoniacale, and of Vesuvius. In the spectrum of those of the Solfatara di Pozzuoli, which contain argon, we have found a sufficiently bright line with the wave-length 531·5, corresponding to that of corona 1474 K, attributed to coronium, an element not yet discovered, and which should be lighter than hydrogen. This line has never before been observed in earthy products. Besides we have noted the following lines:—653·5, 595·5, 536·2. In the spectrum of the gases gathered from the Fumarole of Vesuvius we have observed the lines:—769·5, 631·8, 572·5, 636·5, 441·5, and again 595·5. All these lines do not belong to the spectrum of argon or helium; they show a coincidence or proximity only with some unimportant lines of various elements, such as iron, potassium, titanium. Considering the conditions of our experiments, the presence of these elements in the gases we have studied is not probable. The line 572·5 is near to one of nitrogen, but being the only visible line of the spectrum of this gas, it cannot be attributed to it. Besides coronium we have thus probably other new elements in these gases.

We are diligently pursuing their investigation.

Padua.

R. NASINI,
F. ANDERLINI,
R. SALVADORI.

The Spectrum of Metargon.

THE letter which Messrs. Ramsay, Travers and Baly have addressed you on this subject calls for one or two remarks. The similarity between the carbon and metargon spectra does not only apply to the green band, but to the whole of the visible spectrum, and also, as my previous letter pointed out, to the ultra-violet band commonly ascribed to cyanogen. With the ordinary coil discharge I could see nothing but carbon bands, and it is contrary to all experience that two dissimilar bodies should give complicated spectra so much alike that a two-prism spectroscope can detect no difference between them. With the Leyden jar a strong continuous spectrum appeared, and, overlapping it, some of the lines of argon. The blue argon lines were absent, but my examination was not sufficiently detailed to allow me to say, that the visible lines were those commonly found in the "red spectrum." Neither with nor without the jar did I see any line which could not be assigned either to carbon or to argon, but I should have liked to try a stronger jar and a more powerful coil. With the jar there seemed to me to be signs of decomposition of the gas, as, on removing it again, the carbon lines were weak at first and only gradually returned. The pressure in the tube was rather high; and if the tubes experimented upon by Prof. Ramsay and his coadjutors were all at the same pressure, I should not attach much weight to their observation that the carbon oxide spectrum did not make its appearance after introduction of oxygen, for that spectrum only shows well at lower pressures.

I ask for nothing more than a "suspension of judgment" until a more detailed spectroscopic examination has been made. Only such an examination should include observations at atmospheric pressures, and also at lower pressures than those used so far.

It is also highly desirable to try Leyden jar sparks of much greater intensity than those I saw used at University College. I agree with Prof. Ramsay in so far that the brilliancy and whole appearance of the carbon spectrum does not suggest its being due to an impurity. Taking the spectroscopic evidence by itself, it points in the direction that the gas under examination is a compound of carbon either with argon or with a so far unknown body, and that it may be mixed with a considerable quantity of argon. If that is the case there seems, as far as I know, no *à priori* reason why sparking with oxygen should necessarily remove the carbon. The ratio of specific heats must take care of itself. It is a matter of the greatest interest to pursue the subject; for the origin of the spectrum, whatever it may turn out to be, will probably throw much light on the source of the spectra of comets and of carbon stars.

ARTHUR SCHUSTER.

Liquid Hydrogen.

MR. HAMPSON seems insatiable of contradictions. He has produced a vast quantity of irrelevancies with which I have no concern. But I have denied the accusations he brings against me, and every single statement of his that is relevant. Yet he still complains that I do not deny enough. It is absolutely false to say that I appropriated or profited by any plan, idea, or statement of Mr. Hampson's, either directly or indirectly. I was never informed of his visit, far less of any of the plans he brought to the Royal Institution, nor would anything have induced me to look at them. I have been long enough in this "temple of science" not to know what that might involve. Mr. Hampson got at my assistant behind my back, and persuaded him to look at the plans. I infer from the public correspondence, that he saw that they would not work, and he told Mr. Hampson why they were unworkable.

Even with this assistance it took Mr. Hampson another year to perfect a provisional specification of his invention, which is totally devoid of any plan or drawing of a workable apparatus.

In the meantime Linde had completed his invention, and the Royal Institution went on working on its own lines, just as it did before Mr. Hampson was heard of, and as it would have done had he never been heard of at all.

Like the rest of us, Mr. Hampson was using ideas and principles established by other men, and was trying to apply them and combine them so as to reach a given result. He has no property either in the principles or in the idea of combining them, or in anything except the particular combination to which he himself may give concrete form.

Other men besides myself have successfully combined these principles without any help from Mr. Hampson.

Long before Mr. Hampson's patent was published, I said at the Chemical Society in 1895: "It is a mistake to attribute to Linde the idea of using the cumulative withdrawal of heat for the first time in his apparatus, but he *has succeeded in making a workable industrial machine, and that is a very important step.*"

In the Society of Arts *Journal* I said: "Both Onnes and myself used or economised the temperatures of the expanding gas in order to cool the gas coming forward, but Linde was entitled to *every credit for elaborating a machine in which this was done as perfectly as possible.*"

Further, in the *Chemical Industry Journal* the following passage makes my position clear: "He (Prof. Dewar) was willing to give all credit to Dr. Hampson, Dr. Linde, and any one who effected improvements in these investigations. All he asked was that they should not exaggerate their claims, and seek to block the way to other people who were working in the same direction. Dr. Hampson did not appear to realise that anybody else could be working in the same path and utilising the same ideas. It was quite clear, however, from the facts before them, that that was precisely the state of affairs in the present case."

Such extracts show that I have recognised to the full the merits of the true inventor within the limits of his just claims.

JAMES DEWAR.

Summer and Winter in Relation to the Sunspot Cycle.

THE quality of a winter season may be fairly estimated from the number of days on which the minimum temperature has gone below a given limit; and the quality of a summer season, from the number of days on which the maximum temperature has gone above a given limit. Two tables issued from Greenwich are here convenient for use; one giving frost days (since 1841), the other days on which the temperature reached or exceeded 70°. There are more of the latter than of the former; seventy-seven on an average, as against fifty-five frost days (in September to May).

We may roughly call a winter season *severe* or *mild*, according as it has more or less than the average number of frost days; and a summer season *hot* or *cool*, according as it has more or less than the average number of hot days (in the sense specified).

Confining attention to the groups of five consecutive years having a sunspot maximum, or minimum, year third (or central), I propose to inquire whether there is anything in the winters and summers of these groups pointing to sunspot influence.

(The sunspot maximum years are 1848, 1860, 1870, 1884, 1894; and the minima, 1843, 1856, 1867, 1879, 1890. Winters may, for brevity, be designated by the year in which they *end*; thus, 1842 means 1841-42. In the tables exceptions are marked *e*).

The following statements regarding winter may be verified:—

(1) *In five-year groups having each a sunspot maximum year third (or central), there are generally more mild winters than severe.*

(2) *In five-year groups having each a sunspot minimum year third (or central), there are generally more severe winters than mild.*

The proof is in these tables:—

A.

Max. groups.	Severe.	Mild.
1846-50	2	3
1858-62	2	3
1868-72	3	2*e*
1882-86	1	4
1892-96	2	3
	10	15

B.

Min. groups.	Severe.	Mild.	Av.
1841-45	3	2	
1854-58	5	0	
1865-69	2	2	1
1877-81	3	2	
1888-92	4	1	
	17	7	1

The first table shows one exception to the rule (maximum of 1870). The five years' total, however, it may be stated, is *under*, not *over*, the average.[1] In table B the winter 1840-1 has been included, though the record properly begins with 1841. It was a severe winter. The table has one group with an average winter, so that this group may be considered neutral.

Coming now to the summer season, proof is offered of the following:—

(3) *In five-year groups having each a sunspot maximum year third (or central), there are generally more hot summers than cool.*

The corresponding and opposite statement for minima seems hardly warranted by the present data. The tables are these:—

C.

Max. groups.	Cool.	Hot.
1846-50	2	3
1858-62	2	3
1868-72	1	4
1882-86	3	2*e*
1892-96	2	3
	10	15

D.

Min. groups.	Cool.	Hot.
1841-45	4	1
1854-58	0	5*e*
1865-69	2	3*e*
1877-81	4	1
1888-92	4	1
	14	11

Here we have one exception to our third rule, the group for min. 1884 showing two hot summers and three cool ones. The table D has three cases pointing one way, and two the other.[2]

In view of these facts, I have sought light from a different quarter, taking the mean temperature of the four months May to August, and dealing with the series (from 1841) in the same way. We thus obtain the following tables for summer:—

E.

Max. groups.	Cool.	Hot.
1846-50	1	4
1858-62	2	3
1868-72	2	3
1882-86	4	1*e*
1892-96	2	3
	11	14

F.

Min. groups.	Cool.	Hot.
1841-45	4	1
1854-58	3	2
1865-69	3	2
1877-81	3	2
1888-92	4	1
	17	8

Comparing E and F with C and D, we find general agreement of the two former (E and C), the exceptional group, 1882-86, remaining,[3] while table F gets rid of the exceptions of D. In fact, while the summer seasons 1854, 1855, 1856, and 1867 had more than the average number of hot days, the mean temperature of May to August was, in each year, *under* the average.

[1] It is right to say that this criterion would make the neutral case in B an exception.

[2] In the curve of hot days, there is evidently a long wave of variation, which may complicate matters.

[3] The sunspot maximum of 1884, I may point out, was abnormally low.

We thus seem to be warranted in the fourth proposition.

(4) *In five-year groups having each a sunspot minimum year third (or central), there are generally more cool summers than hot.*

From the present point of view, then, it would appear that in our climate sunspot maxima tend to be associated with a preponderance of mild winters and hot summers; and minima with a preponderance of severe winters and cool summers.

The latter condition of things we should now be near; if we suppose a minimum in 1901, then we might expect at least three of the winters, 1899-1903, to be severe, and three of the summers cool, in the sense indicated.

A further feature may here be noticed. If we arrange the summers and winters in vertical series, according as they are in maximum (or minimum years) one year after maximum, two years after, &c., to the extent of five on either side, there are in these vertical series, I find, only two cases of uniformity throughout, viz. these: (1) *All summers of minimum years have been cool*; (2) *all summers in the fifth year after minima* (and therefore near maxima) *have been hot.* This agrees with the foregoing.

A. B. M.

Rotifers in Lake Bassenthwaite.

IF the occurrence of *Asplanchna* as a conspicuous member of the pelagic fauna of lakes has not hitherto been recorded in Britain, it can only be attributed to the lack of attention in this country to the systematic investigation of our fresh-water fauna. On the continent of Europe and in North America, *Asplanchna priodonta* with its variety *helvetica* and other members of the genus are constantly recorded as among the commonest constituents of the lake plankton. I have on several occasions found *A. priodonta* in lochs near Dundee in swarms similar to that described by Prof. Hickson, and I have no reason to suppose that there is anything exceptional in the phenomenon. Mr. John Hood, of this city, a veteran student of the Rotifera, tells me that its occurrence under these conditions has long been familiar to him. He states that the domestic water supply of Dundee, which always contains a variety of pelagic organisms, was on one occasion rendered quite turbid by swarms of the same species.

It must be remembered that Hudson and Gosse's monograph was written at a time when the tow-net had hardly begun to be employed in fresh-water investigation, and that many of the common pelagic species were either unknown, or, like *Notholca longispina* for example, very little known to the authors.

Prof. Hickson does not state whether any males were present in the gatherings obtained by him. It is probable, as Wesenberg-Lund has recently pointed out (*Zool. Anz.*, March 7, that the appearance of any one species in large numbers is an indication of the approach of the "sexual period," which is always preceded by a period of very rapid parthenogenetic reproduction.

W. T. CALMAN.

University College, Dundee, July 5.

THE STORY OF THE SMITHSONIAN INSTITUTION.[1]

IN this sumptuous volume, produced with all that excellence of type, paper, and illustration, in which so many of the American official publications excel, the story is told of how the Smithsonian Institution was founded, and of the work which it has done in its first half-century.

The Smithsonian Institution, like our own Royal Society, has something of a semi-official connection with the Government. Without being a Government department, or deriving its funds from Government, it is in close correspondence with the ruling powers in respect to scientific matters, advises them upon scientific questions, administers funds voted by Congress for specific scientific purposes, and in general keeps an eye upon the scientific side of many national undertakings.

It is presumably in recognition of this semi-official character of the Institution, that the President of the United States has written a brief but interesting preface to the present volume. In this preface Mr. McKinley recalls how, in 1796, George Washington, in his farewell address to his fellow-countrymen, said "Promote, then, as an object of primary importance, institutions for the general diffusion of knowledge, for in proportion as the structure of a government gives force to public opinion, it is essential that public opinion should be enlightened"; and how, thirty years later, "an Englishman, James Smithson, as though influenced by these words, bequeathed the whole of his property to the United States of America in trust 'to found at Washington an establishment for the increase and diffusion of knowledge among men.'"

James Smithson, the benefactor who is thus commemorated, was born in 1765, and was known in his youth as James Lewis Macie, he being in fact an illegitimate son of Hugh Smithson, afterwards Duke of Northumberland, by Elizabeth Macie, a cousin of the Percys, who, at the time of his birth, was a widow.

This fact of his parentage is important, not only as explaining why James Macie subsequently took the name of Smithson, and so gave its name to the Smithsonian Institution, but as explaining also one strong motive which influenced him in founding that institution; for, all his life, it seems, he smarted under a sense of injustice, and was determined that in some way he would attain to fame, though excluded from hereditary rank. "The best blood of England," he once wrote, "flows in my veins; on my father's side I am a Northumberland, on my mother's side I am related to kings, but this avails me not. My name shall live in the memory of man when the titles of the Northumberlands and the Percys are extinct and forgotten."

Smithson was a student of science, and did some sound scientific work. He was a Fellow of the Royal Society, and contributed twenty-seven papers to the *Philosophical Transactions*, the *Annals of Philosophy*, and the *Philosophical Magazine*—papers which, in the opinion of Dr. S. P. Langley, whose biographical sketch of Smithson fronts this history, "give the idea of an assiduous and faithful experimenter." Nevertheless he did not by this path attain any such eminence as would justify him in hoping for the immortality which he coveted, and there can be little doubt that it was at least in part his consciousness of this fact which led him to follow the remaining path to fame, that of a munificent benefactor to the branch of learning which he loved.

In his later years he was a great sufferer. He lived chiefly in Paris, where he cultivated the friendship of Arago. From Arago's "Eulogy on Ampère" Dr. Langley gives a very interesting extract, which is worth quoting in full, as giving us a vivid glimpse of Smithson's declining years, and a rather touching picture of Arago's friendship with him.

"Some years since in Paris I made the acquaintance of a distinguished foreigner of great wealth, but in wretched health, whose life, save a few hours given to repose, was regularly divided between the most interesting scientific researches and gaming. It was a source of great regret to me that this learned experimentalist should devote the half of so valuable a life to a course so little in harmony with an intellect whose wonderful powers called forth the admiration of the world around him. Unfortunately there occurred fluctuations of loss and gain, momentarily balancing each other, which led him to conclude that the advantages enjoyed by the bank were neither so assured nor considerable as to preclude his winning largely through a run of luck. The analytical formulas of probabilities offering a radical means, the only one perhaps, of dissipating this illusion, I proposed, the number of the games and the stakes being given, to determine in advance, in my study, the amount not merely of the loss of a day, nor that of a week, but of each quarter. The calculation was found

[1] "The Smithsonian Institution, 1846-1896. The History of its First Half-Century." Edited by George Brown Goode. (City of Washington, 1897.)

so regularly to agree with the corresponding diminution of the bank-notes in the foreigner's pocket-book, that a doubt could no longer be entertained."

It may be added, by way of sequel, "that Smithson resolved not to absolutely discontinue play (in which he found the only stimulus which could make him forget his physical suffering), but to do so with a care that the expenditure for this purpose was a definite one, and within his means."

Smithson died in Genoa in 1829, having bequeathed all his property to a nephew, Henry James Hungerford by name, and after him to any child of this nephew, "legitimate or illegitimate"; but in case of the said nephew dying and leaving no child, then all the property was, as mentioned above, to go "to the United States of America, to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men."

Henry Hungerford died unmarried and without heirs in 1835, and Smithson's solicitors forthwith communicated with the United States Embassy in London. Then followed discussions in Senate and House of Representatives. Some senators considered that it would be beneath the dignity of the nation to receive benefits from a foreigner. Other senators considered that it would not. The House of Representatives referred the matter to a select committee, and finally the legacy was accepted, and Richard Rush, a lawyer of high standing, at one time United States Minister at the Court of St. James's, was selected to prosecute the claim in Chancery.

When Mr. Rush arrived in London he found that there were eight hundred cases in Chancery ahead of his, yet he managed to get the suit settled in less than two years, a matter "which gave rise to no little surprise," seeing that "the English lawyers themselves admitted that a Chancery suit was a thing which might begin with a man's life, and its termination be his epitaph." It is pleasant to read that this success "was due in a large degree to the extreme friendliness and consideration manifested by the British law officers, from the Attorney-General down." The suit settled, Mr. Rush took passage home in the packet ship *Mediator* with one hundred and five bags, each containing a thousand sovereigns, except one, "which," reported Mr. Rush, "contained 960 sovereigns and eight shillings and sevenpence *wrapped in paper*"—a particularity which is a little comical in face of the fact that the Treasury accounts show that the odd money which he actually paid in was eight shillings and *sixpence*.

And now, of course, the trouble began. Another eight years must pass before Congress could decide what to do with the money. Like our own Royal Society, the Smithsonian Institution had to go through a period of incubation before it could be hatched. Just as Evelyn, Cowley, Petty, and others proposed sundry schemes for giving body to the "Invisible College," so, numerous "persons versed in science and in matters relating to education" gave their views on the shape which the Smithsonian Institution ought to take. Some advocated the establishment of a university, others a central school of natural science; others, again, an institution for researches in physical science in connection with the useful arts. An experimental farm, a school of astronomy, and a meteorological bureau were other proposals; while ex-President Adams urged the establishment of an astronomical observatory "equal to any in the world," an idea for which he fought with great persistence.

At length, in 1846, the existing Naval Observatory having been organised, Mr. Adams was willing to drop his observatory scheme, which had been standing somewhat in the way of a settlement, and in that year the Act incorporating the Smithsonian Institution was passed by Congress.

To John Quincy Adams, "the Smithsonian" owes much. It was mainly by his influence that the bequest was accepted, and, when accepted, that it was resolved to keep the capital intact and spend only the interest. Next to him, the Institution is indebted for its successful foundation to Joel Poinsett of South Carolina. To Poinsett are due the main features of organisation, the plan for a national museum of science and art, and the inauguration of a system of international exchange of books. Other features are due to other men: the establishment of the library to Rufus Choate, of Massachusetts, and George P. Marsh, of Vermont; the establishment of a staff of resident investigators to Richard Rush, of Pennsylvania; and the organisation of the various branches into one whole to Robert Dale Owen, of Indiana.

For the constitution of the Smithsonian Institution we must refer the reader to the volume before us. There he will find it set forth with fulness, and supplemented with a biographical notice of every member of the Board of Regents down to the present time, and with an interesting chapter on the three successive Secretaries, Prof. Joseph Henry, Prof. Spencer Fullerton Baird, and finally Prof. Samuel Pierpoint Langley, who happily is still spared to the scientific world, and at the age of sixty-four shows no abatement in scientific ardour. That the constitution of the Institution was judiciously conceived is sufficiently shown in the brief paragraph with which the late Dr. Goode closes his chapter on "The Board of Regents": "Notwithstanding the fears so generally entertained fifty years ago, the Institution has never, in any respect, fallen under the influence of political interference. No member of its staff has ever been appointed because of the influence of powerful friends or for any reason except that he was believed to be the best man available for the place. No sinecures have been created, and no breath of suspicion has ever tarnished the reputation of any officer or employee."

And now, at the end of its first half-century, what is the scope of this great Institution, and what is the work which it carries on? "To increase and to diffuse knowledge among men," were the aims of the founder, and to these two aims—the *increase*, and the *diffusion* of knowledge—the Institution strictly addresses itself. The Library, the Publications, the Museum, the Bureau of Exchanges, the Bureau of Ethnology, the Astrophysical Observatory, the Zoological Park, and the exploration work of the Institution are some of the main branches of its system bearing upon one or other of these aims.

In most of these branches the Institution is in close alliance with the United States Government. Its library, for instance, is actually beneath the same roof as the library of Congress, and, though kept distinct, forms for practical purposes one library. It is said that the Institution reaps great advantage by this arrangement, inasmuch as it thus has access to a much larger number of volumes, while effecting a considerable saving in its funds. Indeed, it is a question whether a similar amalgamation might not usefully be made between some of our English libraries. Whatever advantages there may be in each scientific society in Burlington House, for instance, having its own library—and some advantages no doubt there are—it is obvious that a certain waste of funds and force results from the Royal, the Geological, the Chemical, the Linnean, and the Royal Astronomical Societies, all situated in the same quadrangle, being possessed of separate libraries, separate staffs of assistants, separate catalogues, and quintuplet sets of many expensive serials and books.

As with the library, so with the museum; the Government and the Institution are mutually benefited by a close alliance. The nucleus of the museum was Smithson's own cabinet of minerals, consisting of some eight or ten thousand specimens. To this were added, in 1858, the collections formed by various exploring expeditions carried out by the United States Government, which till then had been kept in the Patent Office; and in 1861, the collections accumulated by the unfortunate National Institute—a body which was swamped by its own exertions, for its income did not suffice for it to cope with the flood of materials which poured in from all parts of the world in response to its appeals. To this amalgamation of collections was given the name of the United States National Museum, the whole being placed under the care of the Smithsonian Institution, which pursues the enlightened policy of freely distributing duplicate type specimens to scientific institutions, of presenting sets of general duplicates to colleges for educational purposes, and even of lending original undescribed specimens to experienced men of science.

The Bureau of American Ethnology is also a national undertaking, placed under the direction of the Smithsonian Institution. Its germ was an exploration of the cañons of the Colorado, begun in 1867 by Major Powell, which presently grew into a survey, first geographical, then geological, and finally anthropological. In 1871 Congress made an appropriation to be expended under the direction of the Smithsonian Institution for continuing the explorations and surveys, and the organisation became "The United States Geographical and Geological Survey of the Rocky Mountain Region." In 1874 the survey was transferred to the Department of the Interior, and anthropological researches were made more prominent. In 1879 there were four bureaus engaged in surveys in the Western Territories, and these were reorganised in the present Bureau of Ethnology, under the direction of the Smithsonian Institution. Appropriations are annually voted by Congress to enable the Bureau to continue its researches, and publish its results. Its publications, however, are limited to the thoroughly digested scientific conclusions, and only represent a fragment of the enormous amount of work accomplished. What that work amounts to in bulk may be better conceived from the statement that the fireproof vaults of the "Smithsonian" contain MSS. under more than 2000 titles, besides the material for a "Cyclopædia of Indian Tribes" upon 100,000 cards.

Like the Bureau of Ethnology, the National Zoological Park is primarily American. It was commenced, that is, mainly with a view to preserving animals, and especially native animals, which were likely to become extinct. It has not, however, been so generously treated by the nation as some other departments of the Smithsonian work, and, like many things American, the American Zoo fluctuates with American politics. It began well. Dr. Langley had his dream, and a very noble dream it was; namely, to establish a park in which the wild animals might live "as nearly as possible in the conditions natural to them, so that they might breed and thrive in captivity as in their native haunts." An almost perfect spot was found for this purpose in Rock Creek, with flowing water, varied aspects, and differing soils; sunny slopes, cool hillsides, level meadows and rocky cliffs. It was purchased in 1889, and in the following year an Act was passed placing the park under the direction of the Regents of the Smithsonian Institution. The 185 living animals which the Institution already possessed, and which had hitherto been kept huddled together in low sheds and small paddocks, were transferred to the park. All was going well, when, in 1891, "the mutations of politics caused a change in the dominant political party"—then, estimates were reduced, authority to purchase animals was withdrawn, and even the question of abolishing the park was considered. Notwithstanding these difficulties, many successes have been attained, and Secretary Langley lives in hopes of more adequate Government support.

The same "knack of hoping" has to be exercised by Dr. Langley in respect to the Astrophysical Observatory. Unlike the above-mentioned departments, the Smithsonian Observatory has received no aid from Congress. This observatory, in which Dr. Langley has carried on his excellent work under the greatest difficulties, he himself describes as "a one-story building, or rather shed," erected on a site "surrounded by streets and traffic." It was erected in 1890 in the grounds of the Institution, and the expense of its erection and equipment was principally defrayed by a donation of 5000 dollars from Dr. Graham Bell, and a legacy of the same amount left by Dr. Kidder. It is to be hoped that Dr. Langley's ardent desire for a suitable permanent building on a suitable site may soon meet with a response from the nation.

The exploration work of the Institution has been very notable. Nearly every Western expedition, whether Government or private, of any magnitude, has received aid from the Smithsonian Institution. That the Government Surveys in particular, undertaken as they were for definite, practical purposes, should have the scientific eye following them, and usually a scientific corps attached to them, has been of incalculable advantage for the increase of knowledge. First came the surveys for railways and waggon-roads across the public lands of the West. Then the geological surveys of the same region. Then the explorations of the sea coast, rivers, and lakes of the States by the Fish Commission; and investigations of the North American Indians by the Bureau of Ethnology. With all these Government activities the Institution has been, either directly or indirectly, connected. In fine, to quote the words of Mr. F. W. True, who here gives their history, "the Smithsonian Institution has contributed to the work of exploring the domain of nature not only directly by setting on foot expeditions supported from its own funds, and indirectly by aiding and equipping numerous Government and private expeditions, but more remotely as well by influencing independent workers to explore in many lands, and to add new treasures to the national collections."

It is needless in a scientific journal to speak of the importance of the publication work done by the Institution. The "Smithsonian Contributions to Knowledge," and the "Smithsonian Miscellaneous Collections" are too well known to need any detailed notice. A thousand copies are distributed every year to the leading scientific libraries throughout the world. Neither is it necessary to speak in detail of the liberal policy of the "Smithsonian" in its system of international exchanges, a liberality which was furthered by the American Government and met in a like spirit by the British Government, scientific books sent as presents being exempt from duty in both countries. This exchange system, in which until 1862 the Royal Society of London took part as the forwarding agents for Great Britain, has been of immense practical service to the scientific world. Finally, the reader must be referred to the volume under review for the "Appreciations" of the scientific work accomplished by the Smithsonian Institution with which it closes. The appreciations are interesting, but could scarcely be epitomised within the space of a brief article like the present. They are mostly written by well-known scientific men in the United States: "Physics," by President Mendenhall; "Mathematics," by Prof. R. S. Woodward; "Astronomy," by Mr. Holden, Director of the Lick Observatory; "Chemistry" and "Meteorology," by Marcus Benjamin; "Geology" and "Mineralogy," by Prof. Rice; "Palæontology," by Prof. Cope, of the University of Pennsylvania; and so on through the fifteen chapters into which the "Appreciations" are divided.

Prof. Henry, the first of its three famous Secretaries, often used to say "that co-operation, not monopoly, is the watchword of the Smithsonian Institution. Its policy has always been to devote itself to such useful fields of labour as no other institution could be found ready to take up." That policy has been steadily pursued throughout this, its first, half-century of existence, and by the perusal of this volume most readers will be convinced that it has been justified by the results. H. R.

SPIDER AND PITCHER-PLANT.

IN the insectivorous plants of the genus *Nepenthes*, a form represented by a number of species and widely distributed over the Indian and Australian regions, as well as in Madagascar, the pitchers or insect-traps, which are usually regarded as expansions of the leaf-stalk, are suspended, mouth upwards, at the ends of long tendrils proceeding from the tips of the leaves. The gaping orifice, frequently strengthened and kept open by a thickening of the rim, is protected by a lid, which, while preventing the infall of rain, offers no obstruction to the free entrance of insects. To attract the attention of these animals the pitchers are frequently conspicuously coloured in their upper parts, and honey is secreted from glands scattered around the margin of the aperture and on the under-face of the lid. This gaudy and sweetened portion, designed as it is to catch the eye and act as a bait, constitutes the "attractive" area. A short distance within the cavity and below the attractive area just described, the walls of the pitcher are smooth and of a waxy consistency, so that no foothold is afforded to insects, which are consequently precipitated to the bottom of the pitfall if luckless or incautious enough to venture on this "conductive" area. The lower part of the receptacle is filled to a greater or less extent with a fluid containing, amongst other substances, potassium chloride, malic and citric acids, as well as soda lime and magnesia in smaller quantities and an enzyme, which in the presence of the acids has the power of digesting organic matter (S. H. Vines; quoted by "A. W. B.," NATURE, vol. lvii. pp. 367–368, 1898). This fluid, poured out as a secretion from a large number of glands developed in the adjacent walls of the pitcher, is usually crowded with the indigestible remains of insects, commingled with those of which the nutritious tissues are in process of decomposition under the action of the alimentary juice of the plants and of the bacteria which infest it.

The spiders of the family Thomisidæ belong to that artificial section of the order sometimes spoken of comprehensively as the wandering or hunting species as opposed to those of sedentary habit, which spin snares for the capture of prey. Some of the Thomisidæ live on the ground amongst vegetable débris or beneath stones; others on the trunks or leaves of trees; others, again—and these are the species that have attracted the greatest amount of attention—frequent flowers, and lurk amongst the petals on the watch for visiting insects. To this last category belongs the spider (*Misumena nepenthicola*) now under discussion, a species which invariably takes up its abode in the pitcher of a North Bornean (Labuan) *Nepenthes*, perhaps referable to the species described as *N. phyllamphora*.[1] In any case, whatever the name of the plant may be, the *Misumena* appears to inhabit exclusively the one species; for although several other kinds were found growing in the vicinity, they were never observed to be tenanted by spiders.

According to that skilled collector and trustworthy observer, Mr. A. Everett, who kindly furnished me with the notes forming the basis of the account here given, the pitchers in question are somewhat elongate in shape, and constricted a short distance below the rim, broadening out again as the bottom is approached, and narrowing ultimately to a vanishing point where they join the supporting stalk. Just below the upper constriction the spider spins a slight web, adherent to the wall of the pitcher. This web is not of the nature of a snare or net designed to intercept insects, but extends as a thin carpet over a small portion of the conductive area, and enables the spider to maintain a secure hold on its slippery surface. Here it lives and rears its young, no doubt feeding upon the insects which the *Nepenthes* attracts for its own use, capturing them either as they enter the pitcher, or perhaps after they have fallen into the digestive fluid below.

So far as procuring food is concerned, this spider would seem to be no better off than those of its allies which live in flowers and capture the honey-seeking insects that visit them, except in so far as it is not dependent upon seasonal inflorescence for a place wherein to lurk. But in one very important respect it must presumably score heavily in the struggle for existence—that is to say, in its means of escaping from enemies.

It is a well-known fact that almost all spiders, especially those that occur in tropical and subtropical countries, suffer immense mortality from the relentless persecution of the solitary mason wasps, which at their breeding season scour the country and explore every nook and cranny in the eager search for spiders wherewith to lay up a sufficient store of food for the voracious young wasps during the days of their larval existence. From these enemies the flower-frequenting species have no means of escape, except such as is afforded by quiescence in conjunction with the protective nature of their colours, attitudes and form. The slightest movement on their part will attract the notice of the quick-sighted wasp, and bring swift destruction upon them.

Whether or not the mason wasps have the temerity to invade the pitchers of *Nepenthes* in their quest for victims, there is no evidence to show. Possibly long-billed birds thrust their beaks into the insect-trap to extract any living things or organic débris they may contain. At any rate, the account given by Mr. Everett of the behaviour of this spider when threatened with danger, points forcibly to the conclusion that the species is subject to persecution from enemies of some kind or other. This collector found that when an attempt was made to capture them by tearing open the pitcher, the spiders, although very active, never attempted to escape from the mouth of the vessel, but ran down its inner surface, and plunged boldly into the liquid at the bottom, ultimately, if still pursued, retreating to its very base, and burying themselves amongst the remains of ants, moths, beetles, &c., with which the pitcher was more or less choked.

Although many spiders of semi-aquatic habits, such as *Dolomedes*, *Thalassius*, and some species of *Lycosidæ* plunge beneath the surface of water when threatened with danger, and escape along the stems of the subaqueous weeds; and although an example of *Araneus* (*Epeira*) *cornutus*, a terrestrial species which, however, frequents the banks of streams and marshy country, has been noticed, when disturbed, to drop to the ground, run into the water, hide beneath a tuft of weed,[1] and there remain for a minute or so before venturing to climb back to its web, I am not aware that the adoption of water as a city of refuge has ever been recorded of any member of the family Thomisidæ. These spiders, in fact, as already explained, depend for safety upon protective assimilation to their surroundings. Consequently the habit of plunging into the fluid in the pitcher of *Nepenthes*, adopted by *Misumena nepenthicola*, must be regarded, it appears, as a new instinct acquired by the species in connection with the exceptional nature of its habitat; and its behaviour carries with it the conviction that the species is constantly subject to persecution from some enemy other than man, whether it be bird or wasp.

Possibly the spiders, when once they have taken up

[1] I am indebted to my colleague, Mr. A. B. Rendle, for kindly examining the two fragments of the pitcher sent home with the spiders. Unfortunately the pieces are too small to make the identification of the species other than doubtful.

[1] Prof. Lloyd Morgan, NATURE, vol. xlvii. p. 102, 1893.

their abode in the pitcher are, like the insects that venture in, unable to get out again on account of the opposition to exit offered by the slipperiness of the walls of the conductive area. If this be so, they would be compelled, in case of attack, to seek safety in the lower parts of the pitcher; and while those too timid to take the plunge, or too weak to withstand the immersion, would be captured or destroyed, their instinctively bolder or physically hardier companions would be saved to transmit their characteristics; and so by a process of elimination and selection the instinct would be gradually brought to the state of perfection Mr. Everett has described.

Lastly, if it be wondered by what means the spider is able to resist the action of the fluid, and to regain its position of security in the upper part of the pitcher, it must be remembered, in the first place, that a great many spiders, as well as many insects, can be immersed in water and other liquids, and withdrawn in a perfectly dry state; and in the second place, that almost all spiders when dropping from their webs or leaping after prey, ensure a safe return to the spot they have left by letting out a drag-line of silk, which passes from the spinning mammillæ to the point of departure. A silken thread of this description would enable *M. nepenthicola* to climb out of the digestive fluid which retains the captured insects; while the nature of the integument and of its hairy clothing would prevent the penetration of the fluid during the short time that the spider remains beneath it.

R. I. POCOCK.

FERDINAND COHN.

ON June 25 last the career of one of the great botanists of the latter half of this century was brought to a close. During the span of a long life of seventy years Ferdinand Cohn has devoted his best energies to the advancement of botany, and the list of his papers in the "Royal Society Catalogue of Scientific Papers" bears witness to an unwearied devotion to his life work.

In his earlier years Cohn was amongst the foremost of those who were engaged on investigations into plant life and animal cells, and to the last it was the lowlier members of the vegetable kingdom that attracted his chief attention. But it was ever the striving after a deeper insight into the nature of the living organism that stands out as the keynote of his numerous researches, and the grasp which he possessed of the current problems is seen in one of his earlier papers on *Protococcus pluvialis*. In this memoir he brought forward cogent arguments in support of his view that the Protoplasm, recognised a few years before by Von Mohl as the essential living substance of plants, was identical with Sarcode, first described for animals by Dujardin; and Cohn's arguments were the more worthy of attention inasmuch as he was already familiar with, and was writing about, Infusoria. It is singular that Cohn's claims to have first established this great generalisation should have been so obscured by the work of Brücke and Max Schultze, since the memoirs of these investigators were published several years after Cohn's paper which appeared in 1850, and was shortly afterwards translated into English under the auspices of the Ray Society.

In those early years, from 1847 and onwards, new contributions to science flowed rapidly from the pen of the hard-working man. His papers on *Pilobolus*, *Empusa*, *Sphæroplea* and on *Volvox* are well known. Some of them were at once recognised as of prime importance, and were translated into English and French.

But Cohn's interest was by no means restricted to these channels, for several of his early works deal more especially with physiological problems. The injuries caused by lightning and the problems of disease also engaged his attention, and it was perhaps chiefly in connection with the latter class of questions that his later investigations were pursued. The importance of his work on Bacteria was long ago recognised, and the attitude which, in opposition to Nägeli, he maintained towards the pleomorphism of these organisms has turned out to be substantially the correct one. Naturally, however, it was not to be expected that genera distinguished at this (relatively) early period would prove to be natural ones, but the existence of independent species, also recognised by De Bary, is now everywhere admitted.

In addition to his work as a teacher and an investigator, Cohn's "Beitrage zur Wissenschaftliche Botanik" will always serve to keep his memory green in the minds of botanists. These volumes contain a large number of important papers, many of which were the direct outcome of his personal influence.

The "Kryptogamen-flora von Schlesien" also testifies to his editorial energy, and he was himself one of the most active members of the Schlesische Gesellschaft zu Breslau, and many of his papers are to be found in the records of this Society, to which also in his later years he contributed many valuable and suggestive reviews of current work; and these will always prove of permanent value to the historian of this period.

Cohn was a foreign member of the Royal and Linnean Societies of London, and the gold medal of the latter Society was awarded to him in 1895. Few men have more justly earned the respect of their fellows than he, and all might well profit by the example of his industrious career. He is gone, but his work remains as a lasting monument to his fame:—

"Sicut fortis equus, spatio qui saepe supremo
Vicit Olympia, nunc senio confectu' quiescit."

J. B. FARMER.

NOTES.

THE French Association for the Advancement of Science will this year hold its meeting at Nantes, from August 4 to 11.

THE annual general meeting of the Victoria Institute was held on Monday afternoon last, when Sir George Stokes delivered his presidential address. The subject of the address was "The Perception of Colour."

THE Council of the British Medical Association resolved at its last meeting to found as a memorial of the late Mr. Ernest Hart a scholarship to be called "The Ernest Hart Memorial Scholarship for Preventive Medicine." It was felt that no more fitting means could be found to commemorate at once Mr. Hart's great services to the British Medical Association and to the advancement of the study of preventive medicine. The scholarship, which will be of the annual value of 200*l.*, will be tenable for two years.

AT the recent Council meeting of the Iron and Steel Institute, Prof. Roberts-Austen, C.B., F.R.S., was elected to succeed Mr. Martin Dowlais as president of the Institute.

SIR MARTIN CONWAY has started for Bolivia. It is his intention to explore the high group of the Andes containing the peaks Illimani and Illampu (or Sorate). He is accompanied by the Alpine guides Antoine Maquignaz and Louis Pellissier, who made the first ascent of Mount St. Elias in Alaska last year with the Duke of Abruzzi.

PROF. MAX WEBER, the well-known zoologist of the University of Amsterdam, will leave Europe in October next, for Sourabaya, Java, to take command of a scientific expedition, projected by the Society for the Biological Investigation of the Netherlands Colonies, for the zoological, botanical and oceanographical exploration of the seas of the Indian Archipelago. The course of the expedition, which will last about a year, is divided into two sections. The first, starting from Sourabaya, will pass through the Timor and Tenimber groups of islands to the Aroos and Ké Islands and thence to Banda or Amboina, a total distance by the route selected of about 2500 English miles. The second section, starting from Banda or Amboina, will pass between Halmaheira and Celebes through the chain of islands leading up to the Philippines, and then return to Java by the channel between Celebes and Borneo, making a traject of some 3000 miles. Looking to the advantages derived from Prof. Weber's previous experience in exploration of this nature and his well-known devotion to the subject, there can be little doubt that this expedition will result in large additions to our knowledge of the fauna, flora, and physical structure of the East Indian Archipelago.

MR. A. P. LOW, of the Geological Survey of Canada, has gone to Labrador for the purpose of studying the geological formations, and to make a map of the region. He expects to be absent for eighteen months.

THE second Huxley Lecture on "Recent Advances in Science, and their bearing on Medicine and Surgery" will be delivered at the Charing Cross Hospital Medical School on Monday, October 3, by Prof. Virchow of Berlin. It will be remembered that the first Huxley lecturer was Prof. Michael Foster, F.R.S., and that his discourse was printed in these columns. Prof. Virchow's lecture will, it is stated, be delivered in English.

THE summer session of the Institution of Mechanical Engineers will take place at Derby, commencing on Tuesday, July 26. The following papers have been offered for reading and discussion, not necessarily in the order here given :—Manufacture of aluminium articles, with description of the rolling mills and foundry at Milton, Staffordshire, by Mr. Emanuel Ristori; water softening and purification by the Archbutt-Deeley process, by Mr. Leonard Archbutt; mechanical testing of materials at the locomotive works of the Midland Railway, Derby, by Mr. W. Gadsby Peet; electric current for lighting and power on the Midland Railway, and driving direct by electric motor without shafting, by Mr. W. E. Langdon; narrow-gauge railways, 2 feet and under, by Mr. Leslie S. Robertson; results of recent practical experience with express locomotive engines, by Mr. Walter M. Smith.

THE summer meeting of the Institution of Junior Engineers will be held at Liverpool, from August 8 to 13. The president-elect of the Institution is Sir W. H. White, K.C.B., F.R.S.

THE summer assembly of the National Home-Reading Union will be held at Exeter during the last week of the present month. The inaugural address will be delivered by Sir George W. Kekewich, K.C.B., Secretary of the Education Department, who will take as his subject "The National Home-Reading Union in its Relation to Elementary Education," and short courses of lectures upon the architecture, botany, and geology of the district will be given by Mr. Francis Bond, Prof. Baldwin Brown, Mr. A. W. Clayden and Prof. Weiss. Copies of the full programme may be obtained from the office of the Union, Surrey House, Victoria Embankment.

Science announces that the Academy of Natural Sciences of Philadelphia has received from Miss Anna T. Jeanes a gift of 20,000 dollars to be invested and known as the Mary Jeanes Museum Fund, the income to be used for general museum purposes.

THE Hayden Memorial Geological Award for 1898, consisting of a bronze medal and the interest of the endowment fund, has been conferred upon Prof. Otto Martin Torell, the director of the Geological Survey of Sweden, by the Academy of Natural Sciences of Philadelphia.

THE Belgian Government, setting an example to those of larger and wealthier nations, has offered a premium of 50,000 francs to the inventor of a paste for match-heads free from yellow phosphorus, and capable of igniting upon any dry surface. The conditions under which the competition will take place have been determined by the Ministry, who have agreed that it shall be international, and remain open until January 1, 1899.

AS will be seen by a reference to our advertisement columns, a prize of 500 guineas is offered by the Sulphate of Ammonia Committee for the best essay on the subject of "The Utility of Sulphate of Ammonia in Agriculture," treated from a practical and scientific point of view. All essays sent in must be written in the English language, on one side of the paper only, and bear a distinguishing motto or *nom de plume*, and reach the Chairman of the Committee not later than November 15 of the present year.

PROF. O. C. MARSH has transmitted from New Haven to the Director of the United States Geological Survey the fourth large instalment of vertebrate fossils secured in the West in 1882-92, under his direction, as palæontologist of the United States Geological Survey in charge of vertebrate palæontology. The collection, which is packed in one hundred boxes and weighs over thirteen tons, will, in accordance with law, be deposited in the National Museum. The collection includes twelve skulls and other remains of the gigantic *Ceratopsia* from the Cretaceous; various *Dinocerata* fossils from the Eocene; a series of rare specimens of *Brontotherium*, *Elotherium*, *Miohippus* and other genera from the Miocene; a very extensive collection of rhinoceros and other mammals from the Pliocene, as well as various interesting fossils from more recent deposits. Other collections at present at New Haven will be sent to Washington as soon as their scientific investigation, now in progress, has been completed.

A CIRCULAR letter on the subject of railway passenger communication has been issued by the Board of Trade to the general managers of the different railway companies, calling attention to the recently issued report of the Departmental Committee, which unhesitatingly condemns as inefficient the outside cord system of communication, and does not regard as satisfactory existing methods of communication by pulling a cord or wire passing inside the carriages. The views expressed by the Committee as to the inefficiency of the outside cord communication are fully shared by the Board of Trade, who have for years refused to approve it. It is recommended that the law should be extended so as to require the provision of means of communication on all passenger trains, irrespective of the distance run without a stop. The letter states that the Board attach great importance to the conclusions of the Committee, and that they hope the companies by whom the cord system is still used will at once take steps to substitute for it a proper means of communication, and that the companies will, as a whole, extend the provision of such a means to all passenger trains without waiting for an alteration of the law. It is to be sincerely hoped that the railway companies, to whom the suggestions contained in the letter apply, will set to work to remedy what has been, and still is, a crying evil on many lines of railway.

SOME time ago the Public Control Committee of the London County Council received from the Departmental Committee of the Home Office, which is at present considering the questions of the manufacture and supply of water gas, an inquiry as to the opinion on the subject of the Public Control Committee. This opinion has now been communicated, and is as follows: (1) That considerable danger arises from the introduction of water gas in the process of the enrichment of coal gas; (2) that non-carburetted and non-odorised water gas should not be allowed to be used under any conditions, since it is devoid of smell which would give warning of any escape of the gas; (3) that 25 per cent. should be the *maximum* amount of water gas allowed to be introduced in the enrichment of coal gas, the proportion of water gas being ascertained by determining the amount of carbonic oxide in the rich coal gas (coal gas enriched to this extent would correspond in poisonous character to the Dowson gas, which is already in use for heating purposes and for gas engines, and would exclude the use of carburetted water gas); (4) that when it is proposed to supply poisonous enriched gas to houses and the interior of buildings, a proper inspection be made of the service pipes by a responsible officer appointed by the local or other suitable authority, who should certify that the pipes are in a sound condition and that there is no escape of gas, and that the cost of such inspection be borne by the gas company.

WHAT will be, we should imagine, a boon to electrical engineers has been brought about by the Patent Office having undertaken to supply the Institution of Electrical Engineers every Monday morning with a copy of each electrical patent specification published during the preceding week. The specifications will remain on the table of the Institution for three weeks, and will then be filed.

THE banquet given to the ladies by the Leathersellers' Company at their Hall on the 13th inst. was a very brilliant affair. The life-size portrait of the ex-Master, Dr. Perkin, F.R.S., painted by Mr. Henry Grant, and placed on an easel for close inspection, which it bore well, was an interesting feature of the evening. The Master, Colonel Bevington, "thought all would agree with him that the artist had succeeded in painting a perfect likeness of the learned doctor, and as good a picture as any they already possessed." It represents Dr. Perkin giving an address to the Society of Arts.

AFTER distributing the prizes to the successful students of the Guy's Hospital Medical School on Wednesday, July 13, Mr. Arthur Balfour delivered an interesting address on the subject of the medical profession and its work. In the course of his remarks he said there was a period at which almost the only subsidiary sciences to the art of healing, the only ones of practical value, were anatomy and physiology. But all that has been changed, and at the present moment, if a man is to make progress in medical research, he must draw his inspiration not merely from those sciences which deal with the human organism immediately, but from chemistry and almost every branch—he thought he might say every branch—of physics. But while that tendency has on the one side been making itself manifest, while the interdependence of all these sciences is becoming more and more manifest, while the assistance which each can and must give to the other is becoming more and more evident, the separate sciences themselves are so rapidly accumulating facts, are growing so enormously that specialisation is necessarily and inevitably set up in every one of them, so that you have the double tendency of an interdependence between the sciences which makes it necessary for every man who would further any one of them to have some working acquaintance with many others, but at the same time you have specialisation forced upon you by the accumulation—the rapidly increasing accumulation—of facts in every one of the sciences of which he had spoken. The result of this double tendency is that you must rely more and more for your work and research upon people whose main labour is research. You cannot expect a man in the interstices of a busy life, in the interstices of a great practice, to do much towards the advancement of his science. . . . The man who would succeed in research, the man who, at all events, desires to devote himself to research, must not be asked to burden himself with other labours. He has upon his shoulders not merely what might be called the specialised work of his profession, but he must have a sympathetic and appreciative eye to everything which is going on in other departments of science, so that even where he cannot follow those other departments minutely, he knows by the instinct of genius where to pick up those new discoveries which may help his own special branch of research. For men of that kind we required further endowment. The speaker had all his life been an ardent believer in the cause which is often laughed at—the cause of the endowment of research. In that cause he most firmly believed, and he thought there was no branch of knowledge in which it may find a more useful field of application than in that of advancing medical knowledge. . . . The work of the medical practitioner is seen at once; its value can be immediately appreciated; but he who spends his life in pursuit of the secrets of nature, working in his laboratory, may very often receive no public recognition at all during his life, except from that restricted circle of experts who alone are, after all, capable of forming any valuable estimate as to his merits.

THE young male giraffe, lately received in the Zoological Society's Gardens, is of special interest as representing the Northern form of this animal in contrast to the Southern female which arrived in February 1895, but the differences between them will be much more apparent when both the specimens are adult. Although the fact of the Northern giraffe being different from the Southern form has been suggested by various authors, and several names have been given to each of them, the subject was first placed on a sound basis by Mr. W. E. de Winton in his paper "On the Existing Forms of Giraffe," read before the Zoological Society in February 1897. It was there shown most conclusively that the Northern form, to which Mr. de Winton proposes to restrict the name *Giraffa camelopardalis*, is distinguished from the Southern form by several characters, especially by the great prominence of the third frontal horn, which is barely shown in the Southern form (*Giraffa capensis*). The young giraffe from Senegal, just arrived, belongs to the Northern form, which would appear to extend all across the Sahara into North-eastern Africa. The Cape giraffe seems to be met with in suitable localities all up the east coast into British East Africa, where it is stated that both the forms occur.

REFERENCE has often been made in these columns to the importance of attention to forestry, and we are glad to notice that the Royal Scottish Arboricultural Society has published a memorandum, prepared by the Society for the consideration of the Minister of Agriculture, dealing with the subject of a Scottish model State forest. Commenting upon the memorandum, the *North British Agriculturist* says: "We require a model forest, first of all, that we may be in a position to offer to proprietors, their wood managers and foresters, a practical proof that the principles of modern economic forestry, as taught and practised in France, Germany, India, and other countries, are equally suited to our islands. The model forest is also required as a station of experiment and research into matters connected with the development and characteristics of the various species when grown in this country, such as would indicate the correct sylvicultural treatment to be applied to them, and would enable our teachers of sylviculture to base their instructions on data obtained in this country, instead of relying on figures the result of observations conducted elsewhere. Again, we want a model forest as a field of practical instruction for students. Dr. Schlich writes: 'Something more is wanted than theoretical instruction. Instruction in the field must also be provided. There must be forests which are managed on the right lines, where students find the theory of economic forestry practically illustrated.' At the present time, Edinburgh is the only place in Scotland where lectures on forestry are given; and there does not appear to be any immediate necessity for the establishment of lectureships at other centres. It is the best policy to concentrate our efforts in one place, and to leave nothing undone to improve the facilities for teaching here, rather than to dissipate our strength in attempts to sustain the machinery of instruction in several places. . . . In view of the fact that students, while attending the forestry classes in Edinburgh, are either following other courses of study at the same time, or are employed in the city, it is essential that a model forest for their practical instruction should be provided within such a distance of Edinburgh that they may be able to visit it and return on the same day, as is now done by the students who visit woods in the Lothians, Fife, and other places."

A PRELIMINARY account of the fifth international balloon ascents of June 8 last is given in *Ciel et Terre* of the 1st inst. On the whole, the undertaking met with considerable success, and the results show that an immense field is open for the meteorological and physical investigation of the upper atmosphere. The operations extended from the longitude of Paris to that of St. Petersburg, and from the latitude of the latter place to that of Rome. The three Austrian balloons travelled in the direction of Hungary, and in the *Austria*, Lieut. Hinteroiser reached the height of 4500 metres, and registered a temperature of 17°·6 F. An unmanned balloon, which left Paris in the morning, descended in Westphalia in the afternoon, having reached a height of about 16,000 metres, and recorded a temperature of minus 83° F. Of three unmanned balloons sent up by M. Teisserenc de Bort, from his observatory at Trappes, near Versailles, one travelled 160 kilometres, and registered a temperature of minus 76° at an altitude of 12,500 metres. A similar balloon from Strassburg recorded minus 58° at a height of eleven kilometres. The highest level reached by the mounted balloons was that manned by M. Berson, which left Berlin at about 2h. 30m. a.m. It travelled 160 kilometres, and reached a height of 5500 metres, but only registered a temperature of 10°·4, while another balloon, manned by Lieut. Siegsfeld, registered 17°·6 at 4500 metres. A large unmanned balloon from Paris carried for the first time one of Violle's actinometers. This instrument worked perfectly, and has furnished some interesting results, which do not, however, agree entirely with theoretical ideas. Regret is expressed that this country has as yet taken no part in the exploration.

A REPORT has been received at the Foreign Office from the acting British Consul-General at Hamburg, stating that a Bill will probably be submitted to the German Government for the construction of an inland canal passing through the provinces of the Rhine, Westphalia, Hanover, and Bevergern Elbe, to be known as the "Dortmund Rhine" Canal. The estimated cost of the canal is 6,400,000*l*.

THE Committee of the Society for the Protection of Birds has issued a circular letter urging landowners, shooting tenants and farmers to use their authority with their keepers and others to prevent the free destruction of birds on their land, and to give instructions as to what birds only may be destroyed, which, in the words of the circular, "should properly be only those birds that, from their abundance in any particular district, may do real harm."

THE geological history of the recent flora of Britain was discussed by Mr. Clement Reid in the *Annals of Botany* for August 1888; the author has now contributed further observations on this subject to the same journal for June of this year. During the past ten years much new information has been gathered, and this is summarised in a table showing the geological range of the various species of British plants which have been found in a fossil state; the chronological divisions adopted being Preglacial, Early Glacial, Interglacial, Late Glacial, and Neolithic. About one-seventh of our flowering plants are thus recorded. The orders best represented are mainly those which possess hard fruits or seeds specially adapted for dispersal, and those with deciduous leaves. Mr. Reid remarks that it is doubtful whether a single one of our flowering plants is, strictly speaking, a native of Britain. The whole flora has originated probably in other and various parts of the world. We find now merely the species stranded by successive waves of migration, which have brought together a variety of continental forms, some Arctic, some Southern, a few even American. These migrations were, in his opinion, mainly compelled by climatic changes, though other agencies have played an important part. He thinks it probable that a far larger proportion of our plants was introduced by human agency than is generally believed to have been the case.

IN all text-books, and on the latest maps of Siberia, the coasts of the Arctic Ocean are represented as a flat *tundra* soaked with water. Dr. K. Hikish points out, in an orographical sketch of North Siberia (*Memoirs* of the Russian Geographical Society, vol. xxi. "General Geography"), that this is quite incorrect. Only the Ob region is a real low depression, which attains the Arctic Ocean and ends in low flat shores. In the east of the Yenisei there are no low depressions in Siberia, with the exception of a small one at the mouth of the Lena. The northern coasts of Siberia, from the Yenisei eastwards to Bering Strait, are high, as was known from the earlier explorers, and has been confirmed lately. There are only deltas at the mouths of the Olenek, the Lena, the Yana, and the Indighirka. In the east of the Kolyma the coasts become even hilly, leaving but a narrow strip of low land along the sea beach. Hilly tracts are met with at a short distance from the shores inland.

AT a recent meeting of the Paris Biological Society, M. Courmont gave an account of some experiments he had made with anti-streptococcic serum. He immunised an ass by inoculating it with a culture of streptococci derived from a case of human erysipelas, and thus obtained a serum which rendered a rabbit perfectly immune against these streptococci. He had also isolated eleven kinds of streptococci from erysipelas or suppurating lesions in human beings, and tried the serum obtained from the ass against these. Of the eleven different streptococci seven only were influenced by the serum. Even then, if an ass be inoculated with two samples of streptococci, it is not possible to obtain a serum efficacious against all kinds of streptococci, for the various kinds of this organism are too different for one anti-streptococcic serum to overcome them all.

THE Colonial Bacteriological Institute, attached to the Cape of Good Hope Department of Agriculture, has issued its report for the year 1896. Though belated in appearance, it is a valuable document as indicating the importance of the work carried out at the Institute. Besides the elaborate experimental investigations which have been conducted on rinderpest, we note various other directions in which the activities of the staff have been engaged. For example, no less than 1039 culture tubes of a locust-destroying fungus have been forwarded to different parts of the country, and the reports received as to the efficacy of this fungus are very encouraging. In order that the best results may be obtained, it is recommended that the Veldt should be inoculated twice a year, as the cold of winter seems to act deleteriously on the fungus. Mallein and tuberculin, for the detection of glanders and consumption, are also now produced at the Institute, and arrangements were being made, when the report before us was drawn up, for the elaboration of anti-venomous serum, as well as an anti-toxin for tetanus. The staff is, the Director points out, lamentably insufficient to carry on even the work at present undertaken by the Institute, and the appeal for more assistance is certainly amply justified by the record of what has been already done by the Department.

IN the part of the *Journal* of the Asiatic Society of Bengal issued on April 14, Mr. Frank Finn, of the Indian Museum, brings to a conclusion his series of four papers entitled "Contributions to the Theory of Warning Colours and Mimicry." The paper in question deals with experiments with various birds, from a consideration of which the author draws the following conclusions: (1) That there is a general appetite for butterflies among insectivorous birds, even though they are rarely seen when wild to attack them. (2) That many, probably most species, dislike, if not intensely, at any rate in comparison with other butterflies, the "warningly-coloured" *Danainæ*, *Acræa violæ*, *Delias eucharis*, and *Papilio aristolochiæ*; of these the last being the most distasteful, and the *Danainæ* the least so. (3) That the mimics of these are at any rate relatively palatable, and that the mimicry is commonly effectual under natural conditions. (4) That each bird has to separately acquire its experience, and well remembers what it has learned. That therefore, on the whole, the theory of Wallace and Bates is supported by the facts detailed in this and the author's former papers, so far as they deal with birds (and with the one mammal used). Prof. Poulton's suggestion that animals may be forced by hunger to eat unpalatable forms is also more than confirmed, as the unpalatable forms were commonly eaten without the stimulus of actual hunger—generally without signs of dislike.

THE most recent number of *Malpighia* (Anno xii. fasc. 3, 4) contains a description by Prof. Mattirolo of the *Nuova sala Aldrovandi* founded in honour of the Italian botanist (1549–1605), in connection with the University of Bologna, and opened in December 1897. It comprises a museum, a library, and a herbarium founded on that of Aldrovandi. The account is accompanied by a portrait and a drawing of the library. In the same number is a portrait and a brief sketch of the botanical work of Zannichelli.

THE geology of the Bacau Carpathians forms the subject of an essay by Dr. W. Teisseyre (*Jahrb. der k.k. geol. Reichs.*, Bd. 47, 1898). The strata comprise various members of the Tertiary system, highly inclined, folded, inverted, and overthrust; and sundry drift and alluvial deposits. The district is noted for its oil-springs and mineral waters, and also for its salt-deposits, which occur in both Palæogene (Eocene-Oligocene) and Miocene formations.

The Agricultural Gazette of New South Wales is an admirable journal, and contains a mass of most useful articles which are not only well written, but, in many cases, carefully illustrated. It is issued monthly, and contains in each part notes on fruit, vegetable, and flower culture for the month, besides a number of articles by experts on matters of special interest to the agriculturist. Particular prominence is given to bee-farming, and, in addition to the regular bee calendar, a series of articles on "Bees, and how to manage them" is contributed by Mr. Albert Gale, and the practical and scientific staff attached to the *Gazette* now undertake to investigate bee diseases with a view to reporting on their cause, prevention and cure. The *Gazette* is written by practical men, and is intended for the use of practical men, and should prove of great value to all engaged in agricultural pursuits.

THE results of an investigation of the catalytic influence of various gases and vapours on the oxidation of phosphorus are published by Herr Centnerszwer in a recent number of the *Zeitschrift für physikalische Chemie*. The fact that the luminosity of phosphorus in air is increased by small quantities of certain gases and inhibited by others has long been known, and was in particular investigated by Thomas Graham. According to Graham, one part of turpentine in 4440 of air by volume destroys the luminosity at the ordinary temperature. At a later period Joubert finally established the fact that luminosity and oxidation go hand in hand, and that inhibited phosphorescence could be, as in the case of pure oxygen, resuscitated by a reduction of pressure. The experiments of Herr Centnerszwer have extended over a large range of organic substances. It is found that their specific influence admits of certain general conclusions. Thus it increases in a homologous series as the number of carbon atoms increases; it is approximately the same for isomers; it is increased by a double linkage of carbon atoms; it is not greatly affected by the substitution of chlorine or bromine for hydrogen, but is increased in a high degree by the replacement of hydrogen by iodine. The results have, however, not given any clear insight into the mechanism of the process by which the oxidation is suspended.

THE preparation of sodium perborate $NaBO_3 + 4H_2O$, corresponding to an oxide B_2O_5, is described by M. Tanatar in the *Zeitschrift für physikalische Chemie*. The salt is prepared by the electrolysis of a concentrated aqueous solution of sodium orthoborate, or by oxidation of sodium orthoborate by means of hydrogen peroxide. The corresponding ammonium salt, with one molecule of water, may be prepared in the same way. The perborates are described as powerful oxidising agents, but as quite stable *per se*.

THE *Engineering Magazine* sustains its reputation as one of the best illustrated and most varied in contents of the magazines devoted to trade interests. The July part has just reached us, and contains, among other items, papers on "Sea Power at the end of the Nineteenth Century," "Some Features of Indian Railways," "The Cyanide Process as applied on the Rand," "Applications of Electro-Chemistry," and "Architectural Wrought Iron Ornament." The excellence of the illustrations in the second and last-named articles call for a special word of praise.

A NEW edition—the fifth—of Prof. Schäfer's "The Essentials of Histology" has reached us from the publishers, Messrs. Longmans and Co. The book is so well known that we need do no more than call attention to the appearance of this its latest edition.

MR. H. K. LEWIS has just brought out the second edition of "Practical Organic Chemistry" by Dr. Samuel Rideal. It differs from the first issue in the addition of several organic substances which have recently been included in the schedules for various examinations, and a few other compounds which are of general interest.

NOTICES have appeared from time to time in these columns of the monthly issues of the *Journal* of the Essex Technical Laboratories, and it is now not necessary for us to do more than announce that the third volume of the work has just been published by Messrs. Durrant and Co., Chelmsford, and that it is full of information of value to farmers, horticulturists and others.

Science Progress for July contains, among other contributions, the interesting lecture on "The Fall of Meteorites in Ancient and Modern Times," which was delivered at Oxford in February last by Prof. H. A. Miers, F.R.S.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂) from South Africa, presented by Dr. Suffield; a Brown Capuchin (*Cebus fatuellus*) from South America, presented by

Mrs. Wallace; a Lion (*Felis leo*, ♂) from North Africa, presented by Mr. P. B. Vanden Byle; a Grey Parrot (*Psittacus erithacus*) from West Africa, presented by Mr. Palmer; a Cardinal Grosbeak (*Cardinalis virginianus*) from North America, presented by Mrs. Chambers; two Shags (*Phalacrocorax graculus*) from Scotland, presented by The Maclaine of Lochbuie; three European Pond Tortoises (*Emys orbicularis*) from Italy, presented by Miss E. Endicott; two Axolotls (*Amblystoma tigrinum*) from Central America, presented by Mr. W. R. Temple; a Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. Clyde Hinshelwood; two Common Snakes (*Tropidonotus natrix*) from Germany, presented by Mr. A. Waley; two Orang-outangs (*Simia satyrus*, ♂ ♀) from Borneo, a Squirrel Monkey (*Chrysothrix sciurea*) from Brazil, a Gentoo Penguin (*Pygosceles tæniatus*) from the Falkland Islands, a Maguari Stork (*Dissura maguari*) from South America, two Thick-billed Penguins (*Eudyptes pachyrhynchus*) from New Zealand, a Jardine's Parrot (*Pæocephalus gulielmi*) from West Africa, two —— Honey-eaters (*Ptilotis*, sp. inc.) from Australia, two Elephantine Tortoises (*Testudo elephantina*), a —— Tortoise (*Testudo*, sp. inc.) from the Aldabra Islands, deposited; five Bridled Wallabies (2 ♂, 3 ♀) from Australia, five Ruffs (*Machates pugnax*), two Redshanks (*Totanus calidris*), two Spoonbills (*Platalea leucorodia*), European, ten Common Chameleons (*Chamæleon vulgaris*) from North Africa, purchased; a Macaque Monkey (*Macacus cynomolgus*), two Japanese Deer (*Cervus sika*, ♂ ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Comet Perrine (June 14).—The following is the ephemeris for comet Perrine for the ensuing week:—

1898.	R.A. h. m. s.	Decl. ° ′	Br.
July 21	6 38 7	+38 52·3	3·96
22	42 6	37 58·0	
23	46 4	37 2·6	
24	49 59	36 5·9	
25	53 51	35 8·1	4·67
26	57 41	34 9·1	
27	7 1 29	33 8·9	
28	7 5 16	32 7·5	

A New Form of Grating Spectroscope.—Prof. Michelson describes, in the *Astrophysical Journal* for June, a spectroscope which seems specially adapted for examining any particular line in a spectrum. The idea is that in a grating it is desirable sometimes to be able to throw a large proportion of light into very high orders of spectra—the hundredth, for example—and according to the arrangement here adopted the method seems quite simple. The problem becomes still more simple if the grating be arranged for transmission, as the grating can then be efficiently constructed if one can make a considerable number of plane-parallel plates of glass of the same thickness. Using only seven elements—that is, seven of these plates of glass arranged in step fashion—and placing them between a collimator and an observing telescope, and the collimator slit illuminated by a sodium flame, the broadening of the lines could be easily detected, and the Zeeman effect readily observed when the sodium flame was placed in a magnetic field. The resolving power of this instrument being independent of the number of glass plates, but depending only on the total thickness, the only advantage gained in using a large number of elements is that the spectra are more separated. With a few elements the spectra overlap; but this, as is pointed out, does not make much difference if effects of broadening, shifting or doubling of single lines be alone attempted. A spectroscope with twenty elements has already been in use in the Ryerson Physical Laboratory, and Prof. Michelson is now having another constructed giving greater resolving power, and sufficient for the analysis of close groups of lines.

Structure of the H and K Lines.—Mr. Jewell tells us (*Johns Hopkins University Circular* for June) that while examining a series of photographs of the solar spectrum made by Prof. Rowland in 1888 and 1889, he discovered one plate on which the shading of the H and K lines of calcium was broken up into bands or series. These bands were noticed to begin at the centre of the shaded lines and extend outward, the distance between the component lines of the series increasing as the distance from the centre increased. Further, the series were perfectly symmetrical about the centres about H and K, and the individual lines or components somewhat nebulous, while nearly all the other lines in the same region were sharp and clear. Since that date Mr. Jewell has not been able, except quite recently, to detect this peculiarity in the photographs taken by himself; but, on March 11 last, a plate was exposed to the arc spectrum of calcium (λ 4000) under somewhat special conditions, and this showed the shading broken up into series. The shading on the red side of H was quite distinctly broken up into series similar to those of the solar spectrum mentioned above. The series on the violet side was not so distinct; while the shading is better on the violet side of K than on the red side. Mr. Jewell further says that the resolution into lines is hardly perceptible close to the principal line, but is fairly distinct about three Ångström units from H. Curiously enough, the lines of the series in the arc spectrum plate are reversed; but some distance away from the central lines it is probable that they are continued as emission lines.

To obtain this negative an extremely powerful direct electric current was used, being allowed to act for a short time before the image of the poles was thrown on the slit of the spectroscope, the length of exposure being three to four seconds. In this way the calcium was highly volatilised, and the "highly heated vapour formed a much more extended atmosphere around the poles than with a weaker current; and it is also possible that the conditions throughout the larger part of the arc were more uniform than under ordinary circumstances." Mr. Jewell thinks that, in the case of the solar spectrum referred to, the slit of the spectroscope probably covered a region of the sun's atmosphere where the principal layer of the calcium was of a particular density, and being thus to a degree isolated was able to produce its characteristic series. This, he says, is somewhat confirmed in that the general shading of H and K on the plate is unusually weak.

Blurring Aberration in the Telescope.—In the note which previously appeared in this column (May 26, p. 88), we referred to Mr. Collins' paper on this subject, and remarked that the tilting of the image not only occurs in the case of the reflector, but in that of the refractor also; the effect in the latter case being twice as great as that in the former. We should, however, have made it clearer if we had stated that the tilt is really the same in both instruments of like angular aperture, but the difference in the inequality of size of the images formed from the "marginal" and "central" portions of aperture focussed on a single focal plane is twice as great in the ordinary refractor as with the reflector. The images formed from the central portion of the reflector are smaller than those formed by the marginal rays, while with the refractor the marginal rays produce smaller images than the central rays passing through the lens.

THE LIFE-HISTORY OF THE SALMON.[1]

THE investigations recorded at length in this Report are partly of biological, partly of more purely physiological interest. They were undertaken with the following objects:—

(1) To elucidate some of the factors governing the migration of the salmon, and to study the course of these migrations.

(2) To determine whether or not Miescher is right in his contention that salmon do not feed during their sojourn in fresh water.

(3) If salmon while in the river do not procure an abundance of food, to investigate from what source they obtain the energy for the large amount of muscular work they perform, and whence comes the material to build up the enormous genitalia which are developed before spawning. Such an investigation must necessarily yield information of interest as to the chemical changes of various substances in the animal body.

1 "Report of Investigations on the Life-History of the Salmon in Fresh Water." From the Research Laboratory of the Royal College of Physicians of Edinburgh. Edited by D. Noël Paton, M.D., Superintendent of the Laboratory. A Report to the Scottish Fishery Board presented to Parliament by command of Her Majesty. (John Menzies and Co., Edinburgh.)

The method employed was as follows. From the constant stream of salmon setting from sea to river specimen fish were taken (1) from the estuaries just as the fish were leaving the sea, and (2) from the upper reaches of the river. The rivers selected were the Spey, Dee and Helmsdale. Fish were taken from these stations at three periods: (1) in May and June; (2) in July and August; (3) in October and November.

By comparison of the fish from the upper waters with those just leaving the sea the nature and extent of the changes during the passage of the fish up the rivers were determined. The method may be compared to that of taking samples of the water of a river from two points in order to determine the changes between these points.

In the course of these investigations results obtained from salmon of very different sizes had to be compared, and therefore all weighings, &c., were expressed in terms of a fish of uniform length—the standard fish. The length selected was 100 cm.

The number of fish examined was 104, a number small as compared with the myriads of fish which ascend the rivers. It was considered necessary to investigate how far these fish were fair average specimens of their classes. Mr. Archer's extensive series of measurements and weighings of salmon from various stations enabled him to ascertain that the female fish examined by us were really average specimens, but that the small number of male fish with which we had to deal were not so typical. It is from observations on female fish that our conclusions are drawn.

The first question dealt with was the evidence as to whether salmon feed in fresh water. Dr. Gulland shows that the salmon coming from the sea early in the summer has the stomach lined with a perfectly developed mucous membrane, while in the intestine the mucous membrane is somewhat degenerated. In fish taken from the upper waters the mucous membrane of stomach and intestine are intensely degenerated. In kelts—spawned fish passing back to the sea—there is a regeneration of the mucous membrane.

Dr. Gillespie has investigated the activity of the digestive secretions by preparing in the usual manner glycerin extracts of the mucous membrane of the stomach and intestine. He finds in every case a very low digestive power. From this he concludes that the fish even when approaching to the river mouth have practically ceased to feed.

His further studies of the bacteriology of the alimentary canal show that, while in all situations, as might have been expected, the number of bacteria varies directly with the temperature of the water, in fish from the upper water there is usually a larger number of bacteria, and more especially a larger number of putrefactive bacteria than in fish from the estuaries. From this he concludes that the secretion of acid must be in abeyance in the former.

These investigations, taken with the evidence adduced by Miescher, seem to leave no doubt that the salmon does not *digest* and *use* food during its sojourn in fresh water.

It is because of this prolonged fast, and because of the important changes going on in the fish during the fast, that so interesting a physiological study in metabolism is afforded. An opportunity is offered of investigating the manner in which materials are stored in the animal body, the extent to which they may be transferred from one organ to another, the nature of some of the chemical changes they undergo, and the extent to which the various stored materials are utilised as a source of energy.

Evidence is adduced to show that the fish taken in the upper waters in May and June may have entered the river earlier in the year, and it is therefore not considered fair to compare them with the estuary fish of that period. On the other hand, there is evidence that the fish leaving the sea from May to August go to the upper waters, and hence the upper water fish of July and August are compared with the estuary fish of May to August. Evidence is also presented to show that the fish leaving the sea in October and November do not pass to the upper reaches during these months. Hence the upper water fish of October and November are to be compared with the estuary fish of May to August.

Adopting this method of comparison, the following results have been obtained.

Solids and Water of Muscle, Ovaries, &c.—It is shown that during the sojourn of the fish in fresh water there is a steady loss of solids from the muscles and a steady gain of solids by the genitalia, and that the gain of solids by the genitalia is small compared with the loss of solids from the muscle, that in fact the greater part of the solids lost from the muscles are used for some other purpose than the building up of the genitalia.

Fats of Muscle, Ovaries, &c.—Nothing is more extraordinary than the enormous accumulation of fats which takes place in the muscle of the salmon during its visit to the sea. Not only is the tissue between the individual fibres loaded with fat, but, as shown by Mr. Mahalanobis, an intrafibrous and interfibrillar accumulation of fat occurs. In the river, as the season advances, this accumulated fat steadily disappears from the muscle. There is no reason to suppose that anything of the nature of a degeneration occurs. The fat is simply excreted from the muscle to supply the fat of the growing genitalia, or used in the muscle as a source of energy.

In the muscles the fatty acids are chiefly in the form of ordinary fats. In the ovaries and testes, on the other hand, the fatty acids are largely combined with phosphorus as lecithin. An important decomposition and reconstruction of the fats thus occurs in the growing ovaries. In the ovaries the amount of lecithin is very large, while the amount in the testes is by no means trifling, and the constant occurrence of this substance seems to point to it as the first stage in the formation of nucleins.

Proteids of Muscle, Ovaries, &c.—Dr. Boyd's observations indicate that the albuminous materials of the muscle may be divided into two classes: (1) those soluble in salt solution; (2) those not soluble in salt solution. He shows that globulin substances constitute nearly the whole of the soluble proteids, and that proteoses and peptones are not present in any circumstances. He further shows that there is a small quantity of some phosphorus-containing proteid—either a nuclein or a pseudo-nuclein—among the soluble proteids. It is these soluble proteids which diminish in fish in fresh water. When they are abundant, as in fish at the mouth of the river, on boiling they may coagulate between the flakes of the muscle, and form with the fats the characteristic *curd*.

Of the insoluble proteids, part is composed of white fibrous tissue, part of a phosphorus-containing proteid which may be called myostromin.

Dr. Dunlop's results show more fully the extent to which proteids accumulate in the muscles, and the rate at which they diminish as the fish passes up the river. The first point of interest is that the proteids do not disappear to anything like the same extent or at the same rate as the fats. The second point of interest is that the proteid surplus available for energy—that is, the proteid not used in building the ovaries—is no greater in the upper water fish in October and November than in July and August. This seems to indicate that quite early in the season, while the ovaries are growing slowly, the proteids disappearing from the muscle are more than sufficient to meet the requirements of these structures; while later in the year, when the growth of the ovaries is going on more rapidly, all the proteid disappearing from the muscle is transported to and used in them.

Phosphorus of Muscle, Ovaries, &c.—It is shown that in the female fish only just enough phosphorus is accumulated in the muscle to supply the wants of the growing ovaries, while in the male the accumulation is superabundant. In this connection it is further pointed out that in the male the enormous growth of the bony jaw may use up a further amount of phosphorus. Whether in the female any phosphorus required for the ovaries in excess of that stored in the muscle is procured from the bones, these observations do not indicate.

The phosphorus is stored in the muscle chiefly as phosphates, and to a somewhat smaller extent as lecithin. The amount of lecithin in the muscle is not nearly sufficient to yield the lecithin of the ovaries. In the ovaries the phosphorus is largely in the form of ichthulin, a pseudo-nuclein, so the phosphorus from the phosphates of the muscles must undergo profound changes in the growing ovaries, and being synthesised with organic bodies be built into these compounds. That these compounds are the forerunners of the still more complex nucleins of the embryo is indicated. In the male the transference of the phosphates of the muscle into these higher nuclein compounds is even more direct, and the occurrence of lecithin in considerable amount in the growing testes seems to point to this substance as the first step in the synthesis of inorganic phosphates to nucleic acid.

Iron of Muscle and Ovaries.—Dr. Greig has shown that the ichthulin of the ovaries contains iron, and the amount of iron in the ovaries thus increases as the organs grow. Whence is this iron procured? It has been shown that the iron lost from the muscle is insufficient to yield the iron gained by the ovaries, and it is thus probable that the hæmoglobin of the blood must be drawn on for this element. The liver does not seem to yield iron to the ovaries.

Pigments of Muscle, Ovaries, &c.—Miss Newbigin's study of the pigments of the muscle and ovaries show that two lipochromes are present. First, the very widely distributed yellow pigment, lutein; and second, a bright red lipochrome, which, mixed with the former, gives the characteristic colour to the salmon muscle and ovaries.

Though it has not been possible to investigate the source of the pigments, the evidence adduced tends to show that the characteristic red pigment is probably not derived from the food, but that it is constructed possibly out of the very widely distributed yellow pigment. Its storage in the muscles and its transference to the ovaries is demonstrated. Its fate in the male fish is still obscure, though the deeper pigmentation of the skin in the male suggests its elimination by that channel. What the purpose of the pigment is, is not clearly indicated, though it seems probable that by colouring the ova it may assist in their concealment during development.

Nature of the Transference of Material.—These observations throw important light on the nature of the transference of material. They clearly show that nothing of the nature of a degeneration in the muscle takes place. The muscles simply excrete or give out the material accumulated in them, or utilise it as a source of energy within themselves.

Source of the Energy for Muscular Work, &c.—The extent to which the fats and proteids lost from the muscles are used for the construction of the genitalia on the one hand, and for the liberation of energy on the other, varies somewhat in males and females. Taking the earlier months—to August, it is shown that in the female 12 per cent. of the fats and 3 per cent. of the proteids go to the ovaries, the rest being available for energy; while in the male about 5 per cent. of the fats and 14 per cent. of the proteids go to the testes.

The total energy liberated from fats and proteids is possibly somewhat greater in the male than in the female, being to August 1,271,000 kgms. per fish of standard length in the female, and 1,380,000 kgms. in the male. Of the energy thus liberated about 2200 kgms. are required to raise the fish to the height of the upper water of the river, the remainder being available for the much greater work of overcoming the resistance of the stream, and for internal work and for other calls upon the energy supply.

Of this total available energy in the female, about 20 per cent. is derived from the proteids, while in the male only 9 per cent. is derived from this source. The rest is derived from the fats.

Food Value of Salmon.—The food value per unit of weight of muscle deteriorates as the season advances. In each fish caught in the estuaries the food value remains almost constant, the larger size of the late-coming fish making up for the deterioration of the flesh. The food value of each fish caught in the upper waters is less than that of those caught in the estuaries, and in October and November is only about one-third that of fish caught in the river-mouth. Since the large late-coming fish contain more ova than the smaller fish, their destruction does more damage to the breeding stock.

Factors Determining Migration.—In considering the question of migration, it must be remembered that the Salmonidæ are probably originally fresh-water fish, and that the majority of the family spend their whole life in fresh water. Salmo Salar and other allied species have apparently acquired the habit of quitting their fresh-water home for the sea in search of food, just as the frog leaves the water for the same purpose. When, on the rich marine-feeding grounds, as great a store of nourishment as the body can carry has been accumulated, the fish returns to its native fresh water, and there performs its reproductive act.

That the passage of the fish to fresh water is not governed by the growth of genitalia and by the *nisus generativus*, is shown by the fact that salmon are ascending the rivers throughout the whole year with their genitalia in all stages of development.

From May to August the fish leaving the sea have about the same amount of material stored in their muscles. During these months the ovaries are yet small, and do not act as a reservoir for stored material. In October and November the estuary fish have a smaller amount of stored material in their muscles, since the period of rapid growth of the genitalia has supervened before the full accumulation of material in the muscles has been accomplished. This rapid growth of the genitalia would withdraw material, and prevent its accumulating in the muscle; and thus, when the necessary amount of stored material was accumulated, it would be distributed between these structures. The late-coming salmon, although the supply of solids in the muscles is smaller, have the ovaries so large that the total store of nutrient material in the fish is just about the same as in those entering the estuaries in the earlier months.

The state of nutrition is the factor determining migration towards the river. When the salmon has accumulated the necessary supply of material, it tends to return to its original habitat.

THE STRAMBERG CORALS.[1]

PROGRESS in the classification of corals has been a passage from fog to fog across lucid intervals cleared by successive systems, which have collapsed under the efforts to improve them. The primæval darkness of Ellis, Guettard and Esper was first lightened in 1830 by the classification of de Blainville, which was obsolete within four years of its publication. A long series of memoirs by Edwards and Haime, begun in 1848, gradually laid the foundations of a system at once more adequate to the wide variations in coral structure, and more natural; but it was not until 1857–60 that the two authors' complete classification was published in the great "Histoire Naturelle des Coralliaires." The essential features of their scheme were the separation of the Palæozoic corals as the order Rugosa, and the division of the later corals into two orders, the Aporosa and Perforata, characterised respectively by a solid and a porous wall. The classification gave helpful guidance to those who chose to use it; but many authors preferred to follow de Fromentel, who in 1861 issued a more artificial but simpler system, based on the mode of association of individual corallites into compound coralla. The life of Fromentel's classification was, from its nature, necessarily brief; while that of Edwards and Haime was weak in so many points, that under the numerous amendments of Étallon, Milaschewitsch, von Zittel, and others, the original boundaries became indefinite, and the system once more involved in fog. In 1884, P. M. Duncan restored order by a revision of the genera of Neozoic corals; he adopted, in the main, the same principles as Edwards and Haime, and his revision is still the most useful handbook to coral classification. It has held this position in spite of repeated attempts to change the whole basis of classification. Thus Pratz in 1882 proposed a scheme founded on the septa; von Heider and Ortmann have advocated another, resting on the formation of the "wall"; and recently Miss Ogilvie has suggested a new arrangement, even more radical in its changes.

Miss Ogilvie's views are propounded in two great papers: one in the *Philosophical Transactions*, in which the general principles are stated; and the second, a monograph of the Stramberg Corals, in which her theories are applied in practice. The former work is already known to readers of NATURE by an explanation written by the authoress (vol. lv. p. 280, January 21, 1897), so that the general principles need not be considered here. It has been found in coral history that the best test of a theory of classification is its results. Students of the corals have always been ready to welcome any morphological light that offered guidance through the taxonomic gloom, and have preferred to judge it by the help given in practical work. We therefore turn to Miss Ogilvie's monograph to see whether her classification associates similar corals, and separates those which are unlike.

The authoress is to be congratulated on her material. The Stramberg Schichten have yielded an instructive fauna, different sections of which have been described in other parts of this work by von Zittel, Cotteau, Böhm, Moericke and Zeise. The beds occur on the boundary between the Cretaceous and Jurassic systems, and their fossils have the usual interest of a transition fauna. Miss Ogilvie has described the corals in detail and with care, and her monograph is illustrated by twelve fine large plates. It is unquestionably a most valuable and extensive addition to our knowledge of the Mesozoic corals,

1 "Die Korallen der Stramberger Schichten," by Maria M. Ogilvie, D.Sc., Palæontologische Studien über die Grenzschichten der Jura- und Kreide-Formation im Gebiete der Karpathen, Alpen und Apenninen. Part vii. Palæontographica Supplement, vol. iii. pp. 73–282, pls. vii.–xviii. (1897).

and is well worthy of a place in the series in which it is published.

The monograph has, therefore, a double interest. It makes known to us an important coral fauna, and the descriptions are arranged on a scheme which has all the attractiveness of daring and revolutionary change. The authoress distributes the Stramberg corals among 128 species and 41 genera, which are grouped into nine families. And it is by the constitution of these families that Miss Ogilvie's classification will be judged.

The first family is the Amphiastræidæ, of which the typical genus *Amphiastræa* was founded by Étallon for a Kimmeridgian coral that presents some points of resemblance to the Rugosa. Koby has described a series of Jurassic genera allied to *Amphiastræa*. He placed them in the Rugosa, but made no attempt to formulate a definite family for their reception. Miss Ogilvie has now taken this step, which will probably receive unanimous approval, although whether all the eleven genera are correctly assigned to it is open to doubt. Let us take, for example, the genus *Dendrogyra*, of which the type species is the recent West Indian coral *D. cylindrus*, Ehr. We fail to see in that coral any of the primitive characters of *Amphiastræa*. *Dendrogyra* has a columella, and the corallites are separated by bands of exotheca. The new species which Miss Ogilvie refers to *Dendrogyra* has no exotheca separating the corallites, and there is no columella shown in the figures (Pl. xvi. Fig. 3, 3*a*, 4, 4*a*), although "eine Art von Saulchen" is mentioned in the description. Miss Ogilvie remarks the near affinity of *Dendrogyra* and *Euphyllia*; and if those genera be closely related to her *D. sinuosa*, then we can only conclude that the fossil is no special ally of *Amphiastræa*.

The next family is the Turbinolidæ, represented by the genera *Epismilia* and *Pleurosmilia*. Of the former Miss Ogilvie has seen six Stramberg specimens, which are referred to three species. Both the genera are transferred to the Turbinolidæ from the very original view, that a diminished development of endotheca goes on *pari passu* with a stronger development of "wall." Miss Ogilvie retains throughout von Heider's terms Eutheca and Pseudotheca, and this family illustrates the difficulties they occasion; thus it is stated (p. 134) that the subfamily Trochosmilinæ have "æchte theca vorhanden," whereas *Epismilia*, the second genus placed in it, is stated (p. 141) to have a "Pseudotheka." The retention of *Epismilia* is a step of doubtful value, for there seems good reason to regard the genus as founded only on a worn, weathered *Montlivaltia*. But according to Miss Ogilvie's scheme *Epismilia* and *Montlivaltia* are placed far apart, and separated, in fact, by four families. One of the intermediate families is the Pocilloporidæ, the most novel feature in which is the inclusion there of the genus *Stephanocœnia*. *Pocillopora* has well developed tabuli, rudimentary septa, no pali, and massive cœnenchyma. *Stephanocœnia*, on the other hand, has no tabuli, well-developed septa, exceptionally distinct pali, and there is often no cœnenchyma or exotheca between the corallites. Miss Ogilvie may perhaps be using the name *Stephanocœnia* in some new sense; for she elsewhere remarks, "it is doubtful whether they [*Astrocœnia* and *Stephanocœnia*] are represented in recent seas" (*Phil. Trans.*, vol. 187, p. 307). But *Stephanocœnia* was founded on the common living West Indian coral *S. intersepta*.

The next family is the Madreporidæ represented only by *Thamnaræa*. In the corals of that genus the septa are palisades of irregular, separate, vertical rods, connected by horizontal, synapticular platforms. Miss Ogilvie describes the septa of Madreporidæ as "bilaterally or radially arranged, compact; sometimes represented by a series of horizontal spines projecting inwards from the wall." If *Thamnaræa* is to be retained in the Madreporidæ the family characters must be changed. *Thamnaræa* appears to represent one of the extreme types of the septal structure seen in the genus *Microsolena*, which Miss Ogilvie leaves in the Fungidæ. To separate *Thamnaræa* from *Microsolena*, and ally it to the compact-septumed *Madrepora* is one of the changes which prejudices the principles upon which the proposal is based.

It may be objected that these criticisms are mere details. But it is by such details that works as the present can best be tested. There is no need here to rediscuss the principles, as that has been previously done by Bourne and Bernard. The value of the present work is that it gives us a chance of examining the results to which the principles lead. Although the results may not all be accepted, students of the Madreporaria will be grateful to Miss Ogilvie for this solid addition to the mass of knowledge of Mesozoic corals. Her reshuffling of the genera is useful and suggestive, for it brings together corals usually placed at the opposite ends of the group, and renders necessary the close comparison of genera which otherwise no one would have thought of comparing. Thus the work is of value not only as the description of many new and interesting corals, but as it leads to the re-examination of forms previously known from a fresh point of view, a labour which is always profitable.

J. W. GREGORY.

UNIVERSITY EDUCATION.[1]

THE Johns Hopkins University, which has done me the honour to ask me to say a few words on this occasion, is, although already distinguished, a new and young university. I can remember well its beginning, and as Dr. Gilman has hinted, I may claim to have taken some small part in its birth. When I moved in 1870 from London to Cambridge, I took with me a bright lad of whose ability and industry I had already taken notice. At Cambridge he became my right-hand man, and I had some hopes that I should long have his help; but President Gilman appeared upon the scene, and his influence was so strong that I felt that my own interests were not to be considered, and that I ought to send that favourite across the waters to occupy the first chair of Biology in this new university. Although the memories of him whom I need scarcely name, Henry Newell Martin, are tinged with melancholy, still I feel that this university must always look back with pride and affection on the work which he has done in this country, and in this affection and pride I claim a small share for myself.

Your university is a new one. I come from a very old one; one which was founded six hundred years ago, which has lived through all those centuries, and which, though it has some of the charms, has also some of the evils of antiquity. The traditions of the past weigh heavy upon us. When we attempt to stretch our limbs to meet the new needs of new times we find some old written law, some well-established prejudice, some vested interest preventing our full development. You are a new university; and although I have purposely refrained from refreshing my mind as to the exact status of your regulations, and as to how far you may have already entangled yourselves in the toils of enactments, still I will take it for granted that you differ from us in the freedom with which you can move forward towards the needs of the coming times; and I think perhaps I could not do better at the present moment than to use the opportunity offered me to take my old university as a text, and to draw from it and its history some few plain reflections which I hope may be practical and useful with regard to the conduct of universities. Allthough I understand that I have been especially invited by the medical faculty, I will take leave to treat only of general things, since the welfare of the medical faculty is bound up in that of the whole university.

The morphologists tell us we can learn much by studying the embryo, and something perhaps may be learned by looking back at this old University of Cambridge in the days of long ago—in the days when it too was a relatively young university. Things were very different then from what they are now. The dimly lighted streets or alleys in which the students lived were an emblem of the whole university. There was little outward show of glory then; there were no beautiful buildings, few books, and each student's duty was, in part, to listen to the lecture, to the reading of something which was written, but which he could not see with his own eyes. In spite of all these difficulties there were certain features of the university of that time which I trust I may say have been, with some little wavering here and there, maintained since, and which I cannot help thinking have contributed in very large measure to make it what I may venture to call it, a famous and great university.

One of the most striking features of the attitude of both students and teachers at that early time was that they recognised in the training of the university a preparation for practical life. There were at that time three main occupations in which learning was of practical use; and in correspondence to those three occupations there were established the three great faculties of the

[1] Address delivered at the Johns Hopkins University, Baltimore, October 11, 1897, by Dr. Michael Foster, Sec.R.S. (Reprinted from the *Bulletin* of the Johns Hopkins Hospital April.

university—the faculty of theology, the faculty of law, and the faculty of medicine. And, if one reads what those men of old wrote concerning what they thought ought to be done in the university, one is very much impressed by the conviction which they had that the teaching should be an earnest preparation for practical life. If it soon became necessary to establish a fourth faculty, the faculty of arts, that was simply as a faculty preparatory to the others, as one supplying the first steps for and leading up towards the knowledge which should be of use in practical life; and it is worth noting that although they called that faculty the faculty of arts, and although the acquisition of the Latin language was one of the chief studies of that faculty, necessarily so because all the instruction which could be given was given in that tongue, among what they called the arts were the beginnings of the kind of knowledge which we now call science.

Another feature of the university life of those early times was the very strong feeling that the work of the university consisted not in the mere acquisition of knowledge, but in the training of the mind. The amount of knowledge which they had for distribution was very limited; but they used that small stock of knowledge to the very best of their ability, as the means of awakening the minds of the students and training them for thinking and arriving at conclusions. This is seen even in what they called at that time examinations, though the word then had a very different meaning from what it has now; there were then no written examinations, there was not that demand on paper so characteristic of modern times, and that great necessity of modern civilisation, the waste-paper basket, was unknown. The examiners went quietly to work to ascertain in the most sure way whether a student had profited by what he had listened to. Instead of having two examiners for some hundreds of students, they appointed nine to each student; and these went in with him and out with him until they satisfied themselves that he knew something, and had gathered something from what had been told him. And then as a final test they put him on the "stool" and made him debate in public, the test being used in such a way as to bring out his stock of knowledge, and especially his power of using it and of showing that his mind had been trained at the same time that he had gathered in a certain number of facts.

There was another feature of the university which we sometimes find it difficult to realise: the spirit of inquiry was rife among them. At that time the ways of thinking were devious; but still within the limited circle in which they moved, along the only lines then open to them, the thinkers used their minds in the spirit of free inquiry. When one reflects upon the circumstances in which they worked, one cannot help realising that their long-drawn-out discussions were at bottom an expression of the love of inquiry, and that if they had had the advantages which we enjoy now, that which we call their subtlety would have broken out into discovery and invention.

Lastly, it was a feature of the university at that time that it was willing to take into its bosom any one who showed that he had any promise of benefiting by the instruction there given. It was an open home for all who wished for learning.

These are some of the features of the University of Cambridge in the olden times; and may we not, using them as a text, attempt to draw some conclusions as to what are the proper and essential functions of a university, and what ought to be some of its guiding principles? As I said just now, the knowledge which they possessed was extremely limited, the facts with which they had to deal were very few. What can we say of knowledge at the present time? May we not say, if theirs was too little for them, ours threatens to be too great for us; that we are entering upon an age in which the facts which have to be learned, and the various kinds of knowledge which have to be acquired are becoming too many for us? It is, or it may be perfectly true that one of the advantages of learning is that it enables the learner to learn more rapidly; but is not this true, notwithstanding that the increment of knowledge is increasing far more rapidly than the increment of the power to learn? Is it not a serious matter for consideration that the things that the university has to teach are rapidly becoming far too numerous for the learner to learn? Is it not true that we cannot do now as they did in those old times, teach the student all that was known? We are compelled to make a choice, we must teach to the student some things and omit to teach him others. That is a necessity which it seems to me is increasing as the years go on. Nevertheless that position is a cruel one; for it may be truly said that every kind of knowledge has a value of its own; each kind of knowledge has for the learner a value which can be given by no other kind, and he who fails to gain any one kind of knowledge is thereby a loser. For building up the student into the full and complete man, the best course would be to take in all the knowledge which can be offered by a university; but, as I said just now, a choice must be made, and the consideration of the principles which should guide the decision as to what should be chosen and what should be left, demands the most serious attention. Here I think we may venture to follow the example of the old university. Admitting that each kind of knowledge is particularly fitting for a particular calling, that for every particular calling in life there is a knowledge, or there are kinds of knowledge which are suited or fitted for that calling, and without which that calling can not be pursued with success, in the necessary choice which must be made between this study and that, is it not a wise course to take that which best serves the future calling of the student? I cannot but think that in this choice of which I am speaking, the arguments for what are sometimes called technical education are unanswerable; that one of the principles of most importance in determining the choice of the studies to be taken up by the student lies in the fitness of the study for giving him power in the calling which he proposes to adopt. We must, however, remember that the knowledge which is thus to be imparted to him must be not merely a knowledge of facts, but bring with it the power of thinking. If technical education is understood in this way, not as a mere accumulation of facts, not as the mere heaping of knowledge, but as the training of the mind in some particular kind of knowledge, the dangers, I venture to say, which some fear, will prove unreal, and it will be seen to be a true principle of university education.

There is another aspect in which we may look at university duties. May we not say that the tendency of modern civilisation is to smooth down individual differences, and that the whole tendency of the environment of man is to make each man increasingly more like his brother? There was a time when one could tell by the dress where a man came from; but this has become less and less easy, and it is not in dress alone, but in his very nature that man all over the world becomes more like his fellows. I myself during the short time I have been in this country have felt it more and more difficult to tell what are the differences between an American and an Englishman, and I trust that these differences are equally difficult to you. This may be a favourable aspect, but there is an unfavourable side to this continual influence of things about us. Mr. Francis Galton has shown that there is a great tendency in things to make men more and more alike in stature, and there seems a corresponding tendency to make men all alike in the stature of their minds. We seem tending in many ways to a monotonous mediocrity of intellect. This influence is especially strong among young people. I see for myself in the University of Cambridge that when one young man does one thing they all do it; they go astray like sheep, and they also go straight like sheep. Surely it ought to be a function of the university to counteract this tendency, and so to bring the influences of learning upon the young as to develop individual differences. That I take it is one of the most important functions which a university can exercise, but one which is not always kept in view in university enactments. Here I can speak of my own university, and in doing so can lay the blame for the present condition of things on the traditions of the past. I find in my own university discouragement for the development of individual power. Every lad who comes to the University of Cambridge is compelled to pass through the same examination, to know the same things to the same extent, whatever may be the nature of his mind. He must know a little Latin, a little Greek, a little mathematics, a little history and one or two other subjects. Each one who comes, whatever his previous history, must pass through this one gate; the whole university has been pushed through this one common gate. Now I know that this may be defended; it may be said, for instance, that it is a bad thing not to know Latin. I quite agree with that. I think it a very bad thing not to know Latin, but I also think it a very bad thing for a lad to be thrown into life, it may be to go through life, without any clear idea whatever of the fundamental laws which govern the phenomena of living things. It may be said that it is a bad thing not to know Greek; I agree with that. Not to know Greek is to my mind worse than not to know Latin, but I think also that it is a bad thing for a lad to go through life ignorant of the fundamental laws of chemical action. If you go along in that line of argument, you end by compelling a lad to know everything before he enters the university. If I had my way, and could wipe out the traditions of the past, I should vary that entrance examination. I should hold on to the old tradition of the university that it was ready to receive everybody who was likely to profit by its instructions. I should make the examination look, not backward as it does now, but forward, and should only insist that the lad must give such proofs of intelligence and industry as to lead to the hope that the years of university life would not be spent in vain. When the lad has really entered the university (at times he does not do so until he has spent two or even three years at the place in preparation, and sometimes goes away from the place without having really been admitted), it seems to me there should be a still wider scope for his studies. He has even now, it is true, an opportunity to take a degree in one or other of several branches of learning, but in each case he must follow out a particular schedule which has been laid down, and which compels him to walk along a particular path and no other. If he wishes, for example, to study mathematics with philosophy, he would find that he could not do so, for in the examinations mathematicians have nothing to do with philosophy, and philosophy nothing to do with mathematics; and so in other things. I venture to think that this is not a satisfactory condition of things, and that throughout the whole academic course there should be a freedom of the young mind to develop in the line in which it was intended to develop. When I urge this upon my friends, they all say "It is very good, but it is impossible; the examination machinery would become so complicated as to break down." But I would ask the question, Are examinations all in all? Were the examinations made for universities, or were universities made for examinations? I myself have no doubt about the answer. I trust that this new university, which can walk with freedom along new lines, will find some way of so arranging studies and examinations that the two will not conflict, and that anybody coming here will find that the particular gifts that have been given to him, and which it was intended should be developed, will meet their fullest expansion.

Lastly, there was another feature which the old university possessed and which I may also call an essential feature of a university, that is, the spirit of inquiry. No university can prosper as a university that not only does its best to favour special inquiries when these are started within it, but also in the whole course of its teaching develops, or strives to develop the spirit of inquiry. Now here again I fear that examinations—such at all events is my experience—are antagonistic to inquiry; and I would suggest that in arranging examinations one ought always to look ahead to see how far one can possibly order those examinations so as to favour the teaching which teaches in the real and true way, teaching by regarding each bit of learning as in itself an act of inquiry, and so as to favour in the highest degree actual inquiry when it is taken in hand. This of course is antagonistic to one function of examinations, namely, that of putting young men to compete against each other. You cannot so judge inquiries as to put the inquirers in any class list or in any order; the most you can do is to give an inquiry the stamp of approval of the university, a testimony that the inquiry has been carried out in a satisfactory way. It is true that in this way you lose that which is sometimes thought to be of great value, emulation between the scholars; but if you take away that kind of emulation you substitute for it another one far more strong and effective, that emulation that comes of striving with nature. I take it that the good which is done to a lad in starting him upon an inquiry is infinitely greater than any which can be gained by competition with his fellow students. Here I am glad to say a good word for my own university; for we have in a very quiet way, and unobserved, secured the adoption of an enactment which allows a lad to enter the university and obtain his degree and all which follows upon that without entering into a single examination. At the present moment it is possible for one, it is true under exceptional circumstances, to come to the University of Cambridge in England, and if he convinces a competent body of judges that he is a person likely to carry on inquiry in a successful manner he can enter the university as a student, and if he satisfies another body of men after a time that his inquiries have resulted in a real contribution to knowledge he can secure his degree. He can get that without ever having touched a written examination paper, and I am proud that we are able to offer that to the world; for it has happened again and again that a man who had real genius for a particular line of inquiry stumbled over the preliminary studies of which I have spoken, knocked at the door of our university in vain and was sent away. Now such an one would be admitted, and I venture to say that in the long run the university will be the gainer.

These, then, are some few thoughts concerning universities and their methods. I say I have purposely learned nothing about your enactments, but from what I know of your short past I feel confident that this university will in the future be conspicuous for progress. May I hope that it will carry on education along some of the lines which I have indicated to-day, and perhaps some day we in the old country may mend our ways after your pattern.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Calendar of the Glasgow and West of Scotland Technical College for the Session 1898–99 has just been issued.

DR. R. A. HARPER, of Lake Forest University, has been appointed to succeed Prof. C. R. Barnes in the chair of Botany in the University of Wisconsin.

MR. H. R. M. BORLAND has been appointed junior assistant in the chemical and metallurgical department of the Bristol Merchant Venturers' Technical College.

MR. HERBERT BOLTON, who for the last eight years has held the post of assistant keeper in the Manchester Museum, has just been appointed to the curatorship of the Bristol Museum.

WE learn from the *American Naturalist* that Miss Phœbe Hearst has given a building for the School of Mines to the University of California. The building will be fully equipped at her expense.

PFEIFFER scholarships in science have been awarded, in connection with the Bedford College for Women, London, to Winifred E. Watts and Margaret Foster. The Reid fellowship, tenable at Bedford College, has been awarded to Margaret Lyal Dale.

DR. CHARLES HUNTER STEWART, who for the past ten years has acted as chief assistant in the Bacteriological Laboratory connected with the chair of Medical Jurisprudence and Public Health in Edinburgh University, has been appointed to the new professorship of Public Health and Sanitary Science at Edinburgh University.

THE Science and Art Directory (revised to June 1898) has just reached us from the Department of Science and Art. In it is to be found, as usual, full information as to the regulations for establishing and conducting science and art schools and classes. Several minor alterations have been made in the regulations, and attention is called to these by the use of italic type.

SCIENTIFIC SERIALS.

Memoirs of the Novorossian (Odessa) Society of Naturalists, vol. xx.—On the origin of *limans* in the Government of Kherson, by M. Rudski. A "liman" is the local name for small bays on the sea-coast which are now separated from the sea by a bar, and offer very interesting peculiarities of structure and fauna. Various hypotheses having been made as to their modes of formation; these hypotheses are discussed, and new observations on the oscillations of the limans are given.—Notes on an excursion to Crimea, by the same. Chiefly on the geological changes going on in the coast-line.—Note on the meteorite of Savchinskoye, by R. Prendel (with a photograph of it).—Geological description of the Odessa district, by Prof. Sintsoff. A great deal of attention is paid to the hydrology of the region, and especially to the *limans* (with a geological map).—The Protozoa of the Haji-bei and Kuyalnik *limans*. No less than 130 species were found in the former, which contains a greater number of marine forms, and 75 in the latter.—Chemical researches in the Marmora Sea, on board the *Selanik*, by A. Lebedintseff. Preliminary report, from which it appears that the existence of bacteria producing sulphuretted hydrogen in the water and the mud of the Marmora Sea cannot be doubted.—On a globular syenite on the Bazavluk, by M. Sidorenko.—On the salinity of the Haji-bei and Kuyalnik *limans*, by Prof. Werigo.—Physical and chemical exploration of the Odessa *limans*, by A.

Lebedintseff and W. Krzyzanowski.—Geological explorations along railway lines in South Russia, by V. Laskareff.—On the sexual reproduction of *Schizoneura lanigera*, by S. Mokrzecki (with a coloured plate).—On the influence of substitution on the rate of certain reactions, by P. Petrenko Krichenko.—*Crangon vulgaris*, var. *Shidlovskii*, from the Sea of Japan, by Dr. A. Ostroumoff.

Vol. xxi. part 1.—Materials for the fauna of Coleoptera of South Russia, by E. Kubkovski. An elaborate work which contains a review of the corresponding literature, a sketch of the distribution of Coleoptera in the Steppes, the sandy regions, the waters, &c., and a detailed enumeration of the species.

Memoirs of the Novorossian (Odessa) Society of Naturalists, Mathematical Section, vol. xvii.—Solar radiation, by M. Pantchenko. The author submits to a careful mathematical investigation the different formulæ proposed by Violle, Langley, Abney, Bartolli, Crova, Angot, and Angström. For purely meteorological purposes he finds Angström's formula sufficient; it gives very good results with the actinometric measurements made in Odessa in 1890, 1891 and 1894.

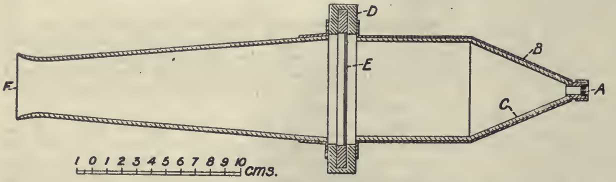
SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16.—"On the Source of the Röntgen Rays in Focus Tubes." By Alan A. Campbell Swinton. Communicated by Lord Kelvin, F.R.S. Received June 7.

The author has already described at the Royal Institution (see NATURE for May 26, page 91) how he has found it possible to study by means of pin-hole photography the active area on the anti-kathode of a focus tube from which the Röntgen rays proceed.

By means of a special camera he has now been able to make further investigations. In the illustration A is the pin-hole in a lead disc secured by a cap to the brass cone B, which is lined with thick lead. D is a framework into which slides either the fluorescent screen E, or a carrier containing a sensitive plate should photographs be required. F is an observation tube for use with the fluorescent screen. It is made of insulating material to avoid danger of shocks.



With this apparatus directed at the anti-kathode of a focus tube, it is easy with the fluorescent screen in place to take accurate note of the image of the active anti-kathode area which appears on the screen, and to observe the variations in form, dimensions, and brilliancy that take place under varying conditions. Similarly by replacing the fluorescent screen by a photographic plate the image can be photographed.

The following are the main effects that the author has observed.

(1) When the anti-kathode intersects the kathode stream at the focus, the dimensions of the active area are independent of the degree of exhaustion. For all other positions beyond the focus it is larger the lower the exhaustion and *vice versa*.

(2) When the anti-kathode intersects the kathode stream beyond the focus, the active area is larger the greater the distance between kathode and anti-kathode.

(3) When the anti-kathode intersects the kathode stream considerably beyond the focus, the active area is found to consist of a well-defined and very intense central nucleus, surrounded by a much fainter but quite appreciable halo. Both of these increase in size as the distance between kathode and anti-kathode is increased. In some cases the halo consists of a well-marked hollow ring with a dark space between it and the central nucleus. In other cases two distinct concentric rings are visible surrounding the nucleus.

(4) With an anti-kathode inclined at an angle of 45° to the axis of the conical kathode stream, it is found that those portions of the stream which impinge most normally upon the anti-kathode surface are considerably the most efficient in producing Röntgen rays.

(5) At the degrees of exhaustion most suitable for producing Röntgen rays, and with concave kathodes of the usual dimensions, the kathode stream proceeds almost entirely from a small central portion of the kathode surface, the remaining portion of the surface being apparently practically inoperative. That this is so was very conclusively established by photographs taken with a tube in which three very minute fragments of glass had attached themselves on to the concave surface of the aluminium kathode. The shadows of two of these fragments appeared in the photographs, and enabled accurate measurements to be made.

(6) The different portions of the kathode stream proceeding from different portions of the kathode cross at the focus and diverge in a cone that retains any special characteristics of the convergent cone. The relative positions of the glass fragments on the kathode, and the positions and enlargement of their shadows on the anti-kathode were found to show this very clearly.

(7) Though by far the greater portion of the Röntgen rays given by a focus tube proceed from the active anti-kathode area, still a very appreciable quantity is also given off by all those portions of the glass of the tube that shows the green fluorescence.

Further, it is noticeable that that portion of the glass that shows the brightest fluorescence, *i.e.* that part which lies in the path in which kathode rays would be reflected from the anti-kathode surface were they reflected according to the law of equal angles of incidence and reflection—gives off the most Röntgen rays, while those portions of the glass that show no fluorescence do not give off any Röntgen rays. The conclusion appears obvious that whatever produces the one also produces the other, but as has been pointed out by Prof. S. P. Thompson the fluorescence is not due to the direct stream of rays from the kathode, but to some description of radiation that proceeds from the surface of the anti-kathode that faces the kathode.

Prof. Thompson calls these radiations "para-kathodic rays," stating that they differ from the Röntgen rays in respect of their power of penetration, and in their capacity of being electrostatically and magnetically deflectable. In these respects the author's experiments confirm those of Prof. Thompson; but when the latter goes on to differentiate these rays from ordinary kathode rays, on account of their not exciting Röntgen rays where they impinge on a solid surface, the author is unable to agree, for, as above stated, these rays do excite Röntgen rays where they impinge upon the glass walls of the tube.

The "para-kathodic" radiations do not, however, appear to be ordinary kathode rays. In the first place they do not proceed directly from the kathode, but only from the surface of the anti-kathode that faces the latter. Secondly, they do not appear to be negatively but positively charged. The author suggests that they may very probably consist of kathode ray particles which, having struck the anti-kathode, and having thus given up their negative charges and acquired positive charges, rebound, both by reason of their elasticity and also by repulsion from the anti-kathode. Perhaps, owing to the comparative roughness of the anti-kathode surface, they fly off to some extent in all available directions, but they do so especially in that direction which the law of equal angles of incidence and reflection requires. It also appears very possible that these rays are identical with the positively electrified streams proceeding from the anode, which the author has investigated by means of radiometer mill wheels, recently described in his paper to the Physical Society (see NATURE for March 31 and June 2, pp. 525 and 119.

"Mathematical Contributions to the Theory of Evolution. V. On the Reconstruction of the Stature of Prehistoric Races." By Karl Pearson, F.R.S., University College, London. Received June 6.

The object of this memoir is to illustrate the general theory by which we may reconstruct from the knowledge of one organ in a fossil or prehistoric race, the dimensions of other organs, when the correlation between organs in existing races of the same species has been ascertained. The particular illustration chosen is the reconstruction of probable stature from a measurement of the long bones.

Up till quite recently this subject remained in great obscurity, partly on account of absence of theory, and partly for want of trustworthy data.

The estimated statures as obtained by Orfila, Topinard and Beddoe, or by use of their methods, differ widely, and those methods have no satisfactory theoretical basis. It was usual to suppose that there was some mean or average ratio of stature to long bone, and even when it was recognised that this ratio varied with the length of the long bone, it was thought sufficient to determine it for two or three separate ranges of stature, and determine its mean value for these ranges by a very limited number of cases.

The first stage in advance was taken when Rollet published his measurements, made in the Anatomical Theatre at Lyons, of the stature and long bones of 100 corpses. Rollet's attempt to establish ratios on the basis of his measurements is not very satisfactory, but to him belongs the credit of having first provided a respectable, if not large amount of data. Rollet's work was followed by a very able memoir on the reconstruction of stature by Manouvrier. There are many traces in Manouvrier's paper of the old view of a "coefficient" by which the long bone must be multiplied in order to obtain the stature. Beyond this view, it cannot be said to contain any theory, and it suffers from certain marked defects.

Manouvrier's memoir was rapidly followed by an excellent piece of work from Rahon, who collected measurements of the long bones of a very wide series of local races of man, and reconstructed their stature by aid of Manouvrier's tables.

The present memoir starts with the theory of probability, which the author has already applied to other problems in evolution, and deduces the most probable stature for any combination of the four long bones. It is shown that for a population with normal correlation, the relation between stature and one or more long bones is always linear. A general theorem is proved to show that no linear function of the long bones can give the probable stature with so small a probable error as the regression formula of the theory of probability. From this result the following conclusions are obtained:

(*a*) No constancy of the ratio stature to long bone is theoretically to be expected, but the ratio of deviation from mean stature to deviation from mean long bone, *i.e.* the regression coefficient is the quantity, the constancy of which might be anticipated.

(*b*) No method of predicting individual stature from the individual long bones, whether one or all are used, can give a result with a less probable error than 2 cm.

(*c*) For the same length of femur, tibia, and humerus, the stature is shorter the longer the radius. This result has considerable bearing on the relationship of man to the anthropomorphous apes.

Formulæ are then obtained for the reconstruction of probable stature as measured:

(*a*) On the corpse, from the lengths of the long bones containing animal matter, and with the cartilages attached. These will possibly be of service for purposes of criminal investigation.

(*b*) In life, from the lengths of the long bones without cartilages, and free of all animal matter.

Corrections are given for cases in which the femur is measured in the oblique position; the tibia is measured with the spine; and the left-, instead of the right-, hand members are known.

The manner in which natural selection modifies the regression formulæ is indicated, It is pointed out that the divergence between such regression formulæ really enables us to predict to some extent the nature of the differential selection which has taken place between two local races. To test how far we may safely apply our formulæ to other than French measurements, the stature of the Ainos ♂ and ♀ is reconstructed by means of them from Koganei's measurements of the long bones, and the result is found to be very satisfactory. With a view of illustrating the change in the regression formulæ owing to selection, the anthropomorphous apes are considered, and it is shown that the gorilla, in the regression formulæ for femur and tibia stands much closer to man than either the chimpanzee or orang.

The formulæ are applied to reconstruct the stature of prehistoric, mediæval and modern races. The modern populations occupying the same districts of Europe as Palæolithic and Neolithic man appear to be taller, but in the case of both south Germany and France there appears to be a slight, but sensible, decrease of stature since proto-historic times. Modern English do not seem to have decreased in stature since the ancient Anglo-Saxons. In the estimates of stature for the above races, the author differs, in some cases very considerably, from previous writers.

Beyond the range of normal population (say from 157 to 175 cm. for ♂), the line of regression ceases to be linear. An attempt is made, such as existing data will allow of, to express the line of regression by the equation to a curve. The prediction of the stature of dwarfs from the curve obtained from the data for giants shows only 2·25 cm. mean error, and must be considered satisfactory. Application is then made of the results to reconstruct the stature of Bushmen, Andamanese, Akkas, and of European neolithic dwarfs.

PARIS.

Academy of Sciences, July 11.—M. Van Tieghem in the chair.—On the decomposition of nitric acid by heat at moderately high temperatures, by M. Berthelot. Pure nitric acid is not decomposed when kept in the dark at the ordinary temperature, but at 100° measurable amounts of oxygen and nitrogen peroxide are produced. Nitric acid of specific gravity 1·333 is not appreciably decomposed under similar conditions.—On the compressibility of air considered as a gaseous mixture, by M. E. H. Amagat. In air, the oxygen and nitrogen appear to be compressed, as if each were at the pressure of the mixture; the volume of the mixture is sensibly equal to the volume of the constituents. A table is given showing the deviations found experimentally for pressures between 100 and 3000 atmospheres, deviations which are within the known experimental error.—On the systems of differential equations satisfied by quadruply periodic functions of the second species, by M. Martin Krause.—On a mode of supporting the motion of a pendulum, by M. A. Guillet. The impulses are given electrically by induction currents at the same point in its path, one as it ascends, and the other as it descends, the disturbances thus set up being exactly equal and of opposite sense. Comparisons with a free pendulum showed that the time of vibration was unaltered by the use of the mechanism described.—On the passage of electromagnetic waves from a primary wire to a secondary wire parallel to it, by M. C. Gutton.—On the mode of oxidation of cobalt salts in alkaline solutions, by M. André Job. It has been known for some time that cobaltous salts, treated with potassium bicarbonate and hydrogen peroxide, give a higher oxidation product having a green colour, the exact composition of which has not hitherto been proved. By means of the ferrous reducing agent recently described by the author, it is now shown that the oxygen taken up corresponds to Co_2O_3. The estimation of cobalt in presence of nickel and iron is easily carried out by this method.—Action of heat upon the double nitrites of the alkalis and metals of the platinum group.—Compounds of rhodium, by MM. A. Jolly and E. Leidié. At 440° the double nitrite $Rh(NO_2)_6.6KNO_2$ is decomposed into nitrogen, nitric oxide, and a salt having approximately the composition $K_2Rh_6O_{13}$ or $K_2O.6RhO_2$. These results are considered as affording evidence in support of the oxide RhO_2.—On the production of tungsten blue, by M. Albert Granger. By the use of a mixed tungstate of barium and sodium a fine indigo-blue glaze is imparted to porcelain, if the temperature is about 1250°, and the heating carried out in a reducing atmosphere.—On the yttrium earths arising from the monazite sands, by M. G. Urbain.—On the brominating action of aluminium bromide in the fatty series, by M. A. Mouneyrat. Ethylene bromide, treated with $AlBr_3$ at 110° C. gave acetylene. With bromide and aluminium bromide, ethyl bromide is readily converted into ethylene dibromide, and the latter again into symmetrical tetra-bromethane. From this hexabromethane can be obtained without difficulty.—On some mixed phenyl-alkyl-carbonic ethers, by MM. P. Cazeneuve and Albert Morel. A description of the mode of preparation and physical properties of the phenylmethyl, phenylethyl, phenylpropyl, phenylisopropyl, phenylisobutyl, phenylisoamyl, and ethylallyl carbonates.—On the saponification velocity of some phosphoric ethers, by M. J. Cavalier.—Action of tetrazodiphenyl, tetrazodiorthotolyl, and tetrazodiorthoanisyl chlorides upon methyl and ethyl cyanacetates, by M. G. Favrel.—On the phosphates in urine, by M. L. Jolly. The facts noticed by MM. Lépine and Aubert, and explained by them by the assumption of incomplete oxidation of phosphorus in the urine, are shown to be susceptible of another explanation.—Presence of chlorophyll in a nostock cultivated entirely in the dark, by MM. A. Étard and Bouilhac. The green colouring matter, previously noticed by M. Bouilhac, is here proved to be ordinary chlorophyll.—On a product of decomposition of albumen, by M. J. M. Albahary. In an attempt to prepare an iodine derivative of albumen, a new acid was obtained, oval-buminic acid, forming a definite, crystallised sodium salt, and also a gold salt. The molecular weight of the acid determined by means of the latter was 1670.—Action of the sorbose bacteria upon xylose, by M. Gabriel Bertrand. The bacterium exerts an oxidising action, an acid, xylonic acid, being formed in small quantity.—New biological observations upon the life in colonies of the fixed tunicates, by M. Antoine Pizon.—Alkaline reaction of the chambers and galleries of ants' nests. Duration of life of decapitated ants, by M. Charles Janet.—Improvement of the wild carrot, by grafting it on the cultivated carrot, by M. Lucien Daniel.—Results of the ascents of three experimental balloons at Trappes, on June 8, by M. L. Teisserenc de Bort. The height attained was 13,000 metres, the lowest temperature −59° C.—On a means of avoiding collisions at sea by means of electromagnetic waves, by MM. A. Berget and L. Décombe.—On stereoscopic vision in kinematography, by M. Aug. Rateau.

AMSTERDAM.

Royal Academy of Sciences, May 28.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Schoute, on cyclographic representation in space of Joachimthal's circles.—Prof. Haga, on maxima and minima of apparent brightness, resulting from optical illusion. When in a plane on which the eye is fixed, two zones of mutually different, but each in itself of uniform (or slowly varying) intensity of light are connected by a zone the intensity of light of which gradually decreases from that of the lighter to that of the darker zone, then the transition zone seems to be separated from the brighter one by a still brighter line and from the darker one by a still darker line. This optical illusion, which occurs under very different circumstances, and the peculiarities and possible explanation of which were briefly indicated by the author, is important: (1) because it has already often (*e.g.* in the case of X-shadow figures) made investigators imagine that they observed diffraction or other important lines; (2) because it is not impossible that, for the above reason, the indistinctness of the edge of a dark or a light line may give, or have given rise to the observation of an apparent doubling of such a line; (3) because it may lead to an incorrect estimation as to the place of the maxima and minima in systems of lines, in which the intensity of light is not symmetrically distributed with respect to the middle of those lines.—Prof. Beyerinck, on the relation of obligatous anaerobics to free oxygen. The moving bacteria present in great numbers in preparations for the microscope, which allow the air to enter at the edge of the cover-glass, arrange themselves in special figures according to their greater or smaller predilection for oxygen. The author has called them "figures of respiration." Formerly he thought that three types might be distinguished: the "aerobic type," represented by those bacteria which seek the highest tension of the dissolved oxygen; the "spirillous type," corresponding to a medium; and the "anaerobic type," corresponding to a minimum tension. Further researches have shown that the anaerobic type, characterised by the accumulation of anaerobic bacteria at the place where the oxygen tension is smallest—generally the centre of the drop—does not exist as a special case, and is only observed when the quantity of oxygen that enters, exceeds a certain minimum, and that at this minimum or below it all observed anaerobics arrange themselves into the figure of the "spirillous type," *i.e.* they do not seek the smallest tension, but a medium one, like the spirilli themselves. Consequently not three, but only two types exist, which may be termed *aerophily* and *micro-aerophily*. It can be shown that what has been said about the mobility holds good for the growth of some, possibly of all anaerobics, so that it is not absolute absence of oxygen that is most beneficial for their growth. The experiment is made by sowing a very great number of non-aerated germs of anaerobics together with a very great number of oxygen-absorbing aerobics in a solid culture mass contained in a glass tube, allowing diluted air to enter at only one end. A level of maximum growth of the anaerobics may then be observed, not deep down, where oxygen is quite absent, but at some distance from the surface, where the tension is most favourable for them, which clearly shows that anaerobics are micro-aerobics also in relation to growth. The anaerobic material, used for the experiment, must be taken from cultures, long continued with the exclusion of oxygen, which enables them to grow deep down in the tube. It is probable that the possibility of their aerobiosis depends on this very oxygen charge quite in the same way as is the case with alcohol yeast. In conclusion all living organisms, examined up to the present moment, are aerophilous or micro-aerophilous with respect to mobility as well as to growth.—Mr. Hamburger on the influence of salt solutions on the volume of animal cells, being at the same time a contribution to the knowledge of their structure.—Mr. P. Zeeman presented a paper on an instance of asymmetry in the change of the spectral lines of iron, radiating in a magnetic field.—Prof. Kamerlingh Onnes presented, on behalf of Mr. E. van Everdingen, jun., a communication entitled "Hall's effect in electrolytes." A formula for this effect in the case of a partially dissociated electrolyte is deduced. By means of the simpler formula for the effect in a completely dissociated solution, the numerical value of the rotation of the equipotential lines in a special case is calculated and compared with the result of Bagard's experiments in the same case. The theoretical value proves to be 10^6 times smaller than the observed value. The author concludes that the difference of potential, observed by Bagard, is due to disturbances, already indicated by Chiavassi and others.

CONTENTS.

THURSDAY, JULY 28, 1898.

SUBMARINE TELEGRAPHS.

Submarine Telegraphs. By Charles Bright, F.R.S.E. Pp. 744. (London: Crosby Lockwood and Son, 1898.)

IF experience, the possession of records, filial devotion, and many friendships qualify a man to chronicle contemporaneous events, Mr. Charles Bright is eminently prepared to write a history in which his father played an important part. This book is full of information. It gives evidence of great industry. It is well printed, admirably illustrated, thoroughly indexed, and makes a book of reference which should be in every engineer's library. The literature of the subject has been very meagre. Two or three text-books deal with the construction and working of cables. Many valuable papers are scattered in the *Proceedings* of engineering institutions, but there is no complete history of an industry that has not yet attained its jubilee. Mr. Bright has fulfilled his task very well. There is a remarkable free use of the footnote system. Sometimes the footnote, the result of subsequent inquiry, contradicts the text, but more often it gives details useful to the engineer, but uninteresting to the general reader. The book is divided into three parts: history, construction, and working. In the first part the evolution of the system of submarine telegraphy, still in active progress and without any sign of finality ahead, is lightly sketched. The days of secrecy have ceased; and manufacturers, engineers, and commercial managers are equally ready to publish all they know. The rough and tumble rule of thumb method of the speculative pioneer has disappeared, and the results of practical observation and scientific deduction control the progress of the industry. It is very interesting to note that the form of the first effective cable laid from Dover to Calais in 1851 has been but very little departed from, but its details and dimensions have changed with every requirement and for every ocean. Its development has given a knowledge of the sea, of its bottom, of its currents, and of its life, that has enlightened the geographer and the biologist. Science has advanced *pari passu* with engineering. The engineer has succeeded in interring many a foolish assumption in Davy Jones' locker, and in bringing to light and illustrating many a new condition undreamt of by the mathematician. Mr. Bright points out that success was obtained in face of scientific and public opinion. Even the Astronomer Royal of the day (Airy)

> "had very foolishly stated that it would be impossible to deposit the cable at so great a depth; and that in any case it was mathematically out of the question to transmit electrical signals through such a length (p. 51).

Now depth is no impediment; there are twelve cables spanning the North Atlantic. Fifty words a minute can be sent across the ordinary Atlantic in each direction at the same time, and it is pronounced by Mr. Preece even not impossible to speak by telephone between New York and London. The mileage of cable laid about the world is 170,000, and 50,000,000*l.* has been invested in the industry. The author avoids the prevalent mistake of using the term "knot" as a standard of length. It is a velocity, and the proper term for lengths is nautical miles (N.M.) or "nauts."

It should be recorded that the first money subscribed for the construction and laying of a submarine cable to cross the Channel, or indeed any sea, was 500*l.* each from Mr. (afterwards Sir Charles) Fox, Mr. Francis Edwards, Mr. J. W. Brett, and Mr. Charles J. Wollaston—the last-named being still living. These formed "The English Channel Submarine Telegraph Company" in 1850, and were the financial pioneers of the industry.

The construction, laying, and repairing of cables are very fully illustrated, the portion dealing with insulating materials is instructive, and the methods of working, together with the speed of signalling, are gone into very thoroughly. There is a want of agreement among experts in adopting some standard of reference as regards rate of working. Words per minute is very vague. What is the length of a word? Is it five letters, seven letters, or even ten letters per word? Are abbreviations used or not? Are the words ordinary or code? How many elements are there allowed in a letter, and how much is allowed for spacing? What allowance is made for skill? The only true criterion of speed is the number of complete waves that can be automatically and clearly transmitted per unit of time, and even this will depend on the sensitiveness and reliability of the apparatus used at each end.

Mr. Bright has executed his task in an impartial and disinterested way. He has marshalled his facts with much clearness, and the few errors detected are errors of proof-reading, easily remedied in the next edition. The most notable omission is that of the modern improvements in repairing apparatus. There is no description of cutting grapnels, or of the ingenious automatic signalling of the cable caught on the prongs of the grapnel at the bottom of the ocean. Moreover, he has not chronicled events in their chronological order, which becomes occasionally embarrassing in tracing historical sequence.

The history of submarine telegraphy is an excellent example of bold commercial enterprise, combined with blind faith in the prowess of the engineer and determined perseverance in overcoming great difficulties. The names of Cyrus Field and John Pender must always be associated with those of Bright, Canning, Varley, Kelvin, Clark, Siemens, and others, living and dead, who have done so much to establish the industry on a sound practical and commercial basis. Science, too, has benefited largely in numerous ways by this very progress. Physics, geography, biology and astronomy have each gained new facts and new conditions. The accurate determination of the longitudes of distant centres is no mean advantage: that of Madras has recently been measured with great skill. The columns of the *Times* every morning show how completely space has been annihilated, and how the uttermost ends of the earth are now virtually in London.

A LIFE OF PASTEUR.

Pasteur. (The Century Science Series.) By Percy Frankland, F.R.S., and Mrs. Percy Frankland. Pp. vi + 224. (London: Cassell and Co., Ltd., 1898.)

IT is a pleasing task to review a book devoted to the life of a great man, and especially so when that book, like the one before us, does not pretend to be an exhaustive biography, but is intended to tell simple salient facts in a straightforward and scientific manner. This is well accomplished in sixteen chapters; and those who read them will have had amply demonstrated to them a most lovable and simple character, and a series of epoch-making discoveries which the reader can never fail to appreciate, for they were all directed to alleviate suffering and distress. In the first chapter one seems to obtain a clue to the bent of Pasteur's mind, for at the age of twenty-five he had worked out the optical properties of the tartaric acids, and had laid the foundation of our knowledge of the grouping of atoms. In the manner in which he studies the growth of the crystals one sees at this early stage the mind of the biologist, and step by step this becomes more noticeable. In the second chapter, two great events are briefly and sympathetically chronicled by the authors. The first is his marriage, the second emphasises his remarkable observation upon the action of fermentation upon the tartaric acids, showing the delicate selective action of organisms in readily picking out what appear to be chemically identical substances. "His work during this period stands out as one of the most remarkable and artistic monuments in the annals of chemical science."

Chapter iii. is a serviceable and useful one. Pasteur is created Dean of the Faculty of Science at Lille, and at once directs his scientific knowledge to the requirements of the place. The town is a centre for the manufacture of alcohol from beetroot, and Pasteur studies fermentation, and Lille and the world at large has benefited by these studies. It is often stated that the seats of learning are not in touch with the communities in the midst of which they live; it is due, to a great extent, to a lack of the sense of citizenship and patriotism, both of which were developed in a remarkable degree in Pasteur. In the brief sketch of the dawn of fermentation, the very natural opposition of the chemists, and of the others of a less bold frame of mind, is admirably brought out, and Liebig and Helmholtz stand forth in the opposition as men of narrower conception.

In 1857 Pasteur was made Director of the École Normale, an honourable title to which was attached a modest salary but no laboratory, France in no way differing from us in this respect. By this time the biological turn of Pasteur's mind had become much more pronounced. He not only saw the living cell at work and producing the fermentation of beer and vinegar, but he recognised that putrefaction and decay were fermentative processes produced by aerobic and anaerobic organisms. And just as his studies in the fermentation of beer marked a new period in the history of brewing, so at the present time his observations upon putrefaction are being made the basis for the treatment of sewage. Criticism and opposition to his views had by this time largely increased, but the result was excellent and far-reaching; for he laid the ghost of spontaneous generation, and demonstrated to the world that for their foods and infective diseases there could be effective sterilisation.

In Chapters vii.-ix. a still further development of fermentation is developed, and one which was destined to lead directly on to Pasteur's greatest service in the cause of humanity. In these chapters are unfolded his observations upon abnormal fermentation or the diseases of wine, beer, and of silkworms. The authors show how the industries concerned profited by these researches, and how the study of the diseases of the silkworms at once pointed out the necessity in the case of man and animals of intelligent central control in all infectious processes.

In Chapter x. and onwards the final work of Pasteur is described. Henceforth Pasteur is known as the pathologist who was able to bring a vast storehouse of chemical knowledge to his aid. He enters upon a new career, and soon begins to exercise as profound an influence in the medical world as the yeast cells did in the fermentative processes which he was the first to describe. Not only in France, but throughout Europe, medical men were encouraged by Pasteur's successes to come forward and prosecute their own studies into the cause of disease. In this manner it is clearly brought out, Davaine pursued his researches in anthrax, and Lord Lister his investigations in the treatment of wounds, methods which were destined to inaugurate a new epoch in surgery. Pasteur himself led the way in one direction of vast importance and utility, namely immunisation. This is developed in Chapters xii. and xiii., and the reader cannot fail to be filled with enthusiasm when he thinks of the beneficial results which have accrued and are likely to accrue from researches, prompted by a profound conviction in Pasteur's mind that there was a possibility of immunising against disease.

Chapter xiv. treats upon the researches in rabies, and every one will share the feelings of the authors in the stress they lay upon this most marvellously bold step in the cure of disease; it was probably his greatest achievement. The transformation worked in the medical profession had become complete, and laboratories similar to the Pasteur Institute were erected all over the civilised world; researches multiplied, and a new literature sprung into existence. We would wish that those who so hotly criticise Pasteur's work, could pause a little and read this chapter on rabies, and could see with us, something beyond the mere experiments therein recorded, the working of a civilising force which Pasteur has caused to take the form of a study in hydrophobia.

R. B.

GARDEN-CRAFT.

Garden-Making. By L. H. Bailey. Pp. vii + 417. (London: Macmillan and Co., Ltd., 1898.)

The Pruning-Book. By L. H. Bailey. Pp. ix + 537. (London: Macmillan and Co., Ltd., 1898.)

THESE two volumes of the Garden-Craft series may, inasmuch as they deal mainly with technical subjects, be here taken together. Products of the pen of Prof. Bailey, originality of treatment may be confidently looked for and as certainly found. Neither principles nor practice in America differ in essentials from those on this side of the globe; their application necessarily differs according to climatal and economic environment. The American territory, however, is so vast that differences of environment are as great in different parts of the Union as they can be between the old Continent and the new.

Business men are keen in the growth, the purchase, and the sale of plants in both countries. The enormous increase in the cultivation of fruit and flowers for market in the vicinity of London and other great towns is one of the most remarkable features of the last quarter of a century, but one which the economists have not yet fully realised.

The mania for cultivating certain classes of plants—for instance, orchids—has led in certain special cases to an enhancement of value which seems preposterous, though it must not be forgotten that there are hundreds of other plants of equal beauty and interest the price of which may be reckoned in pence.

The extravagant use of flowers for decorative purposes by persons who, for the most part, care little and know less of the plants they utilise, is a phenomenon quite as marked, if not more so, in the States than here. In this country we have, happily, nearly abandoned the floral devices where battleships, mail-carts and other incongruous things are simulated in flowers, and carpet-bedding is gradually becoming less offensive here, though in full blaze in the States.

Withal, gardening for gardening sake is at present less prevalent in the States than in the older countries. The repose, the refinement, the seclusion, the interest attaching to the culture of plants and the maintenance of a garden, are relatively less observable in the new than in the old country. America, moreover, although she has given us botanists of the first rank, has not yet furnished gardeners to rank with a Knight, a Herbert or a Lindley.

That such men may be looked for in the future is, we think, evidenced by the superior quality of the American horticultural hand-books, and by the multiplication of experiment stations. We are not speaking of established text-books, but of the flood of gardening literature which is now being poured out, the quality of which is often in inverse proportion to the bulk.

Prof. Bailey's "Garden-Making" is original and suggestive, and the most mechanical operations are illumined by thoughtful comment and quaint remark. It is as well to say that the book is intended for gardeners who pursue the art on a large scale for commercial purposes. The ordinary gardener would be scarified—the word is appropriate—by the "plows," harrows, and "cultivators" here figured, and the amateur would banish from his "borders" such fearsome weapons and those who used them.

Nematode worms cause much destruction in English gardens, but the American gardener, it seems, sterilises the soil by allowing it to become thoroughly frozen before use, a practice which could not always be followed here. The second section of the book is devoted to the subject of laying-out the garden. The author's guiding principle is that the planting should be done with the definite object of producing a picture, however small. Meaningless planting is very properly deprecated, and numberless suggestions are given for planting which shall be at once pleasant and appropriate. The latter part of the volume is devoted to lists of hardy plants, fruits and vegetables, suitable for cultivation in the Northern States.

The "Pruning-Book" is marked by the same characteristics as "Garden-Making." Artificial pruning serves to regulate the struggle for existence among buds, to favour those which are required for the purposes of the gardener, and to obviate and nullify the competition with others. The operations of the gardener thus differ from natural ones in the circumstance that they are effected with a definite object in view; whilst in nature, that bud survives which is best adapted to the conditions. Wounds and their mode of healing receive much attention, and we note that Prof. Bailey recommends an application of Bordeaux mixture as a dressing for wounds, a practice which, so far as we know, has not been followed in this country. In the matter of pruning and training we have not much to learn from our cousins; indeed it seems, from the quotations in Prof. Bailey's book, as if we were the instructors in this case.

OUR BOOK SHELF.

The Diseases of the Lungs. By James Kingston Fowler, M.A., M.D., F.R.C.P., and Rickman J. Godlee, M.S., F.R.C.S. Pp. xv + 707. Plates v. 1060 Illustrations. (London: Longmans, Green, and Co., 1898.)

THE collaboration of a physician and a surgeon for the purpose of producing a text-book of diseases of the lungs is *à priori* likely to be successful. It has long been quite usual to incorporate into text-books on medicine a chapter by a surgeon upon the surgery of the chest; but the present book, so far as we are aware, is the first of its kind. A perfect knowledge of the capabilities of surgery is essential to the physician, and although a relatively small part of the volume before us is from the pen of Prof. Godlee, his contributions to it lend to the book a very special value to the physician.

The book begins with a chapter on the anatomy of the chest by Prof. Godlee, in which are numerous illustrations; the author's reputation as an anatomist is well maintained, and all the anatomical points of importance in the surgery and medical diagnosis of chest disease are well emphasised. The medical part of the volume is introduced by a chapter on physical diagnosis. Nine chapters are devoted to pulmonary tuberculosis, and together form a very exhaustive monograph upon the subject. So much has been written upon the pathology of tuberculosis by pathologists, that in a work like the present, written by a physician, one naturally turns to the clinical part, and especially to treatment. From this it appears that Dr. Fowler shares the general opinion of the value of the so-called open-air treatment of phthisis, especially when combined with forced feeding, as practised at what may be termed the sub-alpine sanatoria abroad. These sanatoria are now not wanting in England and Wales, and it is to be hoped that all consistent with medical ethics will be done to make them well known. Serum treatment, including under this term the "tuberculines," and the antiseptic treatment, are not spoken of very favourably by the author. Prof. Godlee contributes a chapter upon the surgical treatment of pulmonary cavities, and one upon injuries of the lungs. The subjects of hæmoptysis, pulmonary syphilis, pneumothorax, are exhaustively treated. The volume concludes with a short essay on clubbing of the fingers and toes, containing a photograph and skiagram obtained from a patient suffering from this condition; the latter showing that the ends of the terminal phalangeal bones are not enlarged.

The book is well indexed and written in a clear style; it will doubtless occupy a prominent place amongst the text-books of diseases of the lungs, and well deserves to do so. F. W. T.

An Elementary Course of Infinitesimal Calculus. By Horace Lamb, M.A., F.R.S., Professor of Mathematics in the Owens College, formerly Fellow of Trinity College. Pp. xx + 616. (Cambridge: University Press, 1897.)

THE author states that his aim in this book is to teach those portions of the Calculus which are most useful for a student of physics or engineering. We fear that many an engineering student would be disheartened at the start-off by such sections as those in the first chapter on the upper or lower limit of a sequence and of an assemblage. On the other hand, there is surely room to doubt the wisdom of the limitation implied in the statement—"Imaginary quantities are nowhere employed in the book," seeing that this is a book of over 600 pages, and includes chapters on differential equations in which symbols of operation are freely used.

But although we think there is at once too much and too little for the needs of engineering students, and that it is to be regretted that the author has not permitted himself to use illustrations from such subjects as heat or electricity for the benefit of the students of physics he has in view, we are glad to recognise in the work before before us merits of a very high order. Thus immediately after the rules for differentiation are established, we have applications to maxima and minima and to geometrical problems. The rules for integration are then introduced with applications to areas, volumes, moments of inertia, &c. The diagrams are numerous, always large and clear, and often drawn to scale. There are a great many easy, straightforward examples provided; and care has been taken not to admit examples or processes involving difficult analysis or mere ingenious artifice.

Teachers in secondary schools and colleges will be well advised in using this as a text-book for beginners in the Calculus, although it is not in our opinion what is required in technical classes.

Radiography and the "X" Rays. By S. R. Bottone. Pp. x + 176. (London: Whittaker and Co., 1898.)

THIS is another of the now considerable series of more or less popular handbooks dealing with the applications of the Röntgen rays. Medical men, amateur experimenters and others who may wish to put Röntgen photography into practice will find it useful, lucid, and trustworthy. Within the compass of 172 pages the book contains many practical hints on the construction and working of induction coils, influence machines, Crookes' tubes, and fluorescent screens, and on general photographic and manipulatory details.

Ackworth Birds, being a List of Birds in the District of Ackworth, Yorkshire. By Major Walter B. Arundel. Pp. viii + 105. (London: Gurney and Jackson, 1898.)

IT may be well to remark at once that this is not merely an enumeration of the birds observed in Ackworth and the neighbourhood, but a collection of notes on the habits of the species described. On this account, the volume is not only of interest to local ornithologists, but is also a worthy contribution to the literature of bird-life.

Angling Days and an Angler's Books. By Jonathan Dale (I. E. Page). Pp. 160. (London: Elliot Stock, 1898.)

A COLLECTION of stories concerning anglers and angling. A few natural history notes are scattered through the pages; but in the main the book consists of more or less commonplace remarks upon fishing experiences, and the expression of the author's sentiments upon landscapes and rural scenes in general.

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.*]

Liquid Hydrogen.

I SHOULD be inclined to let Prof. Dewar's manner of replying to my statements speak for itself were it not that he makes in his last letter imputations of an unwarrantable kind. He says, "Mr. Hampson got at my assistant behind my back." This expression is quite indefensible. I received an introduction to Mr. Lennox from the senior partner of a large chemical firm in London of the highest standing, who said that he had a familiar acquaintance with Prof. Dewar's assistant. Had he been sufficiently intimate with Prof. Dewar himself to offer me a confident hope of gaining that gentleman's attention directly, I should at that time have been still better pleased with an introduction to him. As it was, I went openly to the Royal Institution, in the busiest part of session, and between the hours of eleven and twelve in the morning. Surely, nothing would have been more natural under these circumstances than a chance meeting with Prof. Dewar himself. Is this the conduct of one who was plotting to "get at" his assistant "behind his back"? Whatever grounds Prof. Dewar may have for thinking his assistant capable of improper action, he has no right to use such abusive terms regarding the very simple and straightforward course that I took in the matter. Prof. Dewar says, "I infer from the public correspondence that he (Mr. Lennox) saw that they (the plans) would not work, and he told Mr. Hampson why they were unworkable." This inference of Prof. Dewar's is altogether false, as is best proved by a study of the correspondence itself. This correspondence took place in *Engineering* last spring. I am myself so satisfied with the conclusions to be drawn from it, that I have had the whole series of letters reprinted, and I will send a copy with pleasure to any one who desires to do me the justice of forming his own opinion on the merits of the case. It is strange that Prof. Dewar, having himself published his belief that his assistant is capable of being "got at" by a complete stranger, should in the very next line attach some importance to that gentleman's account of the transaction as given in those letters. The identity between the "unworkable" plan proposed by me to Mr. Lennox, and that subsequently, or, as Prof. Dewar puts it, "in the meantime," worked out with complete success by Dr. Linde, by myself, and by Messrs. Lennox and Dewar, does not depend on my statement only. All the points of the new combination were put together in the drawings submitted by me to Mr. Lennox, and an exact copy of these drawings was exhibited before the Society of Chemical Industry on May 2 last, when Mr. Lennox was present, as well as Prof. Dewar, and it appears with the published report of my paper. The same combination is found in no earlier drawings except some previous sketches of my own. Prof. Dewar, in his last letter, admits an inventor's property in "the particular combination to which he himself may give concrete form"; and I gave concrete form to this particular combination in the drawings submitted to Mr. Lennox. Prof. Dewar says that it took me "another year to perfect a provisional specification," "which is totally devoid of any plan or drawing of a workable apparatus." It only took five months, of which time half was spent in waiting for Mr. Lennox to fulfil his promise to experiment, and in trying to extract from him some information as to what was being done. It was my failure to obtain any satisfaction on this score that decided me to apply for provisional protection, for which drawings are not required, as Prof. Dewar well knows. My communications to Mr. Lennox were made in November and December 1894, my application for provisional protection in May 1895.

July 22. W. HAMPSON.

The Distribution of Prepotency.

MR. GALTON has raised under this heading a most important point—or, rather, a series of most important points—in the problem of evolution. Perhaps I may be permitted to say a few words with regard to his views on evolution by sports and by normal variation. Mr. Galton's opinion, I think, is that sports are inherited in a higher degree than improbable normal variations, and that evolution must accordingly take place very largely by means of the former. To use a term I have introduced elsewhere, the sport connotes a shifting of the focus of regression, but any normal variation, however improbable, does not. In the preface to the 1892 edition of his "Hereditary Genius," Mr. Galton writes: "All true variations are (as I maintain) of this kind [*i.e.* sports], and it is in consequence impossible that the natural qualities of a race may be permanently changed through the action of selection upon mere variations. The selection of the most serviceable variations cannot even produce any great degree of artificial and temporary improvement, because an equilibrium between deviation and regression will soon be reached, whereby the best of the offspring will cease to be better than their own sires and dams." And again: "The case is quite different in respect to what are technically known as 'sports.' In these a new character suddenly makes its appearance in a particular individual, causing him to differ distinctly from his parents and from others of his race. Such new characters are also found to be transmitted to descendants. Here there has been a change of typical centre, a new point of departure has somehow come into existence towards which regression has henceforth to be measured, and consequently a real step forward has been made in the course of evolution. When natural selection favours a particular sport, it works effectively toward the formation of a new species, but the favour that it simultaneously shows to mere variations seems to be thrown away so far as that end is concerned."

I have cited these passages because Mr. Galton's letter seems written with a view to their support, and because they contain principles which I feel to be unproven and even opposed to fairly well-established theory. I will take these principles in order.

(1) *No real step forward can be made by the selection of mere normal variations.*

This principle is stated as if it flowed from the theory of regression; but it is entirely opposed to that theory, and to Mr. Galton's own law of ancestral heredity. According to that law, if the average midparents of the 1st, 2nd, 3rd . . . generations possess on the average quantities h_1, h_2, h_3 . . . of a character in excess of the general population, then the average offspring will possess a quantity h of the character given by

$$h = \tfrac{1}{2}h_1 + \tfrac{1}{4}h_2 + \tfrac{1}{8}h_3 + \ldots$$

Now, if we select parents with deviations H from the general population, these parents being "mere variations," whose ancestry were entirely mediocre, or $h_2 = h_3 = 0$, we have $h = \frac{1}{2}$ H, or the children have half their parents' character. Their offspring, however, have not only exceptional parents but exceptional grandparents; thus, while they lose as to their parents, they are a stage further removed from mediocrity in their grandparents, and for them $h_1 = \frac{1}{2}$ H, $h_2 =$ H, and $h_3 = h_4 = \ldots = 0$. Hence $h = \frac{1}{2}(\frac{1}{2}\text{H}) + \frac{1}{4}\text{H} = \frac{1}{2}\text{H}$. For the grandchildren, $h = \frac{1}{2}(\frac{1}{2}\text{H}) + \frac{1}{4}(\frac{1}{2}\text{H}) + \frac{1}{8}(\frac{1}{4}\text{H}) = \frac{1}{2}\text{H}$. Thus by a *single* selection from normal variations and in-and-in breeding a stock has been established which differs by $\frac{1}{2}$ H from the general population. Selection for only two generations leads to a stock with three-quarters of the required character, while selection for three generations from mediocrity gives a stock stable with 87·5 per cent. of the selected character.

I contend therefore, against Mr. Galton, that normal variation really affords material for stable changes, and this without that development "slowly through the accumulation of minute and favourable variations during a long succession of generations" which he considers necessary. Artificial selection in the matter of horse-breeding has, I believe, quite play enough for great changes in the material provided by normal variation. If we take a great thoroughbred sire and put first-class thoroughbred mares to him, we should be utterly wrong in supposing a regression in their offspring measured by $\frac{1}{2}$ (the mean deviation of sire and dam) towards the mediocre race-horse. The sire and dam in this case have, even for thoroughbreds, exceptional pedigrees behind them. I think this goes a long way to explain the phenomenon noted by Mr. Galton, namely, certain sires producing such a preponderance of standard performers. There is another point which, I think, Mr. Galton has under-estimated also, namely the effect of fashion on the breeder. Some years ago I saw a good deal of the inner working of a large thoroughbred stud, of which two at least of the stallions were always very famous horses (costing 6000*l.* to 9000*l.*). I believe from forty to fifty public mares were put to these stallions, besides from ten to twenty mares belonging to the stud itself. Their lists were always full; on the other hand, the less fashionable stallions hardly had their complement of mares, and the mares sent to them were often inferior or past their more intense fecundity. This latter is a very important consideration. I have recently been investigating the fertility of 4000 brood-mares. In this case, in one-hundred coverings we find about sixty-three cases in which foals are born and survive to be yearlings, but the standard deviation in this average fecundity is as high as nineteen foals; in other words, there is an immense difference in the capacity of different mares to produce viable offspring. Now a breeder sends not only his best-bred, but his most fecund best-bred mares to the most famous and, therefore, most costly stallions. The result is that comparatively few horses are the sires of the bulk of the best yearlings. It must be remembered that in England we have only some 4000 thoroughbred foals annually, and only a certain fraction of these ever become racers. It would by no means surprise me to find that a quarter of this contribution was due to some six or ten fashionable sires. The American conditions are probably somewhat similar. In other words the second-rate stallions, besides their inferiority in breed, are given far less chance of producing performers.

To complete Mr. Galton's argument it would be necessary to show (1) that the sires who produced only one performer had as much chance of producing performers as those who produced 71 to 154, and (2) that their pedigree was as good as the latters'. Thus it seems to me that Mr. Galton's first principle is opposed to his own law of ancestral heredity, which I look upon as demonstrated to a first approximation by observed facts, and secondly does not, I venture to think, receive support from his data for American horses.

(2) *Sports are more highly inherited than normal variations.*

This seems to me a principle which can only be proven by extensive experiment. In the first place, a "sport" must be carefully distinguished from a normal variation of an improbable degree; and this is not always easy, especially in a case like that of Mr. Galton's American trotters, where high prepotency is asserted to be a sport. In this case it is inheritance in a high degree which leads to the discovery of the sport. But what is the degree of inheritance to be expected when fashion has determined the frequency, it would be hard to say. Further, as I have pointed out under (1), the degree of inheritance depends on the stability of the stock, and the performances of the pedigree of the five leading stallion trotters as compared with the performances of the pedigree of the average stallion trotter are not given by Mr. Galton. The degree of inheritance of the character of the sire by the offspring depends on what I have elsewhere termed the coefficient of stability; and not only is this pedigree often missing in the selection of what is termed a normal variation, but also in the case of what is termed a "sport." It becomes, therefore, difficult to compare the rates of inheritance in the two cases.

There is a well-known case of sheep often cited to show that sports are strongly inherited, but the details of this case are not wholly clear. Polydactyly, which some might term a sport, does not seem to me to indicate any intensity of heredity beyond what may be inferred from an application of the law of ancestral heredity to the pedigree. No direct experiments on sports are known to me. Accordingly I think we must wait until experiment has shown that sports are more highly heritable than normal variations, before we assert that a case of high degree of inheritance is evidence in itself of a sport. Personally I may be bold to set up an opinion against such an authority as Mr. Galton, but the more I learn of race in man, horses and dogs, the less inclined I am to trust sports as a fundamental factor more important than normal variation[1] in the establishment of stable stocks.

But this second principle differs from the first, which I believe to be erroneous, because it ought to be capable of being settled by direct experiment, and is at present only a matter of opinion. Is it absolutely hopeless to wish for the farm which Mr. Galton once dreamed about, where direct experiment might test the laws of heredity on plants and animals?

KARL PEARSON.

[1] I would prefer the term *continuous* variation. I should not necessarily have treated variation according to the normal law of error, as the opposite to a sport.

Moral Sense and Ethic.

IN the criticism of Mr. Sutherland's book by "F. G." (NATURE, July 14, p. 241), no notice is taken of the distinction between moral sentiments and ethical perceptions. Perhaps this distinction is most evident in cases where a man, or woman, perceives an action to be a bad one, and at the same time prefers to do it, and does it.

At p. 249 Principal Lloyd Morgan quotes Mr. Thorndike as saying, of writings about animals, that "they have all been about animal intelligence, never about animal stupidity." The chapter on "the animal faculties" in my work "On Truth," contains a distinct section (p. 355) devoted to "animal stupidity," which is also referred to (p. 124) in my "Origin of Human Reason." ST. GEORGE MIVART.

77 Inverness Terrace, W., July 15.

Curious Phenomenon.

ON July 8, at about 8.50 (Mean European time), I noticed what I took at first to be the end of a rainbow. The sky was nearly cloudless towards the north; 30° south of the zenith began a mass of grey clouds, tinged here and there with red till about 15° from the horizon. Below the lowest of the red clouds was an object, about as broad as a rainbow, a degree or two E. of S., and about 12° high. It was red, but in the first few moments I thought I detected a tinge of green on the E. side. It remained in its original brightness about five minutes, then faded very rapidly, and then remained almost stationary again, finally disappearing about eight minutes after I first saw it. The sun had, so far as I could judge, set about five or ten minutes before I noticed the appearance. I am quite sure of the time, as we have a mid-day gun.

9 Gerhard Street, Kiel. N. W. THOMAS.

The Nature and Habits of Pliny's Solpuga.

ALTHOUGH of great interest in itself, the note by Prof. Cook, in NATURE for July 14, p. 247, becomes more interesting still when considered in connection with Dufour's observation touching the freedom of the Algerian Solpugas from persecution by the solitary wasps. The importance of the fact he records, moreover, would be considerably increased if the reason why the honey-bees of California permit the intrusion of their hives by these Arachnoids was explained. Such an explanation might perhaps furnish a solution to the hitherto unanswered problem why the wasps let the Solpugas alone.

R. I. POCOCK.

THE BUILDINGS AT SOUTH KENSINGTON.

SO far there does not appear to be anything finally settled with regard to the allocation of space to the Science and Art Buildings at South Kensington. While on the one hand Mr. Akers Douglas has declined to give any information to the Chairman of the Select Committee which made the recommendations which have since been strenuously supported by the representatives of Science and Art; on the other, the *Birmingham Daily Post* announces that the matter has been settled on the lines of the recommendations in question.

FIG. 1—The neighbourhood of the South Kensington and Natural History Museums, showing the space (bounded by a black line) available for Science buildings on the east side of Exhibition Road.

In order that the exact nature of the question at issue between the representatives of Science and Art on the one hand, and certain Government officials on the other, may be clearly grasped, it is only necessary to follow up the statistics given by Sir Philip Magnus in his article on Technical High Schools (NATURE, May 19). In this article a comparison was made of the area occupied by the Royal College of Science with that of several German technical schools, one of the results which clearly comes out being that some of the latter are ten times bigger than the College.

It has long been known to the Government that the College is too small. Physics, Astronomical Physics, Geology, Mining, Metallurgy and Mechanics have had to be accommodated wholly or in part in other buildings; and years ago it was agreed on all hands that the needful accommodation should be provided on the west side of Exhibition Road, on the plot of ground between the Imperial Institute Road and the Natural History Museum.

This ground had been purchased by the Government in 1890, and sold by the Royal Commission for the Exhibition of 1851, at one-third its value, for the purpose of erecting scientific buildings on it.

But quite recently all this has been changed; the perfectly novel suggestion being made that a chemical and physical laboratory should be built on the *east* side of Exhibition Road on a part of the plot of vacant ground where it was proposed some years ago to erect buildings to complete the Art Museum. In fact, Mr. Webb's plans to cover all the vacant space with Art buildings were accepted.

Under the old and accepted arrangement we were to have Art, with power of expansion, on the east side, and Science, with power of expansion, on the west side, of Exhibition Road.

Under the new proposal there would be no possibility of continuous and properly provided expansion of either. Adjacent Art buildings would strangle Science, and adjacent Science buildings would strangle Art. Hence the result would be disastrous for both, and it is on this ground that we now find the Royal Society and the Royal Academy shoulder to shoulder, and sending almost identical memorials to the Prime Minister.

The plan of the neighbourhood of the South Kensington and Natural History Museums (Fig. 1) shows, bounded by a black line, the space we may roughly take as available for the Science buildings on the vacant ground south of the existing Art Museum, on the assumption that this vacant ground is divided equally between Art and Science.

Fig. 2 shows the space thus available contrasted with the areas actually occupied by the buildings of certain continental Chemical and Physical Laboratories, *on the same scale.* It will be seen at once that London will be no better off than Graz!

We next turn to the land available on the west side of Exhibition Road. The plot which the Government has obtained from the '51 Exhibition Commissioners for a nominal sum for the purpose of the erection of Science buildings, is that bounded by the Imperial Institute, Exhibition and Cromwell Roads, and Queen's Gate. It contains 20 acres; of this more than 12 acres are allocated to the Natural History Museum. The remainder has to provide for the Inorganic Sciences, Mechanics, Physics and Chemistry in all their branches, and their teaching and applications to industry. It will be seen that the space is far too small for these needs, if the precedent set by the Natural History Museum is to be followed; and it must not be forgotten that in relation to Natural History there is no provision for teaching in the Museum, and from the nature of the subject no applications.

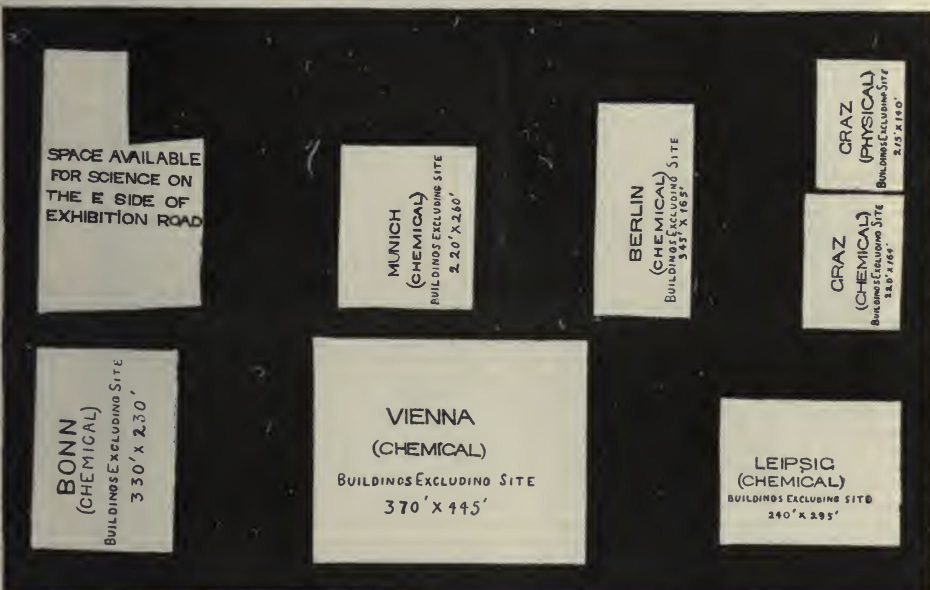


FIG. 2.—Comparison of the space proposed to be devoted to the Chemical and Physical Laboratories at South Kensington, with the space devoted to similar buildings on the Continent.

ASPECTS OF SUN WORSHIP AMONG THE MOKI INDIANS.[1]

THERE probably survives no tribe of Indians in the United States which has preserved its aboriginal worship in a purer form than the so-called Mokis, a group of agricultural people of north-eastern Arizona. These Indians live in seven villages or pueblos, situated on inaccessible mesas, and number a few less than 2000 souls. They inhabit the same territory, and in the case of the denizens of their largest pueblo, Oraibi, live on the

[1] "The Winter Solstice Ceremony at Walpi." (*The American Anthropologist*, March–April 1898.)

same site that their ancestors did when visited by the early Spanish explorers, in the middle of the sixteenth century.

For three hundred years after their discovery the Mokis were practically independent, and notwithstanding efforts were made by zealous priests to Christianise them during that time, these heroic attempts signally failed to change the aboriginal character of their religious beliefs and practices. With a pertinacity, born of conservatism, they still cling to their ancient mythology and ritual, which remains practically unmodified, presenting to the ethnologist a most instructive phase of native American religion.

An examination of this ritual shows it to be a most complicated one, as may be seen by a consultation of the extensive literature which has accumulated on this subject. Notwithstanding considerable progress has been made in the interpretation of many details, much still remains to be studied before accurate general ideas of its character are possible.

The Mokis are primarily agriculturists, and their religion is consequently one in which worship of the sun, rain, and growth of maize is pre-eminent.

The nature of their sun-worship is very obscurely known, notwithstanding it is well marked both in all great ceremonials from one end of the calendar to the other, and in many rites, which are limited to family life. Solar worship is especially prominent in the religious festivals which take place at the two equinoxes, and on the summer and winter solstices. Manifestly an adequate treatment of the subject of sun-worship among a people with whom it is so complicated, and all-pervading, would require a volume; and in a limited space I can hardly hope to do more than mention a few of many aspects of the subject.

The few lines which follow describe an aboriginal astronomical method of determination of the date of the winter solstice ceremony, and the dramatisation adopted in the performance of solar rites at that time. It is well known to students of the Moki ritual that the dates of the months on which the great ceremonials of their calendar are performed vary but little year by year, or that their religious festivals recur annually in the same months, and on or near the same days of the months. This precision would occasion little surprise, but for the fact that these Indians are, and always have been, ignorant of our almanacs, knowing nothing of our months, weeks or days.

The dates of their festivals, recurring year after year on the same, or nearly the same, days of the months, are determined by a method of great antiquity, probably pre-Columbian times. The native calendar of the Maya and kindred peoples of Central America are well known, and the accuracy with which the ceremonial and solar years were adjusted has been commented upon by several well-known Americanists. The Mokis had taken the most important step in the discovery of a similar calendar, for they are able to recognise the same day when it returns, year after year, by a purely astronomical method. To count the intervening days, or to determine the number of days in a ceremonial or solar year, was a secondary step which they never took, nor had they discovered that one festival follows another by a lapse of a certain interval of time.

The student who is interested in the question of the accuracy with which this same date was fixed upon year by year, will find in the *American Anthropologist* a tabular list of ceremonies and dates on which they occur. It will be seen from this list that while there is a variation of a few days in several important festivals, as the snake dance, in the case of those which take place at the winter solstice the method is perfect, and, as a result, the determination accurate to a day.

The dates for the celebration of the great ceremonies in their calendar are determined by the position of the sun on the horizon. The sun-lore, or astronomical knowledge necessary for this purpose, is traditional among men, called sun-priests, who belong to certain clans of the pueblo, and these clans are reputed to have migrated to Moki from ancestral homes in Southern Arizona, bringing this lore with them.

The time of year is determined by the place of the sun at sunrise or sunset, as seen from the roof of a particular house in the pueblo. The points on the horizon of sunrise and sunset, at the summer and winter solstices, are cardinal among these Indians, and they recognise that these directions have no relation to the polar north, or to one west, south and east. The four Moki cardinal points determine the orientation of their sacred rooms or kivas, and are connected with an elaborate world-quarter worship, to discuss which, in detail, would be out of place in this article.

Two of these points are called sun-houses. When the sun sets behind a certain notch in the horizon it descends into a so-called western sun-house which bears 50° south of west from the house of the sun-chief. This notch is made by a depression at the end of the Eldon Mesa, a spur of the San Francisco Mountains, appearing as a slight dent in the horizon silhouetted against the sky. It marks that point on the rim of the horizon south of which the sun never sets. The day on which the sun enters his western house he appears to stop in his southern course, as the word solstice signifies; and on the following day appears to retrace his steps, and set north of this point. Astronomically speaking, he is at the winter solstice.

In the same way a point on the eastern horizon marks the position of the sun when he halts in his northern course. This point marks the eastern sun-house from which the sun emerges at the summer solstice.

The peoples of the eastern and western horizons, as limited by the Moki cardinal points, is marked off by a number of intervals indicated by hillocks, trees, notches, or pinnacles. Each of these horizontal objects has a name known to sun-priests, who likewise know the particular days of the year which the conjunction of the sun, at sunrise or sunset, with these points indicate. Thus, when the sun rises from behind one of these hillocks the time for planting has come; or from a certain notch, the date of a great monthly festival is at hand. The sun-priest, who has determined the time by these solar horizontal observations, communicates the information to a town-crier, who announces it from the house-top in a voice audible throughout the pueblo. The native names of all these horizon points, and the corresponding ceremonials, are given in an account of the Tusayan Katcinas, published in the fifteenth Annual Report of the Bureau of American Ethnology.

It will thus be seen that with the Moki priests the position of the sun, rather than phases of the moon, is the primary method of assigning the dates to their great festivals; but there are certain ceremonials when the appearance of the moon likewise enters into the calculation.

The connection between the diminution of the lengths of the days, the cold winter, and the gradual withdrawal of the sun as each day it sets more and more to the south, has made a profound impression on the observant mind of the Mokis, and the fear naturally arose that the sun is about to desert them. As winter advances his rays become less powerful, and with equal pace a dread grows in the primitive mind that the sun will ultimately wholly abandon the distressed farmers. Special ceremonials arose out of this uncertainty. Means must be adopted to stay the sun's retreat, and rites were inaugurated for that purpose. These were founded on the belief that the sun is an anthropomorphic being who is liable to become feeble; he must be endowed with new life, and thus it comes about that one object of the winter solstice ceremony among the Mokis, as among some other races, is to recall the sun, to draw him back and recuperate his strength to fertilise the earth for successful crops.

For some reason, too profound for me to penetrate, these results are sought to be accomplished by an association of the worship of the sun with that of a plumed serpent. As with more cultured races, solar worship and ophiolatry are intimately associated both in the winter solstice ceremony and in similar weird rites which are performed at the vernal equinox immediately before planting time.

Great Serpent worship occurs in the winter solstice ceremony at Walpi, in the chief ceremonial chamber or kiva of that pueblo, on the night of December 20. At the western end of that room there is erected an altar, in the middle of which is an opening in which is placed a painted effigy of the head of the great serpent, made of a gourd. This effigy, which has a plumed head, is surrounded by artificial flowers made of small discs painted in different colours, and set in an upright framework forming a screen, which conceals one of the performers. A stack of maize is piled in front of this altar, and there are various paraphernalia of worship on the floor before it (Fig 1).

FIG. 1.—The Soyáluña Altar at Walpi.

During the singing of certain songs by the assembled priests, who are warriors, their chief advances to the altar, and sprinkles the snake effigy with sacred meal, at the same time saying a prayer to it.

The man concealed behind the bower or artificial flowers wags the head of the effigy, and blowing through a gourd produces several deep sounds imitating roars of the Great Serpent, in realistic responses to the prayers.

There are several objects sought in these prayers, one of which is that the Great Serpent will fertilise the maize before the altar. It would seem that, in their opinion, the ceremony was efficacious for this purpose, for on the morning following this rite, this maize is distributed among the women of the pueblo, to serve as seed at the next planting.

In a great annual festival at the vernal equinox, we have an even closer connection of sun and serpent worship. At that time a curtain is hung from the rafters of the same room, and this curtain or screen is pierced by a row of six holes, four of which are closed by circular flaps on which sun symbols are painted. These flaps hang by hinges from the upper rim of the orifices, and open towards the spectators. Before this screen, on the floor of the room, there is arranged a miniature field of maize composed of rectangularly arranged hillocks of soil in which sprouted seeds have been inserted. Several men stand behind the screen, and while songs are sung by a chorus, they thrust the heads of effigies of the Great Serpent through the holes in the curtain, raising the flaps decorated with sun emblems. As these monster heads protrude from the screen, a man, personating an earth goddess, passes from one effigy to another holding sacred meat to their mouths for food, and offering their artificially made breasts for nourishment.

Of the several other rites performed before the winter solstice altar, none are more instructive to the student of

Moki sun-worship than the following. Shortly after the ceremonies mentioned above, a number of men, bearing shields with appropriate totems, arrange themselves in two clusters, one on each side of the room, and in their midst stands a performer representing the sun, also bearing a sun-shield (Fig. 2). At a signal the participants, with shields adorned with their totems, engaged in a mimic combat, surging against each other with wild shouting and rhythmic stamping on the floor. This combat is a dramatic representation of the assault of hostile gods on the personator of the sun, who is ultimately victorious over his opponents. It vividly suggests certain Mexican ceremonies performed at the vernal equinox before an idol, Totec (a solar god), save that in the sanguinary Aztec rites men representing hostile gods were sacrificed to recuperate the sun. This episode in the Mexican ceremony is thus referred to by Mr. E. J. Payne in his valuable work on the "History of America." "The victims of the festival, attired like the various deities whom they represented, were conducted to one of those enclosed courts open to the sky, which have been mentioned; here a gladiatorial stone and an altar, elevated on a low platform, stood side by side. Each victim was first placed on the temalacatl and compelled to engage in an imitation of the gladiatorial combat. . . ." On receiving the first wound, he was sacrificed on the solar altar.

In the winter solstice sun-worship among the Mokis there is no such sanguinary outcome to their mimic combat of warriors, for human sacrifice is unknown to them, except in legends. The dramatic combat in the ceremonial room before the altar of the Great Serpent is a bloodless one, but its object is not greatly different from the Mexican variant, viz. to recuperate and draw back the sun by the defeat of hostile powers represented by dramatisation in the sacred room of the pueblo.

J. W. F.

FIG. 2 —Sun Shield of the Horn Society.

CLOSING OF THE BEN NEVIS OBSERVATORIES.

WE have received for publication the following extract from the Report of the Scottish Meteorological Society. It is to be hoped some means will be found of keeping the Observatories going.

"The Directors greatly regret to have to announce that the High and the Low-level Observatories at Ben Nevis will cease to exist in October of this year. This is the necessary outcome of the want of funds. There is no way, so far as the Directors can see, by which these great first-class Meteorological Observatories can be continued, except by aid from the State. In other words, the Directors have no grounds for expecting that further assistance will come from private sources."

"This decision has been come to in consequence of estimates submitted by the Honorary Treasurer, from which it appears that if, in October next, the property belonging to the Directors were realised and all obligations met, there would probably remain a balance of 250*l*. If, however, the Observatories were carried on till October 1899, there would be a debt of probably 150*l*."

"By the establishment of these Observatories, and the unique observations made at them, a great experiment has been carried out with signal success. In this work the Council of the Society has been strengthened by having on the Board of the Directors of the Observatories representatives of the Royal Society of London, the Royal Society of Edinburgh, and the Philosophical Society of Glasgow. The experiment has been, as anticipated, a costly one. A sum of no less than 18,150*l*. has been expended on the inquiry, and the sum has been obtained by contributions partly from scientific bodies, but mainly from the public."

"The Scottish Meteorological Society cannot fail to experience great satisfaction from its having been found possible to do so much; indeed, when resolving on making the experiment, and founding the Observatories, the most sanguine expectation could not have predicted the ready and liberal response made to the appeal for the necessary funds."

"With much pleasure the Directors are able to report that in a large sense the objects aimed at have been attained. A long series of hourly observations has been obtained by night and by day without a break over a period of fifteen years, though these included eye or other observations outside in the severe climate of the top of Ben Nevis, forming a set of observations quite unique, nothing similar having as yet been done at any other High-level Observatory in the world."

"The Directors would have been extremely glad if the period of simultaneous hourly observations at the High and Low-level Observatories could have been prolonged for other three years, in order to give ten annual instead of seven annual averages running from January to December, and to furnish a better basis for a minute and careful discussion of the mass of observations now in the possession of the Society, and available for the study of meteorological phenomena."

"In conclusion, the Directors cannot contemplate without sadness the giving up of these two Observatories, both well-equipped and in full working order, especially as they are strongly of opinion that two such Observatories should continue to be carried on as essentials in the observing system of the country."

NOTES.

SEVERAL congresses and meetings of scientific interest are being held as we go to press. The International Congress on Navigation was opened at Brussels on Monday last; there were more than 1000 delegates present. The opening session of the sixty-sixth annual meeting of the British Medical Association was held, under the presidency of Sir T. Grainger Stewart, in Edinburgh on Tuesday, and on the same day the summer meeting of the Institution of Mechanical Engineers began at Derby, under the chairmanship of Mr. S. W. Johnson.

THE Secretaries to the Reception Committee of the International Congress of Zoology are preparing a list of the Cambridge addresses of the members of the Congress who have definitely announced their intention of attending the approaching meeting. They will be glad to receive any information which will help them to make this list as complete as possible. It would be a convenience if those subscribers who are unable to attend the meeting will inform the Secretaries of the fact. Communications should be addressed to Mr. S. F. Harmer or Mr. A. E. Shipley, The Museums, Cambridge.

THE following grants have recently been made by the Physico-Mathematical Section of the Berlin Academy of Sciences:—2000 marks to Prof. Engler, of Berlin, for the continuation of his monograph on East African plants; 1500 marks to Prof. Schultze, of Berlin, for the publication of a work on American Hektinellidæ; 1000 marks to Prof. Brandt, of Kiel, to enable him to accompany the Prince of Monaco in the Prince's investigations in the Atlantic Ocean; 1000 marks to Prof. Burckhardt, of Basle, for investigations on the comparative anatomy of the brain; 1000 marks to Prof. Kohen, of Greifswald, for the continuation of his investigations on meteoric iron; 600 marks to Prof. Graebner, of Berlin, for the continuation of his investigations of the formation of the German heaths; 500 marks to Dr. Kruger, of Charlottenburg, for investigations on urine; 500 marks to Dr. Küster, of Tübingen, for his investigations on the colouring matter of the blood and bile; 500 marks to Dr. Loesner, of Berlin, for the completion of a monograph on the Aquifoliaceæ; 5000 marks to Dr. F. Ristenpart, of Kiel, for preliminary studies for a "Thesaurus positionum stellarum fixarum"; 1000 marks to Dr. Adolph Sauer, of Heidelberg, for the geological investigation of the Aar region; 1000 marks to Dr. Schellwien, of Königsberg, for an investigation of the Palæozoic Eastern Alps.

PROF. VON LEYDEN has been elected a corresponding member of the Paris Académie des Sciences, in the place of Prof. R. Virchow, who has been made an associate.

PROF. FOUQUÉ, of the Collège de France, has been elected a foreign member of the Vienna Academy of Sciences.

THE death is announced of Prof. Suringar, who succeeded Miquel as director of the Leyden Garden and Herbarium in 1857.

WE regret to learn that Mr. van Voorst, for many years a publisher of scientific works, particularly relating to natural history, died on Sunday last, at Clapham, at the ripe age of ninety-four. He retired from business in 1886.

THE monument to Prof. Charcot is to be formally unveiled at the Salpêtrière in Paris on October 23.

A REUTER telegram from Valparaiso states that a violent shock of earthquake, lasting a minute, was experienced on the night of July 23 at Concepcion and Talcahuano, Chile. Many houses fell in consequence, and others were damaged. Telegraphic communication was interrupted, and the electric light wires were broken. A further shock is reported to have taken place at 1.55 p.m. on July 24.

IT is announced in the July issue of the Johns Hopkins University *Circular*, that during the coming year Prof. Simon Newcomb, F.R.S., until lately director of the U.S. *Nautical Almanac*, will resume his superintendence of the work in mathematics and astronomy in the Johns Hopkins University. He will, it is stated, be especially interested in promoting the work of any student who desires to pursue an advanced course of study in celestial mechanics. Near the beginning of the year, Prof. Newcomb hopes to give a short course of lectures on the Encyclopædia of Mathematical Sciences. The *Circular* also reports that the delivery of the second course of lectures, in connection with the George Huntington Williams Memorial Lectureship, upon the principles of geology may be expected during the coming session. The first course of lectures was given, as will be remembered, by Sir Archibald Geikie, F.R.S., during the session of 1896-97.

THE steps recently taken by the Secretary of State for the Colonies, for instituting a system of instruction for medical officers of the Colonial Service in the treatment of tropical diseases, have already been noticed in the press. In further pursuance of this policy, Mr. Chamberlain has invited the Royal Society to co-operate with the Colonial Office in undertaking a thorough investigation into the origin, transmission, and possible prevention of such diseases, and especially of the malarial fevers which are responsible for such a high rate of mortality and disablement among European officers serving in tropical Africa. The Royal Society has accordingly appointed a Committee to deal with the subject, and has voted a money grant, which will be supplemented by a contribution from the Colonial Office funds, for the purposes of the inquiry. Expert investigators will probably be sent out to Africa to study the diseases on the spot, and the Committee will, at the same time, no doubt take note of the work which has been carried out by Surgeon-Major Ross in Calcutta, in reference to the supposed activity of the mosquito in relation to malaria.

A CONGRESS of the Royal Institute of Public Health will be held in Dublin from August 18 to 23, under the presidency of Sir Charles Cameron. The presidential address will be delivered on the opening day, and during the meeting there will be conferences of naval and army medical officers, of medical officers of health, of sanitary inspectors, and of veterinarians. The Section of Preventive Medicine and Vital Statistics will be presided over by Dr. Grimshaw; that of Chemistry and Meteorology by Prof. Moore; and that of Engineering and Building Construction by Mr. Cotton, of the Local Government Board. There will also be an exhibition of sanitary appliances.

AMONG the subjects proposed for discussion at the forthcoming Congress of the Sanitary Institute, to be held at Birmingham, are: Antiseptics in food; prevention of tuberculosis in relation to meat and milk supply; central cooking stations; bacteriological and clinical diagnosis in relation to the notifiable infectious diseases; prevention of measles in reference to school attendance; the soil in relation to typhoid; vital statistics; dwellings of the working classes; Birmingham water scheme; water supply for rural districts, and the means of protecting it from contamination; the qualities of sewage as affecting the method of disposal; recent advances in sewage treatment: (*a*) towns, (*b*) country houses; the natural purification of sewage; the flora of sewage; purification of trade effluents and utilisation of factory waste products; ventilation of sewers and drains; construction and ventilation of house drainage; the drainage of buildings possessing no open space; the geology of the Midlands in relation to water supply; female occupations in relation to health; the hygiene of infancy; the waste of infant life; village nursing of infectious disease; influence of women in regard to household sanitation; woman's share in sanitary administration; hygiene of dress; teaching of sanitation in elementary schools.

THE Yorkshire Naturalists' Union announce a three days' excursion to Easington, for Spurn and Kilnsea, from July 30 to August 1.

IT is expected that the German Tiefsee Expedition will start from Hamburg at the beginning of August. The steamer *Valdivia* is being fitted out with all the necessary appliances.

A DEPARTMENT for the treatment of hydrophobia by Pasteur's method, and for scientific research on the subject of hydrophobia, has, says the *British Medical Journal*, just been opened in the Berlin Institute for Infectious Diseases (Koch Institute). This establishment is the first of its kind in Germany. Apparently, rabies is becoming more frequent in that country. In spite of the stringent legislation on muzzling, five persons died of hydrophobia in Prussia during the year 1897.

MR. ALEXANDER WHYTE has been appointed, by the Secretary of State for Foreign Affairs, curator of the Botanic Garden, Uganda, which is about to be established for the better examination and development of the agricultural resources of the Protectorate. It will be remembered that Mr. Whyte started a similar enterprise in British Central Africa, in which he was, from 1891–97, head of the Scientific Department.

THE Göttingen Academy of Sciences is reported to have received from the Emperor of Germany's special fund 5000*l*. for gravity determinations in East Africa.

IN a lecture recently delivered at Copenhagen, Prof. la Cour communicated some of the results of the numerous State-aided experiments and tests in connection with the utilisation of the wind's power, which have been carried on by himself over a number of years. After speaking on the historical side of the question, the lecturer referred to the construction of a windmill, and pointed out the fallacy of the opinion that the greatest effect was obtained by horizontally moving wings. Reference was made to the various ways in which the problem of turning the mill according to the wind had been solved, and the lecturer then dealt with the construction of the wings. The question of the effect of the wind's pressure upon a flat surface is a complicated one, but it has been demonstrated that the suction on the lee side is a very important factor. Prof. la Cour had in his experiments measured the effect of an artificial wind upon various models at different speeds, and these experiments pointed to the correctness of some of the ordinarily accepted rules in the construction of windmills; as, for instance, the number of wings. A mill with sixteen wings had only $1\frac{1}{3}$ times as much power as one with four wings. In measuring the percentage of the power of the wind striking the wings, he had arrived at the somewhat startling result of 143·7 per cent. This unlooked-for conclusion was owing to the above-mentioned suction on the lee side of the wind passing between the wings. That the wings should not be plane, but have a bent or a concave shape, was an old-established truism; and the shape of the wings has in reality much influence upon the suction caused more especially by the wind, which just passes the edges of the wing. In measuring the percentage of the wind-power utilised, the wind passing between the wings was taken into account, and instead of 143·7 per cent. the result was 21 per cent. The absolutely best shape for wings has, however, not yet been ascertained. The most important practical point in connection with windmills is the solution of the problem, how best to neutralise the inconveniences caused by the irregularity of the wind. Prof. la Cour has for this purpose constructed an original regulator, called the Kratostate, by means of which a windmill can be used for working a dynamo.

THE St. Petersburg Society of Naturalists has lately opened a fresh-water biological station at Lake Bologoye, on the Valdai plateau, near to a railway junction of the same name. The station was opened after only the sum of 120*l*. had been subscribed, chiefly by M. Voronin, "who made also the gift of three microscopes, a rich algologic library, and a flag." A house on the shores of the lake, and surrounded by a garden, was rented, and the station was well provided with scientific instruments, boats, &c. No fees for housing and work at the station are paid, while the boarding, which is excellent, having been organised on co-operative principles, costs, washing included, only 17 roubles (1*l*. 14*s*.) per month to each visitor. The lake is very shallow, having a uniform depth of 5 metres, A narrow isthmus separates it from Lake Glubokoye, 14 metres deep. The aquatic vegetation of the two lakes is very rich, and two interesting plants have already been discovered: the *Najas minor* (*Caulinia fragilis*), characteristic of the Steppe region, and *Najas flexilis* (*Caulina flexilis*), characteristic of Scandinavia and Finland. The neighbourhood of the station has a rich flora—such rarities as *Viola umbrosa*, *Luzula albida*, *Botrychium virginianum*, &c., growing at the doors of the house. Four persons, all botanists, worked at the station last summer. The lake was carefully mapped, its depth was measured in its wide part, and the phyto-plankton was studied by L. A. Ivanoff, who discovered several interesting forms, including the diatoms *Attheya Zachariasi* and *Rhizolenia longiseta*, akin to marine forms.

AN interesting article is contributed to the June part of the *American Anthropologist* by Mr. J. W. Fewkes, on "An Ancient Human Effigy Vase from Arizona." The ancient people of southern Arizona manufactured human effigies in clay, the typical forms of which, so far as the author is aware, have not been described. The vase in question was obtained by Mr. Fewkes in the summer of 1897, on behalf of the U.S. National Museum, from a cave at Pima, a settlement in the Pueblo Viejo valley. In his opinion the vase was manufactured by the ancient people of Arizona, probably by a people whose ruined houses are found in the neighbourhood from whence the specimen was obtained. The accompanying illustration, copied from a figure appearing in the *American Anthropologist*, shows the general form of the vase. It is made of coarse material, and

has a rough exterior, with patches of calcareous secretions on the surface. The form of the head is shown by a constriction forming the neck, and the eyes, nose, mouth, chin and ears are well represented. No attempt is made to represent the legs, and the arms, it will be noticed, are simply irregular ridges, one on each side of the body. It is supposed that the vase was filled with votive offerings when it was placed in the cave, and that in course of time the contents were washed out. The nature of these offerings may be conjectured from the fragments of shells, turquoises, and other objects strewn about the floor of the cavern.

THE *Lancet* prints the following note on Egyptian native remedies for hydrophobia:—"Though there are no medical accounts of rabies in times past, there are plenty of supposed cures which make it appear as if the disease were well known. Papyri contain mention of the dangers of a bite from serpent, crocodile, or dog. Charms were sold in old days to protect from these three, and there is a folk-lore story where the wicked fairy condemned the heir at his birth to be killed by one of these three biting creatures. He destroyed a serpent who attacked him, and he and his favourite hound killed a crocodile, but the master died in consequence of an accidental bite from the dog during the fight. The modern treatment for a person bitten by a presumably mad dog in Upper Egypt is to kill the dog, extract the spinal cord, bruise the cord with pestle and mortar until a paste is made, and then rub the patient's body all over with paste. Sometimes, too, they burn the dog's hair, and apply the ashes to the bite. The Bedouin make the patient eat the raw liver of the dog, and this is done, too, in the Haussa State of the Western Soudan. In Lower Egypt the favourite remedy has been acquired from the Syrians of Mount Lebanon. It is the *Mylabris punctata*, a dark-blue beetle used instead of cantharides, and well known in the south of France and Spain."

IT is reported that a drainage scheme for Cairo, based on plans by Sir B. Baker, F.R.S., has been submitted to the Ministry of Public Works on behalf of the Cairo Water Company. The estimated cost is £E.600,000, but this does not include anything for maintenance.

AN agricultural department, having for its object the increase, if possible, of the number of the staple products of Zanzibar, has been established in that State. It is under the superintendence of an English horticulturist whose duties are not only to try to improve the methods by which the old-established crops are reared and harvested, but to introduce and cultivate experimentally any other plants which may be likely to thrive in a tropical soil, and which, if successful, would add to the commercial prosperity of the country. Experiments, which already give some promise of good results, have been made with cocoa, kola, vanilla, anatto, and several varieties of rubber, and trials are still being carried on with coffee, candle nut, eucalyptus, and other plants of economic value. Camphor, olives, safflower, nl sarsaparilla are said to have failed.

THE Rev. M. Dechevrens, S.J., Director of the St. Louis Observatory, Jersey, and formerly Director of the Observatory at Zikawei, China, has communicated to the Academy of the *Nuovi Lincei* an interesting discussion of the variations of air temperature in cyclones, and their principal cause. The investigation is based upon an examination of the weather charts published in the daily *Bulletin International* issued by the Meteorological Office of Paris, and particularly those for January to March 1895. The author finds that the extremes of heat and cold, which are observed respectively in areas of low and high barometric pressure, do not occur at the centres of these systems, but are met with in the neighbourhood of the mean isobars. Also that the descending current of air in an area of high pressure escapes along divergent lines, and that it is principally due to this divergence that the cold usual in anticyclones is observed. Similarly, that the relatively high temperature in areas of low pressure is due to the convergence of the ascending air currents. The paper is accompanied by a number of examples, and is illustrated by diagrams, which materially add to its value.

THE twelfth volume (for the year 1896) of the *Analele* of the Meteorological Institute of Roumania, a work of 800 quarto pages, has recently been issued. In addition to the usual meteorological tables it contains ten memoirs, several of which are printed in parallel columns in French and Roumanian. The painstaking director, Dr. S. C. Hepites, writes, among other subjects, on the drought in the Dobrudscha in 1896, on the Roumanian rainfall in 1896, and on the results of twelve years of meteorological observations at Bucharest (1885–1896). He also continues his valuable register of Roumanian earthquakes, from which we learn that, during 1896, eleven shocks were recorded. The majority were of slight intensity, only one (that of March 12) being felt over a large part of the country, and causing small landslips within a limited district.

A RECENT number of the *Aberdeen Journal* prints a communication, received from a correspondent, on the pollution of the river Lossie, by which, it is said, thousands of trout have been poisoned. At the place where the poisoning has occurred the Lossie is at its broadest and deepest, and has been one of the favourite haunts of Elgin anglers. It is fully a mile further up the river from the place where the town's sewage enters, and the water here had continually been used by the cottagers at Scroggiemill and Sheriffmill for domestic uses. In the opinion of many people the pollution is due to the influx of distillery refuse. The same issue of the *Journal* states that a number of distilleries have combined together to offer a premium of 2000*l* to any person devising and handing over to them for their sole use a scheme for the purification of the residual products of distilleries.

PROF. KÜTTNER, of Tübingen, has, says the *Lancet*, been making some interesting experiments with the Röntgen rays at the Constantinople Hospital. In his report, just issued, he says that while the apparatus proved of service when applied with the screen, it was rarely possible to take a satisfactory photograph on account of the difficulty of bringing the patients into the proper position. The former method proved often the only way to ascertain the site of a projectile which had entered the body and had remained there. This was applicable to all parts of the body except the stomach and head. A bullet in the brain, for instance, showed very indistinctly. Prof. Küttner says it is noteworthy that splinters of bullets and of bone which had penetrated into the soft parts of the body could not be distinguished from each other. Also, he says, it was proved that the opinion that deep-lying masses of pus could be located was erroneous. Injuries to the central nervous system, the spinal cord, and the peripheral nerves were solely ascertainable by the aid of the Röntgen rays. It was impossible to do this before. Furthermore, it could be seen whether a bone was totally or only partially severed—a matter of great importance as far as therapeutics are concerned. For shot wounds in the extremities he recommends that a photograph be taken. His conclusion is that the Röntgen rays are of great importance for medical aid in war, but only for fixed hospitals, such as reserve hospitals and those installed in fortresses, while for moving field hospitals their application is very limited.

THE Paris correspondent of the *British Medical Journal* states that the French State engineers have succeeded in giving a formula for making lucifer matches which does not include either white phosphorus or any substance injurious to health. Machinery has also been invented which will contribute to the health and safety of those engaged in match manufacture. The machinery has been tested, and, after a few improvements have been made, it will be generally adopted in the Government match factories.

THE July issue of the Kew *Bulletin* states that, in response to an inquiry from the Kew Gardens for specimens of all the plants yielding a milky juice, samples of Fiji rubber have been received and examined. The first samples received proved entirely valueless; but the second, received in March last, were more promising. *Alstonia plumosa* is described as abounding in the forests, and if carefully treated might prove a useful rubber-producing plant; but, judging from the specimen of rubber received, the preparation of the article has almost become a lost art, for the specimen was soft and viscid on the outside, with little or no elasticity, and practically without value. A later specimen, received in June, was not so viscid, but it gradually became hard and inelastic. A sample of rubber from a tree known as "Baka" (*Ficus obliqua*, Forst. f.) was also received, and although not sufficiently coagulated, was regarded as suitable for mixing purposes, and to be worth today from 1*s*. to 1*s*. 3*d*. per pound. A substance obtained from the "Ban" tree, possibly a member of the *Sapotaceæ*, but, in the absence of flowers, otherwise indeterminable, was slightly elastic, and might command a sale at 10*d*. to 1*s*. per pound. Other specimens, obtained from the "Wasalili" (*Carruthersia scandens*, Seem.) and the "Malawaci" (*Trophis anthropophagorum*, Seem.), were entirely deficient of elastic properties, and reported to be of no commercial value.

THE *Engineer* gives particulars of two forms of artificial india-rubber—one emanating from France, the other from Germany. Textiloid is the name of the French form. It consists of resinoline and admixtures. The resinoline is said to be obtained by treating oil with three or four times its bulk of metallic carbonates, and then with nitric acid. Then follow saponification, precipitation by means of an acid, and dissolution in alcohol or ether. A hundred parts of resinoline are mixed with twenty of zinc, oxide of manganese, &c., and sixty parts of methylated spirit; after several hours the mass is kneaded for one hour or more, and finally compressed. The German process consists in the oxidation of linseed oil, with the addition of prepared jute refuse, or similar hitherto worthless textile refuse, by which means a substance is produced which possesses many of the qualifications of genuine india-rubber. It is capable of being utilised in many ways, and of being manufactured into various articles hitherto made of india-rubber.

THE Council of the Anthropological Institute has decided to alter the size of the quarterly journal of the Institute. The journal in its present form compares unfavourably in size with several Continental publications, and does not allow sufficient scope for extensive illustrations. At the present time there is no anthropological publication in England capable of meeting these requirements, and it has occasionally happened that papers of much interest, accompanied by valuable photographs and drawings, have been published abroad for want of a suitable medium in London. With the desire of obviating this unsatisfactory state of affairs, the Council of the Institute has resolved to sanction additional expenditure on printing in the hope that the proportionate increase in the interest and utility of the journal will secure for it the sympathy and support of all those interested in anthropological studies throughout the Empire. The attempt will be made in the new series to apportion the available space as evenly as possible between the different branches of study included in the general science of man. Folk-lore is provided for elsewhere, but physical anthropology, prehistory, and ethnology have all claims to a more liberal treatment than they have hitherto been able to obtain. In view of the temporary dislocation of existing arrangements which the proposed change will entail, it has been decided that there shall be no issue of the present series in August, and that the new series shall commence in November with a combined August and November part.

IN a note in the *Rendiconto* of the Naples Academy, Signor A. Costa briefly summarises the various problems opened out by the recently discovered reciprocal action of animal toxins. In November 1892, this writer observed when in Algiers that when the sting of a Tunis scorpion was followed by that of *Scolia interstincta* Kl. in the same finger seventeen hours later, the result was a complete removal of all the symptoms of poisoning, the finger regaining its normal state. The recent discovery by M. C. Phisalix, that the poison of hornets confers immunity against viper bites, now suggests the following questions: (1) Have the poisons of all hymenoptera the power of sterilising? (2) Of what animals are the poisons capable of sterilisation? (3) Does any specific or generic relation exist between the sterilising and sterilisable poisons in virtue of which (*e.g.*) the sting of one particular family of hymenoptera confers immunity against the sting or bite of one particular group of animals?

ALTHOUGH volcanic flames have been seen and described by many writers, their existence has been doubted by others. Special interest thus attaches to the outbursts of flame which occurred on Vesuvius in April last, and which are dealt with in two papers—one by Prof. E. Semmola in the *Rendiconto* of the Naples Academy, the other by Prof. V. Matteucci in the *Atti dei Lincei*. From the former paper it would appear that this rare phenomenon may have been caused by the falling in of a part of the crater wall, and consequent blockage of the orifice, the pent-up gases becoming heated until a chimney was formed through which they escaped in flames. Prof. Matteucci's paper concludes with the following summary of the principal points: (1) The greater part of the aeriform substances evolved from volcanic magma has the power of producing flames. (2) The small flames in the crater of Vesuvius were of longer duration than the large ones; these latter did not last without intermission for more than 19 or less than 15 days, and ultimately became small and quiescent like the others. (3) The complex phenomenon, of which the flames were one of the most interesting features, seems only comparable with that described by Sir Humphry Davy. It has not been reproduced, or, at any rate, has not been noticed on Vesuvius for eighty-four years. (4) The spectrum produced by these flames is continuous, like that observed by Libbey in the incandescent lavas, also with flames, of Kilauea.

PROF. VILLARI, writing in the *Atti dei Lincei*, shows how the shadows of Röntgen rays, produced by different vacuum tubes, can be compared by photography. The shadows in question were produced by a circular leaden disc fixed some little distance in front of the plate, a cross of lead being placed in contact with the plate in order to facilitate comparison of the darknesses of different parts of the shadow. Prof. Villari found, and his illustrations show, that the shadow of a body intercepting the radiations from a focus tube is surrounded by a kind of penumbra several millimetres wide, ending abruptly at the outside and darkening rapidly towards the centre of the umbra. When a Crookes' tube is used, the umbra terminates in a clearly defined edge; near the edge, within the umbra, there is seen a black line or fringe; outside the umbra there is a pale penumbra several millimetres wide, fading away outwards, and followed by a bright ring indicating increased radiation. These two fringes, the dark and the light, resemble those of diffraction. The central umbra seems to gradually darken from the periphery to the centre, probably owing to deflection of the rays into the shadow produced by the opaque intercepting body.

A BRIEF memoir on the geology of the country around Bournemouth, by Mr. Clement Reid, has just been issued by the Geological Survey, in explanation of the new series map, Sheet 329. The main points of geological interest are described, including the pipe-clays of Poole, the plant-beds in the Bournemouth cliffs, and the richly fossiliferous clays and sands of Barton. The price of this little memoir is 4*d*., and it is illustrated by figures of some of the characteristic fossils found in the neighbourhood of Bournemouth.

IT is announced that the Trustees of the British Museum are about to issue a facsimile of the famous Rhind mathematical papyrus, which deals with such subjects as the elements of geometry and the theory of fractions. The work was prepared for publication several years ago by the late Dr. Samuel Birch, but has since been revised, and a special introduction to it has been written by Dr. Budge.

A FLORA of the Ardennes, by M. A. Callay, is about to be brought out under the auspices of the Society of Natural History of the Ardennes. It will be published at Charleville by the Society.

THE fossil and recent genera of Eurasian *Dreissensidæ* have been figured by M. N. Andrusov in a series of twenty phototype plates ("Travaux de la Soc. des Naturalistes de St. Petersbourg," vol. xxv.). The genera include *Congeria Dreissensia* and *Dreissensiomya*.

THE U.S. Department of Agriculture has issued a *Bulletin* (No. 16) on American ginseng, its commercial history, production, and cultivation, by Mr. Geo. V. Nash. The plant so called is *Panax quinquefolium*, belonging to the Araliaceæ. At one time in great repute as a sovereign remedy for constitutional weakness, &c., the medicinal use of ginseng is now abandoned except as a demulcent.

A NEW edition of Mr. H. G. Wells's "Text-book of Zoology" has been published by the University Correspondence College Press. The work is more particularly intended for students preparing for examinations of the University of London, and as such it has met with success. The new edition follows the plan and method of the original volume, which appeared about five years ago, but a large part of the text has been rewritten by Mr. A. M. Davies, whose name now appears on the title-page as joint author with Mr. Wells. The preface states: "Only one chapter in the book remains practically unaltered from the first edition, so that while the credit for the general plan of the work belongs to Mr. H. G. Wells, no responsibility attaches to him for any part of the present book." New diagrams have been inserted, and they are remarkably clear and instructive.

IN vol. iii. No. 4 of the *Records of the Australian Museum*, illustrated descriptions appear, by Mr. W. J. Rainbow and Mr. C. Hedley respectively, of a new Araneiad, from Cooktown, and a new Bivalve, *Lima alata*, from Santa Cruz.

A SPECIAL number of the Middlesex Hospital *Journal*, which has just come to hand, contains, in addition to the usual notes, information respecting the various institutions in connection with the hospital, &c., the beginning of a very interesting account, by Dr. A. Coupland, of "The Story of the Middlesex Hospital." The article is illustrated by several figures of the hospital at different stages of its existence, and a reproduction of a photograph of seventeen members of the staff in 1865. Among the number is to be found Prof. Burdon Sanderson, F.R.S., at that time an assistant physician.

THE additions to the Zoological Society's Gardens during the past week include a Naked-footed Owlet (*Athene noctua*), European, presented by the Hon. Walter Rothschild; a Bridled Wallaby (*Onychogale frenata*) from Australia, two Coquerel's Lemurs (*Cheirogaleus coquereli*) from Madagascar, a Glass Snake (*Ophiosaurus apus*), a Back-marked Snake (*Coluber scalaris*), a —— Snake (*Tropidonotus*, sp. inc.), European, ten Algerian Tortoises (*Testudo ibera*) from the Caucasus, nineteen Saddle-backed Tortoises (*Testudo ephippium*) from the Duncan Islands, Galapagos Group; thirty-three South Albemarle Tortoises (*Testudo vicina*) from the Albemarle Islands, Galapagos Group; four Speckled Terrapins (*Clemmys guttata*), thirty-seven Painted Terrapins (*Chrysemys picta*), two American Box Tortoises (*Cistudo carolina*), a Stink-pot Terrapin (*Cinosternon odoratum*), two Alligator Terrapins (*Chelydra serpentina*) from North America, deposited; a Graceful Ground Dove (*Geopelia cuneata*), two Peaceful Ground Doves (*Geopelia tranquilla*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST.:—

August 8. 10h. 7m. to 10h. 44m. Occultation of μ Arietis (mag. 5·8) by the moon.
8. Saturn. Outer minor axis of outer ring, 17″·37.
8. 15h. Mercury at greatest elongation (27° 22′ E.).
10. Meteoric shower from Perseus (radiant 45° + 57°).
11. 14h. 49m to 15h. 38m. Occultation of 118 Tauri (mag. 5·4) by the moon.
12. 12h. 31m. to 13h. 19m. Occultation of 8 Geminorum (mag. 6·5) by the moon.
15. Venus. Illuminated portion = 0·655, diameter = 17″·4.
15. Mars. Illuminated portion = 0·889, diameter = 6″·0.
15. Jupiter. Polar diameter = 29″·8.
15. Saturn. " " = 15″·8.
19. 6h. Venus in conjunction with Jupiter (Venus 1° 51′ S.).
23. 9h. 32m. Minimum of Algol (β Persei).
25. 10h. Mars in conjunction with Neptune (Mars 1° 13′ N.).
28. 12h. 53m. to 13h. 43m. Occultation of σ Capricorni (mag. 5·6) by the moon.

THE MINOR PLANETS.—Mr. John K. Rees, in a lecture before the New York Academy of Sciences (*School of Mines Quarterly*, vol. xix. No. 3), delivered a very interesting discourse on the history of the discovery of the minor planets, a reprint of which has been sent to us. Mr. Rees describes from the beginning how, after the discovery of Uranus by Herschel, Prof. Titius, of Wittenberg, pointed out the existence of a remarkable symmetry in the disposition of the bodies constituting the solar system. It was he who suggested the relationship now known as "Bode's law," Prof. Bode putting into the place of the missing body a hypothetical planet. It is not generally known, perhaps, that Von Zach in 1785 actually calculated elements for this "unseen and unfelt body," and for fifteen years kept in his mind the need for a careful search. At the beginning of this century he organised, what was termed jocularly by him the "Celestial Police" to track and intercept this fugitive object, a force for the express purpose of systematically scanning the heavens; but it was left for the astronomer, Piazzi, who found the first of what eventually proved a series of small bodies, although he was carefully observing the heavens for quite another purpose, namely the formation of a star catalogue. This discovery of the minor planet Ceres was the first of many which followed, and the introduction of photography in this branch of observation has brought to light many small bodies which are now numbered in hundreds, besides rendering the task, which was beset with great difficulties, one that is now simplicity itself.

THE MOON AND AURORÆ.—From the earliest times the presence of auroræ was in some way connected with the influence of the moon, and there may be some, even to-day, who are inclined to hold to this opinion. Prof. H. A. Hazen, in the *Monthly Weather Review* (vol. xxvi. No. 161), discusses the evidence of such supposed influence, using as his data the observations made by the regular observers in the United States Signal Service. We need not, however, refer to the curves and tables which are brought together by Prof. Hazen, but simply quote the words which he uses in summing up the whole of the investigation in question. He says: "It will be seen readily that the whole theory of a lunar influence upon auroras breaks down from first to last under this analysis." That the appearances of auroræ may be connected with the periodicity of sun-spots is another matter, and it is here that probably a close connection exists.

Apropos of auroræ, we notice that Prof. Cleveland Abbe is publishing a very detailed and important historical account of the altitude of auroræ above the earth's surface as determined by observers all over the world. The first of these articles appears in *Terrestrial Magnetism* (vol. iii. No. 2), and is well worth reading by those who are interested in this important question.

MARS IN 1896–7.—Prof. V. Cerulli has just published, in the *Pubblicazioni dell' Osservatorio privato di Collurania* (Teramo) (No. 1), a most important memoir of the planet Mars, as observed by him during the period 1896–7. The volume covers no less than 126 pages, and is accompanied by numerous plates, forming a valuable addition to our knowledge of this interesting planet. Perhaps a special feature of this publication is the determination of the latitudes and longitudes of sixty of the most prominent markings on the surface; and this will, without doubt, be found most valuable to those who wish to locate accurately any surface features which they may from time to time observe. In the remaining portion of the work Prof. Cerulli discusses these and other surface markings which were seen during this period of observation, and a comparison of these with the observations of others should be found of great interest.

RECENT WORK IN THERMOMETRY.

THERMOMETRY is one of those departments of physics which are left almost exclusively to specialists, and writings on the subject are apt to assume an amount of preliminary knowledge not possessed by physicists in general. There thus appears room for a brief account in popular language of recent progress. The space at my disposal being limited, I am obliged to confine my remarks to a comparatively small number of researches, and I can hardly hope that my choice of matter will meet with unmixed approval.

Thermometry possesses two main branches, which, though intimately connected, are yet more or less distinct. One branch deals with the detection of extremely minute differences of temperature, or the subdivision of small temperature intervals; the other aims at assigning a definite numerical value to temperatures on an exact scale. A worker in the first department may employ apparatus showing differences of one-millionth of a degree Centigrade, and he may even believe that he is measuring temperature to this degree of nicety. A worker in the second department, unless endowed with an exceptionally optimistic temperament, will probably not profess to measure temperature to nearer than the one-thousandth of a degree, and that only between the freezing and boiling points of water. Here I shall consider almost exclusively the question of the determination of temperature in absolute measure.

The first requisite is a normal scale to which all measurements can be referred. An ideal scale should be perfect in theory, and easily and exactly realisable in practice. From the former point of view, Lord Kelvin's absolute thermodynamic scale is generally regarded as *facile princeps*. In the meantime, however, it fails to satisfy the second condition. The International Committee of Weights and Measures, representing all the leading Powers, including Great Britain, accordingly selected in 1887 for the normal scale that of the hydrogen constant-volume thermometer, the gas when at 0° C. to be under the pressure of 1 metre of mercury under standard conditions; on this scale equal increments of temperature answer to equal increments of pressure. Apparently the choice was due mainly to two considerations, viz. the very low freezing point of hydrogen, and the existence of theoretical and experimental grounds for believing its scale to approach Lord Kelvin's absolute scale more nearly than that of any other common gas. Whether hydrogen will prove a manageable substance at high temperatures seems open to some doubt. Failure in this respect would be a serious drawback, in view of the rapidly increasing importance of high temperature measurements.

After the choice of a normal scale, we are next concerned with its relationships to other scales that are, or have been previously, in use. Here, however, one difficulty is conspicuously present. Nothing is commoner than such a statement as that a certain temperature was observed on the scale of the air thermometer; but there are air thermometers and air thermometers. Quite apart from the distinction between constant volume and constant pressure instruments, there are questions as to the pressure at 0° C., the purity of the air, the sufficiency or insufficiency of the corrections applied to the observed readings, and a host of others. In most investigations thermometry is but a means to an end, and observers are apt to treat somewhat lightly of preliminaries which are not of general interest. On the other hand, an observer is very apt to attach undue significance to the agreement between the several observations he makes, overlooking the fact that in thermometry such agreement need imply no more than uniformity in the conditions and in the method of experiment. For these several reasons, in translating old temperature observations into the normal hydrogen scale, it would in general be a waste of labour to aim at the degree of accuracy possible in the best thermometric work.

Whilst the exact determination of other scales in terms of the hydrogen scale is from a historical standpoint less important than might appear at first sight, it is still rendered essential by the fact that for many practical purposes the hydrogen thermometer is inconvenient, and is unlikely to supersede other forms.

The most exact scale comparisons are doubtless those made at Sèvres, under the auspices of the international committee of weights and measures. These are described, with the exception of the most recent, in Dr. Guillaume's "Thermométrie de Précision," a work which all really interested in exact thermometry should study for themselves. Air being a composite medium, and so presumably less suitable for the basis of an exact scale than the elementary gases, has apparently not been dealt with at Sèvres; but the work there has included the comparison of the hydrogen, nitrogen and carbonic acid scales, especially of the first two. The investigation covered, in the first instance, the range $-25°$ C. to $+100°$ C., and was executed with great care by Dr. Chappuis. In point of time it preceded and, in fact, led up to the adoption of the hydrogen scale. The comparison of the gas scales was not direct, but through the intermediary of mercury thermometers. From the data on p. 258 of Guillaume's "Thermométrie," one learns that within the range 0° to 100° C. the difference between the hydrogen and nitrogen scales does not exceed 0°·011 C., but at $-25°$ C. it amounts to about 0°·016. The differences between the hydrogen and carbonic acid scales are five or six times as large as these. The hydrogen temperature is algebraically less than the nitrogen or carbonic acid temperatures between 0° and 70° C., but algebraically greater at temperatures below 0° C. In Guillaume's opinion it is probable that ordinary (constant volume) air thermometers give a scale near that of nitrogen, but lying somewhat on the side of the carbonic acid scale, *i.e.* more remote from hydrogen. The probable error in Dr. Chappuis' comparisons is given as $\pm$0°·001 between 0° and 50° C., and twice or thrice as great at either $+75°$ C. or $-25°$ C.

The differences between the several gas scales presumably increase as the temperature falls, but probably never become large. At all events, in 1896 Holborn and Wien (*Wied. Ann.*, vol. lix., 1896, p. 213), using constant volume thermometers (with, however, an initial pressure of only one atmosphere at 0° C.), found the hydrogen thermometer to read only about 0°·6 C. higher than the air thermometer at $-190°$ C., a temperature close to the freezing point of air. Ten years earlier Olszewski found a difference of about 1° between the hydrogen and nitrogen scales at $-150°$ C.; but his thermometry was probably less exact. With only Olszewski's results before him, Guillaume infers that the hydrogen scale is almost certain to agree closely with the absolute scale, even at $-220°$ C.; and Holborn and Wien's observations lead them to a somewhat similar conclusion. Recent comparisons by Olszewski of hydrogen and helium thermometers (NATURE, vol. liv. pp. 378 and 544) are strongly confirmatory.

For every-day use, unfortunately, gas thermometers are somewhat cumbrous. The international committee accordingly assigned an important place in their programme to the determination of the relations between the hydrogen scale and that of the glass-mercury thermometers which they have selected as working standards. The thermal expansion of glass, though small, is not negligible compared to that of mercury, and varies in different kinds of glass. The international committee accordingly selected one special kind of glass, French *verre dur*, as standard. The selection of the glass does not alone suffice to fix the scale. No glass has yet been discovered whose behaviour is decided wholly by the existing conditions. When a thermometer after exposure to a temperature of 50° C. is placed in ice, it reads lower than it would have done prior to the exposure, and this *depression of zero*, as it is called, increases to a certain extent with the duration of the previous heating. It is thus necessary for high accuracy to decide on a uniform plan of dealing with this source of uncertainty. The plan adopted by the international committee is to refer every reading of a thermometer to a zero determined immediately *after* the reading. Under certain circumstances enough is known of the behaviour of *verre dur* to permit of the substitution for the actual zero observation of results extracted from a table of zero depressions. After a reading is taken with a *verre dur* thermometer, a variety of corrections have to be applied. These are necessitated by inequalities in the bore or errors in graduation, by the influence of the external pressure exerted by the atmosphere and the internal pressure exerted by the mercury. Verification at Sèvres consists in evaluating and tabulating all the necessary corrections. After these corrections are applied, the result represents the temperature on the natural *verre dur*—mercury scale.[1] This scale has been compared with that of the hydrogen thermometer at Sèvres from about $-38°$ C. to $+200°$ C. Below $-10°$ C. and above 100° C. the comparison is probably less exact than between these limits.

In considering the probable accuracy of temperature measurements made with *verre dur* thermometers, we have to take into account the consistency of readings taken with the same thermometer, the closeness of readings taken under the same conditions with different thermometers, and, from certain points of view, the degree of accuracy with which readings can be reduced to the hydrogen scale.

The consistency of readings taken with a single *verre dur* thermometer depends in the first instance to some extent on the success with which the correction tables have been constructed at Sèvres; it varies to a large extent with the skill of the observer, the conditions of the experiment, and the temperature to be measured. The ordinary *verre dur* standard thermometer is divided to 0°·1 C. and read by estimation, with the aid of a lens magnifying from ten to twenty times, to 0°·001 C. This involves subdivision of a space into hundredths by eye, a feat which the skilled observers at Sèvres accomplish with marvellous accuracy, but which is far beyond the powers of the ordinary experimenter. In some instances use can be made of a micrometer, but this can hardly be employed unless temperature is practically stationary; and, when this is the case, troubles are apt to arise from capillary action in the mercury. The more remote the temperature to be measured from that of the surrounding air, the greater, as a rule, is the probable error of an observation. Thus, speaking generally, observations between 0° and 40° C. are those capable of the highest accuracy; and here it would appear that the mean results obtained on different occasions by skilled observers for a fixed temperature with a *verre dur* thermometer may be expected to agree to within about $\pm$·001° C.

At temperatures below 100°C. the corrected readings of different *verre dur* thermometers on the same occasion show apparently about as good agreement as is to be expected from the readings of a single *verre dur* thermometer exposed on different occasions to the same fixed temperature. At temperatures, however, approaching 200° C. Dr. Chappuis found that the corrected readings of different *verre dur* thermometers might differ by as much as 0°·05 C.

The accuracy with which the relation of the *verre dur* to the hydrogen scale is known is hard to say. Until the Sèvres comparisons have been repeated at other places, under equally favourable conditions, there will always remain a certain amount of doubt as to the existence of possible local or temporary influences. In the meantime, it is not altogether reassuring that a recent partial comparison of the hydrogen and *verre dur* scales at 10°, 20°, 30° and 40° C., by Dr. Chappuis, gives results differing from those of the original comparison at Sèvres by from 0°·001 to 0°·007 C.

From the above data two considerations naturally arise. At temperatures between $-20°$ C. and 100° C. the natural *verre dur* scale is probably that most easily and exactly realised in practice; and it is, perhaps, fully as correct to regard the present normal hydrogen scale as one deducible in a prescribed arbitrary way from the *verre dur* scale as to accept it as having any real physical existence. On the other hand, there is no such thing as a *verre dur* scale, unless we agree to neglect differences of temperature which are of the same order as differences actually found between different *verre dur* thermometers. At the present moment, for instance, we must apparently treat 0°·05 C. as a negligible quantity in temperature measurements at 200° C. if we are to extend the *verre dur* scale to that point. It has to be borne in mind that identity in the chemical constitution of thermometer glass may not necessarily imply identity in temperature scale.

[1] For any *natural* glass-liquid scale, thermometer degree divisions include equal volumes of the bore.

Age or prolonged annealing may introduce an appreciable change in physical properties.

In addition to the work already referred to, a comparison has been made at Sèvres of the hydrogen scale with the natural scales of low range glass-alcohol and glass-toluene thermometers. At – 70° C. on the hydrogen scale the toluene temperature is – 56°·63 C., as against about – 63° C. on the alcohol scale. Notwithstanding its greater contraction of scale at low temperatures, toluene is preferred by Dr. Chappuis to alcohol, on the ground that the latter is much more difficult to get of uniform purity. At – 70° C. differences of as much as 1° were observed in thermometers filled with alcohol supplied as pure by different first-rate chemists. Even with toluene thermometers, 0°·01 C. appears the limit of accuracy to be hoped for. English alcohol thermometers, I should explain, are not, as a rule, constructed to give temperatures on the glass-alcohol scale. The degree divisions are shortened as we go down the scale, in such a way as to make the thermometer, when exposed to freezing mercury, read – 37°·9 F.; this being the air thermometer temperature for freezing mercury according to Balfour Stewart's determination.

The thermometric work at the German Reichsanstalt[1] has included the comparison of the *verre dur* scale with that of several German glasses, notably the Jena glasses 16^{III} and 59^{III}. The former glass is fairly similar in character to *verre dur*; the latter is a boro-silicate glass capable of resisting very high temperatures, and showing exceptionally small depression of zero. Thermometers made of it, with compressed gas above the mercury to prevent boiling, supply a convenient means of measuring temperatures up to 500° C. or even 550° C. In such high temperature measurements it is often difficult to avoid having a long mercury column emergent above the bath or other source of heat whose temperature is in question. The consequent error can be found apparently with great accuracy by means of a special form of long bulb thermometer ("Faden-thermometer"). Dr. Guillaume, who apparently anticipated the Reichsanstalt observers in the idea, has curiously enough found it foreshadowed in the *Phil. Trans.* for 1777. Using the "Faden-thermometer," the Reichsanstalt observers apparently claim an accuracy of 0°·1 C. in comparisons made in a well-stirred bath at 500° C. They claim, however, an accuracy of 0°·02 C. in comparisons of Jena glass thermometers with the air thermometer between 100° and 300° C. Until these results are confirmed or similar accuracy is claimed by the Sèvres observers, a chronicler may perhaps be pardoned an attitude of reserve.

Even with the aid of compressed gas, the range that can be covered by a mercury thermometer is somewhat limited, in view of modern requirements; and within that range there are many cases in which other means of measuring temperature are preferable. Nearly every property of every natural substance is modified by heat, so that the possible ways of measuring temperature are practically innumerable. Several of the ways that have been proposed for measuring high temperatures are very ingenious and may have a great future before them; but the methods that have actually been utilised to an appreciable extent are but few. Of these the two that have been most to the front of late years have depended on the measurement of electric resistance and electromotive force respectively. The former method we may regard as embodied in the platinum-resistance thermometer. Its introduction and the improvements it has undergone are due mainly to Prof. Callendar and Mr. E. H. Griffiths, while its application to the determination of melting points of metals and alloys is largely due to Mr. C. T. Heycock and Mr. F. H. Neville. A clear description of the necessary apparatus and the mode of graduating platinum thermometers was given by Mr. Griffiths in NATURE, November 1895, p. 39. The essential fact is that a piece of platinum wire, *suitably protected*, is exposed to the temperature it is desired to measure, and its electrical resistance is found by a Wheatstone's bridge method. If R_1 be the resistance in steam, R_0 in ice, R at any other temperature, then

$$pt \equiv 100(R - R_0) \div (R_1 - R_0)$$

is termed the "platinum temperature." In common use pt is employed only to deduce a quantity t, connected with it through the relation

$$t - pt = \delta\{(t/100)^2 - (t/100)\},$$

where δ is a constant, so chosen that t equals 444·53 when the platinum wire is at the temperature of the vapour of sulphur boiling under standard pressure.

[1] Described in various memoirs in the Reichsanstalt's *Wissens. Abhandl.* and in the *Zeitschrift für Instrumentenkunde*.

The investigations of Callendar, Griffiths, Heycock and Neville show that the values obtained in this way for t, over a range of at least 1000° C., are very close in different samples of platinum wire, so that t represents temperature on what is at least very approximately a definite fixed scale. Further, Prof. Callendar found that the scale so arrived at approximates very closely to that of the air thermometer (at constant pressure) over at least the range 0° to 600° C.; whilst the values of t obtained by Messrs. Heycock and Neville for the melting points of silver, gold and copper, lie pretty close to the corresponding air temperature results obtained by Holborn and Wien at the Reichsanstalt.

If the wire of all platinum thermometers possessed the same value of δ, then every platinum thermometer would give the same pt when exposed to the same temperature t. We should then have a definite independent platinum scale, precisely as we now have a definite *verre dur* mercury scale between 0° and 100° C.

In reality, however, δ varies considerably—over at least 25 per cent.—in existing platinum thermometers, so that the present use of the term "platinum temperature" is open to criticism.

The question as to what is the best formula for use in platinum thermometry has been discussed by Mr. Hamilton Dickson recently in the *Phil. Mag.* (December 1897, p. 445, and June 1898). After considering Prof. Callendar's principal formulæ, and others suggested at one time or another by him and Mr. Griffiths, Mr. Dickson decides in favour of the species

$$(R + a)^2 = p(t + b),$$

where a, b, p are constants, and t is the temperature answering to a resistance R in the platinum wire. Mr. Dickson applies this formula to Prof. Callendar's original comparison with the air thermometer, to certain melting point determinations by Prof. Callendar and Mr. Griffiths, and to low temperature comparisons by Profs. Dewar and Fleming and by Messrs Holborn and Wien.

Determining the constants in the several cases by the method of least squares, he finds the probable divergence of observed and calculated values to be of the order 0°·25 C.

The formula approved by Mr. Dickson is really of the type

$$t = a + bR + cR^2,$$

employed previously by Holborn and Wien in discussing observations made by them at the German Reichsanstalt. These gentlemen, perhaps owing to their less exact method of determining the constants, claim for their formula accuracy only of the order 1° C. Their comparison with the air thermometer extended down to – 190° C., so that it seems in any case a valuable tribute to the suitability of platinum thermometers for the measurement of low temperatures.

At high temperatures Holborn and Wien's experience of the platinum thermometer was not very favourable, the wire showing appreciable permanent changes. As Mr. Griffiths, however, points out, these changes occurred at temperatures to which platinum thermometers of the type he approves have frequently been exposed without any apparent ill effect. The preference expressed by Holborn and Wien for thermo-electric methods thus perhaps carries less weight than it might seem to deserve at first sight. It would certainly appear, as pointed out by Mr. Griffiths in NATURE, vol. liii. p. 390, that the determinations of the melting point of copper, about 1080° C., by Heycock and Neville, with a variety of different platinum thermometers, agree considerably better amongst themselves than the corresponding results obtained by Holborn and Wien with thermo-couples.

Be this as it may, there can be no doubt that thermo-couples are very convenient instruments for high temperature measurements, and they have had hitherto a considerably wider use than platinum thermometers.

The physical quantity whose variations in the thermo-couple give temperature variations, is the total electromotive force in a circuit. The mainly active part of the circuit consists of two metals, one of whose common junctions is usually kept at a known fixed temperature, the other being exposed to the temperature it is desired to measure. The most widely used couple of late years has been Le Chatelier's, in which one metal is platinum, the other an alloy of platinum with rhodium (10 per cent. rhodium). The substitution of iridium for rhodium is not uncommon. Holborn and Wien have compared the Le Chatelier couple with the air thermometer at the Reichsanstalt up to 1450° C. In *Wied. Ann.* vol. lvi. p. 364, they say that the readings of different thermo-elements may be expected to agree within $\pm$ 5° at 1000° C., while different observations with the same instrument agree better than this. They also say that properly prepared thermo-elements have remained unaltered for years, whether unemployed or subjected to frequent temperature changes, always provided they are not exposed to certain sources of contamination.

In their more recent low temperature work, already referred to, Holborn and Wien made further use of thermo-couples, but the metals chiefly employed were apparently iron and constantan.

In translating measurements of E.M.F., E, into air temperature, t, Holborn and Wien employ an ordinary algebraic formula

$$t = aE - bE^2 + cE^3.$$

Here, as usual, a, b, c denote constants, which may be determined by observations at three fixed temperatures.

The question of the most suitable type of formula to be applied to thermo-electric data is discussed very fully by Prof. S. W. Holman in the *Phil. Mag.* for June 1896. The three types he advances as most deserving of notice are

$$E = (\tau - \tau_0)\{a + b(\tau + \tau_0)\},$$
$$E = m(\tau^n - \tau_0^n),$$
$$E = mt^n.$$

In all E represents E.M.F, m and n constants to be determined by reference to fixed points, τ and τ_0 temperatures of hot and cold junctions measured from absolute zero, t ordinary Centigrade temperature of hot junction (the cold junction being supposed in ice). The first or algebraic type, in a special form, is usually associated in this country with the name of Prof. Tait. The second type is called by Prof. Holman the *exponential*, and the third the *logarithmic* (as lending itself readily to logarithmic calculation). The three types are applied by Prof. Holman to what he regards as the most notable series of recent observations. In addition to the high temperature observations of Holborn and Wien, already referred to, he considers a number of comparisons of platinum and platinum-iridium couples with constant-pressure air thermometers made by Barus in America, and less extensive series by other observers in France and Germany. Of the three types of formulæ, the algebraic proved the least suitable for application to a wide temperature range.

In a later paper in the *Phil. Mag.* (vol. xlii., 1896, p. 37), Prof. Holman, with Messrs. Lawrence and Barr, apply the three above specified formulæ to observations of their own with couples of platinum and platinum-rhodium at the melting points of aluminium, silver, gold, copper and platinum. The constants in the formulæ were determined from the same three fixed points, viz. the ice point, the boiling point of sulphur at standard pressure, and the melting point of gold. For the second point Callendar and Griffiths' value 444°·53 C. was accepted, and for the third point Holborn and Wien's mean result 1072° C.

Observations were taken at the boiling points of water and naphthalin, as well as at the melting points of the several metals. The temperatures calculated from the three formulæ agree closely for the copper point—which lies near the gold point—and fairly closely for the silver point. For the naphthalin point the calculated values differed from the true air scale temperatures by from 4° to 12°, and the errors in the calculated values for the steam point were fully as large. If the authors are correct in their opinion, "so far . . . as constant or variable instrumental errors are concerned, it is believed that no error beyond 0°·5 to 1° C. exists in the results," we must conclude that further inquiry into thermo-electric methods is highly desirable.

Thermo-electric methods lend themselves fairly readily to the study of gradual temperature changes, the spot of light reflected by the mirror of the galvanometer measuring the E.M.F. being thrown either on a screen or on a photographic plate actuated by clockwork. Prof. Roberts-Austen (*Roy. Soc. Proc.*, vol. xlix., 1891, p. 347) has inaugurated investigations by this method[1] into the phenomena accompanying solidification of metals. Prof. Callendar, on the other hand (*Trans. Roy. Soc. of Canada*, 1897, p. 34), has recently applied the platinum thermometer in the continuous registration of the changes of earth, water and air temperatures; and, unless my memory deceives me, bare wire resistances have been used previously for the last-mentioned purpose

Thermo-electric and electrical resistance methods are also specially applicable to the measurement of minute temperature differences. As examples of this application, we may take the bolometer of Langley and the radio-micrometer of Boys (*Phil. Trans.*, 1889, p. 159). The former instrument in its most approved shape—as in use at the Astrophysical Observatory at Washington—has been described very recently by Prof. Langley himself (*The Smithsonian Institution*, 1846–96, pp. 419–442, Washington, 1897). Its main use at Washington is in mapping out the infra-red spectrum and determining the intensity of the solar radiation at different wave-lengths. It is simply an electrical resistance thermometer, the resistance being that of a "metallic tape usually about ½-inch long, but narrower and far thinner than a human hair . . . this, at present, may be arranged to record changes of temperature as small as one-millionth of a degree." Prof. Langley has devised the means of producing a uniform relative motion of the bolometer and solar spectrum, and obtaining an exact photographic record of the varying heating effect; and in this way he has apparently enormously reduced the labour of mapping the spectrum.

The radio-micrometer, on the other hand, consists essentially of a thermo-electric circuit—the principally effective junction being that of bismuth and antimony—which is suspended by a quartz fibre and is capable of rotation in an intense magnetic field. It is especially suitable for measuring the radiation from a distant or feeble source of heat, the radiation being received on a metal surface in immediate connection with the bismuth antimony junction. The delicacy of the instrument varies greatly with the shape of the circuit and the fineness of the quartz fibre suspension. According to Mr. Boys, it would be possible with the most approved pattern to detect with certainty "a temperature difference of less than one two-millionth of a degree Centigrade." Whether this has been realised in practice, I do not know.

A *differential* radio-micrometer was employed some years ago by Mr. W. E. Wilson and Mr. P. L. Gray (*Phil. Trans.* A, 1894, p. 361) in experiments in which solar radiation was balanced against the radiation from a strip of platinum heated to various known temperatures. The object of the research was to determine the mean effective temperature of the sun. The method is one which would seem capable of numerous useful applications.

As already stated, thermo-electric and electrical resistance methods are by no means the only ones, in addition to gas thermometry, for which high accuracy is claimed in high temperature measurements. There is, however, only one other method to which I shall refer here, viz. the expansion of solids. This is, of course, a very old method, and is generally employed only for commercial purposes for which high accuracy is not aimed at. In 1891, however, Dr. Joly applied the principle in a new special form of instrument, the meldometer, for which high accuracy is apparently claimed as a means of determining melting points. The essential part of the instrument is a thin strip of platinum, kept stretched by a spring and heated as required by an electric current. A minute quantity of the substance under examination is placed on the strip, whose temperature is raised until the substance melts. There is delicate means of measuring the lengthening of the strip, and the corresponding temperature is deduced with the aid of a preliminary calibration, based on observations at two or three known melting points. The meldometer has been used by Prof. Ramsay and Mr. Eumorfopoulos (*Phil. Mag.*, vol. xli., 1896, p. 360) in determining the melting points of a large number of salts, and these observers seem to think highly of it. A meldometer strip was also the source of heat, whose radiation was compared with that of the sun in the experiments of Messrs. Wilson and Gray already referred to. Having had no personal experience of the meldometer, I can only say that I should hardly expect it to rival in accuracy either the thermo-couple or the electrical resistance thermometer; but the smallness of the quantity of material required, is unquestionably a recommendation to its use in determining the melting points of rare or precious substances.

C. CHREE.

[1] Since this article was written there has appeared in the *Phil. Mag.* for July 1898, an interesting paper by Mr. A. Stansfield, describing improvements in Prof. Roberts-Austen's recording pyrometer, and discussing thermo-electric results. Mr. Stansfield obtains $E = a\tau + b \log \tau + c$, for the relation between E.M.F. and temperature, measured from the absolute zero. His melting points agree well, on the whole, with the determinations of Heycock and Neville.

THE DESTRUCTION OF THE BIRDS AND MAMMALS OF THE UNITED STATES.[1]

IN the course of the correspondence of the New York Zoological Society with hunters and collectors regarding a future supply of American mammals and birds with which to stock the Zoological Park, the extent of the disappearance of our vertebrate fauna, as a whole, has become painfully evident. It seems that the war of annihilation, now going on with great activity against all our wild creatures, indiscriminately, is far more universal and far more fatal in its effects than people are aware.

In order either to verify or disprove what appeared to be the existing facts, and to discover possible remedies for existing evils, the Society resolved to make a brief but pointed inquiry into conditions affecting bird life as they exist to-day throughout the United States.

The prime object of this inquiry, and the report on its results, is to call universal attention to the fact that the whole volume of bird and mammal life in the United States is decreasing at an alarming rate.

In seeking a method by which the extent of bird destruction —or preservation—might be reduced to figures and averages, it seemed entirely possible for any person who is specially interested in birds, and who has lived for several years in a given locality, to make and furnish a general estimate as to the abundance of bird life about him to-day in comparison with what it was ten or fifteen years ago. Accordingly the following questions were prepared, and addressed to persons competent to answer them :

(1) Are birds decreasing in number in your locality?

(2) About how many are there now in comparison with the number fifteen years ago? (one-half as many? one-third? one-fourth?)

(3) What agency (or class of men) has been most destructive to the birds of your locality?

(4) What important species of birds or quadrupeds are becoming extinct in your state?

In each state and territory several observers were addressed, and an effort was made to cover the various sections of each large state. Had every addressee responded with a report the results would have been more voluminous, but it is doubtful if the figures given herein would have been greatly changed. While the majority of the persons addressed were ornithologists, and associate members of the American Ornithologists' Union, the list of observers was purposely made to include many well-known sportsmen, guides, collectors of animals, and taxidermists.

The fact that the inquiry was intended as a step in the direction of preservation awakened keen interest, and brought forth reports from nearly two hundred observers, representing all states and territories in the United States, except three. Fully 90 per cent. of the reports bear unmistakable evidence of having been prepared with conscientious thought and care. Many are very full, and particularly valuable by reason of their wealth of detail. The closeness with which the estimates of different observers in a given state or region agree with each other is quite surprising, and this may justly be regarded as evidence of their scientific value.

DESTRUCTIVE AGENCIES NOW IN OPERATION.

If the reports before us are true, the boys of America are the chief destroyers of our passerine birds, and other small non-edible birds generally. The majority of them shoot the birds, a great many devote their energies to gathering eggs, and some do both. Wherever there are herons who bear the fatal gift of "plumes," there will the plume-hunter be found, hard at work. Every now and then the newspapers and sportsmen's magazines record sickening details of the slaughter of gulls, terns, doves, or ducks; of brutal "side" hunts; of enormous catches of trout, bass, or other game fishes. It is estimated that during last autumn's hunting season, three thousand hunters entered the Maine forests in quest of deer, moose and caribou. Not taking into account what they killed and ate while in camp, they brought out 2640 deer, 102 moose. and 53 caribou; and concerning the ability of those three species to survive the attacks of the army of riflemen that annually sweeps through the forests of Maine, Mr. Caton, State Game Warden of Maine, has expressed the opinion that it is only a question of a very short time when the moose and caribou will all have disappeared from the hunting grounds of Maine. It has been estimated that during the past season 7500 deer were killed in that state.

Of the series of one hundred and ninety reports now before us, about 80 per cent. declare a decrease in bird life, and state the causes therefor. The list of destructive agencies now operating against our birds is a long one, and it is interesting to note the number of observers who complain of each. The figures given below show the number of observers who have reported each of these various causes in answer to the third question in the list.

CAUSES OF DECREASE IN BIRD LIFE.

	Reports.
1. Sportsmen, and "so-called sportsmen" ...	54
2. Boys who shoot	42
3. Market-hunters and "pot-hunters"	26
4. Plume hunters, and milliners' hunters... ...	32
5. "Shooters, generally"	21
6. Egg-collecting, chiefly by small boys	20
7. English sparrow	18
8. Clearing off timber, development of towns and cities	31
9. Italians, and others, who devour song birds ...	12
10. Cheap firearms	5
11. Drainage of marshes	5
12. Non-enforcement of laws	5
13. Gun clubs and hunting contests	5
14. Trapping birds for sale alive	2
15. Prospectors, miners and range-riders	2
16. Collectors (ornithologists and taxidermists) ...	5
17. Coloured population	4
18. Indians (for decrease of game quadrupeds) ...	4

SLAUGHTER OF ALL EDIBLE BIRDS.

In the absence of deer, elk, bear and other large mammals, the well-nigh universal desire to range afield and "kill something," expends itself upon the so-called "game" birds. Thousands of usually conscientious sportsmen and farmers find an excuse for killing the last grouse, duck or snipe in their locality in the fact that the bird is a "game bird," *i.e.* fit for food, and therefore deserving of death before the gun.

The list of North American birds universally classified by gunners and others under the general head of "game birds" is not only very large, but is constantly being increased. To-day it stands about as follows, for the United States alone :—

		Species.
Gallinaceous birds—pheasants, grouse, partridges, quail, &c.	about	33
Pigeons and doves	,,	12
Shore birds—snipes, sandpipers, curlews, &c.	,,	47
Anseres—ducks, geese, swans	,,	43
Rails	,,	9
Cranes, herons, egrets, ibises and other large birds always shot on sight, for their plumage or for other reasons	,,	10
		154

DESTRUCTION OF BIRDS FOR MILLINERY PURPOSES.

One of the strangest anomalies of modern civilisation is the spectacle of modern woman—the refined and the tender-hearted, the merciful and compassionate—suddenly transformed into a creature heedlessly destructive of bird life, and in practice as bloodthirsty as the most sanguinary birds of prey.

After having stripped our Atlantic coast, the whole of Florida and the Gulf coast of egrets, terns, and hundreds of thousands of other birds acceptable to the milliners for hat trimmings, the "plume hunters" are now at work along the coast of Mexico and Central America, Lower California, and even upon the headwaters of the Orinoco and Amazon. Quite recently, two of them risked their lives with the Indians on Tiburon Island, Gulf of California, and lost their stake!

THE SCOURGE OF EGG-COLLECTORS.

Throughout the north-eastern quarter of the United States, extending as far westward as the Mississippi River and as far south as Virginia, bird life generally is persecuted by a perfect scourge of egg-collectors, largely in the name of science, but really for purposes of mere curiosity or trade. In the reports

[1] Abridged from a report on the results of an inquiry, contained in the Second Annual Report of the New York Zoological Society, by William T. Hornaday.

now before us, the outcry against the havoc thus wrought is very general and bitter. During the breeding season of the birds that nest in the region indicated, an army of boys and men takes the field, and sweeps through the thickets, the woods and the meadows, searching out the home of every nesting bird, gathering in or destroying all the eggs that are found, and very often shooting great numbers of the nesting birds.

The outcry against the irresponsible, unscientific egg-and-birdskin collectors is almost as great as that against the English sparrow. They are the special enemies of the birds most useful to agriculture—those which seek the privilege of making their homes with us during at least one-half the year, and fighting the noxious insects all through their summer campaign. The amount of actual damage inflicted upon the farmers by those who collect the eggs of insectivorous birds, and useful birds of prey, is undoubtedly great. Is it not time for egg-collecting to be brought to a full stop, at least for five years?

HUNTING CONTESTS, OR "SIDE" HUNTS.

Of all the influences now operating for the destruction of our birds and mammals, the most outrageous is the so-called "side hunt." A side hunt may properly be defined as a game of murder, in which a body of particularly brutal (or thoughtless) men, sometimes *more than a hundred* in number, and usually known as a "gun club," choose sides, arm themselves with guns and an unlimited quantity of ammunition, go forth on a given day, and for a fixed number of days shoot many kinds of wild creatures, "for points." At the close of the slaughter, the victims are collected, counted according to the "points" agreed upon for each species, and the side which has accomplished the greatest amount of butchery is declared the winner.

SPECIES REPORTED AS "EXTINCT," OR "BECOMING EXTINCT."

Mammals.

	Reports.
"The larger quadrupeds, generally"	6
Bison; Buffalo (*Bos americanus*)	15
Elk; Wapiti (*Cervus canadensis*)	22
Moose (*Alces americana*)	7
Virginia or White-tailed Deer (*Cariacus virginianus*)	32
Mule Deer (*Cariacus macrotis*)	3
Black-tailed Deer (*Cariacus columbianus*)	1
Woodland Caribou (*Rangifer caribou*)	2
Prong-horned Antelope (*Antilocapra americana*)	15
Mountain Sheep (*Ovis montana*)	10
Mountain Goat (*Haploceros montanus*)	2
"Bears, generally"	1
California Grizzly Bear (*Ursus horribilis horriaeus*)	2
Black Bear (*Ursus americanus*)	15
Jaguar (*Felis onca*)	1
Puma; Mountain Lion (*Felis concolor*)	6
Red Lynx (*Lynx rufus*)	5
Otter (*Lutra canadensis*)	11
Beaver (*Castor canadensis*)	22

Birds.

"All birds, generally"	3
"Game birds, generally" (meaning gallinaceous species)	5
"Shore birds, generally"	5
"Geese and ducks, generally"	20
"Herons and egrets, generally"; "plume birds"	12
"Hawks, generally"	3
"Owls, generally"	4
Wild Turkey (*Meleagris gallopavo*)	30
Ruffed Grouse (*Bonasa umbellus*)	20
Pinnated Grouse; Prairie Hen (*Tympanuchus americanus*)	13
Heath Hen (*Tympanuchus cupido*)	1
Passenger Pigeon (*Ectopistes migratorius*)	35
Blue Bird (*Sialia sialis*)	15
Carolina Paroquet (*Conurus carolinensis*)	5
Wood Duck (*Aix sponsa*)	5
Flamingo (*Phœnicopterus ruber*)	1
Roseate Spoonbill (*Ajaja ajaja*)	3
White Heron (*Ardea candidissima*)	10
Ivory-billed Woodpecker (*Campephilus principalis*)	4
Pileated Woodpecker (*Ceophlœus pileatus*)	4
California Vulture (*Pseudogryphus californianus*)	1

DECREASE IN BIRD LIFE IN THIRTY STATES.

(The shaded portions show the percentages of decrease throughout the States named during the last fifteen years, according to the reports.)

	Per cent.
Maine	52
New Hampshire	32
Vermont	30
Massachusetts	27
Rhode Island	60
Connecticut	75
New York	48
New Jersey	37
Pennsylvania	51
Ohio	38
Indiana	60
Illinois	38
Michigan	23
Wisconsin	40
Iowa	37
Missouri	36
Nebraska	10
North Dakota	58
District of Columbia	33
South Carolina	32
Georgia	65
Florida	77
Mississippi	37
Louisiana	55
Arkansas	50
Texas	67
Indian Territory	75
Montana	75
Colorado	28
Idaho	40
Average of above	46

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Sir David Salomons, who founded in 1895 at Gonville and Caius College a scholarship to be called the Salomons Engineering Scholarship, has, on the occasion of the celebration of the 550th anniversary of the foundation of the college, increased the annual value of the scholarship from 40*l.* to about 70*l.* The scholarship is open to persons not yet in residence, and is tenable for three years. The person elected is to make a declaration that he *bona fide* intends to enter the engineering profession as a civil and electrical engineer, and will, if required by the governing body of the college, become a candidate for the Mechanical Sciences Tripos. The next examination will be held on Tuesday, November 1, 1898. Candidates must not be more than nineteen years of age on October 1, 1898. The successful candidate will be required to commence residence in October 1899. The subjects of examination will be Euclid, Algebra, Plane Trigonometry, Geometrical and Analytical Conic Sections, Elementary Statics and Dynamics, and Differential Calculus Physics, including

Dynamics and Hydrostatics, with practical work. Candidates must send their names, with testimonials of good conduct and certificate of birth, on or before Tuesday, October 25, to one of the tutors, the Rev. E. S. Roberts or Dr. J. S. Reid.

The Anderson travelling scholarship at Aberdeen University, value 170*l.*, tenable for two years, has been awarded to Mr. J. J. R. Macleod.

Dr. Wm. Duane has been appointed professor of physics in the University of Colorado. He takes the place of Prof. W. J. Waggener, who has resigned owing to failing health.

The building of a new museum of archæology for the University of Pennsylvania was begun in January last. Its cost will be about 100,000*l.*, and it will be completed, it is hoped, early next year.

Science states that the sum of 21,000 dollars has been given by Mr. George A. Fowler, of Kansas City, to cover the cost of re-building the agricultural department buildings of the University of Kansas, recently destroyed by fire.

The following appointments have been made at the Johns Hopkins University:—Associate Prof. J. S. Ames to be professor of physics; Drs. T. C. Gilchrist and J. W. Lord to be clinical professors of dermatology.

Dr. A. M. Stalker has been appointed professor of medicine, and Dr. S. MacEwan professor of surgery at Dundee University College. Lectureships in the same college in forensic medicine and public health, and physiology have, respectively, been conferred upon Dr. C. Templeman and Dr. F. Harris.

University of London.—The following have passed in the recent D.Sc. examination:—In Experimental Physics—Robert Alfred Lehfeldt, Alfred Stansfield, Joseph Herbert Vincent. In Chemistry—Samuel Barnett Schryver, Morris William Travers. In Botany—Arthur Harry Church, Reginald William Phillips, Alfred Barton Rendle. In Zoology—Marion Isabel Newbigin, Ernest Warren. In Physiology—Jn. Le Mare Bunch, Otto Fritz Frankau Grünbaum. In Geology and Physical Geography—Catherine Alice Raisin. In Mental and Moral Science—Jessie Charles.

A petition is about to be presented to the House of Commons by the Association of School Boards, acting for a large number of School Boards in England and Wales, with reference to the action of the Science and Art Department in the appointment of local authorities for secondary education. The petition represents that School Boards have hitherto been recognised by the Science and Art Department as local committees eligible to receive grants from the Department, but recently, in appointing local authorities for the distribution of the grants within certain areas, a large number of the Technical Instruction Committees of County and County Borough Councils have been recognised by the Department as being responsible for the science and art instruction within the areas of such Committees, and to these local authorities will be entrusted the distribution of money voted by Parliament for science and art instruction. These local authorities are thus being invested with many of the important administrative powers of local authorities for secondary education, and the Science and Art Department, it is urged, are carrying into effect without legislation an arrangement that was proposed in the case of the Education Department and of the Science and Art Department by the Education Bill of 1896, which was successfully opposed and withdrawn. In the opinion of the Association the action of the Science and Art Department is a serious interference with the powers of School Boards and of managers of voluntary schools; it forestalls imminent legislation, since a Government measure for secondary education is shortly to be introduced into Parliament; and it disregards the absolute necessity which is universally felt for correlating all educational machinery, and is in direct opposition to the recommendations of the recent Royal Commission on Secondary Education. The petitioners request that steps be taken to secure that the Science and Art Department in making the appointment of local authorities dealing with science and art grants under Clause 7 of the Science and Art Directory, if permitted at all, shall act in accordance with the Association's recommendations, which are stated to be almost identical with those of the Royal Commission.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, June 1898.—The regular meeting, held on April 30, was largely attended. In addition to the presentation of some thirteen papers, a slight amendment was made in the by-laws to provide for life-membership.—The following five papers were read at the meeting:—Example of a single-valued function with a natural boundary, whose inverse is also single-valued, by Prof. Osgood. It is first shown that functions exist which are analytic within the unit circle, which have the unit circle as a natural boundary, and which take on no value more than once. Then an explicit example is taken, viz. the series

$$f(z) = z + \frac{z^{a+2}}{(a+1)(a+2)} + \frac{z^{a^2+2}}{(a^2+1)(a^2+2)} + \ldots$$

where a denotes an integer greater than unity. This example is discussed and illustrated.—Note on Poisson's integral, by Prof. Bôcher. A non-artificial proof is given, and the theorem generalised by inversion, whence results the theorem, If (x, y) is any point within the circle C,

$$V(x, y) = \frac{1}{2\pi}\int_0^{2\pi} V_c d\psi,$$

(A) where ψ is the angle measured from a fixed circle through (x, y) which cuts C orthogonally to a variable circle of the same sort. Hence is derived the further theorem, given a continuous function V_c upon the circumference of the circle C, the function $V(x, y)$ defined by (A) throughout the interior of C is harmonic throughout C, and joins on continuously to the values V_c on the circumference. [From a theorem of Gauss the value of V at the centre (x_0, y_0) of C is the arithmetic mean of its values on the circumference. If V_c denotes the values of V on the circumference, and ϕ is the angle at the centre, we have

$$V(x_0, y_0) = \frac{1}{2\pi}\int_0^{2\pi} V_c d\phi].$$

—On the polynomials of Stieltjes, by Prof. van Vleck. Such a polynomial is defined to be one which satisfies the regular differential equation of the second order.

$$\frac{d^2y}{dx^2} + \left(\frac{1-\lambda_1}{x-e_1} + \ldots + \frac{1-\lambda_r}{x-e_r}\right)\frac{dy}{dx} + \frac{\phi(x)[= A_0x^{r-2} + A_1x^{r-3} + \ldots + A_{r-2}]}{(x-e_1)\ldots(x-e_r)} = 0.$$

—Note on Stokes's theorem in curvilinear coordinates, by Prof. A. G. Webster.—Is continuity of space necessary to Euclid's geometry, by W. M. Strong. The space is thus defined: Let a real number which can be obtained from the integers by a finite number of rational operations and extractions of square roots be called a *quadratic number*. A, B, C are any three points not in a straight line. Such that AC and BC are quadratic in terms of AB. The points whose distances from each of the three points A, B, C, are quadratic in AB, constitute the space (*i.e.* quadratic space). In such a space it is shown that figures may be moved about without change of size or shape. Two other striking peculiarities are—two circumferences may intersect in a single point, and a circumference may have no centre.—A short note on the Steiner points of Pascal's hexagon, by Dr. Snyder, gives a short and simple proof of the conjugate nature of M, N with regard to the conic for which M, N are associated Steiner points (*cf.* Von Staudt, "Ueber die Steiner'schen Gegenpunkte," Crelle, vol. lxii.). In this proof the author claims that it is clearly shown which of Steiner's points are associated as "Gegenpunkte."—There are two reviews, viz. of the "Cours de Géométrie Analytique of Niewenglowski," by Prof. Bôcher, and of Goursat's "Partial Differential Equations," by Prof. E. O. Lovett (thirty-five pages).—The notes give the mathematical courses for the summer semester at the Universities of Berlin, Göttingen, Leipsig, Munich, Columbia, Chicago, and Harvard.—At the end is given the usual list of new publications.

Symons's Monthly Meteorological Magazine, July.—The principal article contains some account, by Mr. Rotch, of the recent International Aeronautical Conference at Strassburg, which was well attended. The methods discussed for obtaining observations were manned and unmanned balloons, the captive kite-balloon, and kites.—M. Cailletet described his apparatus for photographing automatically at fixed invervals a barometer in the balloon and the ground vertically below, so that the height and route of the balloon may be determined. He also exhibited a very sensitive thermometer having a spiral silver tube for its bulb soldered to a glass tube, both being filled with the liquid toluene.—M. Teisserenc also showed a very sensitive self-recording thermometer which is, at the same time, almost insensible to shocks.—Mr. Rotch read a paper on the use of kites, based on the experiments carried on at Blue Hill Observatory. The Conference recommended their use as being of great value to meteorology. Trials were made with the kite-balloon, a captive balloon which, unlike the ordinary spherical one, is not driven down or carried away by strong winds. It is a German invention, and is used in the army for reconnoitring. The Strassburg balloon, which is of smaller construction, is the first adapted for lifting self-recording meteorological instruments.—Results of meteorological observations for June at Camden Square (London) for forty years, 1858-97. The mean of all the maximum temperatures is 71°·3, and of the minimum, 50°·9. The mean rainfall is 2·23 inches; in June of the present year the total fall was 1·11 inches only.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Microscopical Society, June 15.—Mr. E. M. Nelson, President, in the chair.—The President referred to the loss the Society had experienced in the death of Mr. Henry Perigal, who died at the advanced age of ninety-eight. He then exhibited and described two old microscopes, one of which, made by Benjamin Martin, probably dated from about 1770. It had two concave mirrors, one of 4" and the other of 9" focus. The optical part was curious, having a fixed back lens in the tube which was common to all the objectives, each of which was fitted with a lieberkuhn. The other was an antique instrument with simple lenses fitting into one another to increase the power. It seemed to be a copy of one made by Mann and Ashcroft somewhere about 1740, and was made by Cary. He next called attention to an excellent lithographic portrait of Prof. John Quekett, the work of Wm. Lens Aldous, whose son had presented it to the Society.—Mr. Frederick Ives exhibited a camera lucida which he had devised. It was one he had obtained from Messrs. Swift, and he had slightly modified it by depositing on one of the inside faces of the compound prism a very thin specular film of silver, through which it was possible to see the pencil without having to centre the eye, as was the case where the film was opaque with a small hole in it to look through. After some remarks by Mr. Beck, Mr. Swift said there was a difficulty in centring the eye in the old form which did not exist in the one before them, the pencil being seen with ease while delineating the object under observation. The President thought the device a valuable one, and preferable to that of a thick film of silver with a hole in it.—Mr. Ives also exhibited a monochromatic green screen, consisting of dyed films between two plates of glass, which he thought possessed advantages over liquid screens. The one now shown would cut off all beyond the F line on the blue side, including the ultra-violet, and also all red and yellow. In reply to an inquiry, Mr. Ives said that of course the light was not strictly monochromatic; it was a mixture of pure green in the spectrum at the E line, with some yellow-green on one side and blue-green on the other.—Mr. B. W. Priest exhibited a large number of slides of sponges. He said he had brought a selection which would be found to be characteristic of the order Calcarea and the three sub-orders of Silicea, viz. the Monaxonidæ, Tetractinellidæ and Hexactinellidæ, to the last of which he directed attention on account of their great beauty. There were also some slides of fresh-water sponges.—The Secretary said there was a paper of great interest, namely, the continuation of Mr. Millett's report on the Foraminifera of the Malay Archipelago, which being of a very technical character he proposed should be taken as read.—The President reminded the Fellows present that the next meeting of the Society would not take place until October 19.

Mineralogical Society, June 21.—Prof. A. H. Church, F.R.S., Vice-President, in the chair.—Prof. Miers communicated an account of some minute cubic crystals of lead developed by the action of acid upon the surface of cast lead. These, although too small to be isolated and measured individually, were successfully measured by means of the new double-circle or "theodolite"-goniometer, by which all the faces of a complicated crystal may be determined in a single operation.—Mr. E. G. J. Hartley read an account of an analysis of Cornish Chalcophyllite, carried out in the Mineralogical Laboratory at Oxford. This mineral, hitherto supposed to be a basic arsenate of copper and aluminium, he found to contain no less than 7 per cent. of SO_3, which has been overlooked by previous analysts, so that Chalcophyllite must now be classed among the double arsenates and sulphates.—Mr. G. F. H. Smith gave a short account of a possible dimorphous form of Laurionite. In general appearance this mineral is very similar to Laurionite, but on crystallographic and optical examination was found to be monosymmetric, imitating rhombic symmetry by twinning; whereas Laurionite is truly rhombic. From an analysis, made on a small quantity of selected material, Mr. G. T. Prior found the chemical composition to be the same as that of Laurionite.—Mr. Tutton exhibited a new dilatometer designed for the purpose of measuring the thermal dilatation of crystals by Fizeau's delicate method. In this instrument the expansion of the platinum-iridium screws which carry part of the apparatus is exactly compensated by an aluminium block, so that the dilatation of the crystal is measured directly, and comparatively thin crystals can be employed for the experiments.

EDINBURGH.

Royal Society, July 4.—Lord McLaren in the chair.—The Gunning Victoria Jubilee Prize for 1893-6 was presented to Mr. John Aitken, for his varied and important researches in the physics of meteorology. At the request of the Council, the Astronomer Royal for Scotland gave an address on the total solar eclipse of January 21, 1898, with some account of solar observation generally. Prof. Copeland began with a brief statement of what is now known concerning the sun's constitution, and indicated the lines along which an increase of knowledge might fairly be expected from observations of total eclipses. He then described the work his party had been able to accomplish during the recent eclipse. The photographs shown in illustration were chiefly from among those taken by himself and his assistants, and included several of the corona and protuberances and some fine spectrograms of the upper parts of the photosphere of the eclipsed sun. These were obtained with an instrument in which quartz prisms and lenses were used, and the spectral lines could be traced as far as Q. A careful examination would no doubt throw light on the heights reached by the various glowing vapours. The Astronomer Royal expressed his deep sense of gratitude to all who, both officially and privately, had facilitated his labours.—Dr. R. H. Traquair communicated three papers (1) on a new species of *Cephalaspis* found by the Geological Survey of Scotland in the Old Red Sandstone of Oban; (2) on *Thelodus Pagei* (Powrie) from the Old Red Sandstone of Forfarshire; (3) report on fossil fishes collected by the Geological Survey of Scotland on the Upper Silurian rocks of the Lesmahagow district. In this report four new genera and eight new species of fossil fish were described. The remains were in a remarkably good state of preservation, and threw a new light on several important biological problems. Thus certain scales, which had been previously described as sharks' teeth, were proved incontestably to belong to forms of *Thelodus*; and these forms also showed that Powrie's *Cephalopteris* was a *Thelodus* (subject of second paper). The characteristics of the new genera *Lanartia* and *Birkenia* were described at length, one peculiarity of the latter being the direction of the scales, which was from above downwards and forwards, instead of from above downwards and backwards, as in *Ganoids*.—Dr. W. Aitchison Robertson read a paper on the effect of mixed diet as regards salivary digestion. Among the results obtained may be mentioned the following: Porridge, especially if diluted with water or milk, was rapidly digested. Potatoes in a powdered state were also easily digested. Newly-baked bread was not so rapidly acted upon by saliva as stale bread, but the ultimate degree of starch conversion was greater in the former than in the latter. Alcohol retarded salivary digestion of starch, but not so much as infusion of tea. Wines had a marked inhibitory action; but beer aided digestion.

PARIS.

Academy of Sciences, July 18.—M. Wolf in the chair.—Researches on the relations which exist between luminous and chemical energy, by M. Berthelot. An experimental study of the action of sunlight upon concentrated nitric acid, iodic anhydride, hydrogen iodide, and hydrogen bromide, the tubes containing the substances under examination being placed in baths of different substances. Mixtures of hydrogen with carbon dioxide and sulphur were also submitted to sunlight, but with negative results.—On the *Terfezia Leonis* from the department of Landes, by M. Ad. Chatin. The host of this fungus in France, as abroad, is *Helianthemum guttatum*.—Results of recent borings for coal in the north of France, by M. J. Gosselet. An account of a series of borings made in the north of France with the view of finding a prolongation of the great Franco-Belgian coal basin. The borings were not successful.—Remarks by M. Albert Gaudry on the scientific work of M. Victor Lemoine.—M. Mosso was elected a Correspondant in the Section of Medicine and Surgery in the place of the late M. Tholozan.—On a theorem of M. Casserat, by M. Tzitzéica.—On the elastic equilibrium of a pneumatic tyre, by M. L. Lecornu.—Telegraphy without wires and collisions at sea, by M. Édouard Branly. Although it is quite possible for a transmitter on one ship to send signals to another furnished with a sensitive receiver, great difficulties arise when an attempt is made to render the action reciprocal, since the same ship must be furnished with a powerful transmitter and sensitive receivers, and it is scarcely possible to completely shield the latter from the action of the former. The arrangement tentatively suggested is that the current working the transmitter should automatically enclose the neighbouring receivers in a metallic screen.—On the kathode rays, by M. P. Villard.—On a new radio-active substance contained in pitchblende, by M. P. Curie and Mme. S. Curie. Previous researches have shown that the activity of the Becquerel rays emitted by uranium compounds is proportional to the amount of the metal present. This, however, is not the case for pitchblende, in which the activity is much greater than that calculated from its percentage of uranium. Hence arose the possibility of the presence of a new substance, to account for the increased activity. In the separation of the metals as sulphides the active material was thrown down along with bismuth sulphide; a partial separation could be effected by heating in vacuo at 700° C., the sublimate thus obtained possessing 400 times the activity of uranium. Since no chemical substance out of a large number examined behaves in a similar manner, the authors believe the metal to be a new one, and suggest the name of *polonium*, from the country in which the pitchblende was found. The spectrum exhibits no characteristic ray.—Decomposition of calcium and barium phosphates by boiling water, by M. Georges Viard.—On anhydrous-crystallised magnesium sulphide, by M. A. Mourlot. The amorphous sulphide, prepared by the methods of Reichel or Parkinson, is heated in a carbon boat in the electric furnace; the fused mass thus obtained is crystalline, showing rectangular cleavages clearly. The crystallised sulphide can also be readily produced by the action of tin sulphide upon magnesium chloride in the electric furnace.—Exchange of the halogens in the aromatic series, by M. V. Thomas.—Action of bromine upon para-isobutyl phenol in presence of aluminium bromide. Remarks on the bromination of phenols, by M. F. Bodroux.—On the diketones of tetrahydro-β-oxazol, derived from the phenylurethanes of some oxy-acids, by M. E. Lambling.—On the estimation of phosphoric acid, by M. Leo Vignon. Some remarks on the criticisms of M. Lasne.—On the existence, in germinated barley, of a soluble ferment capable of acting upon pectin, by MM. Em. Bourquelot and H. Hérissey.—On the deep-sea Gephyridia collected from great depths, by the *Travailleur* and *Talisman*, by M. Louis Roule.—On the attack of the seeds of *Phaseolus* by *Colletotrichum Lindemuthianum*, by M. Edmond Gain.—On the displacement towards the east of the water running from the plateau of Lannemezan, by M. L. A. Fabre.—On the clinical applications of radiography, by M. Garrigou.

NEW SOUTH WALES.

Royal Society, June 1.—Mr. G. H. Knibbs, President, in the chair.—Aeronautics, by Lawrence Hargrave. The author described at length, with scale drawing and photographs, a kite that under favourable circumstances soars horizontally and at various acute angles to the direction of the wind. The kite is of the well-known cellular form, but in addition has a bent piece of vulcanite nearly midway between the cells. This is called the propeller, and its effect is to create a vortex that acts on its under and concave side. The vortex pushes against the propeller in the same manner that the ball of a water nozzle draws against the orifice from which the water is issuing. The kite is heavily ballasted with lead, and weighs 1·9 lbs. for every square foot of area. Three methods of soaring were described, and eight points that require investigation were indicated for the guidance of any one who has the leisure and sufficient interest in the subject to assist in the work. The paper also contained a short description of a pipe boiler and screw engine that is intended to drive a flying machine, and also the proposed arrangement of aeroplanes for supporting it, with the method of ensuring a safe trial.—Australian divisional systems, by R. H. Mathews. The author pointed out that all tribes of Australian aborigines are divided into two exogamous intermarrying groups—the men of one group marrying the women of the other group. These tribal divisions have been designated organisations or systems. The names of the groups may change with the languages of the people in different districts, but the same system prevails in them all. Besides this segregation into groups, there is a further subdivision of the latter into smaller segments, bearing the names of animals, such as kangaroo, iguana, emu, cod-fish, frog, &c. These animal names have been called *totems*, a word in use for the same purpose among the North American Indians. Mr. Mathews then proceeded to give an exhaustive description of the rules of marriage and descent established in relation to the divisions referred to, selecting examples from various native tribes located in districts widely separated from each other in different parts of Australia.—Artesian waters in New South Wales, by J. W. Boultbee. The paper described briefly the initial efforts at artesian boring in New South Wales, and led up to the utilisation of the water for irrigation purposes; it described the work in that direction undertaken by the Government at the Native Dog and Pera Bores. It pointed out how the Government was guided by American experience, and referred to the areas, soil, water, results, and the revolution effected in some of the States, and the rapid growth of settlement by means of the artesian water supply; it referred to the gradual awakening of the western pastoralists to the benefits conferred. The progress of the work in New South Wales, cost, yield of water, &c., was tabulated.

CONTENTS.

THURSDAY, AUGUST 4, 1898.

THREE BOOKS ON PRACTICAL ELECTRICITY.

The Potentiometer and its Adjuncts. By W. Clark Fisher, A.M.I.C.E. Pp. x + 194. (London: *The Electrician* Printing and Publishing Company, Ltd.)

The Principles of Alternate Current Working. By Alfred Hay, B.Sc., Lecturer on Electrotechnics at the University College, Liverpool. Pp. xi + 276 + iv. (London: Biggs and Co.)

Electric Wiring for the Use of Architects, Underwriters, and the Owners of Buildings. By Russell Robb. Pp. 183. (London and New York: Macmillan and Co., 1896.)

MR. FISHER'S book is another example of the *Electrician* series of technical manuals, written by specialists for those engaged in electrical work. They generally contain very valuable information which could hardly be obtained, except by the expenditure of much trouble, from any other source; they are written with a knowledge of what is important for, at any rate, the practical reader, and they are illustrated in most cases by well-executed drawings of instruments and machinery. All these merits Mr. Fisher's book possesses. It is clear and concise, and has a distinct first-hand value of its own, as the work of one who has himself made the tests and investigated most of the questions which he discusses.

The book starts off with a general description of potentiometer testing, then there is a detailed account of the Crompton potentiometer, and of batteries and galvanometers suitable for use in the kind of work under consideration. The galvanometer which receives most attention is the so-called d'Arsonval instrument. The author is quite right in referring to this galvanometer as a Thomson (not "Thompson," as in the text) or Kelvin instrument. As a matter of fact the galvanometer use of the recorder coil and magnet is, if we remember rightly, explicitly referred to in the original siphon-recorder patent, and several laboratory workers had found the arrangement a very convenient form of galvanometer for various purposes long before "d'Arsonval galvanometers" were ever heard of.

The discussion of standards of E.M.F., and especially the behaviour of the Clark cell, is one in which Mr. Fisher has taken a prominent part, and the chapter on this subject contains much useful information, especially on the subject of the recuperative power of the cell after the passage of a current through it.

Next follow chapters on standard resistances, platinum-thermometry, the erection of apparatus, and the Crompton potentiometer in use, all of which are very valuable. Many practical details, which will materially facilitate the carrying out of the tests, are given under the last two heads.

The book closes with a historical chapter and an account of "bridges" of different kinds. The latter contains a summary of the improvements of the various forms of bridge for low-resistance comparisons which have been suggested in the course of the work of Messrs. Griffiths and Callendar.

This book shows the great advance which resistance testing has made during the last seven or eight years. It is apt, however, to be forgotten in these days of splendidly arranged and made potentiometers that the method is far from new, and is essentially that used long ago by Matthiessen and Hockin in their careful comparisons made in the early days of electrical testing work. The ordinary fall of potential method for the comparison of resistances is the fundamental idea; indeed, a potentiometer method with resistance slides was in use in Lord Kelvin's laboratory when the writer was there fifteen or sixteen years ago, and other arrangements, depending on the same method, were employed as convenience or the work in hand dictated, without any idea that they were other than obvious applications of electrical principles.

While, as we have indicated, the book is a very valuable one, we should like it better if some modes of expressions were modified.

The phrase "tumbled to the fact," for instance, does not seem much of an improvement in brevity or accuracy, or anything else, on the older-fashioned expression "grasped the fact."

Then, again, there is here and there a suspicion of smartness, which is no doubt quite superficial, but would be better absent.

The author's historical notes with respect to Poggendorf (*sic*) are rather curious. It appears that after searching English books in vain for an account of Poggendorff's work, the author ultimately found the desired information in a French electrical dictionary. We had thought the editor (from 1824 to 1877) of the *Annalen der Physik* was fairly well known even in this benighted country; and that references to his papers and an account of their contents were pretty generally available in that great and easily accessible work of reference, Wiedemann's "Elektricität." And, after all, the French dictionary account seems "to leave to desire." Poggendorff did not edit the *Annales de Physique et de Chemie* (*sic*), but the *Annalen der Physik und der Chemie;* with the French journal *Annales de Chimie et de Physique* he had nothing to do.

These are, however, slight blemishes in Mr. Fisher's book, and we hope they will be all cleared away very shortly in a new edition.

Mr. Hay's "Alternate Current Working" is a very good book indeed. It gives in very moderate compass an exceedingly valuable digest of most of the facts and theories of alternate working which it is necessary that students should know. The treatment is generally clear and elegant, and well elucidated by graphical representation of theoretical and experimental results.

The first chapter deals with the graphical representations of functions and elementary trigonometry; the second with scalar and vector quantities, simple harmonic and other periodic functions.

In the next chapter the subject proper of the book is entered on, and it is then in the succeeding chapters developed and discussed, in its theory and practical applications, in a very complete and satisfactory way. The enumeration of a few of the chief topics will give some general idea of the scope and purpose of the work. After a general treatment of alternating currents, chiefly following the law of sines, the practical measurement of power in alternating circuits, the effects of phase displacement, effects of capacity, displacement currents, are all dealt with. Then the transformer is introduced by (1) a chapter on mutual inductance, in which the theory of some important cases of mutually influencing currents is explained, and the rationale of the growth of the current in the outer layers of a conductor and its penetration inwards are touched upon, and (2) a chapter in which the very important case of two mutually influencing circuits, containing simple harmonic electromotive forces, is very well explained by means of vector diagrams.

Here we may incidentally remark that we very much prefer on the whole the analytical treatment of this kind of problem, supplemented by a full graphical exhibition of the results, to an attempt to give a graphical treatment purely of the subject. The analysis is easy enough, if only people will concentrate their attention on the thing to be understood, and generally be at a little real trouble. The purely graphical process is somewhat fatiguing after all, and, while the student may understand a discussion of such a problem as this, he is not likely, unless he obtains some skill in analysis, to be very self-dependent in new questions which may arise. A great deal of the girding at mathematicians and exalting of so-called common-sense and practical methods of treatment (often only illustrations of results otherwise to be demonstrated) is the veriest clap-trap.

However, of anything of this kind there is not a trace in Mr. Hay's book; on the contrary, no difficulty is shirked, and he takes a course which, whether we think it the best or not in all cases, has been suggested to him by experience gained in the efficient school of electrical engineering of which he is in charge at Liverpool.

The running of alternators is next entered on, and synchronous motors, and single phase and polyphase currents, and induction motors generally, with the measurement of power in polyphase circuits, conclude the book.

Want of space prevents our giving a fuller appreciation of this unpretending but very scientific and accurate little book. It is in all respects a piece of good work, and has already proved, we doubt not, thoroughly acceptable to students.

Mr. Russell Robb's treatise on electric wiring gives a useful account of systems of distribution, methods of wiring, and the code of rules for electric wiring now accepted by underwriters throughout the country. The first two chapters on the electrical units, Ohm's law, and such subjects, seem to us for the most part unnecessary. The explanations and analogies are very briefly and somewhat vaguely stated, and an elementary knowledge of these subjects on the part of the reader had better have been taken for granted. Certainly it is not here given, and the only effect the generalities stated can have will be to lead the ordinary business man, *e.g.* the town councillor interested in an electric lighting scheme, to delude himself into fancying he knows what current, electromotive force, and resistance really signify. However, Mr. Robb has done a very useful thing in printing the other parts of his book. The style and get-up of the book are very good, though the size of page, paper, &c., do not strike us as very well chosen. A smaller page, thinner paper, and flexible covers, with excision of the introductory matter referred to above, would have given a much lighter and more convenient book to carry about for reference when wanted. A. GRAY.

THE ANGORA GOAT.

The Angora Goat; and a Paper on the Ostrich. By S. C. Cronwright Schreiner. 8vo. Pp. xv + 296; illustrated. (London: Longmans, Green, and Co., 1898.)

NO one taking up this little volume and looking merely at the cover would have the slightest intimation that it included a chapter on ostriches, and since some of the notes contained therein are of considerable interest, it is well that its existence should be noted. Another surprise is the absence of either preface or introduction, although, perhaps, the book is none the worse for the omission.

When a work commences with references to popular natural histories as the sources of the scientific information, it may be taken as a general rule that the author is insufficiently acquainted with his subject, and is a stranger to the methods of zoological research. Athough thus handicapping himself at the start, Mr. Schreiner very soon shows that he has a complete grasp of all the essential facts connected with the Angora goat and its relations to other wild and domesticated breeds, both from the point of view of the naturalist and from that of the agriculturist and the manufacturer. And he has succeeded in producing a work which cannot fail to be of considerable interest to all those interested in the origin of our domestic animals.

Since Darwin's time, it must be confessed that the attention devoted by naturalists to domesticated animals has been of the very slightest; and this is distinctly to be regretted, since there seems little doubt that much is to be learned from them concerning the capacity for variability in species. And here it may be mentioned that a gallery exhibiting the different breeds of domesticated animals is a desideratum in this country. If it cannot be attempted in the British Museum, it might be commended to the attention of the Royal Agricultural Society.

To return to our subject, the author is quite orthodox in accepting the descent of the domestic breeds from the Persian wild goat (*Capra hircus ægagrus*, as it may well be called), and rejecting the markhor heresy. He next proceeds to show that there is no decisive evidence as to when or where the wild goat was first domesticated, but that there is great probability the Angora breed is one of considerable antiquity.

"It seems quite clear," he writes, "that from remote times the mohair goat developed in the region of Central Asia Minor, and gradually became localised there, the territory which it occupied eventually being restricted to that portion which pre-eminently suited it, the region round Angora, until at last the pure-bred animal was found only there. A continuous course of in-breeding, through a long period of time, fixed it true to type, and made it eventually a thoroughbred; but this also made it small and delicate."

The author also quotes several writers who have pointed out that the climate of Angora exhibits a remarkable tendency to the development of a silky coat in animals of several kinds, this tendency displaying itself among cats and greyhounds, as well as in the goats. Very interesting is his suggestion that the so-called mohair of the Angora goat really corresponds to the under-fur or "pashm" of the wild goat, the ordinary fur of the latter being represented by the "kemp" of the former. If this prove to be well founded, it would be decisive for the origin of the domestic breeds from the wild goat, in contradiction to the markhor (*Capra falconeri*), since under-fur is not developed at all in the latter species.

Although it is considered probable that the Angora originally formed a single pure breed, there is evidence of subsequent crossing with the common Kurd goat, by means of which several sub-breeds have resulted, one of them being now hornless. Crossing seems also to have taken place with a local breed descended from the well-known shawl-goat of Kashmir.

After several chapters devoted to the extent and value of the mohair trade in Turkey, the author comes to what appears to be the chief subject of his work, namely the first importation of the Angora into Cape Colony, and the subsequent development of the South African mohair trade. First of all, in 1725, the experiment was tried of introducing Kashmir goats into the Cape, but it turned out a failure; and probably this was fortunate, since, in the first place, it is a much less valuable animal than the Angora, having only a comparatively small quantity of "pashm" at the roots of its long hair, and, secondly, there is a strong probability that even this would disappear under the influence of a hot climate. Of Angoras the first importation took place in 1838; and it is practically to a single female and her one kid that the existing stock owes its origin. To improve the crosses thus produced between the Boer goats and the Angoras, fresh importations have continued from time to time from that date up to 1896; and some idea of the value attached to high-class blood may be gathered from the fact that no less a sum than 450*l.* has been paid for a single pure-bred ram, and 205*l.* for a ewe. Unfortunately, with some of the importations, pleuro-pneumonia was introduced into the Cape, and, with the usual virulence of such diseases in a new field, played terrible havoc with the flocks. Inoculation and other remedies seem, however, at last to have pretty well stamped out the plague.

In a later chapter statistics and tables are given showing the value of the Cape trade in mohair and goat-skins from the year 1857 to the present time. Of the former commodity the maximum value appears to have been reached in 1895, when the sum realised was 710,867*l.*; while in the latter 1890 was the record year, the declared value then being 142,425*l.* The two final chapters on the Angora are devoted to its importation into the United States and Australia respectively. In the States, although the number of goats in comparison with the population is relatively small, the trade seems to be in thriving condition. Not so in Australia.

"Apart from the suitability or otherwise of Australia to Angora goat farming, the failure to establish the industry there is amply accounted for by the fact that Australia is so perfectly adapted to sheep; so that the question is, after all, not so much whether the Angora will thrive and pay, but whether it will thrive and pay better than the Merino. Goats and sheep never do equally well on the same veld; that which is peculiarly adapted to the one never suiting the other nearly so well."

Did space permit, many more equally interesting extracts might be taken from Mr. Schreiner's work. To many of our readers, as to his reviewer, the extent and value of the mohair trade will doubtless come as a revelation, and since everything relating to the prosperity and wealth of the empire ought to be of interest to every patriotic Englishman, the book may lay claim to a wider circle of readers than might at first sight be attracted by its title.

From mohair to ostrich feathers—another important article of British African trade—is a wide jump, but the portion of the book devoted to this subject is of so much interest, that a few words must be given. And here the interest is not so much from the commercial as from the natural history point of view. Mr. Schreiner strongly combats the generally accepted theory of the polygamous habits of the ostrich.

"Every authority," he writes, "that I have consulted holds that the ostrich is polygamous, but the evidence against polygamy is very strong: a pair make the nest; the hen lays all her eggs (a full sitting) in that nest; the hatching of the eggs and the care of the chicks are shared equally by cock and hen; the cock loses his sexual vigour, and leaves his attention to the hen, soon after beginning to sit; and one hen to a nest yields the best results."

It is true that nests are frequently seen in which two or more hens are laying, but the author believes that such hens have been unable to obtain a mate for themselves, and have attached themselves, *nolens volens*, to one already provided with a partner. In such a nest the eggs get shifted about and never receive regular incubation, with the result that few or no chicks are hatched; this alone forming a strong argument against polygamy being the normal habit. Furthermore, it is added that travellers frequently mistake large chicks for hens, thus asserting polygamy when it is non-existent. The conclusions of one who has had such unusual opportunities of observation should, to say the least, receive the most respectful attention on the part of stay-at-home naturalists.

R. L.

ASTRONOMICAL RELIGION IN EGYPT.

Creation Records discovered in Egypt. By G. St. Clair. Pp. xii + 492. (London: Nutt, 1898.)

THE idea that the religious observances of the Egyptians were founded upon facts of astronomy deduced by them is very old, and almost every text of any length which is published affords additional proof of the substantial correctness of the idea; it could, in fact, hardly be otherwise. Since the visible emblem of the great god of the early Egyptians was the sun, and since the representatives of the lesser gods were the moon and stars, it follows that every religious ceremony which was celebrated publicly in Egypt must have had reference to the conditions and movements of the celestial bodies.

It is quite easy to recognise certain evident proofs of this fact, such as the drawing along of a model of the boat of the sun in a procession to typify the sun's course in heaven, or the drawing of the boat of the god Seker round the sanctuary at dawn in imitation of the sun's motion, but many other equally evident proofs are not so easily explained. We know tolerably well what ceremonies were performed, but we know not the why and the wherefore. In making inquiries into such difficult matters it is important to remember that the knowledge of astronomy possessed by the Egyptians has been greatly overrated, just as their knowledge of mathematics has been, from time immemorial, over-estimated; they probably knew more of both subjects than the rest of the world in the early period of their history, but the limits of their exact knowledge were reached tolerably soon.

No better proof of this statement can be found than in the excellent essay of Sir Norman Lockyer, entitled the "Dawn of Astronomy," a work which has not received the attention which it deserves from certain Egyptologists. It is, however, unnecessary to repeat here the deductions which he has carefully drawn from carefully ascertained facts. Two of the most important results of his work are the certainty with which we may now accept the conclusions that astronomical religion in Egypt dates from a period which may be measured by thousands of years, and the discovery of the principles which guided the Egyptians in planning the sites of their temples from Memphis to the Sudân.

Passing from general considerations such as these we come to Mr. St. Clair's book on "Creation Records discovered in Egypt," wherein we have the first fruits of fifteen years' systematic study of mythology, and an attempt to construct methodically the mythology of the Egyptians. Mr. St. Clair claims, and claims rightly, that it was impossible to understand Egypt's religion and mythology until the various documents which the Egyptians themselves wrote on these subjects had been studied and translated; but the question which naturally arises is, Have enough of these documents been studied, and have they been correctly interpreted? Mr. St. Clair does not pretend that his work is final, and therein is much to be commended; but beyond doubt it shows great industry, and a catholic use of authorities and writers which is not commonly to be found in the book of a man who is attempting to promulgate a theory, however sound or however learned. He has read, apparently, everything which he thought would bear upon his subject, and has fitted a number of facts together with considerable ingenuity; more than this, he states his conclusions and deductions with modesty. Of course many of his conclusions will be combated with vigour, and many will be rejected off-hand; still the whole book is suggestive, and much of it will be accepted by students of astro-theology. The great storehouse from which Mr. St. Clair has drawn is the "Book of the Dead," and it will astonish many to see what an extraordinary collection of facts he has deduced from it; it is, however, a pity that he did not make more use of the early version of the work such as we find on the coffins of Amamu and the Mentu-heteps.

After a table of the Egyptian dynasties, and chapters on the Calendar and its relation to Egyptian Myths, we have a series of essays on the gods, the Nile, the reign of Rā, celestial cities, &c.; these are followed by another series of short chapters on the Creation, Deluge, Confusion of Tongues, and the doctrine of a future life, which many readers will think the most interesting part of the book.

Certain omissions are in places noticeable. Thus in the section on the Creation (p. 420 f.) we notice no account of the story of the Creation as told in the papyrus of Nesi-Amsu; the belief in the necessity of eating the scarabæus in order to obtain children, which exists to this day in the Sudân, ought to have been discussed. It is interesting to point out also that as Thoth was held to be a healer of diseases, so also was the ape, which represented him and was sacred to him, and that this idea of the ape's powers is extant in Egypt to the present day. Barren women have been seen to pass their bodies over Egyptian statues of apes, and to pray at the same time that the disease of barrenness from which they were suffering might be done away by these means; Mr. St. Clair might have instanced several survivals of this nature. On p. 96, for *tet* read *khat;* and to the five constituent parts of the body and soul there enumerated add *ren*, "name"; *khu*, "intelligence"; *sekhem*, "form"; and *ȧb*, "heart."

PSYCHOLOGICAL SCIENCE.

Psychologie als Erfahrungswissenschaft. By H. Cornelius. Pp. v + 445. (Leipzig: B. G. Teubner, 1897.)

Primer of Psychology. By E. B. Titchener. Pp. ix + 314. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1898.)

Outlines of Descriptive Psychology. By G. T. Ladd. Pp. xi + 428. (London: Longmans, Green, and Co., 1898.)

Versuch einer Darstellung der Empfindungen. By W. Przibram. Pp. 28, with five plates. (Vienna: Alfred Hölder, 1898.)

THE marked difference in contents and tone of the four works before us is a striking proof of the extent and variety of the topics embraced in the modern science of psychology. By far the most original and important of the four is the work of H. Cornelius, which treats the problems of psychology, in the main, from the epistemological point of view, with unusual carefulness of statement, and still more unusual lucidity of style. The author is clearly familiar with the recent literature of the subject, English and French as well as German; but the writers whose influence is most clearly traceable in his treatment of his material are both Germans, Avenarius and Mach. The author's attitude towards the main problems of psychological science may be briefly summarised as follows:— Psychology, as the science of "psychical facts," is the only possible basis of a sound general philosophy. Its special task is, by describing those psychical facts in the simplest possible terms, to explain the growth and meaning of the more or less artificial and complicated hypotheses which we frame to ourselves in every-day life, and in scientific reflection, about the nature of the world. In pursuance of this task Mr. Cornelius first devotes a chapter to the question, "What are the ultimate elements into which mental processes can be resolved by analysis?" and then proceeds to trace in detail the formation of derivative psychical products of ever-increasing complexity. In this way he passes in review, one after another, all the most important concepts of physics, æsthetics and ethics. The most noticeable feature of the chapter on the elementary processes is the admission of "ideas" by the side of sensations as a distinct class of primitive mental facts. It is significant that the two best "Psychologies" of recent years, those of Stout and Ebbinghaus, agree in this rejection of the old theory that an "idea" is merely a weaker "impression." Among the many admirable things in Mr. Cornelius' work, which space will not allow me to mention in detail, specially admirable are the careful and elaborate account in Chapter ii. of the growth and meaning of the concept of objective existence and the discussion of the concept of "truth" in Chapter vi. Mr. Cornelius' philosophical position is, as becomes a follower of Avenarius, one of "naïve realism"; that is, he contents himself with explaining how the plain man's ordinary notions of objective existence, of things and of causes, naturally arise from the workings of the psychological mechanism; and he abstains from any metaphysical theories as to the agreement or disagreement of these notions with "reality." Perhaps it may be necessary to remark, for the benefit of any one to whom the term is new, that "naïve realism" is, in fact, almost the same doctrine as the "idealism" of Berkeley's "Three Dialogues."

Physiological psychology falls outside the scope of Mr. Cornelius' treatise, and is explicitly relegated in his introduction to its proper place as a useful appendage to the direct investigation of mental phenomena; he has, however, some ingenious remarks on the "ambiguous" character of the relation between stimulus and sensation which challenge the validity of current methods of formulating the results gained by the "method of just perceptible alterations." His contention, which certainly seems reasonable, is that as the position of the "Unterschiedschwelle" in any series of experiments depends largely upon the direction in which the changes of stimulus have been taking place, it is not permissible to assign to it a value derived by taking the arithmetical mean of the values obtained by varying the stimulus in both directions.

Prof. Titchener's "Primer" is a brief and brightly-written account of the main facts of psychology as seen by a disciple of Wundt, and is better adapted than any work which has as yet come into the present reviewer's hands to serve as a first book for the beginners for whom it is designed. Two most excellent features of the little book, from this point of view, are the price list of psychological apparatus, and the often singularly ingenious problems and exercises appended to the various chapters for home or class work. As was to be expected from Prof. Titchener, the standpoint adopted throughout is that of the new "experimental" school. Here and there one may notice little points of detail, which it is to be hoped the author will improve in a second edition. For instance, the statement on p. 40, that "colours" are "really mixtures of pure colour and brightness" seems to involve a confusion between colour as directly perceived (psychological colour) and the physical and physiological conditions of colour perception. Again, the treatment of "Weber's law," on p. 50, is so brief and meagre as to be rather harmful than helpful to a beginner. There should surely have been some attempt to explain to the beginner what is meant by saying that a certain sensation of pressure, 2P, is double another sensation P. In asserting, with rather more confidence than the ascertained facts seem to warrant, the existence of special "pain-spots" in the skin, as well as in extending the conception of association to cover virtually the whole ground of mental synthesis, Prof. Titchener is presumably following the lead of his master's "Physiologische Psychologie." There is also, perhaps, an excess of loyalty in the adoption of the Wundtian theory about the functions of the frontal lobes (p. 90–91). These however are, after all, very minor blemishes in a work which is on the whole admirably adapted for interesting the young student in a difficult and to some extent repellent subject. It should perhaps be mentioned that the present work is quite independent of the author's "Outlines of Psychology."

Prof. Ladd's "Outlines of Descriptive Psychology" covers much the same ground as Prof. Titchener's little book, and is addressed to the same class of readers. As compared with Prof. Titchener, Prof. Ladd can hardly be recommended to the beginner as a good master. His style is difficult and slightly verbose, while the comparative paucity of experimental detail and the constant reiteration of vague qualifying phrases, like "as it were," "so to say," suggest that he does not always feel quite sure of his ground. The fact is there is far too much for the beginner in Prof. Ladd's "Outlines." There is a good deal of implied metaphysics which can only puzzle a young student, and even apart from the metaphysics, which are probably unconscious, some of the more complicated psychological problems are dealt with in a way that is at once too difficult for the beginner, and too short and easy for the advanced psychologist. It would for instance, have perhaps been better in a work designed as a first book for beginners, to say nothing about the controversy between "nativist" and "empiricist" views of space-perception; but, if the matter was to be introduced at all, a view that has the support of such authorities as Stumpf and James, should not have been dismissed with the curt reflection, "this view is . . . obviously false." Prof. Ladd is perhaps at his best in one or two of the later and more specially philosophical chapters, notably in the last of all, which contains, besides a good summary of the ascertained facts about brain localisation —in which, however, Flechsig is rather disrespectfully treated—a really excellent defence of the popular view of the relation of mind to body.

The posthumously published little pamphlet of W. Przibram is devoted to an attempt to construct a mathematical theory of sensation by means of the symbol $\iota (= \sqrt{-1})$ and its successive powers. Of the value of Mr. Przibram's tract as a contribution to mathematics, I am hardly competent to judge; the singular arbitrariness of its psychological assumptions seems to me to deprive it of any serious significance for the psychologist.

The values of the successive powers of ι of course recur in sets of four; consequently the author boldly affirms that there are only four classes of sensation, and that sensations of temperature are identical in kind with sensations of pressure, and smells with tastes. Pain and pleasure (*Wollust*) appear as opposite special qualities of touch, and are equated with the taste pair bitter-sweet, and the sound pair $e - b$). So again the antithesis red-green is said to correspond to cold-hot and $c - g$.

It is hard to believe that a mathematical theory which involves these and numerous other equally unmeaning assertions can be turned to any serious account by psychologists. A. E. TAYLOR.

OUR BOOK SHELF.

Elementary Practical Zoology. By Frank E. Beddard, M.A. (Oxon.), F.R.S. Pp. vi + 210; with 93 illustrations. (London: Longmans, Green and Co., 1898.)

THIS little book is written as a guide to the elementary zoology required by the Science and Art Department. There already exists at least one work designed for this special purpose, and several others more or less adapted for these examinations. Most of these have been written by men who though teaching zoology can hardly claim to be specialists in this subject; consequently, on coming across a book written by such a well-known zoologist as Mr. Beddard, one naturally expects that the work will be something out of the common. We are afraid that any one taking up this book with such expectations will be disappointed; for although this book may be better than those already in existence, we do not consider that Mr. Beddard has done either himself or the subject justice in it, the book having the appearance of being turned out in a hurry and without due care.

In spite of Mr. Beddard's remark we still believe in Huxley's method of working from the known to the unknown, and should rather have seen the book commence with the frog than with the amœba.

One of the most disappointing portions of this book is the chapter dealing with the earthworm. Mr. Beddard, as is well known, is perhaps our greatest authority on the Oligochæta, and one consequently expects that this chapter would be very superior; but even here we find evidence of want of care, the very illustrations being bad. The first one (Fig. 9), stated to be a side view of the worm, is really a latero-ventral view, and what the row of setæ on the left margin of the figure are is difficult to imagine; they do not tally with the description, nor do they exist in any of our common earthworms. Figs. 12 and 13, too, are curious combinations of the anatomical characters seen in *Lumbricus* and *Allolobophora*, two worms that have been so long confused in the practical text-books; but the author does not state that they are combined figures, and the student will look in vain for the origin of the lateral œsophageal vessel on the twelfth segment, or for six "hearts" in a worm with three pairs of calciferous glands.

So throughout the book we find this lack of care in the preparations of the illustrations, which latter should be of the greatest importance in a practical text-book, and especially in one in which the author frequently states that a description of a given set of organs is unnecessary as the illustration will explain the facts.

Some of the figures are combinations from several published by well-known teachers, and during the process of combination they have suffered considerably; so much so, that the originators will hardly care to see their names attached to them. In the diagram of the vascular system of the frog, after Howes, the *anterior abdominal* is represented as entering the liver quite independent of the *hepatic portal system*, and the latter is indicated in part as joining *directly* with the inferior *vena cava*.

We have yet to learn that the teeth on the radula of the snail are calcified, and that the rabbit has only one deciduous premolar on either side of the lower jaw.

We have only drawn attention to a few of the errors which occur in this work, and we cannot congratulate Mr. Beddard on its production. In our opinion the more elementary a book is the more correct should be its facts, and the greater should be the care expended on it.

M. F. W.

Elementary Conics. By W. H. Besant, Sc.D., F.R.S. Pp. 176. (London: George Bell and Sons, 1898.)

Examples in Analytical Conics for Beginners. By W. M. Baker, M.A. Pp. 87. (London: George Bell and Sons, 1898.)

OF these two volumes of the "Cambridge Mathematical Series," Dr. Besant's book is practically a reprint of the first eight chapters of his "Conic Sections treated Geometrically," which has for so many years held its ground as a favourite text-book among teachers. "Geometrical Conics" seems to be rather less "the fashion" now than it was formerly, and we hope that the present issue, containing all the more important propositions in a small compass, will encourage students in looking up geometrical proofs instead of trusting too exclusively to the often cumbrous and ill-understood methods of coordinate geometry.

Mr. Baker's collection of examples, though intended primarily for the use of Sandhurst and Woolwich candidates, will be welcomed by University students as well. Most beginners in coordinate geometry find the want of a thorough drilling in simple examples which are straightforward applications of book-work, before they can fully grasp the significance of the principles involved. Such exercises this book is intended to supply; but perhaps the most useful feature is the set of questions on "book-work," as these cannot usually be found in any text-book. G. H. B.

Dobbie's Horticultural Handbooks. Edited by William Cuthbertson. *Pansies, Violas, and Violets.* By Charles Jordan, John Ballantyne, Jessie M. Burnie, William Cuthbertson. Pp. 102. (London: Macmillan and Co., Ltd., 1898.)

TO all who grow for pleasure or profit the delightful flowers treated of in the book under review, the present work is to be recommended. In the space of about a hundred pages as much information regarding the evolution of the various varieties of the flowers, their botany, the methods of growing for the garden or for exhibition is given as is likely to be necessary for most readers. And the sentimental side is not overlooked, for some thirteen pages are devoted to the poetry of the subject, short extracts from the writings of various poets being gathered together in praise of the flowers under consideration. The work is illustrated by several very clear wood-engravings.

The Mechanical Engineer's Handy Office Companion. By Robert Edwards. Pp. viii + 70. (London: Crosby Lockwood and Son, 1898.)

THIS small book is what it professes to be, viz. a "handy office companion," giving, as it does, in a succinct form a variety of information likely to be required by mechanical engineers in their every-day office work. At the end of the volume appears a somewhat invidious list of books on mechanical engineering, and allied subjects, which the author recommends to his readers. We miss from the list the titles of very many books which we should have thought merited inclusion as much as several to which attention is called.

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.*]

Metargon and the Interplanetary Medium.

THE detection of metargon, and the statement that its spectrum, at all events, closely agrees with the Swan-spectrum, seems to possess a very great interest for the physics of our solar system. It gives a new and expected support to the assumption of an interplanetary atmosphere, which, as I shortly hope to show, will enable us to indicate the solution of most problems relating to the comets, and probably, also, to the sun.

This medium, which gives the acetylene-bands together with the cyan-bands, is already known through different observations:—

(1) In the absorption spectrum of the sun.

(2) In the emission spectrum of the highest beams of the corona (Tacchini).

(3) In the spectra of *all* comets, traversing all parts of the interplanetarian space.

(4) In the occluded gases of meteorites.

(5) Now, at last, as a constituent of the atmosphere of the earth.

The last observation completes the foregoing series, so that we can say that this medium now is found everywhere; as we should expect to find it, if it really forms a common atmosphere to our planetary system. J. R. RYDBERG.

Lund, July 21.

Metargon.

PROF. SCHUSTER in his last communication on "The Spectrum of Metargon" says, "taking the spectroscopic evidence by itself, it points in the direction that the gas under examination is a compound of carbon either with argon or with a so far unknown body."

This observation has reference to the gas obtained by the volatilisation of a "white solid," amounting to about 1 per cent, which separates during the liquefaction of argon, as stated by Prof. Ramsay and Mr. Travers in their Royal Society papers on the "Companions of Argon." "The argon separated is a liquid, but at the same time a considerable quantity of solid was observed to separate partially round the sides of the tube, and partially below the surface of the liquid." Further, "inasmuch as the gas differs very markedly from argon in its spectrum and in its behaviour at low temperatures, it must be regarded as a distinct elementary substance, and we therefore propose for it the name 'metargon' It would appear to hold the position towards argon that nickel does to cobalt, having approximately the same atomic weight yet different properties." Now, a year ago Lord Rayleigh was kind enough to allow me the use of a sample of pure argon for the purposes of liquefaction. The gas, amounting to about 250 cc., was enclosed in a sealed bulb to which was attached a narrow quill tube for easy condensation in liquid air. I have repeatedly liquefied this sample, and have always obtained a perfectly clear fluid argon free from turbidity, opalescence, or any solid matter. In previous papers I have shown that a very small fraction of a per cent of gaseous impurity, which separates as a solid in the presence of a liquid, can be detected in this way. Thus 0·04 per cent. of carbonic acid in dry air gives an opalescent liquid when similarly treated, and the same thing occurs with oxygen containing less than 0·1 per cent. of chlorine. It would, indeed, be strange if anything like 1 per cent. of a gas giving a white solid at the temperature of liquid air could under similar circumstances escape detection if present in Lord Rayleigh's sample of argon. The question, then, is, Where can the metargon of Prof. Ramsay and Mr. Travers be? JAMES DEWAR.

Royal Institution, August 1.

Liquid Hydrogen.

IN a previous letter I said Mr. Hampson's "*attempt to justify going behind my back in his relations with a member of the staff of the Royal Institution is a too transparent subterfuge to require further comment*," and if I had not reason to feel the necessity of the use of cautious language when using your columns, I should have employed even stronger condemnatory terms.

Considering Mr. Hampson was not seeking from the Royal Institution some general scientific information, but experimental help to improve upon methods of research in which I was actually engaged, and to which my assistant must necessarily be privy, his proceedings were utterly indefensible.

Now Mr. Hampson *tries on a further justification* by pointing to the position of the person who introduced him to the "member of the staff." When Mr. Hampson gives the name of the "senior partner," I will be in a position to judge whether that gentleman's acquaintance with me was such as to fairly warrant him in transferring the introduction to the professor.

In the meantime the question remains, Why did Mr. Hampson, like other persons of University standing desirous of special knowledge or help in the possession of the Royal Institution Chemical Department, not address me in a manly way and request an interview? If he could not write, then why did he not call and send up his card? Why this pretended necessity for an introduction from a superior person of "familiar acquaintance" as a preliminary to a "confident hope of gaining" my "attention directly"? Yet this punctilious gentleman suggests in extenuation that he entertained the possibility of a "*chance meeting*" with me here. How considerate of my position! The course of action Mr. Hampson succeeded in carrying out was admirably adapted to create antagonism between the professor and his assistant.

Mr. Hampson now says: "It is strange Prof. Dewar, having himself published his belief that his assistant is capable of being 'got at' by a complete stranger, should in the very next line attach some importance to that gentleman's account of the transaction." This is, in other words, a covert suggestion that my assistant's veracity is not comparable with his own. Had my assistant ever dreamt that what I regard as a far too precipitate kindness to a "complete stranger" would ultimately be used as material to support an attack upon the character of the professor and the credit of this Institution, I do not doubt for a moment he would have acted with more dignified reserve and cautious consideration; in spite of Mr. Hampson's persuasive influence and the tempting allurement of the introduction from the "senior partner of a large chemical firm in London of the highest standing."

Verily no man can serve two masters at any time, far less when both are engaged on the same research. If conduct like this, which Mr. Hampson has the boldness to characterise as "simple and straightforward," is to be tolerated, the inviolate relations between professor and assistant are ruined, and there is, indeed, an end to any combination of science and morals.

Royal Institution, July 31. JAMES DEWAR.

The Medusa of Lake Urumiah.

I HAVE received to-day a telegram from my son, Mr. R. T. Günther, posted this morning at Tauris, in which he states that the "Medusa" reported by travellers to inhabit in immense numbers Lake Urumiah, proves to be a species of *Branchipus*.

Kew, July 27. ALBERT GÜNTHER.

Distillery Pollution.

THE disposal of the effluents from distilleries and other works is a matter of first interest not only to the proprietors of the works, but also to the riparian owners on the banks of streams on which such works are usually situated, and a few remarks on the possibility of avoiding the Law Courts in matters of pollution of rivers may be of interest, especially to the owners of distilleries. In the Spey district of Scotland, for instance, the great increase of distilleries, both in number and in malting capacity, has in recent years so increased the effluent that although any one distillery may not in itself seriously pollute so large a body of water as the Spey, yet their joint effluent is so great, it is alleged, that the pollution is serious, prejudicially affecting fish life, spawning and the taking of the fly by salmon, and rendering the river otherwise unfit for primary uses. Be these allegations true or false, the fact remains that at the present moment interdict hangs over one distillery—the Macallan Glenlivet Distillery—and if no method is found of avoiding the discharge and consequent fungoid growth, &c., there is no saying what may be the issue and ultimate result to what is now a very large industry. It is not proposed to discuss the two sides of the question—the maintenance of the industry or the preservation of the purity of such a fine river as the Spey, or other rivers similarly situated—but rather to consider what can be done to meet both sides. Now it may be held as true that there is no operation to which the burnt ale or spent lees of a distillery can practically be subjected to, that will render the effluent innocuous. The effluent may be evaporated or spread over irrigation fields, or treated with chemicals or charcoal, and yet the processes are in one way or another defective; and there appears but one solution, not to pass the effluent into the rivers, but take it away in pipes or barges to the sea. In many cases this is quite impracticable, even by the joint action of a number of distilleries; but in some cases the effluent has successfully been taken miles in pipes and discharged into the sea. As is known from large experience in outfall pipes for sewage and paper works effluents, it requires a carefully designed arrangement, the cost of which can only be determined after a minute survey; and usually the cost turns out to be too great, and then there appears to be one solution by passing the effluent out in the form of a fine spray from the top of a high chimney or iron lattice tower. The natural question at once asked is: But you pollute the air instead of the water, and what the better are you for doing so? In the first place, what is discharged is not a gas which, if of a noxious quality, might hurt by being inhaled. It is not like soot, which might leave a black mark on your face or clothes. The spray, if it fell on your skin or clothes, could do you no harm, or at least infinitesimal harm. It is not a poisonous liquid, as cattle can drink it. If it fell on trees or grass, except in large quantities, which would not be the case, it would not burn them. Pollution of air is not objected to unless it be in great excess; indeed, we all pollute the air to our neighbours' and our own disadvantage. We send out gases and smoke from our chimneys, which find their way to our neighbours' carpets and curtains and clothes, and we put out the foulest of gas—viz. sewer gas—daily and hourly from the ventilating pipes of our modern house drains, and many of our factories, electric light stations, &c., pass out gases which individually one would say would be sufficient to affect a whole city. There are many physical reasons which make the great difference on the harmless nature of air pollution from water pollution, and that is the cubic capacity of the polluted substance.

In the case of air the air stream is measured in cubic miles, whereas the water stream is a matter of cubic feet; again, the water flows in one fixed channel, whereas the wind and air stream is constantly varying; again, water pollution is worst just when it is put into the river, whereas air pollution is spread over a large area and is thoroughly mixed up before it comes down, possibly one mile or two miles from where it issued from the chimney.

Again, it may be said that even supposing the spray be harmless, yet it would be very disagreeable to be subjected to a fine rain or Scotch mist when near the distillery. Let us consider a distillery sending out four gallons per minute. An ordinary non-condensing engine uses 20 lb. of water per H.P. per hour, so that the quantity discharged from the top of the chimney is no more than what is sent out from a steam engine (high pressure) of 120 I.H.P., and we know from experience that this can be discharged without being felt, and in most weathers even becoming invisible 100 feet away. If it were practicable to reduce the effluent to a state of fine division as fine as the globules of the so-called white steam, and emit it from the top of a chimney, the solution of the matter would be found at once. It does not at present either appear practicable to reduce the effluent to such a fine state of division, nor fortunately is it necessary to do so, as experiment shows that ordinary sprayed particles are rapidly evaporated and absorbed. Take a spray such as barbers use, and spray it from a height of 5 feet in a still atmosphere, and measure the quantity evaporated in its descent. It will be found that at least 1/8th has been lost. Do the same at 10 feet, and it will be found that 1/4th is lost. Theory points to very rapid evaporation, as the particles get small as the surface becomes rapidly large in comparison with the cubic capacity of the spheres. Another good example of rapid evaporation and absorption by the air is to use the spray over a piece of glass. In ordinary weather only a very short space of time renders the sheet glass quite dry again. These two experiments, and our experience of the discharge from steam engines pointing to this, that instead of experiencing a mist or fine rain, the particles would be so minute and so widespread that no one might suffer any inconvenience, indeed might be quite unconscious of the fact that the spraying was going on except from seeing the white steam mist issuing from the chimney of the distillery.

Coming now to a more practical view as to what would be necessary to obtain the desired effect, and trials lead to this, that for a discharge of four gallons per minute it would be necessary to have a pump to pump up this small quantity, also an air pump to pump about forty times the volume liquid, a 5-H.P. oil engine with air pump attached, such as is used in lighthouses for supplying the air blast to fog signals, being ample. The necessary length of pipes leading up to the spraying apparatus with a number of nozzles, and above all a high point of discharge, completes the arrangement.

The height of discharge is evidently one essential of success. The height will vary with the amount of the effluent, and whether the works be situated on a moor, near a town, or in a cleft in the hills, or among high trees.

The increase in the velocity of the wind with height is an important factor. In measuring the velocity at 50 feet, 100 feet and 200 feet, we find a great increase with height, so that instead of a point of discharge of 200 feet being only capable of doing twice what a height of 100 feet will do, as one might at first suppose, yet a little consideration will show, as the area is a measure of the degree of dispersion, that it will disperse successfully much more. In fact whereas 100 feet might discharge one gallon, 200 feet might discharge eight gallons per minute. It would appear, therefore, that to attempt to deal with the effluent by spraying at a low level, as has been in some quarters suggested, is simply to court failure. The point of discharge must be high, but "how high" is a matter which at present is unknown; nor, indeed, can it be definitely fixed, as has been pointed out, each individual work requiring special consideration of the circumstances. There is one other point that requires to be considered in connection with the whole matter, and that is compensation for water abstraction. At present distillers use the water, and what is not sent off as whisky is returned to the stream. But in the case of carrying the effluent to the sea, compensation would require to be given to the stream by means of reservoirs, and with the spraying apparatus a complicated question would arise as to how much really found its way back into the water-courses of the particular drainage area. This is largely a legal question, but it is not clear how the spraying process could differ from the discharge into the atmosphere of an ordinary steam engine, and so it would appear that water compensation for the stream was with this system unnecessary.

C. A. STEVENSON.

The Nature and Habits of Pliny's Solpuga.

I HAVE never seen one of the Arachnoids in a hive, but have received them several times from trustworthy bee-keepers who have found them in the hives "killing and eating the bees." Other insects do the same thing, especially Formicids and Mutillids. Of course the latter, with more chitine, are better fitted to resist the attack of the bees than are the soft-bodied Datames. It may be that these Solpulgids have some protective scent that makes their entrance to the dark recesses of the hive safe.

A. J. C.

Claremont, Cal., June 23.

THE VACCINATION BILL.

IN connection with the recent discussion on the vaccination question, nothing strikes the inquiring observer more than the shortness of the collective memory of a people, unless, indeed, it be the fact that people are easily led by any small knot of agitators who will shout loudly enough and asseverate with sufficient force and frequency.

That this is true not only of what may be called the masses, but also of their selected representatives in the House of Commons, is evident from what has recently transpired in that august assembly. The career of the Vaccination Bill has been marked by many stormy passages and by very varying fortunes, and now that it has passed through its first stage, there appear to be few who are even partially satisfied. This is a result such as might have been anticipated. Weak concession is not compromise; whilst, on the other hand, obstinate resistance to amendment, from whichever side of the House the overture is made, cannot be put to the credit of the intelligent statesmanship of some of our legislators.

Looked at dispassionately, this question should be largely one of principle; but granting this to its full extent, it must always be recognised that sentiment under certain circumstances may rout principle entirely. Such being the case, principle must in minor points give way to sentiment.

To a very large extent, the present outcry against vaccination is the direct result of the practical disappearance of small-pox from our midst, such disappearance having been brought about by thorough vaccination. This statement may be traversed by some, but all statistics, British and foreign, go in the same direction on this point. At one time every child was expected to have an attack of small-pox, just as certainly as at the present day it is expected to contract an attack of measles. Indeed, children were often put into the way of being infected in order that they might get the attack over as soon as possible. This was so in spite of the fact that the mortality was frightfully high, and that amongst those who survived the attack, blindness, deafness, scarred features, and even greater deformity was perhaps the rule rather than the exception.

Those who then had experience of this small-pox were ready enough to accept vaccination for their children and for themselves. They had almost daily experience of horrors such as we cannot now realise (unless we have passed through a cholera, a plague, or a severe typhoid epidemic), and they were ready to try anything which would give even promise of some amelioration, however slight, of the severity of the attack. We have it on the authority of medical men who were instrumental in carrying on the earlier vaccinations, that the better a population was vaccinated the fewer were the cases, the less was the mortality, and the slighter were the ensuing deformities. For some time, so long indeed as those lived who had known small-pox before vaccination, there was no agitation against vaccination; but as soon as a people arose who knew not small-pox, and who knew not its terrors, the slight discomfort of vaccination was rebelled against.

Two of the most thoroughly vaccinated people in the world are the Scotch and the Swiss. In Scotland the public vaccinator's post is almost a sinecure in most districts, because the parents, of their own free will, call in their medical attendant, in whom of course it may be assumed they have every confidence, to advise them and to perform the operation for them as soon as it is thought to be necessary. The result is that by the time it is six months of age, almost every child is vaccinated under the very best possible conditions, *i.e.* when it is in good health, and is suffering from no teething, skin, or digestive trouble. If a certificate of vaccination under such conditions, or one that it is deemed by the medical attendant advisable to postpone vaccination, were demanded by the registrar, as is now done in Scotland, more thorough vaccination than is now obtained would undoubtedly be the result.

An unvaccinated family or colony is a danger to the community. How firmly this is held in Switzerland is evidenced by the fact that no child is allowed to receive its education at the hands of the State until it has been vaccinated. What is the result? That in Switzerland almost every child which has reached school age is fully vaccinated, and in order to save trouble, *i.e.* to take the best period for the performance of the operation, the child is usually vaccinated before the process of "teething" commences. As is well known, vaccination during this early period has many advantages. In the first place the child is protected during the period when it is otherwise most susceptible to attack by the disease, and at a period when the percentage mortality is highest. Then, too, this is the period when the child can most easily be kept clean and at rest, *i.e.* before it is able to walk and knock its arms about. The irritating and irritable teething period has not commenced, and perhaps most important of all, the child is, or should be, taking chiefly milk foods, so that intestinal and cutaneous irritations and eruptions are of comparatively infrequent occurrence. If in this country these points were more carefully attended to, we should hear far less of eruptions and convulsions "due to vaccination."

It is all very well to talk of the liberty of the subject—the parent—in connection with vaccination, but is it right that this should interfere with the rights of the child? By the Factory Acts children of tender years are protected (more or less efficiently) against the cruelty and greed of parents. Under the Educational Act children are sent to school and prepared to take some respectable part in the world's work. It has even been suggested (often by those who are loudest in their denunciations of compulsory vaccination) that children should be clothed and fed as well as educated at the expense of the State; but as soon as the State steps in to put the child in a position to preserve its life or its sight in the presence of an epidemic of small-pox, there is an outcry by these same people against the invasion of the liberty of the subject and the rights of the individual. Under the Public Health Act a Medical Officer of Health has certain powers that override such liberty or license of the individual as may by its manifestation be dangerous to his neighbours; and even the common law steps in to prevent the cruel or ill treatment of children. It is therefore surely reasonable that helpless children should not be handicapped in life, or be made centres of danger for those around, by being left absolutely unprotected against the attack of a disease which, if unmodified, usually leaves marks both deep and lasting on its victim.

Under the circumstances it is a matter for consideration whether some concession should not be made to sentiment. The days for martyrdom are over, and many of the vaccination "martyrs" have developed and bloomed, because in the first instance they have been too careless to conform to the requirements of the law; once a martyr, however, always a martyr. Is it not a politic suggestion that the onus of objection should be thrown on the shoulders of those who do not wish to have their children vaccinated? If a man takes the trouble to go before a magistrate (or two), and affirm in open court that he has a deeply-rooted objection to vaccination, he may be looked upon as a faddist; but his children might be exempted from vaccination until such time as an epidemic of small-pox made its appearance, when the compulsory rule should at once be put into force. In order that this might be done, the onus of reporting unvaccinated children should rest with the objector, who would be in the position of a ticket-of-leave man who would come up for judgment, and whose children would at the same time come up for vaccination in the presence of an epidemic. Those who would take this trouble might be exempt; but those who would not, could no longer pose as martyrs when failing to comply with such reasonable regulations, and so they would come under the lash of the law.

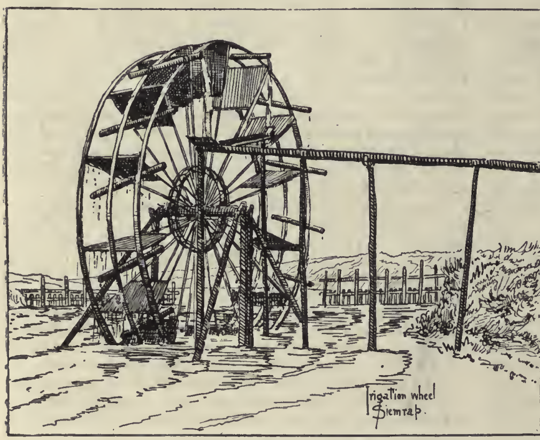
The Vaccination Bill can scarcely pass into law in its present form; its passage in such form would afford evidence that however able a large body of men may be, and however well endowed with common sense, they have not as a body the capacity to legislate, or the backbone to stand out where expert evidence, which is the only evidence that is of any value in this case, is placed in opposition to a fad—not a popular fad—but a fad held by a very small but noisy and self-assertive, and therefore, from the parliamentary point of view, powerful minority. The country as a whole is not against vaccination;

Parliament might therefore legislate for the few, at the same time keeping a very tight grip on those to whom, for sentimental reasons, it grants any indulgences.

Re-vaccination, though not so important as primary vaccination, will at some time have to be considered. Vaccinators are taunted with the fact that, although Jenner maintained that vaccination would confer life-long immunity against small-pox, they are now asking for re-vaccination. Jenner could speak only for his time. Where he goes beyond his facts his theories have not all been confirmed as the result of a wider experience ; but where he kept to facts, and argued from his own observations, he has been proved to be right in almost every instance. It would, indeed, be a dark look-out for medicine if whilst accepting all that is true of the work of our predecessors, we find ourselves by tradition looking out for nothing that is new. The fact that all Jenner's statements have not been implicitly accepted, should be an argument in favour of those that have been confirmed.

MR. WARINGTON SMYTH ON SIAM.[1]

THE good use which Mr. Warington Smyth has made of his five years in Siam is already familiar to geographical readers from several papers published by the Royal Geographical Society, and a wider public will welcome the two volumes which tell in greater detail, and in a more ambitious literary style, of his journeys in that interesting country. Although to a reader unversed in the classical languages the occasional Greek and Latin quotations seem to savour of pedantry, no one can help being attracted by the manly and modest way in which Mr. Smyth recounts his adventures. He disclaims anything in the way of original exploration, and the fulness with which he renders their due to every previous traveller and to all his companions and his assistants, may perhaps lead careless readers to imagine that there is little new or original in the book. Perusal of the chapters will soon dissipate such an idea. Very few travellers have brought to their task more individual energy and enthusiasm, and some have made for themselves a reputation for vast acuteness and reckless daring with less solid basis than that which Mr. Smyth leaves his readers to discover.



Irrigation Wheel at Siemrap.

The professional aspects of the work of the Director of the Department of Mines ("the other half of the Department" is incidentally referred to) have been touched on very lightly, as is proper in a popular book, but enough is said to impart a solid interest to the journeys which are described. Mr. Smyth does not conceal his enthusiasm as a yachtsman, and his exploits in a small sailing-boat, cruising along the stormy shores of the Gulf of Siam for weeks at a time, are much more remarkable than the quiet record of them might lead a landsman to suppose.

The book, of course, contains some chapters on the political situation in Siam, concerning which nothing need be said here, and for the rest it consists of the narratives of journeys interspersed with remarks on the various peoples and customs of the country. A resolute attempt is made to adopt a systematic spelling of Siamese names, and the result is at first sight a little disquieting. *Mekawng* is no doubt preferable on principle to the familiar *Mekong*, but until the eye gets used to it, it suggests Mr. Rudyard Kipling's efforts to phoneticise the language of the young British soldier. We are not sure whether the rule of established custom, which saved Calcutta from its Hunterian disguise, might not also be invoked in favour of Mekong, as appears to have been done for Bangkok.

Mr. Smyth commences with a description of the river and port of Bangkok, the mud-bar at the mouth of which he describes in considerable detail. The advance of the land at the head of the Gulf of Siam is very rapid, on account of the immense quantity of silt carried down by the Menam. Had the water been clear enough to allow of coral growth, the shoals might possibly have rendered the harbour impossible of approach, so that the muddy water in a measure neutralises the effect which it produces. The Menam valley is next described, and an excellent point is made as to the introduction of railways in such a country as Siam. The author is strongly of opinion that the Siamese—a race of born watermen—would benefit more by the improvement of the natural waterways and the construction of canals, than by introducing railways, for which there is no pressing demand. That railways are valuable as means of conveying traffic past interruptions to rivers, or connecting places not already united by water, is not contested.

A series of chapters on the Lao States and the Mekawng gives opportunity for much pleasant description of places and people. The gold of the river valley, which is obtained by washing the gravel, is not likely in Mr. Smyth's opinion to pay Europeans for working. The Mekawng boat, however, is a thing to admire if not to imitate. Its foundation is a great tree-trunk hollowed by the adze, then sunk in the river until water-logged, next steamed over a fire until soft enough to stretch and have the knees and frames put in. A hull so fashioned will never leak, draws little water, is handy to manage, and lasts for twenty years without requiring substantial repairs.

The coasting trip along both shores of the Malay peninsula was of almost greater interest, as fewer Europeans have passed that way. The remarkable weathering of the limestone rocks is described, and several of the structures confidently assigned by previous travellers to volcanic action are shown by the author to be simply the result of weathering. The tin workings of the coast were visited and are admirably described. The Chinaman rules on the tin fields, and constitutes a

[1] "Five Years in Siam, from 1891 to 1896." By H. Warington Smyth, M.A., LL.B., F.G.S., F.R.G.S., formerly Director of the Department of Mines in Siam. With maps and illustrations by the author. In two volumes. Pp. 330, 338. (London : John Murray, 1898.)

political problem of a somewhat complex kind. He is essential to the development of the country and the production of revenue; but his secret societies, and not the law of the land, receive his homage. Mr. Smyth never tires of contrasting the dirty, greedy and ill-mannered Chinaman with the dainty, generous, and courteous Siamese or Shan; only one of the despised race finds favour in his pages—a boatbuilder who created the very clever little vessel in which the voyage to Chantabun was made. This voyage is the subject of several chapters describing visits to various places in Siamese Cambodia, including the famous ruby and sapphire workings east of Chantabun.

Appendices to the number of eighteen give a great deal of interesting information on many matters, economic, scientific, æsthetic, and archæological. The peculiar tides of the Gulf of Siam are discussed, and the singular musical instruments of the country described at length, while some Siamese airs are also reproduced. One of the most interesting of the appendices compares the naval architecture of modern Siam with that of ancient Rome and Egypt. The resemblance of the Siamese and Egyptian vessels, both canoes and sailing-boats, is very remarkable, not only in build but in the manner of working.

Mr. Smyth has illustrated his text throughout with his own clear and characteristic sketches. He comments strongly, but not too strongly, on the unsatisfactory plan of allowing an artist at home, who never saw the scenes himself, to "finish" the sketches of a traveller. Possibly first-rate photographs would be more valuable than the sketches; but they are far preferable to the inferior photographic work too often brought home by amateurs from tropical countries. The specimens of these sketches reproduced will show their interest.

HUGH ROBERT MILL.

Off Sam Roí Yawt: the three hundred peaks.

THE NATURE OF THE ANTAGONISM BETWEEN TOXINS AND ANTITOXINS.

THE subject of toxins and antitoxins, though still in its infancy, is one which possesses considerable importance not only to the scientific world, but also to all members of the community. In the cases of snake poisoning, and diphtheria especially, the curative results that follow the administration of antitoxic serum are most marked, and it is in connection with these two conditions that the subject has been principally worked out. Important and interesting as these results are, foreshadowing as they do a new method of therapeutics in many other diseases, there are still two fundamental questions which have hitherto remained unanswered. The first of these is, What is the nature of the substances in question? The second is, What is the nature of the antagonism between them?

In a paper recently presented to the Royal Society (June 9), Dr. C. J. Martin and Dr. T. Cherry, of Melbourne, have given a very definite and conclusive answer to the second of these questions. The first, the nature of the substances themselves, still demands fuller investigation. The authors show, however, in confirmation of work previously performed by one of them (C. J. M.), and independently by Dr. T. G. Brodie, that the materials in question have a high molecular weight, and fall into the category of proteids or proteid-like substances. A method of separating substances of large from those of smaller molecular size in a solution containing both, consists in filtering it under high pressure through a film of gelatin supported in the wall of a Pasteur-Chamberland filter. The antitoxin of diphtheria does not pass through such a filter; it is probably a globulin, or at any rate its molecular size is of the same order. When antitoxic serum is filtered in the manner just indicated, the whole of the proteids, and together with them all antitoxic virtue, is absent from the filtrate. Toxin, on the other hand, the molecular size of which is of the albumose order, is not held back by the filter. Corresponding results are obtained with the toxin and antitoxin of snake venom.

Coming now to the second question, the nature of the antagonism between these substances, we find that it is one on which a difference of opinion has hitherto been held. Behring, Ehrlich, Kanthack and Brodie maintain that the antagonism is of a chemical nature, and that the antitoxin neutralises the toxin much in the same way that an alkali neutralises an acid. Buchner, Calmette, Metchnikoff, and others, on the other hand, regard the action as an indirect one, operating in some way through the medium of the cells of the organism. The work on which such an assertion rests may be instanced by a typical experiment of Calmette's on cobra poison. The venom is not attenuated by heating its solutions to 68° C. for ten minutes; the antitoxin is, however, completely destroyed by this treatment. Mixtures of cobra toxin and antitoxin, which produced no symptoms when injected into rabbits, killed similar rabbits in a few hours if, after the mixture had remained in contact for ten minutes, it were heated to 68° C. for another ten minutes before injecting; hence the conclusion that the toxin and antitoxin do not interact *in vitro*, but only *in corpore*, and therefore that the action cannot be explained as a simple chemical operation between the two.

Such an experiment is not, however, conclusive; it can be easily repeated with the same result, but the source of fallacy is that it takes no account of the factor—*time*. Every chemical operation has a certain definite velocity coefficient, and the rapidity of action under any circumstances when the reacting compounds are in solution depends upon this coefficient, and also upon the product of the active masses of the compounds present. Temperature will also exercise an important influence.

Remembering the high molecular weight of both toxin and antitoxin, one would *a priori* expect the velocity coefficient of any reaction between them to be a high one, and in addition the solution would contain relatively few molecules; so it is not surprising that any chemical operation should occupy a very appreciable time. If the two substances are left in contact for more than Calmette's ten minutes, the substances completely neutralise each other *in vitro*.

The following table gives a summary of Martin and Cherry's principal experiments with snake venom. On reading along any horizontal line will be seen the influence upon the result of the time during which the toxin and antitoxin were allowed to operate upon each other, with proportion of active masses constant. On reading any vertical line, the influence of varying proportions of active masses with time of operation constant is indicated. The thick line separates off the fatal results from those in which the rabbits lived. All other factors were kept constant. The solutions were mixed in the varying proportions, and stood at laboratory temperature (20°–23° C.). At stated intervals, by a stop-watch, portions were pipetted off, and the reaction terminated by rapidly raising the temperature to 68° C. in a water bath. They were kept at this temperature for ten minutes, cooled, and kept for injection.

Proportion of toxin to antitoxin per kilo		Control venom only.	Time allowed for interaction of toxin and antitoxin, temp. 20°–23° C.					
Antitoxin.	Toxin.		2 mins.	5 mins.	10 mins.	15 mins.	30 mins.	Injected unheated 8 mins.
1 c.c.	2 fatal doses.	Died 15 hours.	Lived (very ill for 2 days).	Lived (ill 1 day).	Lived (no symptoms).	Lived (no symptoms).	Lived (no symptoms).	Lived (no symptoms).
1 c.c.	3 fatal doses.	Died 12 hours.	Died 20 hours.	Died 28 hours.	Lived (ill 2 days).	Lived (ill 1 day).	Lived (no symptoms).	Lived (no symptoms).
1 c.c.	4 fatal doses.	Died 9 hours.	Died 13 hours.	Died 15 hours.	Died 23 hours.	Lived (very ill 2 days).	Lived (no symptoms).	Lived (no symptoms).

Exactly corresponding results were obtained with diphtheria toxin and antitoxin; and we may conclude by quoting an experiment with these substances, in which a different *modus operandi* was adopted. Similar experiments have been recently performed by Brodie, and published in his Arris and Gale lectures; his results completely coincide with those of Martin and Cherry.

A solution of toxin containing eight fatal doses per kilogram of guinea-pig in each c.c. was mixed with sufficient antitoxin to more than completely neutralise all the toxin. This mixture was allowed to remain *in contact at* 30° *C. for two hours*, and then filtered through the gelatin filter. Varying quantities of the filtrate were injected into guinea-pigs up to nearly 4 c.c. per kilogram of body-weight; that is, a quantity originally containing thirty-two fatal doses. The filtrate was quite innocent. The guinea-pigs suffered no inconvenience, and gained weight while under observation in small cages. The injections produced no local œdema.

If the toxin had remained unaffected beside the antitoxin, there was nothing to prevent it passing through the filter in virtue of its relatively small molecular size. As, however, it did not do so, we can only conclude that it had entered into some sort of chemical relationship with the relatively large molecules of the antitoxin during their sojourn together prior to filtration.

W. D. H.

A MINISTER OF EDUCATION AT LAST.

THE Duke of Devonshire made a most important speech on Monday in introducing a new Bill relating to Secondary Education.

The Bill really seeks to reconstruct the whole of our haphazard organisation dealing with Education, Science and Art; whether the recommendation will do harm or good depends upon the reconstructors, and who they are does not appear. It should, however, be a matter of congratulation that the lamentable condition of our present want of system, which has been known to educationists for many a long year, is at last recognised by those who are responsible for its inefficiency.

We gather from the *Times*, (the Bill has not yet been published) that the Government has now come "to the natural and logical conclusion, a conclusion which almost every other civilised nation has reached long ago, that there should be a comprehensive educational department dealing, generally speaking, with our national education as a whole, and presided over by a real Minister of Education. . . . There is to be a Board of Education, as there is a Board of Trade and a Local Government Board, and the new Board is, like these, to have a responsible Minister at its head, the President of the Board. Under him, the present Education Department and the Science and Art Department are to be amalgamated into one office, with one Secretary; and many of the educational powers of the Charity Commissioners are to be at once taken over by the new Board."

We reprint the latter part of the Duke's speech.

The Bills I have to propose are of an extremely limited character. The first proposes to create a central educational authority. Much that is done in it could properly be done by an administrative order by the Government; but in order to obtain Parliamentary sanction to the policy which we propose, we have thought it more desirable to embody our proposals in a Bill. At the present time the President of the Council or the Vice-President of the Council is for many purposes the Minister of Education; but under them are what are virtually two distinct Boards, the Education Department and the Department of Science and Art. We propose to bring these two Departments together to make out of them one office under the control of one permanent Secretary. We propose to put an end to the Committee of Council and to the office of Vice-President of the Committee of Council. We propose to create a Board of Education on the model of the Board of Trade, the Local Government Board, and the Board of Agriculture. The President and the Vice-President, or the President alone, of this Board may be appointed. If the Education Minister should be in the House of Lords, it is provided that the President of the Council will be the President of the Board, and he will be represented by the Vice-President in the House of Commons. If the Minister of Education should be in the House of Commons he will have the office of President, and will have no Vice-President. The Department will be represented in this House by some arrangement such as we have found practical in the case of other Departments. We think that the present time is extremely opportune for such a reorganisation of our Education Department. Next year the Secretary for the Science and Art Department retires under the age rule. The office which he holds is one that has never escaped criticism, and perhaps the strength of Sir John Donnelly's convictions and the energy with which he has supported them has exposed him to even a larger share of criticism than some of his predecessors. I think it only due to Sir John Donnelly to state that the Government has never possessed a more devoted public servant, and that, under conditions extremely difficult, I believe the Department has, under his administration, taken part in the very great development both of scientific and artistic training. But the changed conditions of education, the growth of the Department itself, the growing conviction for a better and a more special technical training for our people—a conviction that has found expression in the Technical Instruction Act—all these have rendered a revision of the scope and character of the Department absolutely necessary at the present time. I believe that that revision will be greatly assisted if we are able to obtain, what we are asking Parliament to give, sanction for the establishment of one central responsible department which should be charged with the supervision of secondary as well as elementary education, and of all the agencies appertaining to both. The Bill, I need hardly say, will not contain the details of the proposed reorganisation. They cannot well be promulgated until Parliament has given its sanction to the principle of the establishment of a central authority. But I may say that the reorganisation will not necessarily be confined to the Department of Science and Art. It would be entirely a mistake to suppose that there is any intention of simply merging the Department of Science and Art into that of Education. The Education Department itself under our plan will require some reorganisation. Some of the duties performed by the Education Department—such as those which relate to training colleges, to training pupil teachers, to the higher-grade schools—are pertaining more to secondary rather than to elementary education; and it may very well be that it will be found expedient to group those functions which are now discharged by the Education Department and others which are now discharged by the Science and Art Department under a Secondary Education Department proper, while a third division may possibly be charged with the supervision of the more technical branches of science and art instruction, and at the same time control and manage the Science and Art Museums which exist both in the metropolis and the provinces. These details of reorganisation have, of course, to be worked out by the departments concerned and by the Treasury after the work which will be undertaken in anticipation of the approval which we hope we may obtain to the proposals we are now making. I do not know whether there are any of your lordships House who are interested in the subject of economy. It is said, I believe, that no one in the House of Commons cares about economy except the Chancellor of the Exchequer and his predecessor. But I do not think that this proposed reorganisation need necessarily lead us, or ought to lead us, to any increased expenditure on administration. It is, of course, impossible to say what this Parliament or future Parliaments may think fit to spend directly on secondary technical, scientific, or artistic education. But, so far as administration is concerned, which is all we are dealing with at present, I see no reason why this arrangement should lead to any increased expenditure. I rather think it will tend to economy. Already by the transfer of training in elementary schools from the Science and Art to the Education Department a very considerable saving has been effected; and in my opinion the system under which grants in aid to science and art teaching are now dispensed is, in consequence of the rapid and unforeseen extension of the system—a system which has been steadily developed from small beginnings indeed—so cumbrous and complicated, and therefore so costly, that I should be very much disappointed if by a more systematic and scientific rearrangement of duties a very considerable economy cannot be brought about. I have said that a great deal of what we proposed to do could be done simply by an administration order to which the sanction of Parliament might be given when the estimates are presented; but, as I have said, we thought it better to embody the main principles in a Bill. But one portion of the duties which we propose to transfer under the Education Department cannot be transferred without legislation. I refer to the supervision of endowed schools under the schemes which have been promoted by the Charity Commissioners. Logic and symmetry may perhaps appear to require that the whole of the powers of the Charity Commissioners, so far as they relate to educational endowments, should be transferred to the Education Department. But the subject of endowments is so delicate, the distinction between charitable and educational objects and charitable trusts, the extent to which the necessities of special cases are to be regarded, the sectarian questions which they involve are all so difficult and controversial in character that we have hesitated to propose to transfer all such questions from a quasi-judicial to a political authority. Under this Bill, therefore, the administration of charitable trusts and the framing of trusts under the Endowed Schools Act will remain untouched, except that an instruction will be given to the Charity Commissioners to frame schemes, so far as they are educational, in consultation with the Education Board, and the Education Board will have power to promote other schemes when required. All these schemes contain a provision with regard to the educational examination of the schools, and the result of that examination is reported to the Charity Commission. They also institute from time to time an administrative inspection of their own, as to the management of the funds of the school and other matters. The educational examination and the administrative inspection, so far as it relates to educational matters, will be transferred to the new Department. In other respects the present powers of the Charity Commissioners will not be interfered with by the Bill. But for the first time a most important part of our educational system will be brought under the cognisances, and to a certain extent under the guidance, of the responsible Minister of Education. The Royal Commission laid considerable stress on the constitution of an educational council with consultative and certain administrative powers. We have been unable to accept those recommendations as a whole. For the purpose of forming and maintaining a registry of teachers a separate and more or less independent council was necessary. A Bill for that purpose was introduced some time ago, which will be reintroduced to-day. It provides a council for this purpose only, some of whose members will be nominated by the Crown, some by the Universities, and ultimately it will contain members directly representative of the registered teachers themselves. But we have not seen our way to give to this council or to any other council statutory powers. We recognise, however, that the advice of educational experts may be of great value to the Board of Education. We have taken power to authorise the President of the Board of Education to appoint an educational committee to advise the Board on such matters as may be referred to it. Such a committee in all probability will be largely founded upon the registration council. In our opinion it would only tend to hamper the responsibility of a Minister if a consultative council were appointed by statute and endowed with statutory powers; in our opinion the Minister must be responsible for the choice of his advisers as well as the action which he takes upon that advice. While it is desirable, almost necessary, that the registration council should have a fixed and permanent character, we thought it desirable to reserve complete discretion to the Minister as to the choice of his advisers. I have endeavoured to explain what these Bills contain. It may appear to be a somewhat rash act to submit proposals of this character to be exposed to discussion and criticism during the long months of a comparatively unoccupied recess. It may be so, but for my part I can only say that I welcome the fullest discussion and criticism. I welcome discussion on a subject in which, in my opinion, too little interest has been hitherto felt by the general public as distinguished from professional experts, and I only trust that these proposals may receive very full discussion and criticism. I have no doubt that they will be condemned by some on account of their incompleteness; I have admitted that they are incomplete, and incomplete on a vital and essential point, but I have endeavoured to show that we have not been insensible to the importance or the urgency of that portion of the question, which we propose at present to postpone. If we have postponed it, it is because we are convinced that the constitution, preliminarily or concurrently, of a strong central authority is necessary for the equally important, perhaps more important, object—the creation of strong local authorities also. If the discussion which follows the introduction of this measure shows that we have over-rated the difficulties which I think still exist in the constitution of satisfactory local authorities, it may still be possible in another session to enlarge the scope of this Bill. But, however that may be, we may feel confident that these limited proposals, standing even alone, will be an important step in the direction of placing our national education upon a sounder and more satisfactory basis.

NOTES.

PROF. E. RAY LANKESTER has been appointed to succeed Sir William Flower as Director of the Natural History Museum at South Kensington.

THE fourth International Congress of Physiologists will assemble at Cambridge on Monday, August 22, and will hold its meetings each morning and afternoon from Tuesday, 23rd, to Friday, 26th, inclusive. The Congress has for its object the advancement of physiology by affording physiologists of various nationalities an opportunity of personally bringing forward experiments, and of exchanging and discussing their views together, and of becoming personally acquainted one with another. The languages to be recognised as official at the Congress are English, French, and German. Membership is open to (1) representatives of physiology in the persons of professors and their assistants; (2) members of physiological and similar purely scientific societies, as for example, American Physiological Society; the Physiological Society, England; Société de Biologie, Paris; Physiologische Gesellschaft, Berlin; (3) ladies and gentlemen who are proposed by a National Committee. Members will be afforded all possible facilities for experimental demonstrations, as well as for the exhibition of preparations and of scientific apparatus. In connection with the Congress there will be an exhibition of physiological apparatus. Those who attend the Congress, and all directors of physiological institutes, as well as instrument-makers recommended by the above, are invited to send exhibits. The exhibition will remain open from Monday, the 22nd, to Saturday, August 27, inclusive. A large number of British, American and Continental physiologists have notified their intention to be present. The organising Committee of the Congress is constituted as follows:—M. Foster, President; M. Blix, H. P. Bowditch, A. Dastre, P. Heger, H. Kronecker, W. Kühne, A. Mosso, W. Wedensky, with L. Fredericq, P. Grützner and C. S. Sherrington, Secretaries. Further information concerning the local arrangements for the Congress can be obtained from Dr. L. E. Shore, St. John's College, Cambridge.

THE Government of the Congo Independent State has, it is stated, just sanctioned an important measure for the advancement of scientific knowledge on the Congo. The despatch, last spring, of the expedition under Lieut. Lemaire was a commencement in this direction, but, whereas his explorations will be chiefly in the Tanganyika region, the new measure will apply to the whole of the State. Twenty posts which are to form the centres of observation, and also the bases for the collection of flora, fauna, and mineralogical specimens, have been decided upon, and are now being carefully organised under the supervision of the proper officers at Brussels. As soon as the posts are in working order, a publication will be issued at Brussels for the purpose of recording the results of these experiments. It will be issued every six weeks, under the title of "Scientific Annals."

MR. W. HARCOURT-BATH has recently returned to England with a large collection of insects obtained in the Himalayas of Sikkim and Thibet, many of which were procured at great altitudes among the snow.

A REMARKABLY fine specimen of the gigantic centipede (*Scolopendra gigas*) may be now seen in the Zoological Society's Insect House. It is not, perhaps, quite full grown, but measures about eight inches in length. It is fed principally on small mice, which it devours with alacrity. This specimen was captured in Trinidad, and forwarded to the Society by Mr. R. R. Mole, of Port-of-Spain.

THE expedition sent out to the Galapagos Islands, at the suggestion of the Hon. Walter Rothschild, last year brought home a fine series of living tortoises, which have been recently deposited in the Zoological Society's Gardens. There are in all fifty-two specimens belonging to the group of large land tortoises namely thirty-three of *Testudo vicina* from the south part of Albemarle Island, and nineteen of *Testudo ephippium* from Duncan Island. These have been placed in the old Tortoise House in the North Garden, where they feed greedily on cabbages. The interesting account of the giant tortoises of the Galapagos, given by Darwin in his "Naturalists' Journal," will be in every one's recollection.

THE Committee appointed by the Board of Trade a year ago, to consider and advise upon the means of obtaining and publishing information as to opportunities for the introduction and development of British home trades in the various districts in which we have official representatives, have adopted their report. As to the means of obtaining further commercial information, it is suggested that the most economical course would be to send out experts periodically to make inquiries and to report upon the progress and the direction of trade. The Committee recommend the establishment of an office whose function it shall be to meet the constantly-increasing demand for prompt and accurate information on commercial matters, so far as it can be met by Government action. Amongst the duties of this new office would be: (1) To collect and focus existing information upon any subjects of commercial interest, whether derived from official or from unofficial sources, and whether relating to British Colonies or dependencies or to foreign countries. (2) To reply to inquiries which can be answered by a short note or by word of mouth, or by reference to published commercial data and statistics. (3) To direct inquirers who want special information to the proper quarter—*e.g.* to the Commercial Department of the Foreign Office, the office of a particular Colony, Chamber of Commerce, the Imperial Institute, and so forth. The proposed office would also bring together all the information contained in the diplomatic and Consular reports bearing upon particular industries and the state of the market for particular classes of goods. By these means it is believed that a wider knowledge of the conditions of the industries and markets abroad would be secured than exists at present.

THE *Engineer* reports that on July 27 a series of experiments in aerial research were conducted in the grounds of Shaw House, near Newbury. The experiments were carried out under the direction of the Rev. J. M. Bacon, Dr. R. Lachlan, Mr. J. N. Maskelyne, and others, with the advice and assistance of Lord Kelvin, Lord Rayleigh, and other men of science. The balloon was in charge of Mr. Percival Spencer and his brother, and was filled with 40,000 cubic feet of gas. The main object of the experiments was to discover in what measure the intensity of sound is influenced by altitude, by the presence of clouds, &c. The weather proved favourable for the observations, and the ascent was successfully made at twenty minutes past five o'clock, the balloon drifting steadily in a north-westerly direction. As soon as the balloon had had a fair start the series of experiments commenced. The first experiment in acoustics was with the voice, followed by five tests with musical instruments, these being succeeded by the discharge of rifles and blasts of the siren from an engine. Then came a rifle volley, followed by a roll of musketry, succeeded in turn by discharges of cotton-powder, four ounces being used in each charge. After this came three further discharges of cotton-powder, with eight ounces in each charge. When the balloon had travelled a considerable distance there were two explosions of cotton-powder with double charges, the final experiment being a comparison between a discharge of four ounces of gunpowder and four ounces of cotton-powder. The aeronauts had with them a receiving instrument, and by noting the altitude and the sounds which reached them, took the angular distance. The balloon descended at ten minutes to seven o'clock at North Denford. All the experiments proved highly successful.

THE attention of the Belfast Corporation Public Health Committee has been recently called to the fact that many cases of typhoid fever had been traced to the eating of shellfish gathered on the banks of Belfast Lough, which are saturated with sewage matter, and it was decided to call public attention to the circumstance in order that people may be apprised of the danger of eating shellfish taken from such an unsavoury locality.

THE Treasurer of Guy's Hospital has received an anonymous donation of 6000 dollars from a gentleman who listened to the speech delivered by Mr. Balfour on the recent occasion of the distribution of prizes in the medical school, with the request that the Governors would use the sum for the purpose of endowment of medical research. This generous response to Mr. Balfour's appeal is most praiseworthy, and the example set by the donor will, we hope, be emulated by many other men of means acting with the same public spirit.

AS has already been announced in these columns, the seventieth meeting of the Society of German Naturalists and Physicians, which is to be held at Düsseldorf in September, will be preceded by an exhibition of "historical-ethnographical medicine," to be opened immediately. The *Athenæum* states that the exhibits will include an exact reproduction of the oldest Egyptian medical papyrus—the Veterinär-papyrus of Kahun, twelfth dynasty—showing the veterinary operations of four thousand years ago. Some of the "finds" of the Imperial German Archæological Institute in Athens will be on view, which demonstrate that the original "god of the physicians" in Athens was Amynos, who was afterwards displaced from that honour, and Asklepios adopted in his stead. Dr. Sudhoff has organised a special department as a "Paracelsus Exhibition."

IN connection with the meeting of the British Medical Association, the University of Edinburgh has conferred the honorary degree of LL.D. on the following medical men:—Dr. Henry Bowditch, professor of physiology, Harvard University; Sir William Broadbent, Bart., F.R.S.; Dr. Lauder Brunton, F.R.S.; Dr. E. Doyen, Paris; Dr. David Ferrier, F.R.S., professor of neurology, King's College, London; Dr. Joseph Forster, professor of hygiene, University of Strassburg; M. le Comte de Franqueville, Member of the Institute of France; Dr. Karl Gerhardt, professor of clinical medicine, University of Berlin; Mr. Jonathan Hutchinson, F.R.S.; Dr. Theodor Kocher, professor of surgery, University of Berne; Dr. August Martin, professor of gynæcology, University of Berlin; Dr. Johann Mikulicz, professor of surgery, University of Breslau; Dr. Ottavio Morisani, professor of midwifery, University of Naples; Dr. William Osler, professor of medicine, University of Baltimore; Dr. William Playfair, professor of obstetric medicine, King's College, London; Dr. Roddick, professor of surgery, University of Montreal, President of British Medical Association, 1897; Dr. Siegmund Rosentein, professor of clinical medicine, University of Leyden; Dr. Hermann Snellen, professor of ophthalmology, University of Utrecht; and Sir Richard Thorne Thorne, K.C.B., F.R.S., chief medical officer, Local Government Board, London.

UNDER the auspices of the Essex Field Club, a meeting of the scientific (Natural History) societies of Norfolk, Suffolk and Essex was recently held at Witham, to take steps for the establishment of an annual conference or congress of these societies. Mr. David Howard occupied the chair, and the discussion was opened by Mr. W. Cole, who read a short paper advocating such an annual assembly, and pointing out how much work might be done conjointly which would be difficult for any one society to accomplish alone. He also advocated, as a possible result of such conferences, the publication of one really good natural history journal for the whole of the "East Anglian" societies. Prof. Meldola, Mr. J. Southwell (Norfolk), Mr. H. Miller (Suffolk), Mr. W. Whitaker, Dr. Vincent (Suffolk), Prof. Boulger (Essex), Mr. J. C. Shenstone (Essex), and the Chairman, strongly supported the proposal. A resolution was unanimously passed that, in the opinion of the meeting, the establishment of an annual congress of the East Anglian societies was much to be desired, and that steps be taken to form a Committee to promote such a congress next year. The large meeting subsequently visited, under the leadership of Prof. Boulger and the Rev. A. Shears, Black Notley, Ray's birth-place and burial-place, and his home at "Dewlands" for twenty years preceding his death. The party was afterwards entertained by the Mayor of Colchester at his beautiful seat at Stisted.

THE report of Dr. T. Oliver, of Newcastle, on a visit of inspection made by him to three French match manufactories, has just been issued as a Parliamentary paper. The report gives particulars as to the works themselves, the number of workpeople employed, the kinds of matches made, an account of the health of those engaged, the precautions taken to guard against sickness, and regulations as to those who are sick, and concludes with the following impressions and deductions: (1) Until recently the match-makers in certain of the French factories suffered severely from phosphorus poisoning; that at the present time there is apparently a reduction in the severer forms of the illness. (2) That the reduction in the amount of illness is attributable to greater care exercised in the selection of the workpeople; raising the age of their admission into the factory; medical examination on entrance; subsequent close supervision; repeated dental examination; personal cleanliness on the part of the workers; early suspension on the appearance of symptoms of ill-health; improved methods of manufacture. (3) That the French Government, aware of the dangers of match-making, is furthering by all possible means new methods of manufacture, and, with this object in view, retains in its service chemists and inventors who are continually making experiments. (4) That the Government has to some extent already succeeded in manufacturing a match capable of striking anywhere, yet free from white phosphorus, but that until now the manufacture of this match is not an industry.

PARTICULARS are given in the *Times* as to a process employed for making wood incombustible, or at any rate incapable of sustaining and conveying flame. The process may be said roughly to consist of removing the natural juices of the wood and replacing them with certain substances which not only make it fireproof, but also have antiseptic properties that prevent decay. The operation is effected in retorts or cylinders. The wood having been run in on trollies, the air-tight door is closed and the contents subjected to heat and the action of a high vacuum. This treatment is continued till the volatile and fermentable constituents have been withdrawn, the time required to attain this result varying with the character of the wood. The next step is to fill the cylinder with the fireproofing solution, the exact composition of which is kept secret, and force it into the wood under hydraulic pressure, the amount of which again differs for different woods, but may reach 150 lb. to the square inch or more. When thoroughly impregnated with the salts the timber is taken out of the cylinders, restacked on the trollies, and put into the drying-kiln—a room through which hot air is continually circulated by powerful fans, and which is fitted with apparatus to condense the vapours given off by the wood. Here it remains till it is thoroughly dried—in the case of a load of average thickness about a month. It is then ready for delivery and use.

WE are glad to learn that efforts are being made to secure for the Maidstone Museum and Public Library the collection of prehistoric flint implements formed during the past thirty-four years by Mr. Benjamin Harrison, and illustrating important periods in the early history of man in Great Britain and elsewhere. It is proposed to select from the specimens in Mr. Harrison's collection the type series chosen from the chalk plateau implements by Sir Joseph Prestwich to illustrate his monographs upon the subject of plateau or eolithic implements, and other type implements which have been figured and described by other writers; a series to show variety of form and the probable uses to which these implements have been put; a collection of paleolithic implements from gravels in the West Kent district; and type series of neolithic implements found in Kent. No more suitable home could be found for these implements than the Maidstone Museum, situated as it is in the county town, and also in the immediate vicinity of the district in which they were discovered. An appeal for subscriptions to purchase the collection, signed by the Mayor of Maidstone, has been issued by the Museum Committee. The public spirit of the municipality in the cause of science, as shown by the efforts being made to acquire Mr. Harrison's collection, is as gratifying as it is rare. Nearly 100*l.* have been raised so far, and there should be no difficulty in increasing this to the amount required. Subscriptions may be sent to the Town Clerk of Maidstone, or to the Harrison Collection Fund, Kentish Bank, Maidstone.

IN the U.S. *Weather Review* or March, Mr. R. de C. Ward describes an interesting formation of small cumulus clouds over a fire, observed by him at the Harvard College Observatory at Arequipa, Peru. Behind the western flank of Mount Charchani, and about fifteen miles away, a column of smoke was rising from a considerable fire of brushwood, at a probable height of about 14,000 feet above sea-level. While looking at the smoke he noticed the formation of a small cumulus cloud directly over it, and from 3000 to 4000 feet above it, the sky being almost clear and the wind nearly calm at the time. The cloud soon disappeared, and was succeeded by another, which again disappeared within five minutes. Eight distinct cloudlets were seen thus to form and dissolve within the space of half an hour, at the end of which time the smoke had disappeared. Although the smoke column was small, the conditions were evidently favourable for cloud formation. Cumulus clouds over fires were described by Espy in his Fourth Meteorological Report; another case was also noted by Mr. Ward in *Science* of January 8, 1897.

AN interesting installation of electric transmission of water power has, says *Engineering*, recently been completed by the utilisation of the River Etsch for the benefit of the towns of Bozen and Meran. The sources of the Etsch are at a great height above the Reschen lake, which is situated some 5200 feet above the level of the sea. At the place where the installation in question has been erected, the fall of the river is 630 feet over a distance of about a mile and a half. So far 6000 horse-power have been utilised, and a similar quantity can be made available at the second fall. The power will be used for electric light, at an extremely cheap rate for industrial purposes, probably electric railways, &c. The course into which the water is conveyed has a length of about 1000 feet; a tunnel has been made through the rocks of 1730 feet in length, and at the end of this is a reservoir, with a capacity of 1335 cubic metres. From here the power conduit, 12 feet in diameter, has been blasted almost vertically in the rock; it ends in a chamber, from whence two steel tubes, about 5 feet in diameter, lead to the turbines. The tubes are for a length of 110 feet inserted in the rock and laid in concrete. From each tube three outlets lead the water to turbines, which are after the Portial Girard system, and of 1000 horse-power each at 320 revolutions, the consumption of water being 1·4 cubic metre per second, with a utilised fall of about 230 feet. The dynamos are direct-coupled with the turbines, and generate currents of 10,000 and 3600 volts. The connection with Bozen has a length of twenty-two miles, and the one to Meran of three miles. They are overhead, supported by 33-feet high poles, and with a tension of respectively 10,000 and 3600 volts. On entering Meran the current is conveyed through two cables to the distributing station, from whence it, by means of underground high-tension network, is conveyed to the transformers and reduced to 115 volts. The same is the case at Bozen, where the current, however, first is reduced from 10,000 to 3600 volts.

THE formulæ relating to recurring series have long been studied, but there has always been a certain incompleteness about their synthetic treatment. This want is now to a certain extent supplied by a paper, communicated by Dr. Carlo Pietracola to the *Atti* of the Naples Academy, of which a brief abstract appears in their *Rendiconto*. Dr. Pietracola deals with the part of the theory regarding the formal relations between the general terms of recurring series and the elements which define them. This subject he treats by a new method, involving a generalisation of the isobaric algorithm, and a number of interesting applications form a noteworthy feature of the paper.

A METHOD of determining simultaneously the electric and thermic conductivities of metals at different temperatures is described by Signor Paolo Straneo in the *Atti dei Lincei*, vii. 11. The principal object of the experiments was to ascertain how the thermic conductivity of a substance varied with the temperature. As regards the internal conductivity, the variations were found to be too small to be determinable to a sufficient degree of precision by existing methods. The coefficient of surface conductivity increases with the temperature, and the dispersivity not only increases with the absolute temperature, like the coefficient of specific heat, but is at least a quadratic function of the difference of temperature between the body and the surrounding air.

THE so-called chromatolysis, supposed by Cavara to exist normally in the nuclei of plants, is discussed in the *Atti dei Lincei* by Dr. B. Longo, who enunciates the following conclusions: (1) The phenonomen of chromatolysis does not exist in the normal vegetable nucleus; (2) the nucleoli consist of one unique substance, and not of a central one representing the nucleolus proper of Cavara, and a peripheric one representing the chromatin; (3) the nucleolus proper of Cavara is nothing but a vacuole; (4) the nucleoli are either perfectly homogeneous or vacuolate, but never alveolate; (5) in the present state of science we are ignorant of the true function of nucleoli.

PROF. G. MERCALLI has recently prepared an important memoir on the earthquakes of southern Calabria and the district around Messina (*Mem. della Soc. Ital. delle Scienze*, ser. iii. vol. xi.). The first part contains a catalogue of all the shocks felt in this region from 1169 to the present day. In the second, a special study is made of the more important seismic series, and especially of that which commenced on February 5, 1783. Of this series alone (1783-86), the author adds notices of about 500 shocks to the 1186 already chronicled by Vivenzio and Pignatari. The most interesting part is, perhaps, the third, which deals with the recent series of earthquakes beginning on November 16, 1894, the origin of which Prof. Mercalli traces to two centres, one in the sea of Palmi, the other beneath the western slope of Aspromonte, between S. Cristina and Delianova. Among the general conclusions formulated are the following:—The Calabro-Messinese earthquakes, as a rule, occur in long series. The great destruction caused by those of 1783 was due not only to the violence of the shocks, but especially to their long duration (two minutes and more), and to the nature of the surface rock-formations. All the great earthquakes of the district are independent of the volcanic foci of Etna and the Aeolian islands, there being about eighteen different seismic centres. With regard to the causes of the earthquakes, the author considers tectonic dislocations insufficient, and would prefer either masses of water passing instantaneously into the state of vapour, laccolitic or plutonic displacements and injections, or subterranean rock-falls. On account of their position and supposed origin, he proposes to apply the term *inter-volcanic* to the Calabro-Messinese earthquakes.

THE Report of Mr. J. C. Willis, director of the Royal Botanic Gardens, Ceylon, on the condition of the Gardens, and the work accomplished during 1897, records a number of interesting points. The appointment of Mr. E. Ernest Green as Honorary Government Entomologist is noteworthy. As to the work of the Gardens, a fair amount of ground was laid out during the year in experimental plots of economic plants, chiefly at Peradeniya. An attempt was made to bring the department more into touch with the public by issuing periodical circulars dealing with horticultural, agricultural, and botanical subjects. Each circular deals with one subject only. Three were published during the latter half of 1897, one being introductory, the others dealing with the cacao disease. Copies are sent free to all Government officers, to planters' associations and similar bodies, and to botanic gardens and similar institutions abroad. Much attention was given during the year to the cacao canker. During the early part of the year an extended investigation of the diseased areas was made, and the disease was found to be common in nearly all parts of the Central and Uva Provinces. The disease was found to be due to the attack of a fungus, whose exact nature is at present unknown, but which almost certainly belongs to the class of fungi which cause the various cankers of stems and roots. The interest taken in the cultivation of Para rubber received a very great impetus during the year, and the demand for seed was enormously larger than the supply. The total crop of seeds from mature trees in the Gardens was rather over 100,000 seeds, of which 88,500 were sold to planters in Ceylon. The cultivation of camphor trees is also full of promise. It is reported that camphor plants continue to grow well at Hakgala, some of them being nine feet high. Of the plants distributed in 1895, some of those in Galle District have grown to a height of twelve feet. In the laboratory attached to the museum, researches were carried on during 1897 by several European investigators. The work of the Gardens has thus been for the advancement of pure as well as economic botany.

A LARGE amount of work is being done in the various American botanical laboratories on the embryology of flowering plants, and interesting results have in several cases been obtained. Among the more recent contributions are one on the Pontederiaceæ (*Pontederia* and *Eichchornia*), by Wilson R. Smith; the results being very similar to those with other Monocotyledons of a low type, such as *Naias* and *Zannichellia*; and one on *Euphorbic corollata*, by Florence May Lyon. The embryo of this plant is characterised by the extremely long synergids, and the very temporary character of the antipodals. The work was in both instances done in the Hull Botanical Laboratory. We have also received Part i. of the second series of the Minnesota Botanical Studies; and three publications from the U.S. Department of Agriculture: a Preliminary Report of the Soils of Florida, by Milton Whitney; and Nutrition Investigations at the University of Tennessee and in Pittsburg respectively, by Dr. Charles E. Wait and Prof. Isabel Bevier.

THE special correspondent of the *Lancet* in Calcutta writes: "A very diplomatic compromise between what ought to be done and the wishes and prejudices of the natives has been effected in Calcutta by the establishment of licensed family hospitals for plague cases. The sanitary measures hitherto adopted elsewhere are not adapted to the Indian people, and consequently the regulations about plague have been evaded in every possible way. The establishment of this system, therefore, has gained the confidence of the people. Besides the public hospitals and the ward hospitals there are numerous private hospitals, so that all the communities are now well provided for. In addition to this, houses possessing anything like suitable accommodation for the isolation of a case of plague are allowed to have one or more rooms set apart for the purpose. By these concessions every case of plague ought to come under observation. The plague scare has greatly subsided, and inoculation is coming slowly into favour among all classes."

THE current number of the *Journal* of the Society of Arts contains the first of Dr. D. Morris's Cantor lectures on "Sources of Commercial India-rubber."

WE learn from the *Kew Bulletin* that a Flora of Simla and the surrounding district is being prepared by Sir Henry Collett, and is expected to comprise about 1500 species of flowering plants. The illustrations are contributed by Miss Smith.

JUDGING from the Report for 1896-97, which has just reached us, the Felsted School Scientific Society is doing good work by creating an interest in science among the members of the rising generation. During the session under review a number of interesting papers and lectures were delivered, among the number being a lecture by Mr. George Murray, F.R.S, on "A Journey to the Tropics," and a paper by Mr. C. Hose, Resident of Baram, Sarawak, entitled "A Visit to Celebes."

SURGEON-GENERAL STERNBERG, of the U.S. Army, contributes an article on "The Sanitary Regeneration of Havana" to the August number of the *Century Magazine*, which should be read by all who take an interest in sanitary matters. The writer of the article considers it practicable to put the city of Havana in such a sanitary condition that it would be exempt from its ever-recurring scourge of yellow fever, but that the undertaking would be of considerable magnitude, involve the expenditure of large sums of money, and require much time for its accomplishment.

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrius*, ♀) from Java, presented by Mr. C. R. Johnson; two Squirrel Monkeys (*Chrysothrix sciurea*) from Guiana, presented by Mr. C. E. Günther; a Common Rat Kangaroo (*Potorous tridactylus*, ♂) from Australia, presented by Major Fleming; a White-crested Jay Thrush (*Garrulax leucolophus*), a White-throated Jay Thrush (*Garrulax albogularis*) from India, presented by Mr. Henry Fulljames; a Rook (*Corvus frugilegus*), British, presented by Mr. Mack; a Leopard Tortoise (*Testudo pardalis*), a Bell's Cinixys (*Cinixys belliana*), a Home's Cinixys (*Cinixys homeana*) from Kavitando, near Victoria Nyanza, presented by Captain E. M. Woodward; a Common Chamæleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. W. Cooper; a Humboldt's Saki (*Pithecia monachus*) from the Amazons; a Vinaceous Amazon (*Chrysotis vinacea*) from Brazil, an Orange-winged Amazon (*Chrysotis amazonica*) from South America, a Festive Amazon (*Chrysotis festiva*) from Guiana; five Gazelles (*Gazella dorcas*) from North Africa, two Magpies (*Pica caudata*), British, deposited; four Cambayan Turtle Doves (*Turtur senegalensis*), a Spotted Pigeon (*Columba maculosa*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

AUGUST METEORS.—In consequence of the brightness of the moon during the earlier portion of this month, only the more brilliant members of the Perseid swarm of meteors are likely to be observed. These meteors originate, as their name indicates, from a point situated in the constellation of Perseus near the star η, which lies in the north-eastern part of the heavens, and is rather low down during the earlier portion of the evening. As the maximum is usually attained on the 10th of the month, the moon should not prove such a disturbing factor; and if the night be fine, observers should make a point of recording their observations in a manner which has been described by Mr. Denning. It is only in this way that observations can be properly discussed and made to serve a useful end. Mr. Denning has recently (*Knowledge*, August 1) published an ephemeris of the position of the radiant point, and below we give an abstract which may prove useful for the present return.

August.	R.A.	Decln.	August.	R.A.	Decln.
4	38	+56	10	45	+57
5	39	56	11	46	57
6	40	56	12	47	57
7	41	57	13	49	58
8	42	57	14	50	58
9	44	+57	15	51	+58

We may mention again that the maximum occurs on the night of the 10th.

WOLF'S COMET.—This comet is gradually decreasing its northern declination, but is increasing slowly in brightness. Its ephemeris for the present week is as follows (*Astr. Nach.*, 3506):—

12h. Berlin M.T.

1898.	R.A. h. m. s.	Decl. ° ′	Br.
August 4	4 37 7	+17 45	2·4
5	39 48	36·8	
6	42 28	27·7	2·4
7	45 7	18·3	
8	47 46	8·7	2·4
9	50 23	16 58 8	
10	52 59	48·8	2·4
11	55 34	38·4	
12	4 58 8	+16 27·9	2·4

Between the above dates, the sun's apparent right ascension at apparent noon lies between 8h. 58m. and 9h. 29m. G.M.T.

THE VARIABLE *o* CETI.—This variable star has always afforded plenty of interest to the observer, and according to the most recent observations much attention must still be paid until we are able to understand all the intricacies which are connected with it. In the current number of the *Astr. Nachr.* (3506) Herr W. Stratonoff gives a short account of his observations, which extend over the years 1896–98 ending January 24, and these show that there are peculiarities which need further study. According to these observations the maximum (3·60 mag.) in 1897 occurred about January 5, which indicated that the time of computed maximum was about sixty-three days too early. The following maximum in 1897 took place on about November 23, the magnitude of the star amounting to less than on the former occasion, namely 3·06. This maximum occurred fourteen days later than the calculated time. The interval between the two amounts to 322 days, which is smaller by nine days than what is generally computed to this star. Herr Stratonoff further points out that after the chief maximum a secondary maximum occurs, twenty-seven days later; this is very interesting, as such a maximum takes place in the well-known variable η Aquilæ. Herr Stratonoff's observations were all made with the naked eye, with the exception of those included in October 22–25, when he used an opera-glass. He attempted, by photographic means, to determine the variations of the star by making equal exposures on different nights, and examining the diameters of the images formed; but he ultimately found that the method was not so accurate as the one, namely Argelander's, that he had employed.

In the same number of the *Astr. Nachr.* Dr. A. A. Nijland communicates a short paper on the same variable, and shows that, according to his observations, the maximum in 1897 occurred sharply on November 26. This determination may be perhaps considered more accurate than that of Herr Stratonoff, whose observations at the time of maximum were less numerous than those of Dr. Nijland. Even in this case the computed time was far too early, amounting to fifty-seven days. In Dr. Nijland's curve the secondary maximum of Herr Stratonoff is also indicated, although the former observer draws his curve through the mean of the observed points, looking upon the variation of intensity as within errors of observation. Assuming that the maximum fell according to Chandler, on January 11, 1897, then the last observed period amounts to about 319 days, which does not differ very much from that found by Herr Stratonoff, as mentioned above. The light curves reproduced in both the papers referred to are well worth perusal, and will perhaps lead other observers to follow the fluctuations of this interesting variable.

THE RED SPOT ON JUPITER, AND ITS SUSPECTED IDENTITY WITH PREVIOUS MARKINGS.

THE outlines of the red spot are still faintly distinguishable on a night of good definition. With a 10-inch reflector and power of 312, I have obtained the following estimated transits:—

Date 1898	Spot on central meridian h. m.	Longitude °
March 22	10 43	23·6
April 15	10 26	22·6
„ 17	12 6	23·6
„ 18	8 0	25·2
„ 22	11 16	24·9
May 14	9 25	24·1
June 7	9 20	25·9

At the present time the spot follows the zero meridian (System II.) of Mr. Crommelin's ephemerides in *Monthly Notices* by 26 degrees, which is equivalent to 43 minutes.

During recent observations the spot has not appeared to be quite centrally placed within the concavity in the great southern belt. Its position is slightly on the following side.

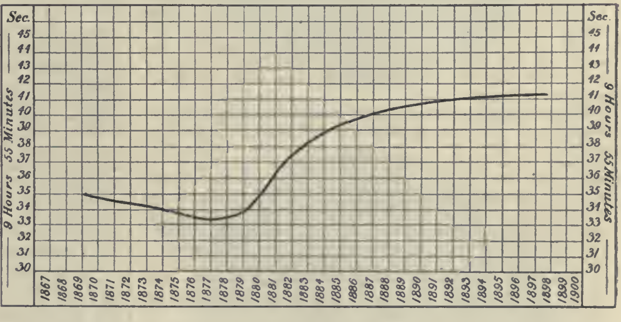
Now that this singular marking has been watched for a period of twenty years, the time may be opportune for referring to the question whether it can be physically identified with the large spot seen at intervals by Cassini, Hooke and Maraldi about two centuries ago, and with more modern observations of somewhat similar formations by Key in June 1843, by Dawes in 1857, by Lassell and Huggins in 1858 and 1859, by Gledhill and Mayer in 1869, 1870 and 1871, by Rosse and Copeland in 1873, and by Russell and Bredichin in 1876. In some instances the features alluded to exhibited a very suggestive resemblance to the red spot, and were, moreover, situated in, or nearly in, the same latitude.

This question of identity, when the details come to be considered, presents so many difficulties that, though the affirmative view has much in its support, it scarcely admits of definitive settlement in respect to the more ancient observations. For our knowledge of the older spots we have to depend upon drawings of the planet; and it is notorious that delineations by different observers are rarely consistent as to the form of an object, or accurate as to its position on the disc. Before the apparition of the red spot in 1878, the great utility of taking the times when the markings passed the central meridian of Jupiter had not been sufficiently recognised, and such observations had been rarely attempted.

Apart from the approximate character of former materials, the extremely variable motion of the Jovian features presents a serious impediment when we attempt to demonstrate the absolute identity of any of them. Were the observed velocities equable, and the spots permanent markings on the real surface, like those discerned on Mars, the matter would be simplified, and we should possess a well-assured base for investigation. It would be easy to determine whether a modern spot occupied the same longitude as one of its prototypes visible at a distant period. Thus, the Kaiser Sea, as we see it to-day on Mars, can be unmistakably identified as one of the principal lineaments drawn by Huygens in 1659 and subsequent years. But the visible markings on Jupiter appear to be quite of another character. They are atmospheric details which display vagaries inducing great changes of appearance and displacements in longitude, so that we can only speak with confidence of individual markings which have been retained continually under telescopic scrutiny. It is true that a break of a few months in such observations need not, in particular cases, be fatal to the identification of markings. There must necessarily occur such breaks during the interval when Jupiter is near conjunction with the sun; but notwithstanding this, there has been no difficulty whatever in recognising the red spot at every reappearance of the planet since 1878. When, however, there occur breaks of two or three years in observations of a supposed identical feature, doubts are at once introduced by the lack of connecting links to bridge over the intervals. This is the case affecting the various features which are suspected to have been early representations of the modern red spot; there are many links wanting in the chain of evidence necessary to prove their identity.

I have been carefully comparing the various observations of apparently analogous markings in the southern hemisphere of Jupiter since 1857, with the view of associating them if possible and discovering what rates and changes of motion influenced them. The result of the examination has tended to strengthen the idea that Gledhill's ellipse of 1869–70, Lord Rosse's and Dr. Copeland's red spot of 1873, and Russell's and Bredichin's oval spot of 1876 were really one and the same object. I believe that all these observations are to be satisfactorily accounted for on the theory of identity. Certainly there are some small differences due to the approximate character of the materials available for discussion. The times of passage of the objects across the central meridian have in most cases to be estimated from their positions as drawn either west or east of it. But it must happen that, in getting transits from such rough data, our resulting values will be sometimes erroneous to the extent of 15 or 20 minutes, and occasionally perhaps it will amount to 30 minutes. Even the latter quantity is not, however, always a very serious item, for when the rotation of a spot has to be derived from, say, observations extending over two years, it only introduces an error of 1 second in the resulting period.

THE GREAT RED SPOT on JUPITER
Variation in Rotation Period 1869 to 1898.



There is little doubt that the red spot before its remarkable intensification of colour, and prior to freeing itself from the obscuring material which apparently veiled it in 1877, had been increasing its velocity of rotation. We know that after 1878 it gradually slackened. When Gledhill first observed the spot in the autumn of 1869, its period of rotation appears to have been about 9h. 55m. 35s. Slightly increasing in velocity, the rate up to the close of 1872, when Lord Rosse and Dr. Copeland redetected the spot by means of the six-foot reflector, was 9h. 55m. 34·5s. It had been seen in the interim by several others. Mr. Gledhill saw the ellipse resting on, and actually in contact with, the great southern equatorial belt on December 1, 1871, and on January 5, 6 and 11–12 it was seen by Messrs. E. B. Knobel, H. Pratt and J. Birmingham respectively (*Astronomical Register*, January and February 1872, and *English Mechanic*, September 13, 1872). Several others, including Dr. F. Terby, appear to have recognised it at about this period. During the interval from Rosse and Copeland's observations in the winter and spring of 1873, to Russell and Bredichin's in the summer of 1876, the mean period of the spot was 9h. 55m. 34s., and between June 1876 and Dennett's observation of July 27, 1878, it had further decreased to about 9h. 55m. 33·5s. Subsequently to this the motion of the spot has slackened until, now, twenty years after Dennett's observation, its period is 9h. 55m. 41·5s., or 9 seconds more. The variation of motion since 1869 can perhaps be graphically represented by a diagram.

The slackening of its motion is still evident, but it is very slight as compared with that which took place in the years from 1879 to 1884.

Taking the whole period from Gledhill's first observation on November 14, 1869, when the spot was central at about 10h. 50m., to one obtained at Bristol on June 7 last, at 9h. 20m., we shall find the interval covered 10,431 days 22 hours and 30 minutes, and that 25,218 rotations were performed with a mean period of 9h. 55m. 37·7s.

In addition to the variation exhibited in the diagram, there have been some minor changes in the motion of the spot. These could, however, only be satisfactorily worked out from the most accurate observations and by determining the rotation periods for short intervals.

As to the question whether the red spot is identical with markings seen in 1857, 1858 and 1859, the matter is open to doubt, for there seems to be a great lack of corroborative observations between 1860 and 1869. The objects delineated by several skilled observers about forty years ago were somewhat similar in position and form to the red spot of recent years, and afford strong presumptive evidence of identity. We have had the spot continuously before us for twenty years, and there can be no doubt that its existence can be traced back to 1869. We ought to be able to go back another ten years and affiliate it with the elliptical markings which were drawn by Dawes, Huggins and others in the region immediately south of the great equatorial belt in 1857, 1858 and 1859, but there is an absence of suitable observations along the interval, and though it is easy to infer that the various objects were identical the fact cannot be demonstrated.

Had observations been more numerous, we should perhaps be able to put our hands on a complete series of records of the red spot extending back for a very long period. It must be remembered that some years ago the planet was so much neglected that a conspicuous feature might easily escape notice during the whole of a favourable apparition. Thus the ellipse of 1869-70 was only seen by Gledhill and Mayer, though Jupiter was a splendid object at about that period. The fact that an object was not seen is, therefore, far from being conclusive evidence of its non-existence.

Though there is reasonable proof that the marking drawn by Russell and Bredichin in 1876 was the same as that which attracted so much notice two years later, it is curious what became of it in 1877. Bredichin gives fifteen drawings of the planet's appearance in the summer of the latter year (see *Annales de l'Observatoire de Moscou*, vol. iv., 1878), but there is no sign of the red spot. The object, if it existed during that opposition, may have been temporarily obscured by more highly reflective material lying above it. It seems to have been much involved with the belts in the southern hemisphere before 1878. Mr. H. C. Russell remarks that he first saw it separated from the belts on July 8, 1878, and was not long in recognising it as an old friend which he had frequently seen in 1876.

Many of the markings on Jupiter are probably formed by materials evolved from the actual surface of the planet, which afterwards become floating masses in the outer region of the atmosphere. Their longitudes do not probably long coincide with that of the original seat of disturbance, for they will fail to keep pace with the exceedingly rapid motion of the sphere, and must exhibit a retardation similar to that so well pronounced in the case of the red spot. The latter has proved itself a very special object with a durableness which does not seem to have characterised other markings. There were "new red spots" in 1886 and 1891, but they did not last long. The majority of the Jovian markings appear to be somewhat transient and irregular in their apparitions, and certain zones of the planet would seem favourable to the production of markings having an individuality of aspect.

The true rotation period of the actual sphere of Jupiter still awaits accurate determination. An occasion might, however, present itself for this element to receive satisfactory investigation. If the spots are really due to eruptions from the planet, and if these should be sustained over periods sufficiently long for the purpose intended, then a string of spots might be formed along a zone, and the time taken to complete the circumference might give data for ascertaining the true rotation period if the retardation of the markings on arriving in the outer atmosphere were allowed for. Thus, in 1880-81 I watched the formation of a complete girdle of spots in about ninety days; and had the distension taken place always on the preceding side, the materials would have been obtained for finding the correct period, for the observed rotation of the spots was 9h. 48m. But the objects appeared to extend themselves both east and west, though the spreading out on the following side may have been due to an increase in the slackening motion, rather than to the formation of new spots. Phenomena of this character obviously offer important features for discussion. Whenever an outbreak of spots takes place, it becomes necessary to learn the direction and rate of its longitudinal distension; for such inquiries may usefully increase our knowledge of the physical condition of Jupiter, and supply us with a more precise value for the rotation period. Our previous acquaintance with this element depends upon atmospheric phenomena, and must be to some extent in error, for the markings display proper motions differing among themselves to the extent of nearly eight minutes, and in nearly every case the rate of velocity appears to vary in an irregular manner but generally lengthening with the time

W. F. DENNING.

THE GERMINATION OF HORDEUM VULGARE.[1]

THE work described in this paper is a continuation of a previous research by Mr. Horace T. Brown and Dr. G. H. Morris published in 1890 (*Jour. Chem. Soc.*, vol. lvii. p. 458), dealing with the respective influences of embryo and endosperm in the alteration of the reserve-starch and cellulose for the requirements of the young plant during germination of seeds of the *Gramineæ*. The seeds of various species were examined, but the main results were obtained with *Hordeum vulgare*; the observations made in this later work are also almost entirely confined to this species, and there can be but little doubt that the results will be found applicable to the *Gramineæ* generally.

It was shown in the earlier paper that the first changes in the endosperm during incipient germination are disintegration and ultimate dissolution of the membranes of the amyliferous cells, this being followed by erosion of the contained starch-granules. These phenomena suggested that the action is due to the influence of the embryo, and not to any autonomous action of the endospermous cells themselves.

While investigating this point, it was found that a carefully excised embryo can exist independently of the seed, if supplied with suitable artificial nutriment in the form of certain carbohydrates, its own proteids yielding sufficient nitrogen for the production of plantlets of considerable size. It was also found that the embryo can be transferred from the endosperm of one seed to that of another, and that healthy plantlets are produced under these artificial conditions.

In this manner it was shown that an excised embryo can induce in starch-granules an action alike in kind and degree to that produced by an embryo growing *in situ* on its natural endosperm, as in normal germination. It was found that the columnar epithele of the scutellum can secrete a very active amylohydrolytic enzyme, and project this into the endosperm or any artificial nutriment in intimate contact with itself. This embryonic activity was, however, recognised not to exclude the possibility that the endospermous cells might participate in the dissolution of their own reserve-materials. To ascertain how far such co-operation might exist, degermed seeds were studied when placed in conditions allowing rapid removal of any products of change. The same end was also obtained by grafting a living embryo from one grain on to the endosperm of another, that had been so treated, so as to destroy presumably all potential vitality of the endospermous cells. Since living embryos induced in these supposititiously dead endosperms all normal changes of depletion, and since no autonomonous changes were observed in the degermed endosperms not attributable at that time to adventitious micro-organisms, the idea of residual vitality in the endosperm as a condition of its depletion seemed superfluous.

Since 1890, Grüss, Hansteen, and others, have confirmed the conclusions formed in 1890, that the embryo can secrete enzymes, but Pfeffer, Hansteen, Grüss, and Puriewitsch have strongly contested the view that the endosperm has no autonomous power of self-depletion. These latter observers state that the amyliferous cells of the endosperm have distinct power of digesting their own reserves, this function being quite independent of any induced action of the embryo, and due to residual vitality.

The present work is the result of a re-examination of the

[1] "On the Depletion of the Endosperm of *Hordeum vulgare* during Germination." By Horace T. Brown, F.R.S., and F. Escombe. (Read before the Royal Society on March 3.)

mutual dependence of embryo and endosperm in *Hordeum vulgare*. In it the proportionate shares taken in the endospermous depletion are evaluated for (1) the embryo, (2) the amyliferous part of the endosperm, (3) the so-called "aleurone-layer" (*Kleberschicht*). The possibility of some of the changes being due to enzymes pre-existent in the seeds is considered, as also of any action being due to micro-organisms in experiments with degermed endosperms. The conclusions are drawn from results given by very many experiments in widely-varied conditions.

Great difficulty was found in the just appreciation of the effects of micro-organisms, for, although their influence on intact seeds is minimal, yet their action on the endosperm bared through degermation produces changes in the cells hardly distinguishable from such as would be induced by the cells themselves, on the assumption that they had living contents.

No antiseptic reagent could be found with such differential action as to inhibit, or materially retard, the growth of micro-organisms, while not hindering normal development of the seedling. But extreme refinements for avoiding air-sown organisms are useless, since complete initial sterilisation of the exterior of the grain cannot be ensured. Differentiation of autonomous action of the tissues from that of extraneous organisms was much aided through study of the action of similar organisms on undoubtedly dead tissue.

To ascertain the self-depletive power of endosperms from which the embryo had been removed, a method was adopted almost identical with that described in the paper of 1890 (*loc. cit.*). The endosperms were placed with their proximal ends downward in small holes in a very thin mica-raft, which was then floated on water so as to just submerge the endospermous surfaces laid bare through degermation, every facility being thus given for outward diffusion of products of change. This method is preferable to Hansteen's plan of affixing the grains to plaster-columns standing in water. In these conditions slow changes undoubtedly occur in the degermed seeds, these being due neither to influence of micro-organisms, nor to enzymes pre-existent in the grains. The changes are very much slower than those of normal germination, but are of the same order, and are undoubtedly due to autonomous action of some part of the endosperm.

There is firstly a tendency for the "aleurone-layer" to separate from the underlying amyliferous cells through cytohydrolysis of the membranes of the latter. This action commences on the dorsal side of the grain near the apex of the scutellum, extends gradually in well-defined directions, and invades slowly the more deeply-seated parts of the endosperm, producing a partially-mealy consistence of the cell-contents. This cytohydrolysis is followed after some days by a more or less partial erosion of the starch-granules underlying immediately the "aleurone-cells." This erosion is, however, very different from that effected by the embryo through the enzyme secreted by its columnar epithele. The difference between these two modes of erosion is clearly shown in the accompanying prints.

These changes in the degermed seeds are without doubt self-induced, since it is impossible to produce them in endosperms that have been demonstrably killed through submersion in chloroform-water for twenty-four hours. It is also certain that the action is initiated by the "aleurone-layer," and not by any autonomous action of the amyliferous cells, since no such changes can be induced in this portion after deprivation of its "aleurone-layer."

Although the statement made in 1890 that the amyliferous cells possess no self-depletive power, is true, the one affirming that the endosperm as a whole is passive during germination requires correction, since the "aleurone-layer" shares with the embryo in preparing the reserve materials for the seedling.

As an active agent in *amylohydrolysis*, the "aleurone-layer" seems to play a subordinate part to the embryo; its principal function appears to be *cytohydrolytic*. Certainly an embryo grafted on an endosperm, the "aleurone-layer" of which has been killed, cannot induce an action comparable in intensity with that produced through joint action of a living embryo and a living "aleurone-layer." This is not due to deficiency in amylohydrolytic power of the embryo, but to the fact that the embryo has relatively small cytohydrolytic power, so that the action of its diastase, owing to the low diffusibility of the latter, is not effective as long as the membranes of the amyliferous cells are undestroyed.

The view put forward in 1890, that the *whole* endosperm is passive during germination, was mainly founded on experiments in which living embryos had been "grafted" on endosperms previously soaked for several months in strong alcohol, a treatment then believed to ensure complete loss of potential vitality of the "aleurone-layer." Such treatment is now known to be insufficient to destroy with certainty even the potential life of the embryo, for barley-seeds have been germinated that had been continuously soaked in strong alcohol for many weeks, and there is reason to believe that the "aleurone-layer" is even more resistant to adverse conditions than the embryo.

The conclusion that the amyliferous cells are incapable of initiating any changes in themselves as deduced from physiological experiments, is strongly supported by cytological observations. A method is described in the paper by which

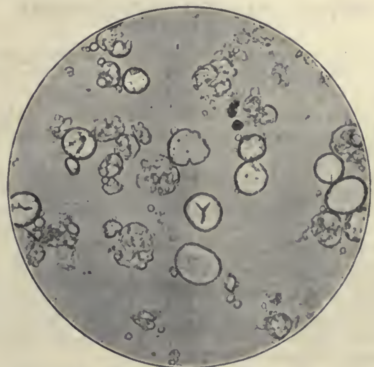


FIG. 1.—Sub-scutellar erosion of starch produced by the embryo. Here the action commences with general *pitting* of the granule. These pits enlarge, and thus break up the granule.

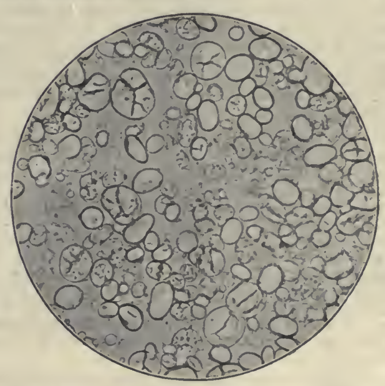


FIG. 2.—"Sub-aleuronic" erosion. Here no preliminary pits are formed, but large *rifts* are produced, and the granule undergoes concentric or irregular dissolution.

these cells can be cleared of their closely-packed starch granules, so that the nuclei can be readily discerned. During development of the amyliferous cells of the endosperm their nuclei become extremely deformed, owing to the increasing pressure of the starch-granules, and are very often disintegrated. It is difficult to believe that cells in this condition can functionate, even if there were no confirmatory evidence such as is afforded by the physiological experiments described.

It is very probable that the "aleurone-layer" possesses a function additional to that exercised during germination, but which can hardly fail to be very important. Its cells, which undoubtedly contain living elements, constitute the outermost peripheral layer of an otherwise *dead* endosperm, and this would be much more liable to attack by any micro-organisms of the soil which succeeded in penetrating the seed-envelopes, if the protective sheath of living cells were not present. It is remarkable that the "aleurone-layer" is much more fully developed over those parts of the seed that may be regarded as dead, becoming very much more attenuated where in proximity to the embryo, the cells of which owing to their vitality do not require an equal amount of protection.

The authors express, finally, their great thanks to Mr. W. T. Thiselton-Dyer and to Dr. D. H. Scott for the opportunities afforded them in the prosecution of this research at the Jodrell Laboratory, Kew.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. J. CROWTHER, at present lecturer in metallurgy in the Owens College, Manchester, has been appointed to a similar position in the Swansea Technical School.

DR. CHEADLE has presented the St. Mary's Hospital Medical School, Paddington, with the sum of 500*l.*, to found a gold medal in clinical medicine.

DR. WALLACE WALKER has been appointed to the additional chair of Chemistry recently founded and endowed by Mr. W. C. McDonald in M'Gill University, Montreal; and Mr. Ernest Rutherford has been appointed to succeed Prof. H. Callendar in the chair of Physics.

THE following appointments have been made at the West Ham Municipal Technical Institute:—Lecturer in physics and mathematics, Mr. S. G. Starling, of the Battersea Polytechnic; demonstrator in physics, Mr. J. Tomkin, of the Royal College of Science; demonstrator in chemistry, Mr. F. H. Streatfeild, of Finsbury Technical College.

THE *Record of Technical and Secondary Education* for July contains illustrated accounts of the Royal Technical Institute, Salford, and the Leith School of Navigation, and an important article on "Technical Institutions and Local Authorities in England," in which it is endeavoured to give trustworthy information as to the amount of money expended on technical buildings by local authorities. The article deals only with the work done in the county boroughs, but a subsequent contribution will deal with the operations in connection with County Councils and other local authorities.

HER Majesty's Commissioners for the Exhibition of 1851 have made the following appointments to Science Research Scholarships, for the year 1898, on the recommendation of the authorities of the respective Universities and Colleges. The scholarships are of the value of 150*l.* a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result directly in work of scientific importance.

	Nominating institution.	Scholar
1	University of Glasgow	James Francis Bottomley
2	University of Aberdeen	Alexander Findlay
3	Mason University College, Birmingham	A. H. Reginald Buller
4	Yorkshire College, Leeds	Harry Thornton Calvert
5	University College, Liverpool	Ernest Brown
6	University College, London	Louis Napoleon George Filon
7	Owens College, Manchester	James Henry Smith
8	Durham College of Science, Newcastle-upon-Tyne	Arthur William Ashton
9	University College, Nottingham	Austin Henry Peake
10	Royal College of Science for Ireland	Robert L. Wills
11	Queen's College, Galway	Hugh Ryan
12	University of Toronto	William Gabb Smeaton
13	Dalhousie University, Halifax, Nova Scotia	Ebenezer Henry Archibald

The following scholarships, granted in 1897, have been continued for a second year on receipt of a satisfactory report of work done during the first year:—

	Nominating institution	Scholar	Places of study
1	University of Edinburgh	Longfield Smith	University of Leipzig; to proceed to University of Heidelberg
2	University of Glasgow	James Muir	Engineering Laboratory, University of Cambridge
3	University of St. Andrews	Harry McDonald Kyle	Gatty Marine Laboratory, St. Andrews, and Laboratoire Arago, Banyuls-sur-mer; to proceed to Marine Laboratory, Heligoland
4	University College, Dundee	Sydney A. Kay	Högskola, Stockholm; to proceed to University of Leipzig
5	Mason College, Birmingham	Gilbert Arden Shakespear	Cavendish Laboratory, University of Cambridge
6	University College, Bristol	Chas. Henry G. Sprankling	Owens College
7	Yorkshire College, Leeds	Harold Albert Wilson	Cavendish Laboratory, University of Cambridge
8	University College, Liverpool	Wm. Augustus Caspari	University of Jena; to proceed to University of Leipzig
9	University College, London	Percy Williams	École de Pharmacie, Paris; to proceed to Prof. Van 't Hoff's Laboratory, Wilmersdorf, Berlin
10	Owens College, Manchester	J. H. Grindley	Owens College (*permitted under special circumstances*)
11	Durham College of Science, Newcastle-upon-Tyne	Robert Railton Hallaway	Universities of Bonn and Heidelberg
12	University College of South Wales and Monmouthshire, Cardiff	Maria Dawson	Botanical Laboratories, University of Cambridge
13	Queen's College, Belfast	W. A. Osborne	University of Tübingen
14	McGill University, Montreal	Jas. Lester Willis Gill	First year, McGill College (*by special permission*); second year, Harvard University
15	Queen's University, Kingston, Ontario	Frederick J. Pope	Columbia University, New York
16	University of Sydney	Tom Percival Strickland	MacDonald Engineering Laboratories, McGill University
17	University of Melbourne	W. Rosenhain	Engineering Laboratory, University of Cambridge

NOTE.—The Report of the Scholar from University College, Nottingham, is not yet due.

The following scholarships, granted in 1896, have been exceptionally renewed for a third year:—

	Nominating institution	Scholar	Places of study
1	Mason College, Birmingham	Thomas Slater Price	University of Leipzig; to proceed to University of Stockholm
2	Yorkshire College, Leeds	Harry Medforth Dawson	Laboratory of Prof. Van 't Hoff, Wilmersdorf, Berlin
3	University College, London	Joseph Ernest Petavel	Davy-Faraday Laboratory
4	University College, Nottingham	George Blackford Bryan	Cavendish Laboratory, Cambridge
5	Dalhousie University, Halifax, Nova Scotia	Douglas McIntosh	Cornell University; to proceed to University of Leipzig

THE Holt Fellowships in Physiology and Pathology established in connection with University College, Liverpool, by the late Mr. George Holt in 1886 for a period of ten years, and renewed for a further period by Mrs. and Miss Holt, have been awarded to the following gentlemen respectively: Mr. A. Hope Simpson, provisionally upon his attaining full qualifications within a period of three months, and Mr. K. Nelson. The Robert Gee Fellowship in Anatomy, of the value of 100*l.*, has been awarded to Mr. F. Lovegrove.

SCIENTIFIC SERIALS.

American Journal of Science, July.—The origin and significance of spines; a study in evolution, by C. E. Beecher. The importance of spines lies not in what they are, but in what they represent. They are simply prickles, thorns, spines or horns. They represent a stage of evolution, a degree of differentiation in the organism, a ratio of its adaptability to its environment, a result of selective forces, and a measure of vital power. Tracing the various groups of forms through their geological development, it is noticed that each group began its history in small, smooth, or unornamented species. As these developed, the spinose forms became more abundant until after the culmination of the group is reached, when this type either became extinct or was continued in smaller or less specialised forms.—Electrical discharge from the point of view of the kinetic theory of matter, by J. E. Moore. When gaseous matter moves in a stream in any definite direction, the pressure of the gas in that direction is increased by an amount proportional to the square of the velocity of translation. The author proves experimentally that the pressure in the direction of discharge is greater than in either of the directions at right angles, by an amount depending upon the velocity of the discharge stream.—Further separations of aluminium by hydrochloric acid, by F. S. Havens. Describes the separation of aluminium from zinc by the action of hydrochloric acid gas in aqueous ethereal solution. Also the separation of the same metal from copper, mercury and bismuth.—On the origin of the corundum associated with the peridotites in North Carolina, by J. H. Pratt. The corundum was held in solution by the molten mass of the dunite when it was introduced into the rock, and separated out among the first minerals when the mass began to cool.—The winter condition of the reserve food substances in the stems of certain deciduous trees, by E. M. Wilcox. Material of the *Liriodendron* collected in October was found to have an abundance of starch in the cells of the cortex, but none in the cells of the medullary sheath, and but few grains in the cells of the wood parenchyma and medullary rays. The cells immediately below the growing point of the stem contained no starch at this time. November and December showed a gradual increase in the amount of the starch in the medullary sheath, but a marked decrease in the amount present in the cortex. At the end of February starch began to appear again in the cortex, but more especially in the cells beneath the growing point.

Annalen der Physik und Chemie, No. 6.—The spectra of iodine, by H. Konen. The author investigates all the different spectra of iodine obtainable by the use of arcs, vacuum tubes, heated vessels, sparks, and fluorescence. He uses the photographic method and an excellent concave grating, and succeeds in cataloguing some 360 lines, extending from 3030 to 5800.—The Leidenfrost drop, by J. Stark. By inserting a drop in the spheroidal state, the hot metallic plate, and a telephone in an electric circuit, the author shows that the drop performs oscillations with respect to the layer of vapour which prevents its evaporation. In the final stages the plate is intermittently wetted. The oscillations are due to differences of surface tension between the hot and cold portions of the drop.—The electromotive behaviour of chromium, by W. Hittorf. Chromium has a different electric behaviour, accordingly as it is in the state to form the monoxide, the sesquioxide, or the peroxide. At ordinary temperatures, and in solutions from which it does not disengage hydrogen, it behaves like a noble metal. But at high temperatures it reduces all the other metals except zinc from their fused salts, and forms its own lowest combination. Fresh surfaces of the metal are in the active state.—The Weston standard cell, by P. Kohnstamm and E. Cohen. The E.M.F. of the cadmium cell shows certain irregularities below 15 degrees, which are due to the fact that the constitution of the cadmium sulphate undergoes some change at that temperature. This change does not affect the water of crystallisation, but corresponds to the change undergone by sulphur at 95 degrees. At temperatures between 15 and 70 degrees the Weston cell is superior to the Clark standard.—On thermophones, by F. Braun. The momentary expansions and contractions produced in a strip of brass or a bolometer by a variable current may be used for the transmission of sound. For this purpose the bolometer is put in circuit with three or four accumulators and a microphone. The effect may be greatly increased by increasing the steady current.—Electric discharge in rarefied gases, by W. Wien. From experiments on the electrostatic deflection of kathode rays, the author calculates their velocity as one-third that of light. Goldstein's canal rays are the prolongation backwards of the kathode rays, and like them are subject to magnetic and electrostatic deflection.—Polarisation of Röntgen rays, by L. Graetz. Polarised X-rays cannot be produced even by using a fluorescent body as an anti-kathode, although such bodies are known to emit polarised light.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 16.—"The Stomodæum, Mesenterial Filaments, and Endoderm of *Xenia*." By J. H. Ashworth, B.Sc., Demonstrator in Zoology, Owens College, Manchester. Communicated by Prof. Hickson, F.R.S.

The Xeniidæ are distinguished from all other Alcyonaria by their soft fleshy consistency and non-retractile polyps.

The stomodæum of each polyp is moderately long (1·8 – 2·2 mm.), and has a well-marked ventral groove or siphonoglyphe, the cells of the lower third of which bear long flagella. Among the cells forming the remainder of the wall of the stomodæum are numerous "goblet cells," which have not hitherto been noticed in the stomodæum of the Alcyonaria. These cells generally appear empty, having discharged their secretion, which, in some cases, can be seen issuing from the cell into the cavity of the stomodæum. These secreting cells occur chiefly in the middle and lower portions of the stomodæum, and are most abundant on the lateral walls near the siphonoglyphe.

These "goblet cells" of the stomodæum are the only secreting cells connected with the digestive cavity, as the six thick ventral and lateral mesenterial filaments, which bear the gland cells in other Alcyonaria, are absent in all polyps of this *Xenia*. The two dorsal mesenterial filaments are present and have a similar course and structure to those of *Alcyonium*. Wilson and Hickson have shown that the ventral mesenterial filaments bear the cells which produce the digestive secretion. The absence of these filaments in this *Xenia* is probably correlated with the presence of gland cells in the stomodæum, which from their position and structure appear to perform some digestive function.

The siphonozooids which occur in Pennatulids and some other Alcyonaria are the only recorded examples of polyps in which the ventral and lateral mesenterial filaments are absent. According to Wilson, these siphonozooids derive their food supply from the autozooids or feeding polyps, and therefore do not require cells to produce a digestive secretion.

The endoderm cells which line the cœlentera and the cavities of the tentacles contain numerous small vacuoles which give the protoplasm a reticulate appearance. Among the ordinary endoderm cells are numerous cells, the inner or free end of which is produced into a long pseudopodium, which is from four to eight times as long as the basal portion of the cell. The pseudopodia, which appear to be flexible, may attain a length of ·12 mm. They are not vacuolated, their protoplasm being homogeneous or very finely granular. The basal part of the cell from which the pseudopodium arises has the reticulate protoplasm of an ordinary endoderm cell, and the nucleus of the cell is situated in this portion. These pseudopodia-bearing cells are very numerous and occur in all parts of the endoderm, lining the cœlentera and the cavities of the tentacles.

EDINBURGH.

Royal Society, July 18.—Lord McLaren in the chair. In a note on the electrolysis of ethyl potassium diethoxysuccinate, Prof. Crum Brown and Dr. H. W. Bolam showed that the electrolytic synthesis of dibasic acids applies to the unsymmetrical diethoxysuccinic acid

$$COOH—C(OEt)_2—CH_2—COOH,$$

although it does not apply to monoethoxysuccinic acid

$$COOH—CH(OEt)—CH_2—COOH.$$

—Mr. W. W. Taylor communicated a note on the freezing point of aqueous solutions of sodium mellitate. The work was undertaken at Prof. Crum Brown's suggestion to test Van t' Hoff's theory of the depression of the freezing point of solutions of electrolytes. The molecular depressions obtained experimentally for solutions of different concentration were from 4 to 6 times the normal molecular depression, 1·87. According to the theory the greatest possible depression is 7 times the normal.—Sir John Murray, K.C.B., presented two papers—one on the deposits collected by the s.s. *Britannia* in the Western

Atlantic in 1897, and the other on some of the deposits collected by the German ship *Gazelle* in 1874 and 1875. In an appendix to the former paper, Mr. R. G. Peakes compared the mean temperature of the sea-bottom between the Bermudas and the West Indies as determined by thermometric observations with that estimated from the resistance of the telegraph cable. The values were respectively 36°·57 and 33°·3 F., a serious discrepancy, which seemed to be difficult to trace to any fault in the electrical resistance method.—In notes on coral reefs at Port Louis and Grand Port, Mauritius, Mr. W. Shield gave an account of twelve borings at these places, one of which at Port Louis reached a depth of 68 feet. The character of the material brought up from each boring was described in detail, but no general result was indicated.—Dr. James Burgess, in a note on finding log sines and log tangents of small arcs, gave formulæ which were much simpler and more accurate than those hitherto published. For example, the log sine of an arc of x minutes and h seconds was given by the expression

$$\log \text{sine}\, x' + \log (x'' + h'') - \log x'' - \cdot 12\, x^{\circ}\, h'',$$

where x'' is the x minutes expressed in seconds and x° the same expressed in degrees.—Prof. Tait gave a generalisation of what is known as Josephus' problem, and showed how by a simple arithmetic process the problem could be extended to huge numbers. Thus he found that if every third man were removed from a ring of 8,968,992 until only one was left, that one would be the first.—Prof. Tait also communicated some recent experimental results on the compressibility of sugar solutions, which was found to be not much less than that of water, whereas the compressibility of brines is notably less. The results accord with the general principle that the greater the change of volume on dissolving the less the compressibility. —The Chairman read a short review of the work of the session.

PARIS.

Academy of Sciences, July 25.—M. Wolf in the chair.—On the numerical calculation of the coefficients in the development of the function of perturbation, by M. O. Callandreau.—Thermogenesis in tetanus, by MM. d'Arsonval and Charrin. Experiments upon rabbits show that disturbances, of an oscillatory character, in the production of animal heat make their appearance at an early stage of incubation, and increase in strength until the crisis of the disease is reached.—Note upon animal heat, by M. Émile Blanchard. Some observations on the temperature of insects, more especially of those which are remarkable for their rapid movements.—On a theorem of M. Poincaré, by M. S. Zaremba.—On the absorption of the light emitted by a body placed in a magnetic field, by M. Auguste Righi.—Electrical resistance at the contact of two discs of the same metal, by M. Edouard Branly. Two smooth, plane discs of zinc or copper, when pressed together, offer practically no resistance to an electric current under any circumstances. In the case of aluminium, iron and bismuth, however, the resistance, although small when the discs are simply pressed together, is greatly increased when they are forcibly brought together by falling from a height. The author is unable to offer any explanation of these phenomena.—On the diffusion of kathode rays, by M. P. Villard. The phenomena attributed by Prof. S. P. Thompson to *parakathode rays* appear to be really caused by diffusion of kathode rays.—Measurement of the velocity of the electrified particles during discharge under the influence of ultra-violet light, by M. H. Buisson. The velocity found varied from 25 to 135 centimetres per second, according to the difference of potential between the plates of the condenser, and was independent of the intensity of the light employed.—On the determination of arsenic in antimony and other metals, by M. O. Ducru. The author recommends the process of distillation with hydrochloric acid and ferric chloride, the arsenic in the distillate being afterwards precipitated by hydrogen sulphide. —On the composition of phosphorescent sulphides of strontium, by M. José Rodriguez Mourelo. The specimens of sulphide of strontium employed in the author's previous researches contained as impurities, varying in amount according to the method of preparation, strontium sulphate, sulphide and sulphate of barium, calcium sulphide, sodium sulphide, sodium chloride, and traces of aluminium and iron. Pure monosulphide of strontium is not phosphorescent.—Detection and estimation of methyl alcohol in ethyl alcohol, by M. A. Trillat. The process described depends upon the formation of methylal, when methyl alcohol is oxidised with potassium bichromate and sulphuric acid, and the conversion of this substance, by condensation with dimethylaniline, into tetramethyldiamidodiphenylmethane. This compound, when oxidised with peroxide of lead in acetic acid solution, gives an intense blue coloration, the depth of which is proportional to the amount of methyl alcohol originally present in the liquid under examination.—On the aloins, by M. E. Léger. A number of substitution derivatives of barbaloin and of isobarbaloin are described, and the conviction is expressed that these are the only aloins which exist in the various aloes of commerce.—Study of the phosphoric acid dissolved by the water of the soil, by M. Th. Schloesing fils. The dissolved phosphoric acid appears to be independent of the amount of water in the soil.—On the composition and alimentary value of millet, by M. Ballard. This grain is rich in nitrogen and fat; it resembles maize in composition, and forms a more complete food than wheat.—Contributions to the study of the function of the nucleolus by M. Antoine Pizon.—On the different phases in the development of a new species of *Sarcina*, by M. E. Roze. The new species, for which the name *Sarcina evolveus* is suggested, was observed upon the macerated tubercles of *Boussingaultia baselloides*.—On a silicified *Lepidodendron* from Brazil, by M. R. Zeiller.—Production of acute meningoencephalo-myelitis in the dog by the bacillus of septicæmia of the guinea-pig.—On the polar vortex, by M. A. Poincaré. This paper deals with the movements of the atmosphere in the polar regions.—On the adherence of the copper washes used in combating the cryptogamic diseases of the vine, by MM. G. M. Guillon and G. Gouirand. For the destruction of the parasites of the vine, the use of a large quantity of cupric sulphate is of less importance than the close adherence of the salt to the surface of all the organs of the plant. This adherence is sought to be effected by the addition of such substances as molasses, soap, gelatine, lime and other alkalies, to the solution of cupric sulphate. The present paper gives the results of a number of experiments in which glass plates were sprinkled with the various washes, dried in the sun, exposed for a certain time to the action of rain, and the amount of copper left determined. Lime and gelatine appear to be the most effective fixing agents.

CONTENTS.

THURSDAY, AUGUST 11, 1898.

THE PALÆONTOLOGY OF VERTEBRATES.

Outlines of Vertebrate Palæontology. By A. Smith Woodward. (Cambridge Natural Science Manuals.) Pp. xvi + 470; illustrated. (Cambridge: University Press, 1898.)

IT is now thirty-eight years since the appearance of the first edition of Owen's "Palæontology," which may be regarded as the first systematic treatise on that subject issued in this country. And if the section of that work devoted to the vertebrates be contrasted with the volume now before us, some idea of the enormous strides made in this branch of biological science during the period will be self-apparent. At the time that Owen wrote, our knowledge of fossil fishes remained much in the state it was left by the labours of Georges Cuvier and Hugh Miller; the restoration of the armour-plated fish-like types appearing as more or less grotesque caricatures of what we now know to be their true form; while the classification was as crude as it was unphilosophical.

The group now termed the Stegosauria was at that time placed among the Reptilia, and was represented chiefly by the true Labyrinthodonts and the *Archegosaurus;* the latter of which still figured as the representative of the so-called "archetype." Although among the true reptiles the Ichthyosaurs, Plesiosaurs, and Pterodactyles were already fairly well known, the Anomodonts were in evidence mainly by a few skulls, and their apparent relationship to mammals was undreamt of. North America and Belgium had not yet opened to our view the marvellous array of Dinosaurs; while among birds *Archæopteryx* was still an unknown quantity. To attempt to point out the deficiencies which then prevailed in our knowledge of the Mammalia would far exceed our space, but it may be mentioned that the Creodont Carnivora, and the Amblypod Ungulates, together with several other American groups of the latter order, had not yet been recognised. And whole mammalian faunas, such as those of Quercy, Samos, Maragha, the "Bad Lands" of North America, and Patagonia, were quite unheard of.

The advance during this period of considerably less than half a century, both in the amount of material available for work and in the work actually accomplished, has, indeed, been so vast that the vertebrate palæontology of 1860 is scarcely comparable with that of 1898. The one hardly merited the name of a science at all, while the other is entitled to rank with modern vertebrate zoology, of which, indeed, it is but the complement and keystone. As we have probably already explored most of the bone-beds of the world the science is unlikely to advance during the next forty years by the leaps and bounds which have marked its progress in the past, but even at a much lower rate of speed our successors at the end of that period will probably be surprised at the imperfection of our own knowledge.

With the advantage of all the labours—and failures—of his predecessors in this field at his disposal, it is not to be wondered at that Mr. Woodward has succeeded in producing a volume that will eclipse or throw into the shade all previous works on the subject. In bringing the classification of fossil fishes up to its present state of comparative perfection the author himself occupies the foremost place among palæontologists; and in regard to this portion of the subject criticism would be almost an impertinence. He has also contributed important original information with regard to the structure and affinities of the extinct crocodiles and certain other groups of reptiles. With regard to the remaining groups of vertebrates, the author's position in the British Museum affords him exceptional opportunities of not only keeping abreast with modern discovery, but also of verifying and criticising the work of his fellow labourers by an examination of many of the actual specimens on which such work is based. And when he has seen reason so to do, he has not hesitated to propose new interpretations.

In his preface Mr. Woodward states that the main object of his work has been to produce a volume suitable to the requirements of "students of vertebrate morphology and zoology who are desirous of examining in detail the palæontological aspect of their subject." And how important it is to bring the workers in the zoology of the present time into closer touch with those who devote themselves to the same study in the past, needs no urging on our part. While, therefore, the work is not to be regarded as one that will satisfy all the needs of the advanced student of vertebrate palæontology, it will be invaluable even to him; and for those for whom it is specially designed it appears, in the main, to be all that can be desired.

One highly important feature in the treatise is the selection of a few of the better-known types of each group to indicate the leading structural peculiarities thereof; and the reader is accordingly spared all mention of the imperfect and unsatisfactory specimens which too frequently render palæontology so unattractive to workers in recent zoology. So far as we are capable of judging, Mr. Woodward appears to have attained remarkable accuracy in regard to the facts connected with the animals he describes. And what makes his descriptions particularly valuable is that the details of structure are arranged in each instance, so far as practicable, in the same order; thus rendering the comparison of one major or minor group with another of the same rank as easy as possible. The admirable illustrations, many of which are original, while others are borrowed from the writings of well-known specialists, serve to explain and accentuate the descriptions; and if the careful reader fails to grasp the leading morphological traits of the groups and genera described, it will certainly not be the fault of the author.

One point that strikes the critic is that the author is somewhat too apt to describe groups or genera with a somewhat over-degree of confidence as to their affinities, and in regard to the remains which have been referred to them.

Take, for example, the genus *Homalodontotherium*, originally described by Sir W. H. Flower, on the evidence of an imperfect skull from the Tertiaries of Patagonia, now in the British Museum. No one reading the description would imagine that there are palæontologists who believe that the reference of this genus to the "Ancylopoda" is based on a misconception, and that there are even some who doubt whether the limb-bones assigned to it in this volume are rightly associated. Whenever such doubts exist, either in regard to systematic position or the association of remains, the mention of them is, in our opinion, of prime importance.

Another point to which we take exception is the author's hesitation in adopting the rule of priority in nomenclature, unless strong reasons exist against it in particular cases. The result of this hesitation is that in many cases we have two names given for a genus as if they were of equal value. We find, for instance, *Belodon* or *Phytosaurus*, *Hyopotamus* or *Ancodus*, and *Giraffa* or *Camelopardalis*. In the third case the introduction of the alternative is obviously superfluous, as it is used by no zoologist with any respect for himself; but in the others, the second name is the one that should be employed. Whether he accept priority or no, the author ought to have made up his mind which name he intended to use, and have stuck to that and that alone. The man who hesitates in this respect is lost.

In regard to the classification of the higher vertebrates, the author follows to a great extent the schemes of some of those by whom he has been preceded. But in certain cases innovations are made, some of them doubtfully advantageous. We fail, for instance, to see the advisability of definitely including the problematical Eocene group Tillodontia within the Rodent order, of which it completely destroys the definition. Till their affinities be proved absolutely certain, it seems to us preferable to follow Sir William Flower in regarding such groups as occupying undetermined positions.

In view of recent discoveries with regard to vestiges of a placenta in certain living marsupials, the author's observations in regard to the phylogeny of that group will be read with special interest. Mr. Woodward is of opinion that marsupials have become non-placental by degeneration, and that the loss of nearly all replacement in the dental series is likewise an acquired feature. But he believes that the little *Triconodon* of the Dorsetshire Purbeck had already acquired the modern dental type; and it is consequently to be inferred that marsupials had become differentiated from a primitive placental type by the middle of the Jurassic epoch, and that such marsupials existed in the northern hemisphere. Now in a later passage (p. 431) we read that "the skeleton of these Australian marsupials does not appear to differ in any essential respects from that of the Creodonta and Condylarthra met with in the northern hemisphere at the dawn of the Eocene period. It is quite likely, therefore, that they [the Australian marsupials] are the direct descendants of some unknown families of the latter groups in the southern hemisphere." But he has already admitted the existence of true marsupials in the northern hemisphere during the Jurassic, and it is, therefore, obvious that, allowing time for migration of the evolved marsupials into the northern hemisphere, "some unknown families of Creodonta and Condylarthra" must have existed in the southern hemisphere at least as early as the Lower Jurassic, if not the Triassic! If we read the author's meaning correctly, there is no getting away from this *crux*, and it is certainly a "large order" that the groups in question should be of such vast antiquity. We are prepared to accept the origin of the Monotremes from the Anomodonts or some allied Batrachians, and have indeed urged it ourselves; but, in the absence of tangible evidence, to be asked to believe that the Creodonts originated in the Trias or Lower Jura from the Theriodonts (which is practically what the above amounts to) at present staggers our powers of credulity.

On p. 430 the author revives the old theory as to the complete isolation of Australia "from all other existing continental areas since the remote epoch when Prototheria and Metatheria were the dominant mammals." And in order to support this contention he is compelled to remove the Patagonian Tertiary *Prothylacinus* (p. 388) from the Marsupials, and to place it among the Creodonts. But if an animal with a thylacine-like dentition (perhaps with somewhat fuller replacement) and skull, and an inflected lower jaw is not a Marsupial, it seems to us that we may as well give up our present system of classification altogether. Moreover, the isolation theory involves great difficulties with regard to the origin of the American opossums and selvas and the Australian dasyurids.

There are, however, difficulties into which the author's fondness for the isolation of continental areas leads him in other parts of the world. On p. 419 we are told that "South America must have been quite an isolated region from the close of the Cretaceous to the dawn of the Pliocene." It is true that on p. 429 this isolation is limited, so far as words go, to North America; but the general idea conveyed is the same, and nothing is mentioned with regard to the necessity of connection with other lands to explain the evolution of the fauna. The separation from North America is undoubtedly true, and thus far we are glad to be in agreement with the author. But when he speaks of universal isolation since the Cretaceous, it practically implies that the Ungulates and Rodents of South America have had no connection whatever with those of the rest of the world, since it is more than doubtful if these orders, as such, were evolved in Cretaceous times. And we should like to be informed how the occurrence of Octodonts in both South America and Africa is to be explained; to say nothing of the apparent connection indicated by recent discoveries between the African hyraces and the Patagonian Toxodonts and Typotheres. Moreover, in this connection the author seems deliberately to have walked into a pitfall of his own digging. The aforesaid Patagonian *Homalodontotherium* is referred (p. 307), in opposition to the views of most writers, to a group of Ungulates known as the *Ancylopoda*, and typified by the European, Asiatic, and North American genus *Chalicotherium*. Now *Chalicotherium* is unknown before the Oligocene, and if South America has been shut off from the rest of the world between the Cretaceous and the Pliocene it would involve the supposition that it originated quite independently of *Homalodontotherium*; or, in other words, two members of one and the same group were developed in isolated areas without the possibility of the existence of a common ancestor.

But this is not all the fault we have to find with Mr. Woodward's treatment of the *Ancylopoda*. He mentions and describes *Homalodontotherium* first, so that the unsophisticated student would take that genus (instead of *Chalicotherium* or *Macrotherium*) to be the type of the group, whereas it is more than doubtful whether it belongs to it at all. And it must be added that, in our opinion, the whole suborder is an unnecessary one. The teeth of the two genera last mentioned are so like those of the *Brontotheriidæ*, that we are persuaded the *Chalicotheriidæ* are merely Perissodactyles that have developed an edentate-like type of foot. A somewhat similar type has originated independently among the Artiodactyla in the *Agriochæridæ*, and there is no reason why it should not occur in the Perissodactyles.

Space prevents allusion to several other points inviting criticism; but, in the main, we are satisfied that Mr. Woodward has succeeded in producing a very valuable work, so far as actual facts are concerned. In regard to theories, it is possible that he may see his way to certain modifications in a later edition. An important feature is the bibliography at the end, which is generally remarkable for its accuracy, although the present reviewer must disclaim the authorship of a work with which he is credited under the title of "Deer and their Horns."

R. L.

THE SCIENCE OF PREVENTIVE MEDICINE.

Transactions of the British Institute of Preventive Medicine. (First Series). Pp. xi + 163. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1897.)

In an editorial note to this volume Dr. Allen Macfadyen writes that "the papers included in this volume have been contributed by members of the staff of the Institute, and were completed early in the present year" (1897), so that more than a year ago the British Institute of Preventive Medicine was able to point to this series of completed but unpublished papers, which, however, only saw the light at the end of 1897, as evidence of the activity of its staff.

As considerable interest is naturally being evinced in the Institute, which has just taken up its abode in a new home at Chelsea, it is perhaps desirable to give more than a mere review of the work that has so quietly and steadily, but unostentatiously, been going on in the old habitation.

As Lord Lister points out in a short introductory notice, "The British Institute of Preventive Medicine was incorporated on July 25, 1891, with the view of founding in the United Kingdom an institute similar in character and purpose to the 'Institut Pasteur' in Paris, the 'Hygienisches Institut' in Berlin, and other establishments of a like nature existing abroad." The main objects of the Institute, as set forth in the memorandum of Association, are as follows:—

"(1) To investigate the means of preventing and curing the various infective diseases of men and animals, and to provide a place where researches may be carried on for this purpose.

"(2) To provide instruction in preventive medicine to medical officers of health, medical practitioners, veterinary surgeons, and advanced students.

"(3) To prepare, and to supply to those requiring them, such special protective and curative materials as have already been found, or shall in future be found of value.

"Further, to provide the means for carrying out investigations in all branches of bacteriology, including those of practical importance to chemists, agriculturists, and manufacturers."

It had evidently also been anticipated that it would be necessary to carry out the examination of water and sewage as regards their bacteriological and chemical contents, and with this in view a chemist has been appointed on the staff to take charge of such work. How far the objects of the Institute have been gained is evident from even a superficial glance at the papers contained in this first series of *Transactions*; while on a more careful study of the contents of this volume it is evident that much work of permanent value has been done under the direction of Dr. Macfadyen, Dr. Hewlett, and Mr. Lunt.

The first paper, which is evidently based on work carried out in connection with the production of anti-streptococcic serum, deals especially with the exaltation of the virulence of the streptococcus pyogenes and the streptococcus erysipelas by passing them through the rabbit. In the course of twenty-six such passages, Dr. Bulloch found that he was able to increase the virulence from a strength such that one-quarter of a c.c. was necessary to kill one kilogramme of rabbit to a strength such that one-millionth c.c. was sufficient to bring about the same result; but Dr. Bulloch comes to the conclusion that (1) the degree to which the streptococcus can be exalted by passage through a susceptible animal varies; (2) that an animal immunised against a streptococcus from a case of erysipelas is also immune against a streptococcus from a case of abscess, which indicates that so far, at any rate, as a horse is concerned, these organisms have a very similar action, and that, therefore, they are closely allied from a biological point of view.

The second paper, "On the so-called 'pseudo' Diphtheria Bacillus, and its Relation to the Klebs-Löffler Bacillus," by Dr. Richard T. Hewlett and Miss Edith Knight, has a practical bearing on the diagnosis of diphtheria by microscopic and cultural examination. Drs. Hewlett and Knight arrive at the conclusion that at least two forms have been described as "pseudo" diphtheria bacilli: "(*a*) one in morphology, a Klebs-Löffler bacillus, but non-virulent (Roux and Yersin, &c.), and (*b*) another shorter, plumper, and more regular in form, and staining more uniformly than the Klebs-Löffler bacillus ("Löffler, Von Hoffmann, Park, Beebe, Peters, &c.)," but that "the term should be reserved for the latter form." They also maintain that by gradual heating it is apparently possible to convert a typical Klebs-Löffler virulent bacillus into a typical non-virulent "pseudo" bacillus, and by cultivation and incubation and passage through an animal to convert a "pseudo" into a Klebs-Löffler bacillus. From what we know of the history of epidemics of diphtheria, and of the cultural characteristics of organisms that are carried through a long series of generations, there is no doubt that the virulence of the diphtheria bacillus varies enormously; but whether we have simply a non-virulent form and a virulent form of the same organism, or whether two organisms—of the same group, no doubt, but having permanently different degrees of virulence—growing side by side in different proportions and at different periods of the disease, it is very difficult to determine. At the same time it must be acknowledged that Dr. Hewlett and Miss Knight bring forward considerable evidence in support of their thesis.

Other papers of equal importance, but of less general interest, are those by Messrs. W. St. C. Symmers and Alex. G. R. Foulerton. Drs. Macfadyen and Hewlett describe a method for the sterilisation of milk by a coil-heating apparatus, by means of which successful Pasteurisation may be carried out (at a temperature of from 68° to 72° C.), such temperature having little, if any, injurious effect on the milk, but increasing its keeping quality enormously. They also show that the diphtheria bacillus, the typhoid bacillus, the tubercle bacillus and streptococcus pyogenes are rendered incapable of doing any harm by being treated in this apparatus, along with milk.

Mr. Lunt contributes an interesting article on the sterilisation of water by filtration through the Berkefeld filter. The methods he uses are exceedingly ingenious, and the results obtained apparently very trustworthy. He comes to the conclusion that the Berkefeld filter keeps back all organisms for at least twenty-four to forty-eight hours, and that only water bacteria can pass through this filter at any time, except in those cases where there is a rapid oscillation in the pressure under which the water is passed through the filter. Under these circumstances organisms of all kinds appear to be "percussed" through the fine pores of the filtering candle.

A paper "On the bacillus of bubonic plague—Pesstis," by Dr. R T. Hewlett, gives some interesting information concerning this organism. In "Bacteria and dust in air," Dr. Macfadyen and Mr. Lunt give the results of a repetition of some of Dr. Aiken's experiments on dust particles in the air; they give in addition, however, an enumeration of the number of micro-organisms that were present in duplicate samples of air; they find that the number of dust particles is enormously greater than the number of bacteria. In one case in the open air there was just one organism to every 38,300,000 dust particles present; whilst in the air in a room, amongst 18,000,000 particles of dust only one organism could be detected. Mr. Lunt furnishes the final paper in the volume: on a convenient method of preserving living pure cultivations of water bacteria, and on their multiplication in sterilised water. Mr. Lunt falls in with the theory that has been put so strongly forward during the last year or two, that although water organisms grow well in water, those organisms which do not belong to this group gradually die out. He obtains results of considerable interest as regards the classification of certain species of bacteria in a group called water bacteria, having the following characters: (*a*) to be found in natural water; (*b*) capable of living for very long periods in sterilised water; (*c*) capable of very rapid multiplication in sterilised water; (*d*) showing no signs of degeneration when kept for long periods in sterilised water. This article is of considerable practical value, and forms a fitting conclusion to a series of papers which will have a far more than ephemeral interest. We congratulate the British Institute of Preventive Medicine on the manifestation of useful activity afforded by the present volume.

A NEW TEXT-BOOK ON ELEMENTARY ALGEBRA.

Introduction to Algebra, for the Use oj Secondary Schools and Technical Colleges. By G. Chrystal, M.A., LL.D. Pp. xviii + 412 + xxvi. (London: Adam and Charles Black, 1898.)

THE appearance of this book marks another stage in the improvement which is at last being effected in English treatises on elementary algebra. How different it is from the old-fashioned text-book will be partly realised by observing that the first sixty-two pages are assigned to the discussion of the fundamental laws of algebra; that upwards of fifty pages are devoted to elementary curve-tracing; and that the elementary tneory of rational functions is presented in a correct and fairly methodical shape. The notions of degree, homogeneity, and symmetry are introduced, as they ought to be, at an early opportunity, and their importance duly emphasised, and illustrated; in this and other ways the student's attention is directed to the all-important subject of algebraic form. The chapter on the resolution of integral functions into factors is both clear and scientific; this fact alone distinguishes Prof. Chrystal's work from the great majority of its predecessors. The binomial theorem, for a positive integral exponent, instead of having a special chapter devoted to it, and being treated as a sort of mathematical Rubicon, is deduced, in passing, as a particular case of distributing a product. Finally we may remark (*à propos* of a recent correspondence in this journal) that the solution of a quadratic equation is made to depend on the factorising of its characteristic, and the ordinary method by "completing the square" is ignored, except, oddly enough, in one example, where it is quite unnecessary, and the factorisation is otherwise obvious.

In the matter of notation, also, and in methods of work, the author has shown himself independent of tradition: thus the method of detached coefficients is employed whenever it is convenient, and the symbols Σ and Π are freely used from the outset. With this we entirely agree; on the other hand, the use of the solidus appears to us excessive; for instance, we find the worked examples in Chapter xv. difficult to follow. But, of course, a person in the habit of constantly using this notation might be of a different opinion.

All competent and honest teachers who wish to make their pupils think, and not merely to acquire that shallow unreasoning dexterity which scores in examinations, but is otherwise of little use and even, by itself, pernicious, will welcome this work as the best intermediate class-book that has yet appeared. In some respects it compares favourably with the author's larger treatise: less encyclopædic, it has the advantage of greater unity; and, what is more important, it is written after a wider experience of teaching and examining. The effect of this appears in various ways; in remarks on common errors of beginners, in leading up to general laws by particular examples, in occasional anticipation of theorems to be presently proved, and in the statement of results not within the scope of the treatise, but intelligible and stimulating to the student, who thus gets some glimpses of the regions he may some day hope to explore.

In order to secure for a work of this kind the fair trial which it so thoroughly deserves, we venture to make an appeal to the great body of examiners, in whose hands lies so much power for influencing, either for good or ill, the character of mathematical teaching in schools. A paper on elementary algebra is too often a medley of questions, generally of a stock type, which do, indeed, test the candidate's familiarity with certain set rules, and to some extent his ingenuity in applying them, but are very far from gauging his powers of mathematical reasoning. So long as this is the case, a premium is offered to radically bad methods of teaching. A boy can be taught the rule for algebraic long division in a very short time, without any attempt to make him understand its object or principle; and what is the use of wasting time upon such superfluities, when we can take him on to the practice of G.C.M., and thus enable him to make sure of answering two questions in his examination? Now it is quite possible to combine questions on set rules (and it would be absurd to propose the entire omission of them) with fair and simple questions on matters of principle: if this were done, it would be a great encouragement to a good teacher, and tend to raise the average standard of instruction.

The book being so good, it is worth while to call attention to the points in which it appears capable of improvement. First of all, sufficient emphasis is not laid on the fact that in *applications* of algebra the signs + and − are used both as symbols of operation and also as indications of quality, or "sense": that this is possible, without causing confusion, is not obvious *a priori*. Thus, in the case of steps, let πa mean a step of a units to the right, νb a step of b units to the left, and let + and − refer, in the usual way, to the composition of steps: then we have formulæ such as $\pi a + \pi b = \pi(a + b)$, $\pi a - \nu b = \pi(a + b)$, $\pi a + \nu b = \pi(a - b)$ or $\nu(b - a)$ according as $a > \text{or} < b$, and so on. If we write + and − for π and ν throughout, apply the formal rules $+(+a) = a$, $+(-a) = -a$, &c., and then interpret the sign of any result qualitatively, *i.e.* as π or ν according as it is + or −, the conclusion is correct, and the same as if the complete notation had been used throughout. This remark is due to De Morgan, and has been strangely ignored by subsequent writers.

The expression "latent sign" occurs without explanation, and apparently for the first time on p. 64. This is a point which often puzzles beginners, and might well receive a little attention.

Chapters xvi. and xvii., on irrational functions and surds, are a miserable compromise, as Prof. Chrystal is evidently aware. Arts. 169–74, 181–84, should have been omitted altogether; this would leave room for other illustrations, especially of Art. 172. Most of the examples, too, are of a thoroughly unpractical type; they might, perhaps, be put in an appendix as samples of the curious trifling of examiners.

Arithmetical Progression is without value in itself, but affords capital exercise in what may be called algebraical counting [99·9 per cent. of ordinary students say that the nth term is $a + nd$], in the derivation and use of a general formula, and many things besides. For these reasons it might be discussed at an earlier stage; the formula $s = \frac{1}{2}n(a + l)$, which, by the by, is not given, may be illustrated by two pieces of paper cut in the shape of the side elevation of a staircase.

In treating Geometrical Progression, it might be well to prove, without using the binomial theorem, that as n increases indefinitely r^n becomes infinite or infinitesimal according as $|r|$ exceeds or falls short of unity. This would enable the teacher to take it earlier, if he wished.

Two additions might very well be made in the interest of technical or scientific students. The principle used in calculating the slope of a graph from its equation might be explained and illustrated; and it might be stated, without proof, that the binomial theorem is true for all rational values of n if x is a proper fraction, and hence deduced, or proved separately, that $(1 + x)^n = 1 + nx$ approximately, whenever x and nx are both small.

Another thing that might easily be done would be to introduce examples involving complex quantities in the later chapters, for instance those on partial fractions, on proportion, and on series. Purely algebraic work with complex quantities is too much neglected, and the sooner a student becomes familiar with it the better.

As might be expected, there are very few definite inaccuracies; there is, however, a rather striking one at the top of p. 68. It is, of course, untrue that "the larger n the more slowly does x_n increase between $x = 0$ and $x = +1$"; and this slip is the more remarkable because it is contradicted by the figure on p. 67. The tyro may amuse himself by finding the value of x for which x^m and x^n are increasing at the same rate.

G. B. M.

THE CUNEIFORM INSCRIPTIONS OF WESTERN ASIA.

First Steps in Assyrian. By L. W. King. Pp. cxxxix + 399. 8vo. (London: Kegan Paul and Co, Ltd., 1898.)

THE appearance of Mr. King's volume, with its modestly worded title, is opportune, and we think it likely that it will be welcomed by every student of the literatures of the East. The author's avowed object is to help the student of the cuneiform inscriptions who has, as yet, made but little progress in his difficult work, but there is little doubt that Mr. King's stout volume will be of considerable use to others besides him.

The readers of NATURE will remember that attention has been called in these pages to the series of important texts which the Trustees of the British Museum have recently issued, and those who have taken the trouble to examine the various parts as they appeared will have found that, with the exception of short prefaces which roughly classify the texts, no detailed information of their contents has been given. Any translations, or even good summaries of the contents of most of the texts, are, in the present state of Assyriological knowledge, impossible; and if we consider for a moment that not only is the language in which a large section of the documents is written imperfectly known, but also that the readings of several of the signs are doubtful, this fact will not appear wonderful. It must not, however, be imagined that Assyriologists are beaten, far from it; but they ask for time, and time must be given to them. Their chief necessity is, of course, the texts, and the sooner these are put into their hands the better for the progress of Assyriology. Another want is students to work at the Accadian, Sumerian, and Semitic inscriptions which are now available in abundance, and it is much to be hoped that Mr. King's book will induce young men of means and leisure to devote themselves to these most important subjects.

About thirty years ago, when the late Sir Henry Rawlinson and Mr. George Smith were working through the masses of inscribed clay fragments from the Royal Library at Nineveh, it was commonly thought that the originals of the early portions of Genesis would be found among them, and the identification of the Story of the Deluge which Mr. G. Smith published in 1870, greatly stimulated the hopes of the theologian and historian. As a result the most absurd expectations were formed, and for some years after this date, the study of cuneiform was cultivated by many solely with the view of discovering parallelisms and "proofs" of the Bible narrative. Attempts were made by Oppert, Schrader, Sayce, and others to formulate a grammar of the cuneiform inscriptions, and their works were instrumental in setting the subject on a firm base. Semitic scholars in general were somewhat sceptical, but that is hardly to be wondered at when we consider the colossal ignorance of general Semitic grammar which some of the early Assyrian "scholars" displayed in their publications. Since that time, however, the knowledge of the cuneiform inscriptions has increased greatly, and Mr. King's book is a proof of this fact; to some who have gone on crying persistently that Assyriology is "uncertain" and "nebulous" it will come as an unpleasant surprise. Roughly speaking, it may be divided into three parts: (1) Grammar; (2) cuneiform texts; and (3) vocabulary. In the first part Mr. King describes briefly the origin and rise of our cuneiform knowledge, and gives a tolerably full sketch of Assyrian grammar, with sign lists, lists of ideographs, &c. In the second part we have a series of forty-two complete extracts from cuneiform compositions of all periods from B.C. 2200 to B.C 600; these comprise historical, mythological, religious, magical, epistolary and other texts, including the Tell el-Amarna tablets. In the third part are a number of cuneiform texts, specially arranged to enable the beginner to test his own knowledge and to gain experience and confidence in deciphering new compositions, and a complete vocabulary to the whole book. From beginning to end cuneiform type is used, and as the fount is of the same size as that employed by the late Sir Henry Rawlinson, it will not be found troublesome to the eyes. The full transliterations and translations will materially help the beginner, and even the more advanced student will, at times, be glad of them; and, as far as we can see, Mr. King is abreast of all the modern readings and renderings adopted by American and German scholars. We notice that he follows those who read the name of the plague-god Ura, and has no doubt good reason for so doing; it seems, however, that Father Scheil has found the name spelt Dibbara, syllabically, which reading agrees with that suggested by Harper, Delitzsch and others.

It is to be hoped that Mr. King's book will attract new workers to the field of Assyriology, and that it will lead them eventually to the unravelling of the meanings of the difficult texts, which were written in the most complex of characters by Semitic and non-Semitic peoples alike at the dawn of civilisation.

THE NEBULAR HYPOTHESIS.

Essai synthétique sur la formation du Système Solaire; première partie: formation du système. Par M. le Général Lafouge. Pp. ix + 226. (Chalons sur Marne: Martin Frères, 1898.)

THE nebular hypothesis of the origin of the planetary system, presented by Laplace "avec la défiance que doit inspirer tout ce qui n'est point un résultat de l'observation ou du calcul," is now just over a century old. At the time of its conception weak points must have been apparent, probably to none more clearly than to Laplace himself, although the main points of his theory are displayed with a concise lucidity, which is unfortunately rarely to be found in the works of later writers on the same subject. And now, after years of criticism and counter suggestions prompted by speculations both rational and irrational, the hypothesis stands very much in its original position. Its inadequacy in some special directions has, it is true, become more fully realised as fresh facts have arisen to be explained. We are not concerned here in mentioning the particular directions in which the original hypothesis stands in need of support, further than to point out that the author has not given particular attention to these difficulties. Without entering into objections, which Lord Kelvin and others have raised from purely theoretical considerations, it will be sufficient to mention that the symmetry which is found to exist in the arrangement of the planetary system offers a difficulty to which no adequate answer has been found. No mathematical proof has yet been given, nor is it given in this book, to show that a ring of vapour surrounding the sun or central mass could condense into a single planet of considerable mass. The conditions supposed by Laplace seem more favourable to the formation of a swarm of small bodies more resembling the asteroids, or bodies of even lesser bulk, than that of a system of planets, encircled by satellites. Nor does the simple observation of nebulæ in the sky contribute any material support to the original theory. Those nebulæ whose construction can best be studied in the telescope do not present that regularity of outline or condensation, which would seem to be demanded by the construction of such regular mechanism as the solar system possesses. But the fundamental principle contained in Laplace is that the formation of the planetary system is the result of a process rather than of an act, and this suggestion remains practically undisputed. If the details and facts by which Laplace sought to maintain his hypothesis have received little confirmation since his time, it is still safe to say that his generic thought has not been refuted after a century of research. Indeed research has had little direct bearing on the subject, with the exception of two most remarkable investigations: the one, that of M. Poincaré on the possible forms of equilibrium of a rotating fluid mass; the other, the great work of Prof. G. H. Darwin on the effects of tidal action.

Nevertheless, in spite of the really small increase of our knowledge in comparison with the great difficulty of the problem involved, there has been no lack of speculations, more or less scientific, on a subject which has evidently exercised a not unnatural fascination on many minds. The authors of these elaborations of the original theory, of whom M. Faye is perhaps the best known example, have all borrowed at least the central idea of Laplace, deriving the whole solar system from a single aggregation by some process of successive annulation. This is the course adopted by General Lafouge, who, however, is not content to start with a nebula endowed with sensible heat and angular momentum. He imagines the nebula to exist in its initial stage of an indefinite and irregular shape at a temperature of 0° on the absolute scale, and in this mass the attenuated constituents, dissociated by the cold, are perfectly intermixed. Such a process of dissociation is not in agreement with what is known of the properties of matter, and little can be said in favour of the assumption. The homogeneous material of the nebula is, in the author's hypothesis, subject to molecular cohesion, but not to internal attracting forces. Yet the nebula is under the attracting influence of external bodies from which are derived motions of translation and rotation, together with the formation of a central nucleus of increased relative density, while the whole body takes a spheroidal shape as it loses its homogeneity. The action of tides, which is here made use of, though rather vaguely described, is beyond all doubt an influence of the highest importance in the early history of the nascent system. But to attribute great dynamical effects to external attraction, while denying the evident result of mutual attractions of the several parts of the nebula itself, is, if we have correctly apprehended the author, an absurd inconsistency which makes us distrust the whole theory as here presented. And yet, while denying that internal gravitation is operative, General Lafouge supposes a molecular cohesion sufficient to cause the nebula to finally "tourner tout d'une pièce."

A dense central nucleus is now formed, as the author is careful to explain, by the attraction of exterior masses. No thermal effect arises from this operation, because no internal work is done; but the nucleus acts as a centre of attraction to which the outer parts are drawn. In this way heat is developed, and the angular velocity is increased by the contraction in volume, just as in the theory of Laplace. Dilation of the nucleus takes place as a consequence of the rise of temperature, and, assisted by the centrifugal force, a stratum of the nucleus rises until equilibrium is attained under the pressure of the materials descending from the outer regions. In this way a ring is formed, which is later to give birth to the first planet. Meanwhile more rings are formed in the same way, towards the outside of the nebula, the outside ring, and consequently the outside planet, being formed last, as in M. Faye's system. The nucleus, however, continues to be enlarged by additions from the outer material, and by the dilation caused by the heat disengaged, until finally it absorbs the rings to which it has given rise. Under new conditions of pressure the ring splits up into vortices, which gather up the scattered fragments of the ring and form an agglomeration, which remains as a planet, while the central mass, after absorbing all the residual matter of the original nebula, finally contracts as it loses heat by radiation. For the explanatory details of the actual conditions of the solar system, and for a theory of the origin of comets, space cannot be found here, and on these points the essay itself must be consulted.

Although the sources from which General Lafouge has gathered his ideas are not very frequently acknowledged, there seems to be reason to suppose that many of them are not original. Doubtless the plan of the author was to advance a theory which should commend itself as a reasoned whole, and therefore the origin of an idea seemed to him of little importance compared with its intrinsic merit. Thus the division of rings into multiple branches by means of currents from the polar regions seems suggested by an idea of M. Roche; little or no use is made of these multiple branches, however. On the subject of solar heat again, a view is advanced which seems a mere modification, without improvement, of the discredited theory of Sir W. Siemens. Originality and sound argument have not entered in large proportion into the composition of this essay, which, however, is probably not much worse and certainly not much better than many of its predecessors, elaborated with the same object in view. New facts acquired by the use of special apparatus may warrant or necessitate enlarged discussion of the theory of the origin of the cosmos; but to us it appears that science is not edified by these attempts to explain cosmogony by simply supplementing our very meagre knowledge of the operation of natural laws by a mass of conjectural hypotheses. Surely Laplace is right in saying: "Ces phénomènes et quelques autres semblablement expliqués, nous autorisent à penser que tous dépendent de ces loix, par des rapports plus ou moins cachés, qui doivent être le principal objet de nos recherches; mais dont il est plus sage d'avouer l'ignorance, que d'y substituer des causes imaginaires."

OUR BOOK SHELF.

Photographische Bibliothek, Nos. 9 and 10. *Das Fernobjektiv.* By Hans Schmidt. Pp. vi + 120. *Der Gummidruck.* By J. Gaedicke. Pp. vi + 79. (Berlin: Gustav Schmidt, 1898.)

IN the first of these two books Herr Hans Schmidt has brought together a good account of the manipulations necessary for the effective and successful working of the tele-photographic lens—the lens of the future, as he terms it in his preface. He divides his subject into four parts, the first two dealing with lenses generally, and the telephotographic lenses, namely Steinheil's, Voigtländer's, and Zeiss's, in particular. In Part iii. he discusses their employment for obtaining pictures of different styles, such as architecture, portraits, landscapes, concluding in the fourth and last part with the practical work of setting up the apparatus, and the other manipulations previous to obtaining the finished picture.

Those who work with or intend to use lenses of this kind, cannot do better than consult this book, which is written by one who is familiar with their intricacies. Numerous reproductions from negatives, taken by the author himself, illustrate the several types of pictures which can be successfully obtained with these lenses.

In the second of these books the author, Herr J. Gaedicke, treats of the process, a form of direct pigment printing, that has proved so successful. Although the author uses the term "Gummidruck" (printing by means of india-rubber), he is careful enough to point out that other means besides india-rubber are now employed. The process, which is here very clearly described, is accompanied by many wrinkles which will be useful to those who have never previously employed it.

Perhaps few amateurs would attempt this method of printing, considering the numerous other more simple means in use, but professionals will find that a great latitude can be obtained in development, so that the appearance of the picture can be made to suit various tastes.

A short and interesting historical notice is given showing how the process has gradually been evolved, and this is followed by an account of the advantages of the method, the materials employed, and the whole manipulation.

Chapter vii. describes briefly the three-colour and combination pigment printing, while Chapter viii. contains a summary of the process. Two plates, which accompany the text, illustrate the difference between the simple- and combination-gummidruck.

Text-Book of Physical Chemistry. By Clarence L. Speyers. Pp. vii + 224. (New York: D. van Nostrand Company. London: E. and F. N. Spon, Ltd., 1898.)

Beginning with a chapter on energetics, in which Ostwald is followed, the author treats in order the properties of gases, thermodynamics, physical change including the properties of solutions, chemical equilibrium and chemical change, Gibbs' phase rule, the effect of temperature on chemical change, and electrochemistry. A satisfactory feature is the free use of the calculus. The book is intended for students; under these circumstances the omission of all reference to original papers is, we think, a serious mistake. The method adopted is to give the theory of a phenomenon in mathematical form, following this up by a number of exercises illustrating the equation obtained. The exercises appear to be taken, as a rule, from the original memoirs dealing with the subject under consideration, and are doubtless useful; but in many cases the deduction of the equation is too much abbreviated to be easily followed, and the experimental basis of the theory is nowhere sufficiently fully considered. This tendency to put theory before experiment is especially objectionable in teaching.

The treatment from the standpoint of energetics, adopted in the opening chapters, is not strikingly successful. The following statement occurs, for example, on p. 18: "When we attempt to get work from the volume energy of a gas, we find that the work we get comes from heat energy, or some other energy, and that *so long as the gas remains a perfect gas and its mass does not change so long the volume energy of the gas remains constant, whether T changes or not.*" The volume energy of a perfect gas is, however, given by the product of its volume and pressure, and is therefore proportional to the absolute temperature.

The author's view (p. 20), that "The kinetic theory is a troublesome thing and is becoming an object of ridicule," will hardly meet with universal acceptance.

Notwithstanding the faults above mentioned, it is only fair to add that the book is up to date, and that the range of subjects considered is wider than usual.

Recueil de Données Numériques Optique. By H. Dufet. Premier Fascicule. Pp. ix + 415. (Paris: Gauthier-Villars et Fils, 1898.)

Both chemists and physicists will be much indebted to the French Physical Society for the valuable and useful volumes which they are now publishing. The one before us, which is devoted to wave-lengths, and indices of gases and liquids, contains a mass of data, which have been collected from far and near, and brought together in a compact and serviceable form.

Great value must be attached to the volume, as references are given in every case; and even though the work is not quite complete, it is a most desirable addition to every chemical and physical library.

The preparation of the data here collected must have entailed a great amount of work, and M. Dufet deserves the thanks of scientific men for completing the present volume.

LETTERS TO THE EDITOR

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

Solar Halos.

There is a coloured halo at a considerable angular distance from the sun that is a very usual phenomenon in (*e.g.*) the Engadine in winter. Its angular diameter appears to be the same as that of the distant white halo sometimes seen round the moon.

On July 2 we were ascending the Furgen Pass from the Breuil side, and such a coloured halo was visible. The snow slope and ridge in the front of us cut off the lower part of this halo; but it was completed both in colour and form by reflection off the snow. Thus the coloured circle was complete; but the upper part (more than half, of course) appeared "in the air," the lower part "on the snow."

The surface of the snow was unusually sparkling in appearance.

It may be of interest to record that, when I have been at a considerable height (over 6000 feet above the sea at the least), and there have been very fine cirrus clouds close to the sun, I have seen exceedingly pure colours *not* arranged in rings. Thus I have seen, in a cloud, a very delicate rose-crimson entirely surrounded by a very pure green. With more continuous mist or cloud between me and the sun, I have seen a succession of coloured rings round the sun; and I have seen these vanish and give place to the single coloured halo of large diameter referred to earlier.

In the Engadine in winter I once saw a very complicated arrangement of circles and parhelia; but it would be impossible to describe these without a figure. I have such a figure, and could lend it to any one specially interested in the subject.

5 Keppel Place, Devonport. W. Larden.

A Living Toad in a Snake.

I should be obliged by your inserting the following experience if you think it remarkable.

Yesterday we killed an adder (?) here, about 38 inches long; and seeing that he had made a meal evidently some little time before, out of curiosity we opened him, and extracted a large toad, which was about half-way down the snake's interior, or about 18 inches.

The toad, whose head was much wider than the snake's, and whose body was many times as large as his enemy's head, we of course all thought must be dead; and we laid him on a flower-bed, wondering how he could have got inside the snake at all, for it certainly seemed a case of the greater being contained in the less. Of course we knew the marvellous stretching powers of a snake's jaws, but this seemed to eclipse them all.

As we watched the toad he seemed to move, so we bethought ourselves of trying to revive him, and, after pouring water freely over him, and whisky and water down his throat, we were intensely astonished to see him revive; so much so that he stood up on all-fours, blown out like a balloon, and made a kind of a dart at a stick in the most comical way.

Eventually "Jonah," as we promptly christened him, disappeared amongst the flowers. Can any of your readers quote a like case of resuscitation? Perhaps some of them might be able to afford information as to the probable duration of the toad's entombment. F. W. Major.

Woodlands, Bettws-y-coed, N. Wales, August 2.

PHOSPHORUS IN LUCIFER MATCHES.

THE recent omission by a well-known firm of match manufacturers to comply with the regulations relative to notification to the Home Office of cases of phosphorus-necrosis among their employés, and the consequent strictures in the House of Commons on the adequacy of the present methods of factory inspection in the case of dangerous trades, have once more drawn attention to the evils which arise from the employment of "ordinary," or, as it is frequently called, "yellow" phosphorus in the manufacture of lucifer matches. As was recently pointed out in the course of the debate upon the Home Office vote, the story is really a very old one. "Phossy jaw" has been on more than one occasion the subject of Parliamentary inquiry. Practically nothing in the way of remedy has followed from these inquiries. The public has been shocked, for a time, with the tales of what the "lucifer disease" may mean to the unfortunate wretch who may be smitten with it, and then the matter is forgotten, until such a startling episode as that which occurred the other day once more rouses attention to it. The temper of the House on the occasion of the debate referred to was, however, unmistakable, and faithfully reflected the state of opinion outside. The country has at length made up its mind that some solution must be found. The old excuses that nothing is possible will no longer suffice. There is a growing conviction that a remedy is at hand, and if the manufacturers will not voluntarily adopt it, the Legislature must arm the Home Office with the necessary powers to compel the adoption.

The word *phosphorus* was originally applied to any substance, solid or liquid, which had the property of shining in the dark, and the characters of the various *phosphori* up to that time known were made the subject of inquiry by Robert Boyle, about the middle of the seventeenth century. The term has, however, practically lost its generic sense, and has become restricted to the wax-like substance discovered by Brand, of Hamburg, in 1674, and which was originally known as the *noctiluca* or the *phosphorus mirabilis*. There is some evidence that phosphorus was known to the Arabs: to judge from the mode of its preparation it was probably identical with the "carbuncle" of Alchild Bechil. It was first brought to this country in 1677 by Krafft, who purchased the secret of its preparation from the Hamburg alchemist, and it naturally made a great sensation when exhibited to the "experimentarian philosophers" of Gresham College, as Hobbes sneeringly called the progenitors of the Royal Society. Boyle seems to have obtained some hint of its origin, or the mode of its manufacture, and in one of the last of his scientific papers he describes in detail a method by which it may be obtained.

Phosphorus was first commercially made in this country by Godfrey Hankewitz, who appears to have acted as a laboratory assistant to Boyle, and who probably made it by Boyle's method. "This phosphorus," wrote Hankewitz, "is a subject that occupies much the thoughts and fancies of some alchemists who work on microcosmical substances, and out of it they promise themselves golden mountains." Nobody of his time made more in the way of gold out of phosphorus than did Mr. Hankewitz at his little shop in the Strand, for he seems to have had the monopoly of its sale for many years. Owing to the difficulty of its preparation, and the comparatively small yield, its price was relatively very high, and even down to about the middle of the eighteenth century it brought from 10 to 12 ducats an ounce. The discovery by Gahn, in 1769, that calcium phosphate was the main constituent of bone-ash gave a great impetus to the manufacture of phosphorus, and it is from one or other of the many forms of calcium phosphate, but principally from bone-ash, that the greater portion of the phosphorus now manufactured is obtained.

The ease with which phosphorus is inflamed must have led to many attempts to employ it as a ready source of fire, in spite of its high price. One of the earliest of these methods consisted in rubbing a fragment of the element between folds of coarse paper and igniting a sulphur-tipped splint—such as the brimstone matches which accompanied the tinder-box—by its flame. Such a method, it need hardly be said, was highly dangerous, and as the burns produced by phosphorus are extremely painful and peculiarly difficult to heal, it quickly fell into disfavour. Indeed, the substance itself acquired so evil a reputation that its employment in any form was absolutely prohibited in several Continental States. The phosphorus bottle of Cagniard de la Tour was practically the last attempt to effect the ignition of a sulphur splint by the direct action of phosphorus, *i.e.* without the intermediate action of an oxidising composition.

Friction matches were first made in the beginning of this century. Chancel, in 1805, had devised the "oxymuriate match," in which potassium chlorate, then newly discovered by Berthollet, was mixed with sugar and gum water, and the mixture affixed to the end of a slip of wood, which was caused to ignite by immersion in oil of vitriol. By adding a small quantity of phosphorus to the mixture it was found that the match could be ignited by simple friction, but such matches were highly dangerous both to prepare and to use; and, although various attempts were made to minimise their danger by the addition of such substances as magnesia and plaster of Paris, the friction matches failed for a time to supersede the "chemical matches" of Chancel, which continued to be made and sold in increasing numbers down to about 1845.

The credit of having made the first phosphorus friction match is usually attributed to Derosne; but, according to Nicklés, Derosne's match was merely an improvement of that made by Derepas in 1812, which in its turn was only a development of a phosphorus match produced in 1805–6. The late Sir Isaac Holden was wont to claim the credit of having been the first to make a phosphorus friction match in this country.

It is worthy of note, however, that the first friction matches made in England were free from phosphorus. These were the "lucifers" or "Congreves" of John Walker, of Stockton-on-Tees, first manufactured in 1827. They consisted of strips of stout cardboard, or thin wooden splints, about 2½ inches long, coated to about one-third of their length with sulphur, and tipped with a mixture of antimony sulphide, potassium chlorate, and starch and gum. From the London *Atlas* of January 10, 1830, we learn that they were sold in tin boxes, each containing about fifty matches, for half-a-crown a box. With each box was supplied a folded piece of glass-paper; on drawing the match between the folds the composition inflamed and ignited the sulphur on the splint. Matches tipped with a similar composition were made at about the same period in France by Sasaresse and Merckel, and in Austria by Siegel.

In Germany the invention of the phosphorus match is ascribed to Kämmerer; but the most prominent name in connection with its manufacture is Preschel, of Vienna, who, with Moldenhauer, of Darmstadt, made Austria and South Germany the chief sources of the supply of matches in Europe. It was Moldenhauer who first introduced magnesia and chalk into the composition in order to neutralise the effect of the deliquescent oxidation products of phosphorus. To-day the chief producing match country of the world is Scandinavia, where there are upwards of fourscore factories, the foremost of which is at Jönköping, employing about 6000 workpeople.

No sooner had the manufacture of the lucifer match become a well-established industry than the attention of various Governments was called to the effect of phosphorus upon the health of the operatives, and especially to its action in inducing necrosis of the upper and lower jaw-bones. The workpeople who suffered most were naturally those who came most in contact with the fumes—such as the men engaged in mixing the composition, those employed in dipping the splints, or the females who "boxed" the finished matches.

Nowadays the mixing is done under such conditions that the workmen are not much exposed to the fumes; but the dippers, who, when at work, stand over a heated "stone" or plate coated with the composition, are especially liable to be attacked. It does not seem to be certainly established how the necrosis is actually brought about. There is no doubt, however, that workers with carious teeth are soonest affected. Phosphorus as such would appear to have little action; indeed, it is highly improbable that the so-called "fume" can contain any sensible quantity of the free element, and it has been surmised with good reason that it consists of the lower oxides of phosphorus, and in particular of phosphorus oxide, which, as shown by Thorpe and Tutton, is actually more volatile than phosphorus itself. In "boxing" it frequently happens that numbers of the matches ignite, and the air of the boxing-factory is occasionally charged with a considerable amount of these oxides of phosphorus, mixed with phosphoric oxide. The evil effect of these fumes may be minimised by efficient ventilation, and by cleanliness on the part of the operatives, combined with strict attention to the condition of the teeth. Whether, however, it can be altogether obviated by such measures remains to be seen.

The discovery of red phosphorus, in 1845, by Schrötter, of Vienna, led to many attempts to employ it in place of the more volatile and more inflammable variety. Red, or, as it sometimes is erroneously called, amorphous phosphorus, is a micro-crystalline powder of properties very dissimilar to those of ordinary or yellow phosphorus. It can be handled with impunity, is practically non-volatile, does not oxidise at ordinary temperatures, and therefore emits no "fume." It is, moreover, non-poisonous, and no cases of necrosis have been known to attend its use. Inasmuch as it confers ready inflammability upon the igniting compositions with which splints may be tipped, its general employment might, it was thought, obviate all risk of the "lucifer disease." Igniting compositions containing red phosphorus were first tried in Germany in 1850, and about the same time in this country by Dixon and Co., of Manchester, and by Bell and Black in London, but they were not altogether successful. The matches were difficult to strike, and the ignition was almost explosive in character.

These disadvantages are not by any means insuperable; excellent matches of the kind were seen in the Paris Exhibition of 1867, and again in the Vienna Exhibition of 1873. Hochstetter, of Frankfort, manufactures matches containing red phosphorus, which are said to be cheaper than ordinary matches; they burn quietly, and may be ignited even on a cloth surface.

The "safety" matches which, in this country, are usually associated with the names of Bryant and May, were originally suggested by the late Prof. Böttger, and were first made by Lundstrom, of Jönköping, in 1855. In this match the splint, according to Lundstrom's original patent, was dipped in a composition consisting of antimony sulphide, potassium chlorate and glue, and was ignited by rubbing against a specially prepared surface consisting of a mixture of red phosphorus, antimony sulphide and glue. Other varieties of the same kind of match contain in addition potassium bichromate, ferric oxide, minium, or manganese oxide. The amonnt of the red phosphorus needed to ignite these matches is extremely small, less than one five-thousandth of a grain being, it is said, sufficient. In fact it is possible to inflame many of them without any phosphorus at all, especially when they are rubbed against a smooth surface such as that of glass or paper.

These facts make it hopeful that before very long the dreaded lucifer disease may be a thing of the past. There is, indeed, no longer any valid reason why it should be allowed to exist. Yellow phosphorus is not essential to the manufacture of a lucifer match. If phosphorus in any form is required, it need only be in the form of the innocuous red variety—even for a "strike anywhere" match. Red phosphorus matches are rapidly gaining ground all over the Continent, and the day will probably come when this country will range itself with Denmark and Switzerland, and prohibit the use of all matches containing ordinary phosphorus.

GERMAN DEEP-SEA EXPEDITION IN THE STEAMSHIP "VALDIVIA."

THIS expedition was planned by Prof. Chun, of Leipzig, and was originally intended to be exclusively zoological, but, on the representation of Prof. Ratzel, physical and chemical researches were included in the programme. During last winter the German Parliament voted a sum of 300,000 marks to cover the expenses of the expedition, and further sums will probably be voted for the same purpose, and for the publication of the results.

The steamship *Valdivia* was some time ago chartered from the Hamburg-American Line, and has been fitted up with bacteriological, chemical, and biological laboratories, as well as with instruments for sounding, taking temperatures and samples of deep-sea waters, and for dredging, trawling, and the working of plankton nets at various depths. The *Valdivia* is a ship of 2600 tons gross, has a length of 320 feet, a width of 43 feet, and an indicated power of 1250 horses. She is thus as large as, if not larger than, H.M.S. *Challenger*. Captain Krech, a well-known commander of the Hamburg-American Line, has been selected to take command of the expedition, with eight officers and engineers and thirty-five of a crew; most of the officers have previously served under Captain Krech. The *Valdivia* steams from ten to eleven knots, and at the outset of the expedition had on board 2400 tons of coal, consisting chiefly of briquettes.

The laboratories and workrooms on board the *Valdivia* are more commodious and better fitted up with apparatus for scientific investigation than in any previous expedition of the kind, and the same may be said with respect to the various deck appliances for carrying on the deep-sea observations. Besides there is almost a superabundance of room for the storage of all the specimens that may be collected either at sea or on land. The cabins of the scientific staff are handsome and roomy, and the large cabin is supplied with a most magnificent scientific library, including a complete set of the Reports on the Scientific Results of the *Challenger* Expedition. According to arrangement, the ship is to be provisioned, and all the other expenses of the expedition are to be defrayed by the Company for the sum of 340,000 marks. The table of the scientific staff and officers is to be supplied with wine at cost price. The members of the scientific staff receive eight marks each per day from Government, and their lives are insured for 30,000 marks each in case of death.

The scientific staff of the expedition is as follows:—

Official Members.

(1) Prof. Carl Chun (Leipzig), Leader.
(2) Prof. Schimper (Bonn a/Rh.), Botanist.
(3) Dr. Apstein (Kiel), Zoologist.
(4) Dr. Vanhöffen (Kiel), Zoologist.
(5) Dr. Braem (Breslau), Zoologist.
(6) Dr. G. Schott (Hamburg Seewarte), Oceanographer.
(7) Dr. P. Schmidt (Leipzig), Chemist.
(8) Officer Sachse (Hamb.-Amer. Line), Navigator.
(9) Dr. Bachmann (Breslau), Physician and Bacteriologist.

Non-official Members.

(10) Dr. Brauer (Marburg a/L.), Zoologist.
(11) Dr. zur Strassen (Leipzig), Zoologist.
(12) Herr F. Winter (Frankfurt a/M.), Scientific Draughtsman and Photographer.

It is proposed to divide the voyage into three periods :—

I. From Hamburg round the north of Scotland, passing the Cape de Verdes to Cape Town, for which 100 days is estimated, Cape Town being reached in the second half of November.

II. From Cape Town, including an examination of the Agulhas Bank and the deep waters to the south, then southwards to the edge of Antarctic ice, returning northwards through the centre of the Indian Ocean to Coccos and Christmas Island and to Padang.

III. From Padang to Ceylon, Chagos, Seychelle, and Amirante Islands, to Zanzibar. Then home by Socotra, the Red Sea and the Mediterranean, Hamburg being reached early in June next year.

On August 1 the *Valdivia* left Hamburg, and was accompanied as far as Cuxhaven by Staats-Secretär von Posadowsky (the Burgomaster of Hamburg), the Directors of the Hamburg-American Line, Prof. Neumayer (Director of the Deutsche Seewarte), and many scientific men. In wishing success to the expedition, the German Minister dwelt upon the importance of a great State like Germany undertaking work of purely scientific character, such as that in which the members of the expedition were to be engaged; although no practical outcome was at present visible from researches of the kind, still the acquisition of new knowledge was, he held, one of the first duties of the State. The Chairman of the Directors of the Hamburg-American Line mentioned in his speech that the Directors considered it a privilege to be able to encourage scientific work; the Company had spared no pains in fitting up the ship and providing it with capable officers, and they expected to lose rather than to make money by the contract that had been entered into.

The ship left Cuxhaven at 8 p.m. on August 1, and during the 2nd and 3rd the dredging and some of the other apparatus were tried for the first time with great success. On the evening of the 3rd she anchored in the Firth of Forth, off Granton, for the purpose of taking on board some additional apparatus, and to permit the members of the expedition to examine the *Challenger* specimens of deep-sea deposits, as well as to land Dr. von Drygalski (who has been nominated as the scientific leader of the German South Polar Expedition of 1900), Dr. Pfeffer (of the Hamburg Museum), and Sir John Murray, who had accompanied the *Valdivia* from Hamburg. The members of the expedition were entertained at dinner in Edinburgh on the afternoon of the 4th, and in the evening the ship sailed again for the Faroe Channel. Geheimrath Dr. Mikulicz, professor of surgery in Breslau, joined the expedition at Edinburgh, and will accompany it as far as the Canaries.

THROUGH UNKNOWN TIBET.[1]

UNTIL a little more than thirty years ago our knowledge of the Tibetan plateau—one of the most remarkable areas on the earth's surface—was exceedingly small, and was very much the same as it had remained since the journeys of Manning and Bogle in the last century. About 1865, natives of India trained by the officers of the Great Trigonometrical Survey were employed in the exploration of portions of Central Asia inaccessible to Europeans; and in the course of the next ten to fifteen years great additions to our knowledge of Southern Tibet and of the trade routes leading to Lhasa from various directions were made by several intelligent and enterprising men, especially those known as Nain Singh, A.K., and the Mirza. A series of Russian explorations begun by Przevalski in 1870, continued by him for many years, and further prosecuted after his death by Pevtsof and others, added to our maps the main features of the Northern Tibetan escarpment, whilst considerable additions were made from time to time by Carey, Bonvalot and Prince Henry of Orleans, Rockhill, and other travellers; but still an immense area in the north western part of the plateau was completely unexplored until 1891. This, the highest part of Tibet, extends at least 600 miles from east to west, and 250 to 300 from north to south; and very little, if any, of its surface is less than 16,000 feet above the sea-level. It is intersected by snow-bearing ranges of mountains, and dotted over with numerous lakes, many of which are salt.

This bleak and barren region is known as the Chang or Chang-tung, and is a wilderness inhabited solely by

Surveying.

wild animals. A few nomads drive their flocks and herds to the lower and more grassy tracts on the border of the high plateau for pasture during the summer, but they appear never to visit the greater part of the area. Here is the especial home of the Tibetan antelope and the wild yak, at all events in the summer.

In 1874-75 a traverse of the plateau from Ladak to Tengri Nor and Lhasa was mapped by Nain Singh; but the region then examined lies at a somewhat lower elevation than the area to the northward, and the latter was first crossed from west to east by Bower and Thorold in 1891. Their route across the Chang, except in the neighbourhood of the Ladak frontier, lay south of the 34th parallel, still leaving a broad area, marked as "unexplored" on the Royal Geographical Society's Map of Tibet, published in 1894, between the 34th parallel and the Kuenlun. Part of this country was crossed from north to south by Littledale in 1895, in his attempt to reach Lhasa from the northward, his route

[1] By M. S. Wellby, Captain 18th Hussars. Pp. xiv + 440. (London: T. Fisher Unwin, 1898.)

lying rather further west than the traverse of M. Bonvalot and Prince Henry of Orleans; but Littledale's return journey from Tengri Nor westward to Ladak was south of the high Chang throughout. At last, as related in the work now under notice, Captain Wellby and his companion, Lieut. Malcolm, have succeeded in crossing Tibet from west to east by a route that ran for a long distance in the neighbourhood of the 35th parallel, and that admirably intersects the tract hitherto unexplored.

The two travellers started on May 4, 1896, from Leh, in Ladak, with one trained Indian surveyor, Shahzad Mir, duffadar (serjeant) of the 11th Bengal Lancers, who had a considerable experience of Central Asiatic travelling, and ten other men, Ladakis and Yarkandis, as muleteers and servants. The first attempt to penetrate into Tibet by a route across the middle contracted portion of the Pangong lake was frustrated by Tibetan opposition; and after Captain Wellby's party had gone round the north-western extremity of the lake, and then travelled for some ten marches to the eastward, they were again stopped by the people of Rudok, compelled to recross a formidable pass, the Napu-la, and to go north as far as the Lanak-la before they could resume their journey to the eastward. After this their course lay first to the north-east for about 100 miles, and then in an eastwardly direction, no human beings being met with from the Lanak pass, close to the Ladak frontier in longitude 80° on May 29, until more than three months afterwards, when a travelling camp of Tibetan merchants on their way from Lhasa to Kansu in China was accidentally overtaken on September 6, close to the 93rd meridian. From these merchants, whose great caravan of 1500 tame yak is well described, the travellers met, on the whole, with hospitable treatment, and shortly after leaving the caravan they found some friendly Mongolian nomads, by whose aid Captain Wellby and his party, now greatly reduced in numbers, were enabled to pass through part of Tsaidam, and, after skirting Koko-nor, to reach on October 14 the frontier town of Tankar (the Donkir or Donkyr of maps) in the Chinese province of Kansu. Here a friendly missionary—Mr. Rijnhart—was found, who, having occasion to go eastward, accompanied the travellers down the Great Yellow River of China and as far as Peking. In company with Mr. Rijnhart a visit was paid to the great Kumbum Monastery near Tankar, and at Sining Mr. Ridley, of the Inland China Mission, gave an account of the Kansu Mahommedan rebellion of 1895–6, which had just been suppressed. The remainder of the journey through China, though of interest, contains descriptions of countries already comparatively well known.

Bridge in China, five miles from Tankar.

The "Unknown Tibet" of the title is of course the region traversed between the Ladak frontier and Tsaidam, and the journey, of which a good route map has been made, has added greatly to our knowledge of the region. The country is very similar to that a little to the southward, described by Captain Bower, and appears to differ in no great degree, except in its almost arctic climate, from the usual type of Central Asiatic scenery. Wild yak, Tibetan antelopes and kyang abounded in those parts of the area in which grass and fresh water were obtainable, the chief other animals mentioned being the Tibetan gazelle or goa, a large wild cat (probably a lynx), hares and marmots. Some of the latter appear to have been very large, and if they attain the dimensions attributed to them by Captain Wellby, who says they were "of enormous size, as large as men," it is probable that some unknown form was seen by him. Bears were only met with to the eastward. It is impossible to help regretting that neither of the travellers appears to have had any knowledge of zoology or geology, and it is difficult to avoid contrasting them in these respects with most of the Russian explorers. On two occasions (pp. 76, 110) fossils appear to have been observed, but we remain in ignorance of what they were. The only specimens brought back consisted of plants, of which a list is given. It is, however, only right to say that these specimens were brought back despite most serious difficulties through deficiency of carriage, and that, in addition to the geographical observations, careful records were kept of barometrical and thermometrical readings.

On the whole the journey would have been a great success but for the loss of the muleteers, and the sad fate of at least two of them. These two men, one of whom was sick and the other dangerously injured by a gun accident, were left behind with a supply of food and a pony in the middle of the wilderness. No more was heard of them. Three weeks later the remaining muleteers struck work, and left in a body, and, although one subsequently was taken on again, the travellers refused to take back the others, who had behaved badly throughout. As the men, five in number, were, when last seen, fully 300 miles from Lhasa, to which place they had declared their intention of proceeding, as they had little or no food, and the country all around was uninhabited, it is very probable that they all perished from starvation. Out of the ten muleteers and servants who had left Leh, only three reached the Chinese frontier with the two European travellers and the Indian surveyor.

Of thirty-nine mules and ponies, but three mules survived the hardships of travel, and during the latter part of their journey in Tibet, before meeting the merchants' caravan, the travellers appear to have lived chiefly on game—not always easily procurable—and wild onions.

The account of the journey is well written and fairly illustrated, although, as is so frequently the case, some of the "process blocks" used for cuts illustrate very little except the imperfections of the photographs from which they are copied. It is questionable whether any useful information is afforded by figures like those on pp. 180, 200 and 238. Unfortunately, too, the best views are from the accessible regions of Kashmir and China, not from "Unknown Tibet"; but this is easily understood. The scenery in the Tibetan wilderness is difficult to photograph, and the time of the travellers must have been fully occupied with more urgent matters. The two examples herewith given will serve as specimens of the illustrations.

MEETING OF THE BRITISH MEDICAL ASSOCIATION.

THE meeting of the British Medical Association, which has just terminated at Edinburgh, must be regarded as a great success, both with regard to business and pleasure. At the end of July there is a strong predisposing cause towards holiday; and an excitant which draws the medical man towards so favourite an area for holiday-making as Scotland at this time of the year is naturally welcome to all. A congress is a very good beginning to a holiday, as the recollection of it tends to alleviate what is often the boredom of idleness; and doubtless thoughts born of discussion in Edinburgh are now being developed and bearing fruit a hundredfold in the remoter holiday-taking places of Scotland.

In giving in these columns a short account of the business accomplished at the meeting, it will be best, perhaps, to limit one's attention to those regions of medicine and the allied sciences which are of interest to the general scientific reader.

An interesting address in medicine was delivered by Dr. Fraser. He reviewed succinctly the importance with regard to diagnosis of modern bacteriological method, and then proceeded to give some account of the toxic origin of infectious diseases, emphasising the great activity of some toxins killing as they do—at least, in the case of the tetanus toxin—six hundred million times their own weight of living tissue. He then passed on to consider the production of artificial resistance to disease, and the origin of the protection-producing substances, concluding his lecture with a brief review of the present state of serum therapeutics.

Dr. George Balfour gave an interesting address upon a personal experience of an almost forgotten episode in medical history, the episode in question being the treatment of pneumonia by blood-letting. The lecturer gave an amusing account of how he was treated at the hands of the local medical autocrats of the time when he advocated the abandonment of blood-letting in this disease.

Sir William Broadbent opened a discussion on the significance and consequences of different states of vascular tension with their general management. He discussed the different clinical conditions giving rise to increased and diminished vascular tension respectively, and indicated the lines of treatment appropriate to each. He did not enter into the vexed question of the accurate measurement of blood pressure in man, and practically limited his remarks to arterial tension.

Prof. Bradbury, of Cambridge, read a paper upon the management of general vascular conditions with special reference to the use of erythrol tetra-nitrate. This drug, it will be remembered, was introduced by Prof. Bradbury as a result of experiments made by him and Mr. Marshall at Cambridge some few years ago. Its vaso-dilating action is less transient than that of the vaso-dilators hitherto at the command of the physician. Prof. Bradbury's later experience seems in every way to have confirmed the earlier results he obtained with this drug. Dr. Haig emphasised the significance of uric acid in the production of high arterial tension.

A discussion was opened by Dr. Alexander James on the clinical varieties of hepatic cirrhosis. An interesting paper was communicated in this connection by Prof. Adami, of Montreal. The author pointed out that the experimental injection of alcohol, although resulting in fatty degeneration of the liver, only gives rise to a very slight amount of cirrhosis, the typical hobnailed liver having never been produced experimentally. He also referred to the views of Hanot, who regards the enlarged cirrhotic liver associated with jaundice as being of an infectious origin. The author then described his own researches, which were made in connection with a very remarkable disease affecting cattle in a limited area of Nova Scotia, the main lesion of this disease being extensive cirrhosis of the liver. From all the animals he obtained a characteristic micro-organism, which apparently presented considerable resistance to staining reagents. Time has not yet permitted the author to make cultures of this organism, but he is about to do so. His results in this connection will be awaited with considerable interest.

Prof. MacCall Anderson pleaded for the more general use of tuberculin. He thinks much might yet be done with tuberculin in cases of consumption if it were combined with suitable hygienic and dietetic measures. The open-air treatment of consumption received much consideration, many of its votaries giving their results.

The meetings of the Section of Psychology were especially interesting. In the presidential address given by Dr. T. S. Clouston upon "The Neuroses and Psychoses of Decadence," the lecturer contrasted these with the neuroses of development. He pointed out that man's normal average life may be divided into three periods of twenty-five years each; he then proceeded to give statistics which tended to show that the neuroses prevail largely in the period of brain growth and development of function, the very best years of life being very free from them. They come on during decadence with a rush and to a far more deadly degree than even during development, senility being the most deadly period of all.

Dr. John Sibbald opened the discussion upon Suicide, its Social and Psychiatrical Aspects. The author contributed a paper giving the statistics of suicide for England, Wales and Scotland. He showed that the rate of suicide per annum per million of population had risen during the past thirty years from sixty-seven to eighty-six in England and from forty to fifty-four in Scotland. He then proceeded to give statistics with regard to the methods of suicide. Dr. Haigh read a paper on the cause of suicide, the all toxic uric acid according to this author playing here a most important *rôle*. Dr. Morselli, of Genoa, contributed an interesting paper on the characteristics of suicide by the insane as compared with those of suicide by the sane. On Friday, the 29th, this Section proceeded to consider the subject of Hypnotism, its phenomena and theories. An interesting feature in this discussion was a speech by Mr. Myers, of Cambridge, on the psychological side of hypnotism. Mr. Myers contrasted hypnotism with hysteria, sleep, and somnabulism. The author concluded his remarks with discussing the probable nature of "suggestion." Did the hypnotiser by suggestion merely infuse power or evoke it? Mr. Myers held the view that in some cases there was an actual transmission of power from operator to subject, a kind of telepathy. In other cases the hypnotiser merely taught the subject to start self-suggestion of his own, and he cited the miracles performed at Lourdes as an instance of the latter method. Prof. Benedikt, of Vienna, made some interesting remarks on this subject.

In the Section of Neurology Dr. Ferrier opened a discussion on the treatment, curative and palliative, of intracranial tumours. The discussion was continued by Drs. Dercum, Collins, Sir William Broadbent, and others. Dr. Buzzard introduced a discussion on the influence of micro-organisms and toxins on the production of disease of the cerebral and peripheral nervous system. According to the author micro-organisms in this connection acted in two ways: directly by their actual effect on the nervous tissue, and indirectly through the agency of chemical substances produced by their action on the blood or other tissues of the body. The author mentioned in this connection the so-called infective diseases of the central nervous system. The paper provoked a lively discussion.

The Section of Pharmacology and Therapeutics commenced its business with an address from Dr. Affleck. The lecturer sketched the progress of therapeutics, including under this term balneo-therapeutics. Concerning actual pharmacology not much was said. Dr. Herschell introduced a discussion on the treatment of diseases of the stomach; the Section had the advantage of the presence and opinions of Prof. Ewald, of Berlin, and Dr. Lauder Brunton. Prof. Turck, of Chicago, gave a demonstration of the various methods he employed in the diagnosis and treatment of gastric disorders.

A new feature of this year's meeting was the inclusion of a Section dealing with Medicine in relation to Life Insurance, with Dr. Claud Muirhead as President. The points discussed in their relation to life assurance were cardiac disease, middle-ear disease, and pregnancy.

The Section of Pathology, under the presidency of Prof. Greenfield, proceeded to discuss the nature and treatment of Leucocytosis. The subject was introduced by Dr. Robert Muir. Papers were also read by Dr. Lazarus Barlow on Irritation of Pleura and Pleurisy, and by Dr. Durham on the Agglutinating and Sedimenting Properties of Serum, and their relation to Immunity. Prof. Stockman contributed a paper on the Pathological Effects of Dead Tubercle Bacilli. Many other papers followed, giving rise to considerable discussion.

The Section of Physiology was opened by a lecture by Prof. Rutherford on Tone Sensation. Dr. Waller read a paper on the Action of Anæsthetics on Vegetable and Animal Protoplasm. Dr. Waller seems to have turned his attention from nerve fibres to nerve cells. His paper included the description of some interesting experiments upon the action of alcohol and ether vapour upon the spinal cord of the frog. He further showed that anæsthetics exerted the same paralysing influence upon vegetable as upon animal cells. The paper was illustrated by lantern slides and diagrams. Dr. Weymouth Reid joined in the subsequent discussion. Dr. A. C. Sturrock read a paper on the Selective Affinity of the Tissues, especially as regards the Mammary Gland.

In the Section of Anatomy, Prof. Cunningham opened a discussion on Anatomic Variations, dividing them into two great classes, prospective and retrospective. The former were indicative of changes that might yet become normal in the history of the species, while the latter were of two kinds: first, simple arrest; and, secondly, development along lines which had once been normal for the species. The address was illustrated by lantern slides of the brains of apes and microcephalic idiots. The President closed the meeting with some remarks on the teaching of anatomy. F. W. TUNNICLIFFE.

PROFESSOR GEORG BAUR.

BORN on January 4, 1859, at Weisswasser (Bohemia), where for a time his father was Professor of Mathematics, Georg Baur passed his youth in Hessen and Württemberg. He went through the Gymnasium at Stuttgart, and in 1878 entered the University at Munich, taking up especially the study of palæontology, geology, zoology, and mineralogy. In 1880 he went to Leipzig, where he studied under Credner and Leukhart. Two years later he returned to Munich, and there obtained the degree of Doctor of Philosophy. He remained in Munich from 1882 to 1884 as assistant to Prof. von Kupffer, to whom he was much attached, and who in turn honoured him with his friendship. In 1884 Dr. Baur accepted a call to New Haven, Conn., as assistant to Prof. O. C. Marsh. He relinquished this position in 1890 to accept the post of docent at the Clark University of Worcester, Mass. A year later he succeeded, after great difficulties, in getting up an expedition to the Galapagos Islands, leaving in May and returning in October with a valuable collection of the flora and fauna of these interesting islands. In 1892 he went to Chicago University as Assistant Professor of Comparative Osteology and Palæontology, and was made Associate Professor in 1895.

It was in September 1897 that a serious break-down of his health gave the first indication of mental overwork. From the beginning of his career Dr. Baur had been so intensely devoted to his studies and researches, that almost no leisure remained to him for recreation; no fewer than 143 separate papers testify to his industry. A vacation of a few months, mostly spent at one of the Wisconsin lakes, seemed to benefit him. Returning to Chicago in December, the physicians recommended either a sojourn in California or in Germany. The wish to be near his relatives made him decide for his old home, and together with his family he left for Europe, the University generously granting a further leave of absence. The gravity of his illness (paralysis), already suspected in America, was at once recognised at Munich. The disease made such rapid progress, that not many weeks after his return from a short stay in Southern Tyrol his transfer to an asylum was found to be necessary. The end came on June 25.

The family have received many touching expressions of sympathy. At the grave Prof. von Kupffer spoke feelingly, referring to the great talents, the keen perception, the untiring industry of the deceased by which he had created himself an honoured place in anatomy and palæontology. "Though young in years," he said, "Prof. Baur was an authority in many a field. In remembrance of the time we worked together, of the friendship which united us, I lay down in deep sorrow this laurel wreath."

THE BEN NEVIS OBSERVATORIES.

WITH reference to the announcement in NATURE of July 28, intimating that, unless means were provided, the Observatories at Ben Nevis would be closed in October next, we are glad to be able to state that it will not be necessary to take that step this year. The subjoined letter explains how this threatened misfortune to meteorological science has for the present been averted.

Scottish Meteorological Society, 122 *George Street*, *Edinburgh*, *July* 27, 1898.

It was announced last week in your columns that the Ben Nevis Observatories were to be closed in October next for want of funds. It gives me much pleasure to announce now that this will not be the case. I have received a letter from Mr. J. Mackay Bernard, Kippenross, in which he promises to give 500*l.* "in order that the Observatories may be carried on for another year." The record of observations for one whole year will thus be the result of Mr. Bernard's great generosity.

He expresses a hope in his letter that before the end of that year arrangements may have been made for the permanent carrying on of the work by State aid, and his very liberal and prompt action makes the Directors more hopeful than they were that this desirable end may yet be reached. But if the State does not charge itself with the maintenance of these Observatories, then Mr. Bernard's example may perhaps be followed by others, so that the Directors may at least be able to obtain continuous and complete observations for the eleven years of a sun spot period. This would mean the making of an important addition to knowledge by Scotland, and in that aspect Mr. Bernard is patriotic as well as liberal.

In conclusion, allow me to thank you, and the press generally, in the name of the Directors, for the sympathetic attitude which has been taken by the newspapers towards the work carried on by the Scottish Meteorological Society.

ARTHUR MITCHELL, *Hon. Sec.*

The question of the position of the Ben Nevis Observatories came up in the House of Commons on Friday last in connection with the annual vote of 15,300*l.* to the Meteorological Council for meteorological observations. As this sum (nearly 3000*l.* of which is annually expended upon telegraphic reports and storm warnings) is for observations throughout the United Kingdom, Scotland at present receives a proportional part of it, and a grant of 350*l.* is made annually for the two Ben Nevis Observatories—the high level observatory receiving 100*l.* and the low level observatory 250*l.* Mr. Hanbury, Financial Secretary to the Treasury, has undertaken to ascertain whether a larger amount could not be granted to Scotland out of the Parliamentary vote in respect of the observatory on the summit of Ben Nevis, the suggestion being that a grant of 500*l.* a year should be made for five years. In a leading article in Monday's *Times*, the valuable work carried on at the observatory is pointed out, and the hope is expressed that Mr. Hanbury will succeed in effecting such a redistribution of the grant to the Meteorological Council as will provide for its further prosecution and development. The value of the observatory as a meteorological station is beyond question, and something should certainly be done to place its work upon a permanent footing.

NOTES.

THE *Standard* of Friday last contained the following telegram from its Vienna correspondent :—"On the closing day of the International Congress for Applied Chemistry, an interesting paper was read by Dr. Leo Lilienfeld on the synthesis of albuminous substances. By means of the condensation of phenol and amido-acetic acid with phosphoric oxychloride, the lecturer has succeeded in producing pepton, a substance which, it had hitherto been believed, could be obtained only from organic substances. In order to dispel any doubt as to the possibility of thus making artificial albumen, the lecturer carried out the entire process in the presence of the assembled chemists, and then demonstrated the identity of artificial and natural albumen by means of reactions." This announcement is of great interest to chemists, and we shall give an account of the synthesis next week, when further details will probably be available.

NEWS has just been received of the death of Prof. James Hall, the veteran State Geologist of Albany, New York.

UPON the recent retirement from the Indian Medical Service of Brigade-Surgeon Lieutenant-Colonel D. D. Cunningham, F.R.S., Professor of Physiology, Medical College, Calcutta, the Government of India have placed on record their high appreciation of the eminent services rendered by him to the State. Dr. Cunningham was appointed to the chair of Physiology in the Medical College at Calcutta in 1879—a post which he continued to occupy till he was compelled to take sick leave last year. By his zeal and devotion to his work he introduced a high standard of efficiency in the teaching of physiology in the College. He was the first professor to demonstrate histological preparations to the students in a systematic way, and also the first to teach them the practical use of the microscope. He twice received the thanks of the Government of India for reports submitted by him in collaboration with the late Dr. Lewis. Dr. Cunningham's most recent investigations have been connected with snake-bite and the discovery of a remedy. In a letter to the Director-General of the Indian Medical Service, the Governor-General writes :—"By the retirement of Dr. Cunningham the Government of India lose the services of one of the most distinguished of the scientific men who have served them, the Indian Medical service one of its most eminent members, and yourself an invaluable adviser. He carries with him on his retirement the warmest thanks of the Government of India for his long and distingushed services."

SOME of the objections to the system of granting indulgences to anti-vaccinationists were pointed out in last week's NATURE. Since then the Vaccination Bill has had an eventful history. It came before the House of Lords in Committee on Thursday last, and the second clause—the conscience clause—providing parents with a means of exemption from penalties for the non-vaccination of their children, was rejected. The amended Bill had therefore to go back to the House of Commons, where it was considered on Friday, and a motion to disagree with the Lords' decision to leave out the conscience clause was carried. In consequence of this vote, the Bill again came before the Upper House on Monday, with the result that the conscience clause was reinstated—the Lords reversing on Monday their decision of Thursday last. It may be expedient to pass the Bill in its complete form, but the principle of permitting conscientious anti-vaccinationists to put themselves beyond penalties other than those which their neglect will bring upon them, is unsound and dangerous.

IN view of the proposed alterations in the laws relating to vaccination now contemplated in the Bill before Parliament, the Council of the Royal College of Surgeons of England have reaffirmed the following resolution adopted by them in 1893 and forwarded to the Royal Commission on Vaccination, viz.:—"We, the Council of the Royal College of Surgeons of England, desire to put on record at the present time our opinion of the value of vaccination as a protection against small-pox. We consider the evidence in favour of its life-saving power to be overwhelming, and we believe, from evidence equally strong, that the dangers incidental to the operation, when properly performed, are infinitesimal. Experience has satisfied us that, even when vaccination fails to afford complete exemption from small-pox, it so modifies the severity of the disease as not only to greatly reduce its mortality but to lessen the frequency of blindness, disfigurement, and other grave injuries. We should therefore regard as a national calamity any alteration in the law which now makes vaccination compulsory. We are, moreover, firmly convinced that re-vaccination is an additional safeguard and should be universally practised."

HERR ALBIN BELAR, director of the seismological station in the k.k. Oberrealschule at Laibach, Austria, is making an endeavour to collect information with reference to the earthquake which occurred in Dalmatia on July 2, and caused great destruction in the town of Sinj. The disturbance was recorded at Laibach by four instruments, and a number of observations and pictures referring to the earthquake have been collected there. It is proposed to publish these records, together with any other papers which may be obtained, either on the recent earthquake, or on the nature of earthquakes generally, and recent seismology, in a work by the sale of which it is hoped to obtain funds for the relief of the people who have suffered losses by the shock. Contributions intended for this work may be in German, French, Italian, or English, and should be sent to Herr Belar before the middle of December.

MANY Polish men of science have signed a protest against the action of the Prussian authorities at Posen (Poznań) in prohibiting them from attending the meeting of the Polish Association for the Promotion of Medical and Natural Knowledge, which it was proposed to hold in that town at the beginning of the present month. Early in July the organising committee of the meeting was informed by the Director of Police that persons of Polish nationality would not be permitted to take part in the proceedings, and that if they went to Posen they would be expelled from the country immediately. For thirty years the Association has held its meetings without any difficulties, and in the year 1884 a meeting was held in the town of Posen itself. The recent action, directed as it was against men whose only object was calm and friendly intercourse, violates the legitimate claims of science, and discourages scientific investigation in Poland. It is unfortunate that intellectual enterprise should be made to suffer on account of strained relations between certain members of German and Polish nationalities. The protest against the measures taken by the Prussian police authorities has been signed by most men of science in Cracow and Lemberg, and forwarded to the Polish members of the Austrian Parliament.

THE death is announced of Prof. George Ebers, author of numerous works on Egyptology. Prof. Ebers was born in Berlin in 1837. He studied first at Göttingen, and then in Berlin, where he came under the influence of the egyptologists Brugsch, Lepsius, and Böckh. After taking his degree at Jena, he undertook a journey of a year's duration in Egypt and Nubia, and on his return in 1870 he was appointed to a professorship at Leipzig. In 1872 he visited Egypt for a second time, and on this occasion made his discovery at Thebes of the celebrated papyrus which is known by his name.

PARTICULARS of the career of the late Dr. Johan Eliza de Vry, the eminent Dutch pharmacist and quinologist, who died at The Hague on July 30, in his eighty-sixth year, are given in the *Chemist and Druggist*. Dr. de Vry was born on January 31, 1813, at Rotterdam. His first appearance in the literary world was with a Dutch translation of Heinrich Rose's "Handbook of Analytical Chemistry," which was at that time a famous text-book. This work brought him into direct correspondence with many of the leading chemists of the day, among these being Pelletier, for whom Dr. de Vry always entertained the utmost reverence. It was through Pelletier's influence that his attention was especially directed to quinine and the cinchona alkaloids generally, concerning which he was to become one of the chief living authorities. De Vry took the degree of Ph.D. at Leyden University in 1838, and was subsequently appointed teacher of chemistry and pharmacy in the Medico-Pharmaceutical College of his native city. In 1850 he sold his pharmacy, which he had carried on for eighteen years, and devoted himself to scientific work exclusively. At that period he published an immense number of papers on pharmaceutical subjects—nitroglycerin, morphia, red phosphorus, cherry-laurel water, and cinchona, occupying his attention. In 1856 he was elected an honorary member of the Pharmaceutical Society of Great Britain, and in 1857 he went to Java on a commission by the Dutch Government as Inspector of Chemical Investigation. He stayed in Java six years, and it is universally admitted that his labours materially assisted in the development of the cinchona industry there. After finishing his labours in the island, Dr. de Vry visited India, and gave much assistance to the Indian Government in regard to the cultivation of cinchona and the extraction of the alkaloids there. For his services in this direction he was rewarded by the Queen of England with the C.I.E. in 1880. In 1895 he was awarded the Hanbury gold medal given by the Pharmaceutical Society of Great Britain, and only a few weeks before his death the University of Utrecht bestowed upon him the honorary degree of M.D.

THE British Mycological Society's second annual week's fungus foray will be held in Dublin from September 19 to 24.

A SEVERE shock of earthquake, lasting five seconds, occurred in Messina at 2.33 a.m. on Saturday, August 6, and was followed by three weaker shocks.

THIS year's meeting of the French Association for the Advancement of Science opened at Nantes on August 4. M. E. Grimaux, the president, delivered an address on the chemistry of the infinitely small, referring more particularly to Pasteur's researches. About 30,000 francs were voted as grants in aid of scientific work, 13,126 francs being from the funds of the Association, and 18,800 from the Girard legacy fund.

THE Government of British Guiana has lately taken steps of great practical utility in arranging for geological surveys in the gold districts. From a report on the gold and forest industries of British Guiana we learn that a survey has already been conducted by Prof. J. B. Harrison in the north-west district, and the results embodied in a report, while an additional report on the petrology of the district is awaiting publication. A further expedition to examine the formations of the Potaro-Conowarook district is now being organised. The great importance of this work will be recognised in view of the fact that there are no trustworthy official reports on the geology of British Guiana in existence. The experience of the past ten years has proved that British Guiana is rich in gold; and what is now needed is the importation into the Colony, and the adoption of, mechanical washing appliances for alluvial gold. By such means deposits of alluvial gold, vast areas of which are known to exist, but would not pay to work by the means now employed, could be made to produce large quantities of gold. During the year ending on June 30, the amount of gold exported from the Colony was 117,265 ounces, or a decrease of 10,326 ounces upon the output of 1896–97. This serious decrease is partly ascribed to exceptionally bad weather, and partly to the exhaustion of alluvial workings in the Barima district.

PROF. KARPINSKY contributes to the latest issue of the *Bulletin* of the St. Petersburg Academy of Sciences an interesting note on hail observed on April 30, 1897, by M. Czernik, near Ivangorod, in Russian Poland. The hail was falling that day from two nearly quite opposite directions, and was of two entirely different kinds. One variety consisted of large grains of a pear-like shape, and of a peculiar structure; while the other consisted of smaller, transparent grains, which had the shape of flattened ellipsoids. These latter contained nothing, but the former had in their central opaque portions black granules which proved, on chemical analysis, to consist of iron, with traces of nickel and cobalt, and silicon. These granules were sent to the Academy, and Prof. Karpinsky analysed them. The powder obtained from these granules consisted chiefly of magnetic iron oxide, which had been formed through the oxidation of magnetic iron; the latter could be seen very well. Moreover, the granules contained augite and, probably, sulphuretted iron, and some other substances not yet determined. Besides iron, they also showed traces of nickel and sulphur. "Such a composition," the Russian professor concludes, "leaves not the slightest doubt about the cosmic origin of the granules contained in that hail." It is interesting to note that, some time ago, M. Czernik collected at the same spot hail which contained granules of volcanic ashes from Vesuvius.

ADMIRAL MAKAROFF, the well-known explorer of the North Pacific, has lately made the proposal to reach the North Pole by means of powerful ice-breakers. The proposal sounds rather strange at first, but the Russian Admiral bases it on sound scientific reasoning and on a good deal of actual experience. Ice-breakers have been used in Russia (at Cronstadt) since 1864, and lately great progress was achieved in their construction in America by arming such vessels with two screws at the stern and a third one at the stem. The American ice-breaker, *Ste. Marie*, 3000 horse-power, easily sails through ice 2½ feet thick, and pierces ice-walls 15 feet high. Still more powerful ice-breakers have lately been built in America and in this country for the Trans-Siberian railway and the port of Vladivostok. Taking into account that, according to Nansen, the ice-walls (*toroses*) in the Arctic basin seldom attain the height of 25 feet, and that the polar sea is free from ice over, at least, one third of its surface, while all the ice is weakened in summer by thawing, and especially by interior canals due to accumulations of salt, and by crevices, Admiral Makaroff concludes that an ice-breaking steamer of 20,000 horse-power would overcome all the difficulties which polar ice may oppose to her progress. The distance between the latitude of 78° N. to the pole being 720 miles, he calculates the various speeds at which such a steamer could make her way through ice of various thicknesses from four to seven feet, and he finds that the total distance could be covered in twelve days. Moreover, instead of one ice-breaker of 20,000 horse-power, it would be advantageous to have two such vessels of 10,000 horse-power each, it having lately been proved by actual experiment in Russia that two ice-breakers placed one behind the other, and the rear one pushing the front one by means of a special wooden frame, act as effectively as one single ice-breaker of a double force. Admiral Makaroff's proposal is, therefore, to build two special ice-breakers of 6000 tons and 10,000 horse-power each, provided with stem screws, and to force a way through the ice to the pole.

A SHORT account of a recent research, by Prof. Marinelli, on the progressive increase of the area of the Po delta is given in the *Geographical Journal*. From a comparison of the Austrian map of about 1823 with the result of modern surveys carried out in 1893, Prof. Marinelli is led to the conclusion that the mean annual increase during those seventy years has been about ·762 sq. kilom. (·293 sq. miles). Taking all known data into consideration, the estimated total increase during six centuries amounts to 516 sq. kilom. (198 sq. miles), which means that, by the action of one river alone, Italy has in that period gained no less than $\frac{1}{610}$ of its previous area, while recent surveys show that the increase is actively maintained at the present day. At the end of his article Prof. Marinelli gives some notes on the length of time which would probably be required to fill up the whole of the Northern Adriatic above 44° 45′ N. lat. The disposition now displayed by the mouths of the Po to bend in the direction of the axis of the gulf introduces a special element of uncertainty, but the conclusion is that the time required would certainly exceed 100 centuries, and would probably be more than 120.

IN connection with the reports which have appeared from time to time that Andrée's and other balloons have been sighted in the distance, it is worth while to direct attention to an observation recorded by Mr. F. F. Payne in the Canadian *Monthly Weather Review*. Looking at the sky one afternoon, Mr. Payne saw a large, grey, pear-shaped object sailing rapidly across, immediately behind a thin stratum of cirro-stratus cloud. At first the object was taken for a balloon, its outline being sharply defined, and its shape and size exactly corresponding to one; but as no cage was seen, it was concluded that it must be a mass of cloud, and after watching it for about six minutes, its mass became less dense and finally it disappeared. Whilst no whirling motion could be noticed, this balloon-like mass was undoubtedly of cyclonic formation, appearing less elongated when viewed at a distance probably of a mile and only about 30° from the zenith. The observation suggests an origin for strange war balloons and other aerial machines occasionally reported as having been sighted.

THE Quarterly Summary of the *Weekly Weather Report*, issued by the Meteorological Council for the months April to June last, show that the rainfall for that period has been above the normal amount in all districts. The mean for the wheat-producing districts was 6·5 inches, against 5·8 inches for the thirty-three years 1866-98; and the mean for the grazing, &c., districts was 9·2 inches, against 7·4 inches for the same period. For the whole of the United Kingdom the amount was 7·9 inches, as compared with 6·6 inches for the thirty-three years in question. Reckoning from the beginnng of the present year the rainfall to the end of July is, however, deficient in all districts save three—viz. the north of Scotland (where the excess amounts to 7 inches), the north-west of England, and the north of Ireland. The greatest deficiency is in the Midland counties, where it amounts to 5 inches. The general deficiency is due to the scarcity of rain in the first quarter of the year; and during the past month the fall has been, generally, much below the average, amounting to only about one-tenth of the average in the Scilly Islands.

THE remarkable sounds known as "mist pouffers" and "barisal guns," heard in many parts of the world at sea and near coasts, have frequently been described in these columns. The U.S. *Monthly Weather Review* (April) contains communications by Mr. Samuel W. Kain and others, which show that these sounds are very frequent on fine, calm summer days in the Bay of Fundy. Prof. Cleveland Abbe points out that the descriptions given of these oceanic noises show that sometimes they have precisely the same characteristics as the noises that may be heard in an aquarium when one stands alongside of a large glass tank and watches the motions of the drum fish. The salt water drum fish (*Pogonias chromis*) is common on the Atlantic coast of the United States, and other varieties will doubtless be found in other parts of the world. A large drum fish will give out a sound that may be heard a long distance, and it is suggested that some of the sounds which have been heard may have been produced by this or another fish. Prof. Abbe thinks that the noises proceeding from the ocean have probably very different characters and origins; some are due to the drum fish; others are made by the breakers dashing on rocky cliffs, whence heavy thuds spread for several miles through the air and many miles further through the ocean; others are due to the cracking of rocks in ledges near the surface, such as those on which lighthouses are built; others, finally, are occasionally due to genuine earthquakes occurring at the bottom of the neighbouring ocean. It is highly probable that a careful collation of observations from many stations in any given locality, such as the Bay of Fundy, will throw a clear light upon the locality whence the noises emanate.

THE locust disease fungus cultivated by Dr. Edington, director of the Bacteriological Institute, Grahamstown, for the purpose of destroying locusts, appears to be giving satisfactory results. A writer in the Cape *Agricultural Journal* states that he gave a number of healthy locusts (*Voetgangers*) internal doses of liquid in which cultures of the fungus had been dissolved, and afterwards placed them among the locusts at the head of three large swarms. On the fourth day after, numbers of locusts died, and on the seventh day after the introduction of those infected, the three swarms were entirely destroyed.

BACTERIAL cultures have been made on almost all vegetables, but the potato and the carrot are the principal ones which are in daily use in bacteriology. M. Roger has, however, says the *Lancet*, reported to the Paris Society of Biology that in his opinion the artichoke possesses several advantageous qualities in this respect. Nothing is more simple than to prepare it for the purpose. After having stripped off the scales the thick part is cut up into little cubes, care being taken to preserve the fibres (*foin*). The pieces are placed in tubes plugged with damp wadding, the fibres being uppermost, so that the culture medium is represented by a fleshy mass surmounted by a sort of tuft. When the wadding is inserted the whole is heated in an oven to 115° C. for a quarter of an hour. In making the inoculation the germs must be deposited at the point of insertion of the flowers. Speaking at the same meeting of the Society of Biology, M. Carnot mentioned that he had ascertained that if a small quantity of liquid derived from a previous culture of Koch's bacillus is added to the ordinary culture media before they are inoculated with tuberculous material the effect is to hasten the growth considerably. In practice the same result is obtained by adding some drops of tuberculin to the culture media. If, on the contrary, the quantity of tuberculin is increased—if, for instance, thirty drops are added to a culture instead of five or six—the culture either does not undergo development or else its development soon stops.

A REMARKABLE testimony to the effectiveness of Prof. Haffkine's system of inoculation as a plague preventive is published in a report on the inoculations among the Khoja community of Bombay, referred to in the *Pioneer Mail*. His Highness Aga Khan, the head of the community, was himself inoculated as an example to his followers, and he established an inoculation station at Mazgaon, at which 5000 Khojas were inoculated between December 1897 and April 20, 1898, 184 other Khojas being inoculated in municipal stations. The daily strength of the inoculated for the period was 3184. It is calculated that there were 9516 uninoculated persons in the community, and among these there were 77 deaths from plague and 94 from other causes during the period mentioned. Among the 3184 persons inoculated during this period there were three deaths from plague and four deaths from other causes. These are the most striking results observed up to the present time. Eliminating the five deaths from plague and the fifty-six deaths from other causes which occurred among uninoculated persons under the age of three or over sixty, the figures are still sufficiently remarkable. There is a difference of 89·7 per cent. of deaths from plague in favour of the inoculated part of the community, and of 73·3 per cent. of deaths from other causes. Prof. Haffkine is justified in saying that, making allowance for inaccurate classification, and admitting that some of the deaths among the uninoculated may have been those of sickly persons who feared to undergo the operation, the results indicate that, besides being a protection against plague, this inoculation influences favourably the resistance to certain other diseases, a fact with regard to which exact material is being accumulated at the Research Laboratory at Bombay.

PROFS. LUMMER AND PRINGSHEIM have communicated to *Wiedemann's Annalen* the results of their determinations of the ratio of the specific heats of certain gases. These results were obtained from the relationship between temperature and pressure in an adiabatic expansion of the gas, a new form of bolometer being employed in the measurement of temperature. The final values obtained for the ratio in question are: for air, 1·4025; for oxygen, 1·3977; for carbonic acid, 1·2995; and for hydrogen, 1·4084. These values are rather greater than those obtained by the same writers in 1887, when a silver wire 0·04 mm. thick was used in the bolometer.

THE problem of the flow of water in uniform pipes and channels, said by Saint Venant to constitute a hopeless enigma, forms the subject of a comprehensive paper by Mr. G. H. Knibbs in the *Journal and Proceedings of the Royal Society of New South Wales* (xxxi.). The formulæ used by engineers in general are shown by the author to be systematically defective, even in respect of their mathematical form, and the main object of the paper is to indicate a scheme of empirical analysis of, and to develop a type of formula for, the flow of water in pipes and channels. By means of tables, the general expression supplied can be rendered easy of manipulation for the purposes of practical calculation. Mr. Knibbs concludes that the law of velocity as related to temperature with at least two (or better, three) pipes of very different roughness, requires further experimental investigation. The variation of the velocity with respect to the radius of pipes also needs investigation; this evidently should be done with, at least, three series having widely different degrees of roughness, so as to ascertain the influence of the roughness upon the variation. In channel investigations the author hopes that the triangular form may be adhered to throughout; the law of flow may then be discovered, and the influence of form constituted a subsequent subject of inquiry.

AN interesting series of determinations of the local variations in the intensity of gravity in the vicinity of Mount Etna and in Eastern Sicily generally is detailed by Signor A. Riccò in the *Atti dei Lincei*, vii. (2) 1. The observations were made with the assistance of Colonel Von Sterneck's pendulums, kindly lent for the purpose by the Hydrographic Bureau of Pola, while the staff of the Observatory at Catania all took part in the work of observing. The general results obtained are somewhat remarkable. In the neighbourhood of Catania and Messina the value of gravity, reduced to sea-level, exceeds that given by theoretical formulæ by about 150×10^{-5} units, an amount equivalent, according to Helmert, to that due to a stratum of rock of density 2·5, of 1500 metres thickness. But this excess diminishes rapidly in the neighbourhood of Mount Etna, and becomes a minimum at the summit, where it is less than 50×10^{-5} units. This diminution appears somewhat difficult to explain, even on the hypothesis of the existence of large subterranean cavities within and beneath the mountain. Another remarkable result is that at Catania the deviation of the vertical is small, and in a direction away from Mount Etna; this result, however, obtains a satisfactory explanation, according to Signor Riccò, in the attraction of massive basaltic rocks of Monte Lauro to the south of the station.

AN elaborate memoir by Dr. J. Zenneck on the markings of pythons, boas, and allied genera of snakes appears in the current number of the *Zeitschrift für wissenschaftliche Zoologie*. It consists of 384 pages and eight plates, and deals especially with the nature and extent of the variation in colour-markings possible within the limits of a species. Considering the great number of specimens of each species which Dr. Zenneck has had the opportunity of examining, the work should prove a valuable addition to the literature of systematic herpetology.

THE flat fishes of Cape Colony are described by Mr. G. A. Boulenger, F.R.S., in a bulletin just published by the Department of Agriculture at the Cape. Only five kinds of flat fishes were known from the coast of South Africa until recently, when Dr. Gilchrist, the marine biologist to the Cape Government, sent Mr. Boulenger a sixth, allied to the British Scald-fish, and representing a species not only new to the South African fauna, but also new to science. All the material obtained in the course of the investigation of the marine fauna undertaken by the Cape Government will be worked up by specialists, and the results published in bulletins similar to the present one. The investigations will deal with marine biology in the widest sense of the term, including the study of conditions of life dependent on physical factors, such as currents, temperature, &c.

THE third number of the second part of the second volume of the new enlarged edition of Dr. Ostwald's "Lehrbuch der allgemeinen Chemie" has just been published by Engelmann, of Leipzig. About three more numbers have to appear before the new edition is completed, and it is announced that they will be published as soon as possible.

VOL. iii. of "Among British Birds in their Nesting Haunts," illustrated by the camera by O. A. J. Lee, has been brought to completion by the issue of Part 12 by the publisher, David Douglas, Edinburgh. This part deals with the tree-creeper, blackbird, rock-pipit, magpie, ringdove, sedge-warbler, dipper, fulmar and dunlin.

ATTENTION may appropriately be called at the present time of year to the publication of a new edition of the late Mr. John Ball's Alpine Guide, vol. i., dealing with the Western Alps. The work has been reconstructed and revised on behalf of the Alpine Club by Mr. W. A. B. Coolidge, and its place is between such a Guide for ordinary travellers as "Murray," and such a special series as the "Climbers' Guides." We shall review the new edition in a future issue, and content ourselves now with merely announcing its publication by Messrs. Longmans, Green, and Co.

A SECOND and revised edition of the standard work on "Hydrographical Surveying," by Rear-Admiral Sir William J. L. Wharton, K.C.B., has been published by Mr. John Murray. The work originally appeared in 1882, and has instructed many naval officers in the principles of marine surveying. The new edition is in the same form as the old one, but the descriptions of instruments and fittings which have changed in the interval between the two issues have been brought up to date, thus increasing the usefulness of the book for members of the nautical surveying service.

THE *Agricultural Gazette* of New South Wales (for May) is as usual, full of valuable articles and notes. The present issue contains the continuation of articles on "The Growth of Gall-making Insects," "Bees, and how to manage them," and "The Bee Calendar," besides a number of other contributions likely to be of practical service to all who take an interest in agricultural and kindred pursuits. We notice that a series of articles especially intended as a guide for beginners in the application of science to agriculture and horticulture is to be commenced in the next number of the *Gazette*.

THE Manchester Microscopical Society may take credit to itself for the volume of *Transactions* just published. A number of interesting papers are published in the volume, and the report shows that the session in which they were read was in every respect a successful one. A paper by Mr. Mark L. Sykes, on "Natural Selection in the Lepidoptera," illustrated by eight good plates, deserves special mention. The butterflies shown upon the first two plates illustrate the mutual protection afforded by the simulation of various inedible species to each other in the same region; while the six remaining plates illustrate mimicry of inedible by edible species. Among other subjects of papers in the volume are: the Hemiptera-Homoptera, influence of light and temperature on vegetation, the functions and structures of leaves, and adaptations in plants.

THE current issue of the *National Geographic Magazine* (Washington) is a National Educational Association number, and contains many interesting and valuable contributions. Mr. W. J. McGee writes on "American Geographic Education" and "Geographic Development of the District of Columbia," and Mr. Henry Gannett, of the U.S. Geological Survey, shows, in an article entitled "Geographic Work of the General Government," how, through a number of bureaus and departments, the United States Government is engaged in promoting the study of geography in its various branches. The longest, and perhaps most valuable, contribution to the number is by Mr. G. K. Gilbert, of the U.S. Geological Survey, on the "Origin of the Physical Features of the United States." This paper was, we are told, prepared as an introduction to a course of afternoon lectures planned by the late Mr. Hubbard, to present the effect of geographic environment on the civilisation and progress of the United States.

THE twenty-ninth annual report of the Norfolk and Norwich Naturalist's Society forms an important contribution to the natural history of the district, thirteen of the fifteen papers published being of a local character. The presidential address, delivered by Mr. A. W. Preston, is mainly meteorological in character, and is accompanied by a series of ten tables indicating the highest, lowest and mean temperatures, the monthly and annual rainfall, the prevailing direction of the wind, and particulars of the duration in each quarter; all these extending over the ten years ending 1897. Mr. Southwell contributes a paper (with map) on an ancient decoy at Feltwell, and some further remarks on the Swan pit at St. Helen's, Norwich. He also records the addition of two new species of birds to the Norfolk list, viz. the Mediterranean Herring Gull (*Larus cachinnaus*) and the Tawny Pipit, bringing the number of fully recognised species of birds which have been obtained in Norfolk to 308; in addition to eight doubtful species. Mr. Gurney contributes a paper on the "Economy of the Cuckoo," in which he considers in detail some of the moot points in the life-history of this common but still mysterious bird. Mr. A. Patterson sends his usual "Natural History Notes from Yarmouth," and Mr. G. H. Harris the eighteenth consecutive report on the herring fishery at Yarmouth and Lowestoft. These notes, in the absence of any official returns on the subject, should have more than local value. An obituary notice of the late Sir Edward Newton, as former president of the Society, should be mentioned; also the fact that mainly through the instrumentality of the Society the close-time for wild-fowl, other than ducks breeding in the county, has been extended to September 1 in each year. The Society is to be congratulated on the list of its members, its financial prosperity, and the excellent work it is so successfully performing.

THE additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Miss Ethel Ansorge; a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Mr. R. Routledge; a Hairy Armadillo (*Dasypus villosus*) from La Plata, presented by Mr. W. Harman; a —— Ichneumon (*Helogale*, sp. inc.), an Abyssinian Guinea Fowl (*Numida ptilorhyncha*) from East Africa, presented by Mr. R. M. Hawker; a Red-masked Conure (*Conurus rubrolarvatus*) from Ecuador, presented by Mrs. E. Henry; a

Raven (*Corvus corax*), European, presented by Mr. H. W. Mansell; two Yellow-bellied Liothrix (*Liothrix luteus*) from India, two Grey-headed Love-Birds (*Agapornis cana*) from Madagascar, two Passerine Parrots (*Psittacula passerina*) from South America, a Yellow-rumped Seed-eater (*Crithazra chrysopyga*), a Black-bellied Weaver Bird (*Euplectes afer*), a Grenadier Weaver Bird (*Euplectes oryx*), a Crimson-eared Waxbill (*Estrelda phœnicotis*), two Orange-cheeked Waxbills (*Estrelda melpoda*) from West Africa, a Superb Tanager (*Calliste fastuosa*) from Brazil, a Parrot Finch (*Erythrura psittacea*) from New Caledonia, two Red-crested Finches (*Coryphospingus cristatus*) from South America, five Amadavade Finches (*Estrelda amadava*) from India, two Chestnut-eared Finches (*Amadina castanotis*) from Australia, three Bar-crested Finches (*Munia nisora*) from Java, a Black-headed Finch (*Munia malacca*) from India, two Banded Grass Finches (*Poephila cincta*) from Queensland, two Lazuline Finches (*Guiraca parellina*) from Central America, a Red-tailed Finch (*Estrelda ruficauda*) from New South Wales, five Indian Silver-bills (*Munia malabarica*) from India, presented by Mr. A. J. Aitchinson; a Common Wombat (*Phascolomys mitchelli*) from Australia, an American Siskin (*Chrysomitris tristis*) from North America, three Amphiumas (*Amphiuma means*) from North America, a Black Iguana (*Metopoceros cornutus*) from the West Indies, deposited; a Garden Dormouse (*Myoxus quercinus*), European, received in exchange; two Wapiti Deer (*Cervus canadensis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

WOLF'S COMET.—The following is a continuation of the ephemeris of Wolf's comet as computed by Herr Thraen (*Astr. Nach.*, 3506):—

12h. Berlin M.T.

1898.	R.A. h. m. s.	Decl. ° '	Br.
August 12	4 58 8	+16 27·9	2·4
13	5 0 41	17·1	
14	3 14	6·0	2·5
15	5 45	15 54·7	
16	8 15	43·3	2·5
17	10 44	31·6	
18	5 13 12	+15 19·6	2·5

The comet is moving in the constellation of Taurus, lying some distance to the west of Aldebaran.

DR. GILL ON SIR JOHN HERSCHEL.—We have received a reprint (from the *Cape Times*, June 24) of an address which was delivered by Dr. Gill at the prize distribution, Diocesan College, Feldhausen, on June 23 last. On this occasion Dr. Gill uncovered a portrait of Sir John Herschel, which had been presented to the school by Mr. Gordon. The same generous donor has promised also a yearly Herschel prize. In his address, Dr. Gill, after referring to the earlier life of Sir John Herschel, and pointing out how he re-examined, with instruments made by himself, the whole of the nebulæ, star clusters, and double stars which had been discovered by his father, and finished this review of the northern hemisphere, mentions how Herschel began a similar study in the southern hemisphere. "Towards the end of 1833, being then forty years of age, he sailed for the Cape, and after a voyage of sixty-three days arrived in Table Bay on January 15, 1834. He selected the house and grounds of Feldhausen for his residence, and on February 22 began the work of observation which he concluded in 1838. On his return to England he spent nine years in the arrangement, the reduction, and the publication of these Cape observations, which were printed in one splendid volume at the expense of the Duke of Northumberland." In a later part of the address Dr. Gill refers to Herschel as "the prose poet of science; his popular scientific works are models of clearness, and his presidential addresses teem with passages of surpassing beauty. His life was a pure and blameless one from first to last, full of the noblest effort and the noblest aim from the time when as a young Cambridge graduate he registered a vow 'to try to leave the world wiser than he found it'—a vow that his life amply fulfilled."

THE PARIS OBSERVATORY.—On February 8 of this year M. Lœwy presented his report of the Paris Observatory for the year 1897 to the Council of the Observatory. Perhaps the most important fact which he communicated was the reorganisation of the meridian work. Up to the present time the greater part of the *personnel* of the meridian instruments has been employed in the revisions of the zones of Lalande, a piece of work that has been pursued steadily since the year 1854; in this, no less than 600,000 observations of stars of Lalande have been made. As this great enterprise is now nearly completed, M. Lœwy points out that other problems can now be attacked, and consequently a different organisation for meridian studies becomes necessary. The three meridian instruments, according to the new scheme, are each used by two astronomers, who make, reduce, discuss and publish the observations in their own names. The meridian circle *du jardin* has been used for the absolute determination of latitude and its variations, the large meridian instrument for absolute determinations of declinations of fundamental stars, while the instruments of Gambey have been employed for filling up gaps in the observations of the stars of Lalande.

During the year 1897 as many as 16,824 meridian observations were made, together with 333 planetary observations. The large equatorial coudé has been devoted to obtaining photographs of the moon which were required to make the series complete. The present report contains a beautiful heliogravure cliché of the moon relative to a phase which presents the greatest photographic difficulties. It was obtained immediately after the sun had set, the moon then having a very low altitude and being only 4 days 6·4 hours old. The equatorials in the east and west towers have been used, as formerly, for observations of comets, minor planets, double stars, nebulæ and occultations. The photographic chart of the heavens seems to be progressing, although the year was not very suitable for such work. The catalogue, we are told, is practically finished, with the exception of some isolated clichés. In the spectroscopic research department M. Deslandres has been continuing his interesting investigations. With the large reflector of 1·20 metres and a spectroscope of three prisms he has secured 47 negatives, which will furnish the velocities in the line of sight of the star studied, and in the laboratory he has been experimenting on the question of the relationship between coronal and kathodic rays.

The report contains, further, the work of the bureau of computations, observatory and personal publications, &c.; but even a brief account of these would render this note too long.

THE FRENCH ASTRONOMICAL SOCIETY.—The *Bulletin* of this Society for the current month is devoted nearly wholly to reproductions of some lunar charts obtained by Messrs. Lœwy and Puiseux at the Paris Observatory, and numerous accounts of the nearly total eclipse of the moon which took place on the 3rd of last month. In the former, four of these most excellent lunar pictures are reproduced, and the description which accompanies them points out the most curious objects in special relation to a better understanding of the order and succession of physical forces which have been at work on our satellite. In the observations of the lunar eclipse we are presented with some excellent reproductions from photographs of the phenomenon at different stages.

THE ELECTRICAL RESISTANCE AND MICRO-STRUCTURE OF ALLOYS.

IN a note in NATURE for June 18, 1896, on "The Electrical Resistance of Alloys," Lord Rayleigh suggested that the entirely different behaviour of pure metals and of alloys with respect to the resistance which they offer to the passage through them of an electrical current, might be partly due to thermo-electric effects.

Profs. Dewar and Fleming have shown that the resistance of a pure metal tends to disappear as absolute zero is approached, and quite recently Prof. Dewar has pointed out that the resistance of platinum in boiling hydrogen is reduced nearly to $\frac{1}{11}$th of its resistance when in boiling oxygen. So far as they have been examined, alloys show no such diminution in their electrical resistance, and the following extract from Lord Rayleigh's note gives his suggested explanation on the supposition that the metals in an alloy are arranged in laminæ, and that the current flows across the laminæ.

"According to the discovery of Peltier, when an electric current flows from one metal to another there is a development or absorption of heat at the junction. The temperature disturbance thus arising increases until the conduction of heat through the laminæ balances the Peltier effect at the junctions, and it gives rise to a thermo-electromotive force opposing the passage of the current. Inasmuch as the difference of temperature at the alternate junctions is itself proportional to the current, so is also the reverse electromotive force thereby called into play. Now a reverse electromotive force proportional to current is indistinguishable experimentally from a *resistance;* so that the combination of laminated conductors exhibits a false resistance, having (so far as is known) nothing in common with the real resistance of the metals."

The structure of eutectic alloys seems to have a special bearing on this question, and seems to afford strong support to the view suggested by Lord Rayleigh. Guthrie pointed out in 1884 that the particular alloy of two metals possessing the lowest freezing point of any alloy of the two that can be made, and which he called the eutectic, is analogous to a cryohydrate, the cryohydrates being regarded as eutectics of ice and the particular salts employed.

FIG. 1.—Silver-lead eutectic, × 100. Oblique illumination.

As Prof. Roberts-Austen in his valuable Cantor Lectures on Alloys (delivered March–April 1897) has pointed out, the analogy between cryohydrates, eutectic alloys and the pearlite of steels is now completely established. The elaborate microscopical investigations of steel and of eutectic alloys made by Osmond, Charpy, Stead and others, together with the work of Ponsot on the cryohydrates, reveal the presence in each case of two different constituents arranged in microscopic laminæ. In the case of the cryohydrates the two constituents are ice and the salt, in eutectic alloys they are the constituent metals, and in the pearlite of steels they consist of alternate layers of pure iron and iron carbide.

In connection with an investigation of the micro-structure of silver-lead alloys the writer has had occasion to examine the eutectic of these two metals, an alloy containing about 2·8 per cent. of silver, and the accompanying photographs of this convey an excellent idea of the structure of eutectic alloys in general.

Fig. 1 shows the appearance presented by a polished surface of a section of this alloy after etching for several hours with acetic acid at the ordinary temperature. The lead has partially dissolved, exposing the silver in bright plates, the edges of which, a good deal bent over and distorted by the action of the stream of wash water, are presented to the observer. A section cut at right angles to the one figured, which is cut parallel to the cooling surface, presents a similar appearance.

By acting on a portion of this alloy with the vapour of hot acetic acid for several weeks the lead was wholly dissolved, and the bright plates were separated and examined. They proved to be pure silver. They are translucent, the light transmitted through them being violet or greyish violet. Some of these plates were mounted in balsam, and Fig. 2 is reproduced from a photograph of one such preparation taken with a $\frac{1}{12}$" oil immersion objective. Measurements of a number of plates which happened to be lying on edge showed that their thickness was less than $\frac{1}{80000}$ of an inch, but accurate measurements in this way are not possible owing to the "black and white dot" effect well known to microscopists.

As will be seen from the figure, the plates exhibit distinct cleavage at angles of 60° or 120° to their longer axes. Some of them are seen to be crossed by a series of faint markings at these angles, markings bearing a very curious resemblance to those obtained by Commander Hartmann by subjecting metallic plates to compressional or torsional strain (Hartmann: "Distribution des déformations dans les métaux soumis a des efforts," Figs. 21 and 173, pp. 25 and 175). It is difficult to avoid the conclusion that they have a similar origin, the strain in this case being probably due to the shrinkage of the alloy on solidification or on subsequent cooling. A distinct folding or crumpling of the plate can be seen in the photograph, showing that in spite of their pronounced directions of cleavage the plates are not excessively brittle.

The bearing of this structure of an alloy on Lord Rayleigh's remarks will be readily understood. The greater number of alloys which have been subjected to tests of their electrical resistance are *partially* made up of the eutectic of their constituents, the remainder of the alloy consisting of one of the two metals or of a compound of the two. It is not conceivable that the work done in rolling and wire-drawing, though it may cause some splitting up of the plates in the eutectic, should entirely destroy this laminated structure; and its existence would almost certainly give rise to the thermo-electric effects which may be the cause of the abnormal resistance of many alloys compared with that of the metals of which they are composed.

SAVILLE SHAW.

FIG. 2.—Eutectic silver plate, × 300.

THE BOARD OF EDUCATION BILL.

THE following are the clauses of the Bill introduced by the Duke of Devonshire in the House of Lords last week, and having for its object the establishment of a Board of Education for England and Wales.

I.—(1) There shall be established a Board of Education charged with the superintendence of matters relating to education in England and Wales.

(2) The Board shall consist of the Lord President of the Council, Her Majesty's Principal Secretaries of State, the First Commissioner of Her Majesty's Treasury, the Chancellor of Her Majesty's Exchequer, and one other person appointed by Her Majesty the Queen and holding office during Her Majesty's pleasure, and it shall be lawful for Her Majesty to appoint a

President, and, if he is Lord President of the Council, a Vice-President, of the Board.

II.—(1) The Board of Education shall take the place of the Education Department (including the Department of Science and Art), and all enactments and documents shall be construed accordingly; and as from the establishment of the Board of Education the Education Department Act, 1856, shall be repealed.

(2) There shall be exercised by the Board of Education the powers conferred on the Charity Commissioners by any scheme made in pursuance of the Endowed Schools Acts, 1869 to 1889, except that—

(*a*) any power with respect to a question as to the construction of a scheme or other document shall be exercised by the Charity Commissioners; and

(*b*) any power with respect to the control or management of property forming the capital of any endowment, shall be exercised by the Charity Commissioners with the concurrence of the Board of Education;

and for this purpose the powers exercisable by the Charity Commissioners under the enactments mentioned in the schedule may also be exercised by the Board of Education.

(3) The Charity Commissioners shall, in framing schemes in pursuance of the Endowed Schools Acts, 1869 to 1889, act in consultation with the Board of Education, and shall frame a scheme under those Acts if so requested by the Board.

(4) In addition to any powers exercisable under this section or otherwise, the Board of Education may, by their officers, visit, inspect, and examine any school, and give certificates in respect of the teaching therein, whether the school is subject to the Charitable Trusts Acts or the Endowed Schools Acts, or not. Provided that, in the case of a school not so subject, the power conferred by this sub-section shall be exercised only with the consent of the governing body of the school.

III.—It shall be lawful for Her Majesty in Council from time to time, by order, to appoint a consultative committee for the purpose of advising the Board of Education on any matter referred to the committee by the Board.

IV.—The Board of Education may appoint such officers and servants as the Board may, with the sanction of the Treasury, determine, and there shall be paid, out of moneys provided by Parliament, to any member of the Board not holding another salaried office, and to the officers and servants of the Board, such salaries or remuneration as the Treasury may determine.

V.—(1) The Board of Education may sue and be sued and may for all purposes be described by that name.

(2) The Board shall have an official seal, which shall be officially and judicially noticed, and that seal shall be authenticated by the signature of the President or some member of the Board, or of a secretary, or of some person authorised by the President or some member of the Board to act on behalf of a secretary.

(3) Every document purporting to be an instrument issued by the Board of Education, and to be sealed with the seal of the Board, authenticated in manner provided by this Act, or to be signed by a secretary or any person authorised by the President or some member of the Board to act on behalf of a secretary, shall be received in evidence and be deemed to be such an instrument without further proof, unless the contrary is shown.

(4) A certificate signed by the President or any member of the Board of Education that any instrument purporting to be made or issued by the President or some member of the Board is so made or issued shall be conclusive evidence of the fact.

VI. The President or Vice-President of the Board of Education shall be capable of being elected to, and of voting in, the Commons House of Parliament, and the offices of President and Vice-President of the Board of Education shall be deemed to be offices included in Schedule H. of the Representation of the People Act, 1867; in Schedule H. of the Representation of the People (Scotland) Act, 1868; in Schedule E. of the Representation of the People (Ireland) Act, 1868; and in Part I. of the Schedule of the Promissory Oaths Act, 1868.

VII.—(1) This Act shall not extend to Scotland or Ireland.

(2) This Act may be cited as the Board of Education Act, 1898.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. D. K. MORRIS has been appointed lecturer on technical electricity in the Mason University College, Birmingham.

MR. J. J. FINDLAY, Principal of the Training Department of the College of Preceptors, has been appointed head master of the Cardiff Intermediate School.

THE following appointments to posts in University College, Sheffield, have recently been made:—Lecturer in physiology: Mr. C. F. Myers-Ward, of the Owens College, Manchester. Assistant lecturer in mathematics: Mr. G. St. L. Carson, late Fellow of Trinity College, Cambridge. Assistant lecturer and demonstrator of physics: Mr. Albert Griffiths, of the Owens College, Manchester.

"UNIVERSITY reform," on which so much public attention is now concentrated in this country, would appear to be a no less burning question in Italy, to judge from the opinions expressed by Prof. C. Ferrini in the *Rendiconti del R. Istituto Lombardo*, xxxi. 11-12. The principal evil of the Italian University system at the present time would appear to be the large and ever-increasing body of ill-prepared students swarming into university classes, many of whom possess little or no aptitude for study. This results in a lowering of the standard of teaching, the effects of which are already making themselves shown, and the supply of graduates seeking employment in the learned professions is largely in excess of the demand. Prof. Ferrini considers the most feasible remedy to be a raising of the fees charged for admission to university courses. Any funds arising from this increase might, of course, be devoted to the furtherance of advanced work, but the main object in view would be to exclude idle and incompetent students from the class rooms, and to stimulate those who entered on the curriculum to make better use of their opportunities, with, moreover, better prospects of obtaining employment afterwards in a less overcrowded market. Having had nearly equal experience of German and Italian universities, Prof. Ferrini considers that the introduction of the German system into Italy could only lead to pernicious results, the principal reason being the great difference in the preparation provided in the two countries for lads before they enter college.

THE London Technical Education Board have arranged for the Session 1898-99 a number of evening science classes, and Saturday morning classes for teachers, in conjunction with University College, King's College, and Bedford College. At University College, Profs. Hudson Beare, Fleming, and Ramsay will between them deliver a course of twelve lectures upon the principles of chemical technology. The lectures will deal with the generation of power and its cost, the generation of electric currents and their application in electro-chemical processes, and the chemistry of the various processes now adopted. Prof. Fleming will also give a course of lectures upon electrical measurements, and Prof. Hudson Beare a course on mechanical engineering. At King's College, evening courses of lectures will be delivered by Prof. Robinson on civil engineering, Prof. Banister Fletcher on architecture, and Prof. Grylls Adams on physics. These courses of instruction will afford an opportunity to students who can study only in the evenings to obtain instruction in well-equipped University laboratories, and will make available to evening students the same advantages as are enjoyed by University day students, but they are only intended for those who are practically engaged during the day in some trade, business, or occupation.

Saturday morning classes have been arranged by the London Technical Education Board for teachers. At King's College, a course of about ten lectures will be given by Prof. Hudson, on the teaching of elementary mathematics. The object of these lectures is to help those who are practically engaged in teaching, and wish to become acquainted with modern mothods and improvements in order to render their teaching more effective. A course of about fifteen lectures on heat engines and general laboratory work will be delivered by Prof. Capper. The object of the course is to acquaint teachers with modern methods of teaching the subject, and to illustrate the use and preparation of laboratory apparatus for demonstration. At University College, a course of ten lectures will be given by Prof. Fleming, on magnets and electric currents. The object of the course is to give instruction in modern methods of science teaching. It will consist in the delivery by the professor of a model lecture to exhibit methods of dealing with the subject, adapted for science teachers and teachers in Board schools who, having some knowledge of the subject, desire to receive instruction in the scientific construction and use of experimental apparatus and the improvements of methods of teaching. A course of ten lectures with demonstrations on advanced graphical statics as applied to girders and arches will be delivered by Prof. Karl Pearson. A course of twenty lectures on physiology will be delivered by Prof. Halliburton. Some of the meetings of the class will be devoted to the performance by the students themselves of the fundamental experiments in connection with the microscope and the methods of chemically testing substances of physiological importance, such as foods, the air, &c. A course of ten lectures on elementary physical measurements, each lecture followed by a class for practical work, will be given by Miss Edith Aitken at Bedford College. The Technical Education Board is doing very valuable work by thus assisting to extend the knowledge of the principles of rational science teaching.

SCIENTIFIC SERIAL.

Bollettino della Società Sismologica Italiana, vol. iv. No. 1. —The new volume begins with the rules of the Society and a list of the Fellows, there being forty-four Italian and nine foreign members.—Dr. Papavasiliou continues his list of earthquakes observed in Greece in 1897; during the last half of the year sixty-four shocks were recorded, fifty-two of which were felt in Zante.—Vesuvian notes for the year 1897, by G. Mercalli. —The Indian earthquake of June 12, 1897, by G. Agamennone; a summary of several preliminary notices in NATURE and elsewhere.—Notices of earthquakes observed in Italy (July 1–27, 1897), by G. Agamennone, the most important being the Garganic earthquakes of July 3 and 24, earthquakes in Alessandria on July 6, Carniola on July 15, and Pisa on July 27, and distant earthquakes on July 22 and 27.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 1.—M. Wolf in the chair.—Further researches on the metal-backed glass mirrors of antiquity, by M. Berthelot. The three mirrors described were originally discovered in Thrace and Egypt. The metal backing consists of almost pure lead, which, in the molten state, appears to have been poured on the concave surface of discs cut from balloons of blown glass.—On the theory of the abacus of alignment, by M. Ernest Duporcq.—On the theory of reed-pipes, by M. A. Aignan. Remarks and experiments on the production of sound in pipes with free and beating reeds.—Action of pure hydrogen phosphide upon cupric sulphate, by M. E. Rubénovitch. The results obtained by previous experimenters seem to show that the product of the action of hydrogen phosphide upon salts of copper is of variable composition. The author, however, by working with pure hydrogen phosphide obtained by the dissociation of phosphonium chloride, and by taking precautions to exclude air or oxygen from the apparatus employed, finds that a well-defined copper phosphide of the formula $P_2Cu_5H_2O$ is produced. This is a black substance, which, on heating to 150° C., loses all its water and becomes of a reddish brown colour. It oxidises slowly in the air, and dissolves in sulphuric acid with liberation of hydrogen phosphide, whilst excess of oxygen during its preparation gives rise to rapid decomposition with formation of metallic copper and phosphoric acid.—Action of bromine upon normal propyl bromide in presence of anhydrous aluminium bromide, by M. A. Mouneyrat. It has been shown, in a preceding note, that by treating ethyl bromide with bromine in presence of aluminium bromide, the hydrogen atoms may be successively replaced by bromine, the final product being hexabromethane, C_2Br_6. The present paper describes a series of similar experiments with normal propyl bromide, the highest brominated derivative yet obtained being pentabromopropane, $CHBr_2—CHBr—CHBr_2$. In the reactions involved the aluminium bromide abstracts the elements of hydrobromic acid from the alkyl bromide and the ethylenic derivative, thus temporarily formed, immediately takes up two atoms of bromine.—On the hydrolysis of ethane-dipyrocatechin, by M. Ch. Moureu. The author has previously shown that ethane-dipyrocatechin yields, on hydrolysis with dilute sulphuric acid, pyrocatechin and a compound of the formula $C_8H_8O_4$. This latter, it is now proved, is identical with the orthohydroxyphenoxyacetic acid obtained by the interaction of monochloracetic acid and the monosodium derivative of pyrocatechin. The mechanism of this singular reaction is discussed.—On a new *Trichophyton* productive of herpes in the horse, by MM. Matruchot and Dassonville. An epidemic of herpes among the horses of an artillery regiment was found to be due to a fungus which the authors succeeded in isolating, and the pathogenic nature of which was verified by inoculation experiments on guinea-pigs and on man. The organism is a *Trychophyton* related to, but not identical with, the species described by Sabourand and Bodin as producing herpetic affections.—Physiological function of iron in the vegetable organism, by M. Jules Stoklasa. It has long been recognised that iron is necessary for vegetable life, and microscopic observations have led to the supposition that the metal exists in organic combination in the nucleus of the cell. It is not present in chlorophyll. The author has extracted from onions and from peas a substance, containing 1·68 per cent. of iron, which closely resembles, in composition and properties, the hermatogen obtained by Bunge from yolk of egg. This compound is also contained in non-chlorophyllaceous plants, as was proved by its being obtained from moulds (*Mucor mucedo*) and fungi (*Boletus edulis*).—Fructifications of *Macrostachya*, by M. B. Renault.—On pietine, or stalk disease, in wheat, by M. Louis Mangin. This disease has been attributed by MM. Prillieux and Delacroix to the action of *Ophiobolus graminis*, but inoculation experiments carried out by the author tend to prove that the injurious effects are, for the most part, caused by *Leptospæria herpotrichoides*, although the two parasites are frequently associated.

NEW SOUTH WALES.

Linnean Society, June 29.—Prof. J. T. Wilson, President, in the chair.—Observations on the vegetation of Lord Howe Island, by J. H. Maiden. The author visited Lord Howe Island in H.M.C.S. *Thetis* in March and April last, spending nine days on the island. Hemsley's Flora of the island (*Annals of Botany*, x. p. 221, June 1896) records 206 plants and three introduced ones, total 209. The author has added 16 species and one named variety to the indigenous flora, and 17 species of introduced plants, while he has removed five species of supposed indigenous plants from Hemsley's list. So that, according to the present paper, the flora of Lord Howe Island stands at present at 217 indigenous species (being a net addition of 11), and 10 introduced ones.—Notes on *Sterculia* (*Brachychiton*) *lurida* and *S. discolor*, by J. H. Maiden and E. Betche. The authors give reasons for believing that *Sterculia lurida* is but the young state of *S. discolor*, and cannot even rank as a distinct variety, much less as a species.—On two well-known, but hitherto undescribed, species of *Eucalyptus*, by R. T. Baker. The author shows that under *Eucalyptus Stuartiana*, F.v.M., no less than three species and one variety are included.—Descriptions of some apparently common Australian Nematodes found at Sydney or in Port Jackson, by Dr. N. A. Cobb. Nineteen species and one variety, referable to eleven genera, are described as new. With two exceptions they are marine forms.

AMSTERDAM.

Royal Academy of Sciences, June 25—Prof. van de Sande Bakhuyzen in the chair.—Prof. H. Behrens and Mr. H. Baucke on Babbits' antifriction metal. By slow cooling this alloy (82Sn, 9Sb, 9Cn) is really split up into compounds of different fusibility. The separation and chemical examination of these compounds have been carried out by Mr. H. Baucke, analytical chemist, of Amsterdam. By pressure between hot iron plates a metallic mother liquid was squeezed out; the remaining cakes of crystalline metal were treated with hydrochloric acid and washed with water. An alloy, containing 90Sn, 10Sb, on being thus treated, yielded the same cubic crystals as Babbits' metal, which were found to answer to the formula $SbSn_2$ (found 33·7 Sb, calculated 33·8 Sb). With 42Sb prismatic crystal of the compounds SbSn were obtained (found 50·35 Sb, calculated 50·37 Sb). In Babbits' metal the copper forms brittle needles of whitish bronze containing no antimony. Such bronzes show less stability than the compounds of tin and antimony. From an alloy of 90Sn 10Cn, the compound CnSn was obtained. Repeated heating and cooling brought the percentage of copper up from 35 to 58. Microscopical examination of bearings showed that cushions heated by running, were poor in cubic crystals of the compound $SbSn_2$. Babbits' metal is made amorphous by casting in cold moulds. Axles running on such metal get tinned; this leads to sticking and heating; finally recrystallisation sets in, and liquid tin is squeezed out; while a compact layer of crystals is formed on the axle. Microscopical examination of the metallic deposit from the lubricating oil led to the unexpected result, that metal with crystals of moderate size will develop ball-cushions. Tin is ground to a fine dust by the sharp fragments of the bronze needles, the hard cubes of $SbSn_2$ are rounded, undermined, and finally worked up into something like metallic pebbles of microscopical size (0·08 to 0·1 mm.). Similar spheroids were obtained from bearings of magnolia metal and of aluminium brass, but not from ordinary brass, nor from grey cast iron.—Prof. Lobry de Bruyn communicated a number of observations on the state of insoluble amorphous substances, which are made to form in gelatine as medium. These substances, which are precipitated from aqueous solutions, remain dissolved in gelatine as colloids, and on solidification yield transparent masses. With incident light some exhibit fluorescence or light reflexion; others do not do so, or only very sparingly.—Prof. van de Sande Bakhuyzen made a communication on behalf of Dr. E. F. van de Sande Bakhuyzen, entitled "The motion of the terrestrial pole according to the observations of the years 1890 to 1896."—Prof. Haga, on a five-cellar quadrant electrometer and the measurements of current intensity carried out with it. A description was given of a five-cellar quadrant electrometer furnished with a damper, consisting of a copper cylindrical mantle, moving in a magnetic field. Owing to the great stability and sensitiveness of the instrument, the strength of strong as well as of weak currents could easily be measured to within 0·1 per cent. by comparing the potential difference at the extremities of a known resistance with a normal Clark-element.—Dr. C. H. Wind, on the influence of the dimensions of the source of light in Fresnel's diffraction phenomena and on the diffraction of X-rays (third communication). The diffraction phenomena, modified by the widening of the light slit, were discussed, this time in connection with the optical delusion discovered by the author. By this discovery some difficulties that still remained were cleared up, but the conclusion as to the evidence of the undulatory character of X-rays, which was to be inferred from previous experiments, had to be retracted. Finally new experiments were communicated, in which a still faint indication of diffraction of X-rays manifested itself, and from which was inferred, with the greatest possible reserve, $T_x = 0·1$ to $0·2\ \mu\mu$.—Prof. Kamerlingh Onnes (*a*), on behalf of Dr. E. van Everdingen, jun., on the galvano-magnetic and thermo-magnetic phenomena in bismuth. Observations were made of the four transverse phenomena in *one* plate of bismuth decomposed by electrolysis. The results were compared with those arrived at by Von Ettingshausen and Nernst and with Riecke's theory of electrical and thermal phenomena in metals. Some among them appeared to agree neither with those results nor with the theory in its present form. (*b*) On behalf of Dr. J. Verschaffelt, on the deviation of De Heen's experiments from Van der Waals's law of continuity. (*c*) On behalf of Mr. C. M. A. Hartman, on composition and volumes of the coexisting phases of mixtures of methyl chloride and carbonic acid. The equilibrium between the two phases being established, parts of both are separated, each between two cocks, and then collected in gas-measuring tubes. The densities of the phases are inferred from the volumes of the gas, and the molecular proportions of the components are found by analysing. A remarkable result of the preliminary determinations is that there is a nearly linear relation between the pressure and the composition of the liquid phase, showing that the exponents in Van der Waals's formula for this case are nearly zero.—Prof. Lorentz, on the influence of a magnetic field on radiation. The elementary theory of the Zeeman-effect is not sufficient to account for the phenomena observed by Cornu, Michelson, Tolver Preston and Becquerel; it will therefore have to be replaced by a more general one Fortunately, without entering into the details of the mechanism of radiation, it is possible to arrive at some general results concerning the state of polarisation in different cases. After discussing this question, the author shows how (as was suggested to him by Mr. A. Pannekoek) the equations in his paper in *Wied. Ann.*, 63, p. 278, may be made to furnish an explanation of Cornu's quadruplet. This explanation would, however, require a structure of the molecules which it seems difficult to imagine.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (mathematico-physical section) for 1898, part 1, contains the following memoirs communicated to the Society.

January 8.—E. Study: Proof of a theorem of Dedekind's.

February 5.—A. Peter: The anatomical structure of the stem in the genus *Scorzonera*; contributions (II.) to our knowledge of the *Hieracia* of Eastern Europe and Asia.

February 19.—E. Riecke: Theory of galvanism and of heat.

March 5.—A. Schönflies: A new geometrical method in the domain of differential geometry.—G. Kolossoff: A particular case in the motion of a "universal top" whose point of support is free to move in a horizontal plane.—A. Sommerfeld: Remarks on Hess's case in the motion of a top.

March 19.—E. Wiechert: Hypotheses subserving a theory of electric and magnetic phenomena.

April 30.—W. Voigt and L. Januszkiewicz: Observations on rigidity under homogeneous deformation.

The *Proceedings* of the Society, part 1, 1898, contain reports on the progress made in the publication of Gauss's works, by F. Klein; on the publication of the great Lexicon of the Egyptian language, hieroglyphic and hieratic, by R. Pietschmann; and on the oldest papal documents. There is also a sympathetic memoir of the antiquary Wattenbach, by Dr. P. Kehr.

CONTENTS.

THURSDAY, AUGUST 18, 1898.

THE CORRESPONDENCE OF HUYGENS.

Œuvres complètes de Christiaan Huygens publiées par la Société Hollandaise des Sciences. Tome Septième. Correspondence 1670–1675. Pp. 624. 4to. (La Haye, 1897.)

SEVEN large quarto volumes of letters to and from Huygens have now been published; but the completion of the work is not yet in sight, as the volume before us only reaches the end of the year 1675, and Huygens lived till 1695. We may therefore probably look forward to three or four more volumes, making in all ten or eleven, before this undertaking is brought to a close. A future historian of science in the seventeenth century will no doubt find excellent material in this vast collection of letters exchanged between Huygens and the principal physicists, astronomers, and mathematicians of his time, to which are added many short papers, reprinted from the *Journal des Savants* and the *Phil. Trans.* But, on the other hand, the task of the historian would have been materially lightened if he had been spared the trouble of wading through a great many uninteresting, more or less private, letters, which help to swell these bulky volumes, but which might very well have been omitted. This is particularly the case with the letters written to Lodewijk Huygens, for though they bear witness to the brotherly affection of the writer, and are often of interest as throwing light on the state of the Netherlands in the days of William III., particularly in the year 1672, when the armies of Louis XIV. overran the country, and the last days of the Republic seemed to have come, still most of these letters are rather out of place among the scientific ones, and would have been better published separately. But hero-worship is unfortunately a disease which it is extremely difficult to resist, and we can well understand that the Dutch Society of Science has wished to do honour to their great countryman by giving as complete a picture of him as possible, both as a private man and as a philosopher.

The years covered by the present volume, 1670–1675, were by Huygens spent in Paris, where he had resided since 1666, except the period from the summer of 1670 till the following spring, which he spent in his native country in order to recover his health after a severe illness in the beginning of 1670. It was a stirring time in the scientific world. The discovery of the solar spectrum by Newton and the method of drawing tangents to curves discovered by Sluse were published in 1672, the "Horologium Oscillatorium" of Huygens was issued in 1673, giving to the world the theory of the pendulum, the discovery of evolutes, the isochronism of the cycloid and other problems of importance; while the application of a spiral spring to the balance of a watch was first announced in 1675. These and other matters are discussed in the correspondence; while the great respect in which Huygens was held is also shown by letters on other subjects, on which his opinion was asked. Thus the architect Perrault, the builder of the palatial Paris Observatory, "le plus somptueux monument qu'on a jamais consacré à l'astronomie," as Lalande calls it, sends Huygens a long essay giving his ideas about the origin of springs in the earth; it forms the preface to his "Traité de l'Origine des Fontaines," and need therefore not have been inserted among the correspondence of Huygens, as the reply of the latter, in which he shortly gives the theory of the barometer and the syphon, can be read without reference to Perrault's essay. We also find Huygens consulted on matters more outside his own sphere; thus he and Hudde in 1671, at the request of the States of Holland and West Frisland, sent a lengthy report to the States-General on the deepening and regulation of the Lower Rhine and the Yssel, on which subject Huygens and Hudde also exchanged several letters.

There are not many letters in this volume on practical astronomy, for the simple reason that most practical astronomers at that time lived in Paris; Cassini, Picard and Roemer were there; in England, Flamsteed and Halley were still young men, and in the rest of Europe there were simply no observers except Hevelius. There are, however, some letters and short papers (some of which were printed at the time in the *Journal des Savants*) on the disappearance of Saturn's ring in 1671, in which year the earth twice passed through the plane of the ring and supplied a splendid confirmation of Huygens' discovery of the true nature of the appendages of the planet. The phenomena were carefully observed both by Huygens himself and at the new Paris Observatory by Cassini, who shortly afterwards discovered two satellites of Saturn with the new telescopes constructed by Campani. The excellence of these is acknowledged by Huygens in a letter to his brother Constantin, in which he humorously remarks that though the new lenses of 36 and 46 feet focal length show mountains and other surface-details on the moon much better than the old ones did, we have not yet got so far as to see church spires and trees. The construction of telescopes was a subject in which the two brothers were both specially interested, and on several occasions Christian sent Constantin information about the new methods of polishing lenses practised in Paris by Le Bas and Borel. It is well known that the single-lens objectives of those days were of very great focal length; there was one of 60 feet at the Paris Observatory, which was very troublesome to use, and Borel even boasted of having made one of 150 feet; "mais il est Gascon," says Huygens.

In England the desire of getting achromatic telescopes had led Gregory and Newton to the invention of the reflecting telescope. In this country Huygens, who was himself a Fellow of the Royal Society, had an indefatigable correspondent in Oldenburg, who not only as secretary to the Society and editor of the *Philosophical Transactions*, but also by his very extensive correspondence, was one of the chief centres of scientific life. At the desire of the Society, Oldenburg communicated an account of Newton's invention to Huygens, who published it in the *Journal des Savants* of February 29, 1672, and also sent his brother Constantin a description of it. He tried at once to make a mirror for himself, but found great practical difficulties in getting a good polish without altering the figure. His defence of Newton's construction against the objections of Cassegrain is reprinted in this volume from the *Journal des Savants*. With Newton himself Huygens does not seem to have been in direct communication, but through Oldenburg the doubts of the Dutch philosopher as to the actual number of colours in the sun-spectrum were brought to the knowledge of Newton, who replied to them in two papers printed in the *Philosophical Transactions* and reprinted in the present volume. The first and last pages of one of the papers, which was written in the form of a letter to Oldenburg, are given in facsimile.

Among letters concerning Huygens' principal work, the "Horologium Oscillatorium," we find his well-known letter to Leopold de' Medici of May 1673, protesting against the accusation of plagiarism, which for years caused him a great deal of annoyance. Both this letter as well as Leopold's reply have been printed before, but the editor takes the opportunity of reviewing in a very long footnote the whole question as to the priority of Galileo. The *mensurator temporis* actually constructed by Galileo was a failure, but in 1641 he gave verbal instructions to his son Vincenzio which resulted in a design of the latter described by Viviani in 1659 in a report to Leopold of Toscana. The editor maintains that a clock can never have been made from this design, or that if made it must have been impossible to make it go, as the wheel would have oscillated instead of rotating; but this conclusion seems very doubtful, since it depends altogether on the accuracy of the drawing published by Favaro in 1891, from among several existing in the National Library of Florence. In any case it remains an undoubted fact that Galileo was the first to propose the application of pendulums to clocks, that he found the principle of the escapement, and that he only by his age and blindness was prevented from perfecting the invention. The mythical claims of Joost Bürgi, so strenuously advocated by Rudolph Wolf, may be safely dismissed, and that Huygens made the invention quite independently is not doubted by anybody.

Tiresome questions of priority were always cropping up in the seventeenth century, and Huygens had also to deal with such in the matter of the isochronism of the cycloid. He defended himself against the claims of Hooke and others in a letter to Oldenburg in June 1673, which called forth a dignified reply from the latter, in which he says that English philosophers are not in the habit of attributing to themselves the discoveries of others, but neither will they allow others to deprive them of what is theirs; many inventive Englishmen have found new truths of which they have spoken freely before printing anything about them, but of late years they have been more careful to preserve their discoveries through the medium of the *Phil. Trans.* Huygens seems to have taken offence at this, as he did not answer for a long time; and when he wrote again he explained his silence by saying that his letters apparently "ne servoient qu'a me mettre mal avec vos Messieurs dela, les vns ne prenant pas en bonne part la liberté dont j'usois a dire mes sentiments sur leurs ouvrages, et a leur faire des objections, les autres se formant d'autres sujets de mecontentements, ou je n'en attendois point du tout."

The last great invention of Huygens dealt with in this volume is the application of a spiral spring to the balance of a watch. On January 30, 1675, Huygens in a letter to Oldenburg informed him that he had made a new invention in timekeepers which he announced in an anagram, and a few days later he applied to Colbert for a patent in France for twenty years. The watchmaker Thuret, whom he had employed to carry out the invention, gave Huygens a good deal of anxiety by pretending that the invention was his own, or at least was made by him and Huygens jointly; but after a few weeks he was obliged to give up his pretensions. Eventually, however, Huygens left all watchmakers at liberty to work at the new invention, foreseeing that any attempt to enforce the patent would involve him in endless lawsuits and expense. A scatter-brained person, Abbé Hautefeuille, had resisted the granting of the patent on the plea that he had himself applied a straight spring to a clock instead of a pendulum, and that the invention of Huygens was essentially the same thing! Of more importance was the claim immediately made by Hooke, that he had many years previously made the same invention and that watches had actually been made in accordance with it. How Hooke stuck to his colours, and how he picked a violent quarrel with Oldenburg, whom he described as "one that made a trade of intelligence" and accused of having betrayed the invention to Huygens, all this is well known, and the present volume, in which all the documents are reprinted, does not throw any additional light on the matter.

In addition to several plates giving photographic reproductions of letters and sketches, the volume contains a fine portrait of Huygens and a view of the manor-house of Zuylichem. The very numerous footnotes give ample information about persons and matters referred to in the letters and documents. J. L. E. Dreyer.

DANTE'S TEN HEAVENS.

Dante's Ten Heavens. By Edmond G. Gardner, M.A. Pp. xii + 310. (Westminster: A. Constable and Co., 1898.)

THE many works in the English language which are being constantly added to the already colossal Dantesque literature are a subject for sincere congratulation alike to the country which gave birth to the immortal author of the *Divina Commedia*, and to the English nation. It is, I think, the most conclusive proof of the conspicuous greatness of Dante that his fame should increase in proportion as the era of which he was the first bard and prophet advances in civilisation. "Dante's Ten Heavens," by Mr. E. G. Gardner, is one of the latest contributions to the great subject under discussion, and for the earnest and loving care which the author has evidently devoted to his work he deserves unstinted praise. He has studied a great deal of what has been said about Dante's theological and ethical ideas, and, although Mr. Gardner in his book treats especially of the *Paradiso*, he often compares similar passages in the three parts of the poem; so that his work will be of great service to those who are interested in these studies. It is, however, to be regretted that he has published his work in the form of an essay; in my opinion, he should have appended his notes to an edition of the whole text of the *Paradiso;* for his valuable remarks would then have presented themselves to the reader singly, and each in its proper place; but in the form they have been published, my conviction compels me to say that the uninitiated, for whom the book is avowedly intended, will be rather discouraged or repulsed by the mass of theological and ethical disquisitions the book mainly consists of, with but a very few glimpses of the poetry which richly adorns *Paradiso*, and makes the serious matters dealt with in it attractive, enjoyable, and exalting. In reading Mr. Gardner's book, one would almost think that Dante in his *Paradiso* simply rhymed St. Thomas Aquinas, Dionysius the Areopagite, St. Bernard, and Richard of St. Victor; whereas, in reality, he was the great Christian poet who expressed in the language of his people, and handed down to posterity, vivified and enhanced with his beautiful poetry, the thoughts and ideas which the school and the cloister entertained and preached concerning the deep questions of human existence. Mr. Gardner should have kept in mind the words which he himself quotes on p. 48 of his book:—

> "Metter potete ben per l'alto sale
> Vostro navigio, servando mio solco
> Dinnanzi l'acqua che ritorna uguale."
> Par., C. ii., lines 13-15.

Had he done so, had he been more graphic in his account of the sublime ethereal pilgrimage, his readers would follow much more easily his guidance, and feel a greater interest in the poem. The fact is that Dante's *Paradiso* should be read and studied (with good notes, of course) in the very words of the sublime poet himself; in truth, many passages in the translations already published of it are dim and clumsy rendering of the original, and oftentimes, for anybody who knows any Italian at all, more difficult to understand than the original text itself. Little, far too little is said by Mr. Gardner about the beautiful diction, the marvellous style, and the stupendous poetic conceptions abundantly displayed by Dante in the last, but the greatest and most sublime, of the three parts of the *Divina Commedia;* and he has said scarcely anything at all of his surprising and admirable knowledge of the physical sciences and astronomy. But, surely, it is for these eminent qualities I have just enumerated that Dante is entitled to that great and ever-increasing consideration and admiration which he attracts at the present time; it is the all-surveying, all-embracing, all-stirring character of his intellect that arrests and commands the attention of all the thinking minds of the present inquiring age. As Mr. Gardner cannot, I think, be one of those critics who injudiciously hold that science is opposed to poetry—that the one must inevitably mar the scope of the other—I cannot understand why he does not praise Dante for his great and, considering the age he lived in, truly amazing knowledge of the highest problems of science. Had not Dante's mind been so copiously stored with all the learning of the best instructed of his contemporaries, most certainly his poetic imagination could never have taken its start from the lofty plane it rose from in the *Divina Commedia*, and his *Paradiso* could never have been more than a grand rhapsody. It suffices to compare Dante's magnificent poem with the Vision of Alberigo, the monk of Monte Cassino, or "De Jerusalem Celesti," of Fra Giacomino of Verona, to see how puerile even poetic conceptions will appear when they are expressed by minds untaught, and obliged to rely upon their unaided natural resources.

The *Purgatorio*, and the *Paradiso*, the work of heaven and earth,

> "Al quale ha posto mano e cielo e terra,"
> Par., C. xxv., line 2.

contain innumerable passages, which prove Dante's immense knowledge of the physical sciences, and astronomy. With reference to the physical sciences, I will only mention the following points:—

His allusion to the principle of universal gravitation: Inf., C. xxxiv., lines 73 and 74.

His remarkably accurate description of the origin of rain: Purg., C. v., line 109-112.

His explanation of the way in which the vegetable humour of the vine, fostered by the light and heat of the sun, becomes grapes: Purg., C. xxv., lines 77 and 78.

His knowledge of the theory of the decomposition of light; in fact, the prismatic nature of the solar spectrum: Purg., C. xxix., lines 73-78.

His knowledge that flowers are only leaves metamorphosed: Par., C. xxxvii., lines 38 and 39.

And, to go no further in this department, his recommendation of experiment and scientific observation, in preference to empiricism: Par., C. ii., lines 95-97.

In astronomy, Dante's knowledge was still more remarkable; not so much for any great discovery made by himself, but because of the thorough mastery he possessed of what was then known of that science, and also because of the many theories then advocated, his pre-eminently eclectic mind seems, generally, to have embraced those only which more recent researches have proved to be the correct ones. And if it be said that Dante did not acquiesce in the Pythagorean system of astronomy (*Convito;* Bk. iii., Ch. 5), we must remember that the illustrious astronomer Ptolemy himself also withheld his approval of that grand but badly advocated system, and, what is more, three centuries after Dante the immortal Galileo was, at first, strongly opposed to the Pythagorean system, as revived and supported by Copernicus.

The following lines, for instance, unmistakably show that Dante knew the theory of the Precession of the Equinoxes, in about 26,000 years. To indicate the vanity of worldly fame, Dante makes a spirit ask him what his fame will be in a thousand years,

> "ch' è più corto
> Spazio all' eterno, ch' un muover di ciglia
> Al cerchio che più tardi in cielo è torto."
> Purg., C. xi., lines 106-108.

Also the following lines, in which our poet describes the obliquity of the ecliptic, and eloquently reminds us of the beneficial influence therefrom:—

> "Vedi come da indi si dirama
> L' obliquo cerchio che i pianeti porta,
> Per satisfare al mondo che li chiama;
> E se la strada lor fosse men torta,
> Molta virtù nel ciel sarebbe invano,
> E quasi ogni potenzia quaggiù morta."
> Par., C. x., lines 13-18.

See, also, how Dante characterises in the following lines the mighty power of the sun :—

> "Lo ministro maggior della natura,
> Che del valor del cielo il mondo imprenta,
> E col suo lume il tempo ne misura,"
> Par., C. x., lines 28–30.

It is also remarkable that the great Italian poet, differing in opinion from Aristotle ("il maestro di color che sanno"), and Ptolemy, who believed that the light of the Milky Way was caused by the density of the sky at the zone through which it passes, thought, with Democritus, that the puzzling galaxy consisted of an immense number of stars, more or less bright; as the following lines tell us :—

> "Come, distiuta da minori e maggi
> Lumi, biancheggia tra i poli del mondo
> Galassia sì, che fa dubbiar ben saggi,"
> Par., C. xiv., lines 97–99.

And, to finish with quotations, see in the following lines how Dante held firm the true one of the many theories of the tides which were advocated in the Middle Ages :—

> "E come il volger del ciel della luna
> Cuopre e discuopre i liti senza posa,
> Così fa di Fiorenza la fortuna;"
> Par., C. xvi., lines 82–84.

The foregoing quotations are sufficient to prove that Dante possessed a vast amount of scientific knowledge, which, in most cases, he displays most judiciously to interest his readers, and to inculcate in their minds the truths he wants to teach them. In conclusion, I beg leave to say again that if the fame of the great Italian grows in proportion with the world's civilisation, it is because he was not merely a great poet, but because he was also a great artist, a profound philosopher, an eminent astronomer, and an inspired theologian.

N. PERINI.

COLENSO'S MAORI DICTIONARY.

A Maori English Lexicon. By the Rev. W. Colenso. (Wellington, 1898.)

MR. COLENSO'S Maori English Lexicon, being, as stated on the title-page, a comprehensive dictionary of the New Zealand tongue, including mythical, mythological, "taboo" or sacred, genealogical, proverbial, poetical, tropological, sacerdotal, incantatory, natural history, idiomatic, abbreviated, tribal and other names and terms of and allusions to persons, things, acts, and places in ancient times, also showing their affinities with cognate Polynesian dialects and foreign languages, with copious pure Maori examples, has a sad history to tell. To begin with, it is only a first instalment, going no further than *Anguta* in the Maori English part, and *to come* in the English Maori part; nor does it seem settled even now that Mr. Colenso will be able to finish the publication of it. That such a lexicon ought to have been published by the New Zealand Government long ago, admits of no gainsaying. It is a work practically useful to the whole Colony, and who is to publish such a work if the Government declines to do so? As far back as 1861 the Rev. W. Colenso made his first proposal to the House of Representatives. His motion, he tells us, was favourably received, and the resolution was passed, "That the House considers it highly desirable that a sum of money be devoted for the purpose of commencing a Standard Library Dictionary of the Maori Language." But there followed the ominous sentence, "as soon as the finances of the Colony will permit." A new application was made in 1862, when the finances seemed to be in a flourishing state, but without results. Then came the war in 1863, and nothing was done. The Governor, Sir George Grey, took an active interest in the matter; but in spite of that, nothing was done in 1864. At last, in 1865, an estimate was asked for, and Mr. Colenso stated that the time required would be seven years, and the expense would be 300*l.* per annum. In 1865 the House once more decided that it is highly desirable that the Maori dictionary should be commenced forthwith. Mr. Colenso then devoted himself entirely to this work, shutting himself up, as he says, fourteen and even sixteen hours a day. He gave up his official duties and his useful natural history studies, which had made his name familiar to students at home. He received, however, but scant recognition from the Government, and in 1867 it seems that an official inquiry was called for by the House, and another gentleman was appointed to inspect and report. The report was favourable, and so were some other reports in 1868. But the House seems to have grown impatient. Mr. Colenso was informed that the work must be finished by 1870, and that no more money should be paid after that date. After that, the relations between the Government and the compiler of the dictionary seem to have become strained. Unfortunately illness supervened, possibly aggravated by disappointment, for Mr. Colenso speaks of "having been goaded on to desperation almost through the remarks made in the House and the bad faith of the Government." In 1870 Mr. Colenso entered the Provincial Council again, and was appointed Inspector of Schools, so that he could devote his spare time only to the prosecution of his literary labours. A last appeal was made by Mr. Colenso in 1875, offering to hand over his materials to Government, or to go on again with his work if the Government would grant the necessary funds. To this, we are informed, no answer was returned, but transactions went on, more or less unsatisfactory, till at last the first instalment of the dictionary was sent to press, and published in 1898!

This certainly seems a sad history, and, considering Mr. Colenso's age, we can hardly hope that he will be allowed to finish this great undertaking. In the meantime two Maori dictionaries have been published by Williams and by Tregear, but on a smaller scale; so that Mr. Colenso's work may still be very useful as filling many a gap left by his predecessors. It is difficult for an outsider to form an opinion as to the rights of the case. Scholars are sometimes dilatory, and Governments are sometimes stingy, and that on the highest principles. Personal feuds, too, are difficult to avoid when different parties divide the Government, and patronage is put into the hands of whatever party is in power.

The loss to science, particularly to linguistic studies, is very great, for by his long residence among the Maoris Mr. Colenso seemed highly qualified for the work which he had undertaken, and which, under more favourable auspices, he might have finished by this time. On comparing some of the entries, even in this small fragment we come across several which are most interesting. It is well known that the Maoris call their gods *Atuas*. But the question is, why? It seems at first sight as if *Atua* was derived from *atu*, a particle expressive of many things. Mr. Colenso enumerates thirty-three meanings of it, one of which is an emphatic *very*, used also to form superlatives and to express extraordinary greatness, or anything that goes beyond everything else. *Atua* may have been derived from it, though it seems to convey not so much the idea of exceeding greatness as of being terrible. Hence it is used as a name of any supernatural and malevolent being, a demon, and also of their gods, many of whom were more or less malevolent. The most dreaded and powerful *Atuas* were *Tu*, *Rongo*, *Tane*, *Tangaroa*, *Tawhiri matea*, and *Whiro*, four of whom appear again as the gods of Hawaii, viz. *Tu*, *Lono* (Rongo), *Kane* (Tane), and *Kanaloa* (Tangaroa). All of these, though invoked, were hated and often threatened by their worshippers. Idols also are called *atua*, and a number of imaginary invisible evil powers, genii, spooks and gnomes, go by the same name. *Atua* is applied also to sickness, pain and death, as personified, in fact, to anything abnormal and monstrous, disgusting and disagreeable. Natives who never touch pork, eels, or even mutton, call them also *atua;* in fact, anything uncanny or unlucky is *atua*. It was unfortunate that the same word should have been taken by the missionaries as the name of the Deity, the one true God, the God of the Christians. This to the natives sounded at first like a solecism, but in the course of time it has lost its original meaning, and serves its purpose now as the name of the God of Love. Mr. Colenso would prefer *Matua*, *Matua-pai* for that purpose, though *Matua* itself is but a derivative of *Atua*.

One remark we should like to make in conclusion. Mr. Colenso generally adds Maori sentences in proof of the meaning assigned to each Maori word. But, alas! he gives no translations; and as the study of Maori has not yet been recognised in our schools and universities, much of the usefulness of these *pièces justificatives* is lost on those who consult his dictionary, however convinced they may feel that Mr. Colenso has rightly interpreted them.

THE SPIDERS OF HUNGARY.

Araneæ hungariæ . . . conscriptæ a Cornelio Chyzer et Ladislao Kulczyński. Vols. i.–ii. (Budapesth: 1891–1897.)

OWING to the homogeneous character of the fauna of Central Europe, this work, although purporting to deal merely with the spiders of Hungary, forms an admirable basis for the study of the species that inhabit the rest of the continent. The determination of the species occurring in the area over which the authors' researches have extended, has of necessity involved a comparison between them and the species previously recorded from Scandinavia, Prussia, Great Britain and France by Clerck, Westring, Menge, Koch, Blackwall, Walckenaer, Simon and others. The fact that so many naturalists have worked more or less independently, sometimes indeed contemporaneously, at the spiders of their respective countries has unavoidably caused a great deal of clashing in the specific nomenclature; and the endeavour to clear away the resulting confusion certainly forms the most difficult part of the labours of an author who attempts at the present time to monograph the spiders of any area in Europe. It is evident that Dr. Chyzer and Prof. Kulczyński have in nowise shirked their duty in this respect; and although it is improbable that their efforts have met in every instance with the success they deserve, it would be unfair to lay to their charge the blame for any failures that may hereafter come to light. Rather must the responsibility rest with those of their predecessors and contemporaries who, especially when dealing with the more obscure species, have failed to realise the importance of setting aside, as a standard for future comparison, one typical example out of a series of specimens upon which a description was based, or have regarded subsequently and, as results have shown, often wrongly identified examples as of equal importance to the one upon which the species was originally established.

Of the excellence of the book as a whole the names of the authors is sufficient guarantee. A passing word of praise, however, must be bestowed upon the method in which the specific and generic diagnoses are dealt with, since it is a method which might with advantage be imitated by all systematic workers who wish to lighten the labours of those that come after them. The characters of the species and genera are set forth in tabular or synoptic form, so that they may be readily comprehended, and so that a spider of unknown affinities may be rapidly identified, even by a student unfamiliar with the taxonomic features of the family to which it belongs. Such tables, moreover, have the further advantage of inspiring confidence in the ability of an author, since they bear witness to the gift of the scientific faculty of analysis, the absence of which too often renders abortive the efforts of many a systematic zoologist.

Since the families to which the spiders enumerated belong are not diagnosed, it may be supposed that these volumes are not intended for the use of beginners, but only for those who have mastered the first principles of the classification of the Araneæ. This is, I think, an omission which somewhat impairs the value of the work. One page, or, perhaps, two pages at most, might with great advantage and but little trouble have been devoted to a tabular representation of the groups of this rank, exactly as has been done in the case of the genera and species. Unfortunately it is quite the fashion amongst arachnologists to fight shy of such a task.

Another slight blemish, in my opinion, is the adoption of such terms as Misumenoidæ and Calommatoidæ for the older and better known Thomisidæ and Atypidæ respectively. The former, and others that could be named, were introduced by Dr. Thorell for reasons that appeared inadequate to most of his contemporaries. Happily they have been recently abandoned by the author to whom they owed their existence, and but for their reappearance in the present case would by this time in all probability have dropped into merited oblivion.

This, however, is after all a matter of very little moment, and cannot be said to affect adversely in any degree the purpose that the volumes were intended to fulfil. If to what has already been said in their favour, it is added that they are illustrated with fifteen lithographic plates containing over one thousand figures, it will be evident that Dr. Chyzer and Prof. Kulczyński have produced a work which will take rank as one of the most important contributions to our knowledge of European spiders that has appeared this century.

R. I. POCOCK.

OUR BOOK SHELF.

Electrodynamics: The Direct Current Motor. By C. A. Carus-Wilson, M.A., late Professor of Electrical Engineering, McGill University, Montreal. Pp. 298. (London: Longmans, Green and Co., 1898.)

IN no department of applied science has advance in the last few years been more striking than in the application of the continuous current motor to traction purposes. This rapid advance has, however, until quite recently been rather in the United States, in Canada, and on the Continent, than in our own country. The appearance of this book by Prof. Carus-Wilson, of the McGill University, dealing with those problems which face the electrical engineer when deciding upon the choice of motors, is therefore singularly opportune.

The growth of our great towns has brought about an ever-increasing demand for rapid transit combined with frequent stoppages. In all the new schemes for underground electric railways in London an attempt is being made to combine these two opposing requirements. The starting torque or accelerating power of a motor is its most important merit from the traction engineer's point of view. Prof. Carus-Wilson lays considerable stress on the properties of series and shunt wound motors at rest before proceeding to treat of his subject in a more general way. His graphical methods of attacking the various mechanical problems are very carefully worked out, and the book is illustrated throughout by a remarkable series of very neat and clear diagrams—some theoretically obtained, and others the result of experiments on the tractive force and acceleration of actual electric locomotives.

The author makes use of many new terms, the meaning of which one does not fully appreciate on a first reading. Many expressions are used in quite an unusual sense, as, for example, "magnetisation curve," meaning a curve of distribution of magnetic flux. The term "acceleration curve" is also applied where one would be inclined to say "curve of velocity." These differences of language are, however, no doubt inseparable from the originality of the author's methods.

The book, though not a large one, is yet undoubtedly an important contribution to technical literature.

D. K. M.

A Trip to Venus. By John Munro. Pp. 254. (London: Jarrold and Sons, 1897.)

THE apparent similarity between the physical conditions of the planet Mars and those which exist upon the earth have furnished several writers with material upon which to exercise their imaginations. Many considerations point, however, to the earth's twin sister, Venus, as possessing conditions of habitability more closely resembling those enjoyed by us than would be found on Mars, which fact has given Mr. Munro a text for this novel.

The prescription for a story on extra-terrestrial affairs appears to contain as essential constituents a description of a flying machine in which "a new force" is utilised, a modicum of astronomical information, a few sentimental episodes, and some representations of wonderful forms of organic life observed in the "other world" with which the narrative is concerned. Mr. Munro departs but very slightly from this formula. The actors in his little drama are a gentleman who represents the mind of the average man and tells the story, an astronomer who speaks like a text-book, an inventor who constructs a flying machine of marvellous efficiency, and a young lady whose presence naturally introduces into the narrative the vein of sentiment without which no novel is complete. This is the company which makes the trip to Venus and Mercury, and brings back information as to the inhabitants of those planets and on various other objects and phenomena which, unfortunately, astronomers have to actually observe from the bottom of a restless atmospheric sea.

It is perhaps a doubtful compliment to say that a work of fiction is instructive, but we cannot resist paying it in the present case. As a story Mr. Munro's novel is but of indifferent quality, but as a series of short disquisitions upon astronomical matters, more or less worked into a narrative, the book is worth reading, especially as it possesses the merit of correctness so far as it goes.

The idea of the supposed inhabitants of Mars signalling to the earth by burning different elements, which are subjected to spectroscopic analysis by the astronomer of the party, is noteworthy, and it is a pity that the author did not make more of it. The description of the meeting of the Royal Astronomical Society, given in the last chapter, is a disappointing and unnecessary epilogue of the story.

A Dictionary of Bird Notes, &c. By C. L. Hett. Pp. 138. (Brigg: Jackson, 1898.)

THIS little volume is obviously intended for the field-observer, being bound with the corners rounded off and blank pages for notes opposite the pages of letter-press. The author has secured the co-operation of a number of fellow bird-lovers; and their joint labours have resulted in the production of a syllabic reproduction of the notes of every British bird, which it may be hoped will prove satisfactory not only to themselves but to ornithologists in general. Judging from his preface, the author himself appears to be confident that he has achieved complete success, but we fear that many persons would require a supplemental education before they are capable of appreciating the merits of his scheme. The correctness of many of the notes are self-apparent, but some are decidedly difficult of pronunciation by the uninitiated, and it is to be hoped that many of his readers are unfamiliar with the precise tone of "the snore of a drunken man," which is given as one of the notes of the chaffinch.

The glossary of popular, local, and old-fashioned names of British birds, which forms one of the appendices, will certainly prove useful to young ornithologists dwelling in the provinces, and may sometimes even be a help to their more experienced brethren. R. L.

Chemical Analysis, Qualitative and Quantitative. By W. Briggs, M.A., and R. W. Stewart, D.Sc. Pp. x + 128. (London: W. B. Clive.)

THE pupil who uses this book ought to obtain an intelligent grasp of the principles of chemical analysis. A chapter on simple experiments in manipulation leads to chapters on the reactions of the various groups of metals and the acids, and these are followed by instructions for systematic analysis, analysis of mixtures, and volumetric work. The instructions are clear and concise, but, as might be expected from the nature of the subject, the book departs but little from the style of others of the same kind.

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.*]

Potential Matter.—A Holiday Dream.

WHEN the year's work is over and all sense of responsibility has left us, who has not occasionally set his fancy free to dream about the unknown, perhaps the unknowable? And what should more frequently cross our dreams than what is so persistently before us in our serious moments of consciousness—the universal law of gravitation. We can leave our spectroscopes and magnets at home, but we cannot fly from the mysterious force which causes the rain-drops to fall from the clouds, and our children to tumble down the staircase. What is gravity? We teach our students to accept the fact and not to trouble about its cause—most excellent advice—but this is vacation time, and we are not restricted to lecture-room science.

Lasage's particles are not satisfactory; they are too materialistic for the holiday mind; but I have always been fascinated by a passage occurring somewhere in Maxwell's writings, where Lord Kelvin is quoted as having pointed out that two sources or two sinks of incompressible liquid will attract each other with the orthodox distance law.

Let us dream, then, of a world in which atoms are sources through which an invisible fluid is pouring into three-dimensioned space. What becomes of this fluid? Does it go on for ever increasing the volume of that all-pervading medium which already fills a vast, but not necessarily infinite, space? When we speak of the constancy of matter, we mean only the constancy of inertia, and how are we to prove that what we call matter is not an endless stream, constantly renewing itself and pushing forward the boundaries of our universe? The conception of atoms as sources of fluid does not, however, necessarily involve such a perpetual increase of substance, for an equal number of sinks may keep withdrawing the increment.

These sinks would form another set of atoms, possibly equal to our own in all respects but one; they would mutually gravitate towards each other, but be repelled from the matter which we deal with on this earth. If matter is essentially dynamical, and we imagine the motion within an atom to be reversed, the question arises whether the reversed motion is similar to the original one; in other words, whether the new atom so formed may by a change of position be brought into coincidence with the old one. And if this is not the case, we must ask ourselves whether the new atom will behave gravitationally like the old one. If atoms are sources of liquid there would be no reciprocity, and the sinks would form another and so far unrecognised world. But sources and sinks compel us to the supposition of a fourth dimension, which belongs to the domain of nightmares, not of dreams, and we try to shake ourselves free from the idea.

I, for one, cannot quite succeed in this effort, for something has been left behind, which is not easily got rid of, when once its symmetrical beauty is perceived. Surely something is wanting in our conception of the universe. We know positive and negative electricity, north and south magnetism, and why not some extra terrestrial matter related to terrestrial matter as the source is to the sink, gravitating towards its own kind, but driven away from the substances of which the solar system is composed. Worlds may have formed of this stuff, with elements and compounds possessing identical properties with our own, undistinguishable in fact from them until they are brought into each other's vicinity. If there is negative electricity, why not negative gold, as yellow and valuable as our own, with the same boiling point and identical spectral lines; different only in so far that if brought down to us it would rise up into space with an acceleration of 981. The fact that we are not acquainted with such matter does not prove its non-existence; for if it ever existed on our earth, it would long have been repelled by it and expelled from it. Some day we may detect a mutual repulsion between different star groups, and obtain a sound footing for what at present is only a random flight of the imagination.

Even now some might argue that we possess some substantial evidence of repulsive forces. In our glorification of the Newtonian system we are apt to overlook some obvious facts which the law of gravitation fails to explain. One of these is the rotational velocity of our solar and of many stellar systems, which cannot be self-generated. Unless we threw our laws of dynamics overboard, or imagine the rotation to have been impressed by creation, we must conclude that some outside body or system of bodies is endowed with an equal and opposite angular momentum. What has become of that outside body, and how could it have parted company with our solar system, if attractive forces only were acting? Another unexplained fact is found in the large velocities of some of the fixed stars, which, according to Prof. Newcomb's calculations, cannot be explained by gravitational attractions only.

The atom and the anti-atom may enter into chemical combination, because at small distances molecular forces would overpower gravitational repulsions. Large tracts of space might thus be filled unknown to us with a substance in which gravity is practically non-existent, until by some accidental cause, such as a meteorite flying through it, unstable equilibrium is established, the matter collecting on one side, the anti-matter on the other until two worlds are formed separating from each other, never to unite again.

Matter and anti-matter may further coexist in bodies of small mass. Such compound mixtures flying hither and thither through space, coming during their journey into the sphere of influence of our sun, would exhibit a curious phenomenon. The matter circulating in a comet's orbit, the anti-matter repelled and thrown back into space, forming an appendage which is always directed away from the sun. Has any one yet given a satisfying explanation of comets' tails; is the cause of coronal streamers known, and can any one look at a picture of the great prominence of the 1885 eclipse, and still believe that gravitational attraction or electric repulsion is sufficient to account for its extravagant shape? But this is not a scientific discussion. I do not wish to argue in favour of the existence of anti-atoms, but only to give my thoughts a free course in the contemplation of its possibility.

What is inertia? When the atom and anti-atom unite, is it gravity only that is neutralised, or inertia also? May there not be, in fact, potential matter as well as potential energy? And if that is the case, can we imagine a vast expanse, without motion or mass, filled with this primordial mixture, which we cannot call a substance because it possesses none of the attributes which characterise matter ready to be called into life by the creative spark? Was this the beginning of the world? Is our much-exalted axiom of the constancy of mass an illusion based on the limited experience of our immediate surroundings? Whether such thoughts are ridiculed as the inspirations of madness, or allowed to be the serious possibilities of a future science, they add renewed interest to the careful examination of the incipient worlds which our telescopes have revealed to us. Astronomy, the oldest and yet most juvenile of sciences, may still have some surprises in store. May anti-matter be commended to its care! But I must stop—the holidays are nearing their end—the British Association is looming in the distance; we must return to sober science, and dreams must go to sleep till next year.

Do dreams ever come true? ARTHUR SCHUSTER.

Live Frog taken out of a Snake.

YOUR correspondent, Colonel Major, may be interested to hear of another instance of a Batrachian returning alive from the stomach of a snake. A grass snake of about 24 inches, kept in captivity, had not fed for three weeks: it was then given a very large specimen of the common frog, full-grown; this was swallowed at once, in the usual way by taking the hind leg first. In about an hour and a half the frog was a third of the way down the snake's body. Then, on the snake being played with and handled, after some minutes the lump began to move up rapidly towards the head of the snake, the mouth opened and out slid the frog; rather off colour, and not very happy-looking, but quite able to hop about in a shuffling fashion, though decidedly shaky on his legs. To an amphibian imprisonment without air could not be very hurtful for a few hours, were it not for the poison of the gastric juices. When the grass snake was left again with the frog it re-swallowed its prey. A snake will often take half an hour swallowing a frog: the distension of the jaws during the operation is extraordinary to witness. In about an hour's time the frog will be a third of the way down the snake's body. ROSE HAIG THOMAS.

Badenweiler, August 14.

In the spring of 1885, at Divonne-les-Bains, I killed a snake, and on cutting it open I found one frog slightly decomposed and another frog apparently dead; the latter recovered in about a quarter of an hour, and hopped away. H. Ling Roth.

32 Prescot Street, Halifax, August 12.

Dogmatism on the Moon and the Weather.

In a recent little book, "The Story of the Weather," by G. F. Chambers, I have come across one of those *ex cathedrâ* statements which, I think, illustrate the curious disposition of the mind (even the scientific mind) to circumscribe and limit truth. "No one in his senses," our Meteorological Office is quoted as saying, "can believe in the moon's influence on the weather." Is the matter, then, clear as noonday, or as an axiom of mathematics? Supposing we have, thus far, no proof of such influence, how can we possibly be certain that no such influence exists, or will ever be demonstrated? I happen to be, unfortunately, one of those "lunatics"; but I rather think I am in good company. The author of the book himself, oddly enough, just before approving, apparently, the above dictum, expresses his firm conviction (p. 197) that the full moon scatters clouds! (a point, however, which I cannot say I have studied).

A. B. M.

Rules for Compositors and Readers.

In the *British Printer* for May and June of last year appears an article under the above heading, by Mr. Horace Hart, Controller, Clarendon Press, Oxford, which, as in my case, may have escaped the notice of some of your readers. On this assumption it would be as well, taking into consideration the importance of the matter to scientific men generally and directors of museums in particular, to ask for the views of others qualified to judge upon the advisability of discarding the use of the digraphs œ and æ in Greek words written in English characters, in Latin words, and—presumably—in words derived therefrom, such as Coelenterata and Caesarean, which, according to Mr. Hart, should not be written, as they usually are, Cœlenterata and Cæsarean. The importance of such a ruling cannot be over-estimated in any museum which desires to teach and not mislead its students—to say nothing of the waste of elaborate labels which the disuse of the digraphs entails, and these considerations must be my excuse for troubling your technical readers for their opinions.

Leicester. Montagu Browne.

"ARTIFICIAL FOOD."

UNDER the above title the *Daily Chronicle* of Friday, August 5, prints a telegram from its Vienna correspondent announcing the synthetic preparation, by Dr. Leon Lilienfeld, of albumen having "absolutely the same nourishing qualities as found in that which is obtained from organic beings." Such a synthesis would undoubtedly mark an epoch both in chemistry and physiology, but unfortunately for those who have attached undue importance to Dr. Lilienfeld's announcement, the data given in the sensational telegrams, if correct, were sufficient to show that, whatever he might have achieved he had certainly not obtained the substance commonly known as albumen. It is enough to point out that with the materials employed, the artificial product could not contain sulphur, which, at any rate up to the present, is regarded as an essential constituent of albumen.

The report of the International Congress of Applied Chemistry, given in the number of the *Chemiker Zeitung* (xxii. 644) just to hand, includes a short account of Dr. Lilienfeld's paper. Translated it runs:—

"Dr. Lilienfeld gave a very interesting account of the artificial synthesis of albuminous substances (*Eiweisskörper*). It has been found possible to prepare pepton hydrochloride by the condensation of phenol and glycocoll with phosphoric oxychloride; thus obtained, it gives all the reactions of the albuminoids. The lecturer experimentally demonstrated the preparation and properties of the new compound. By previous conversion into the sulphate and decomposition of the latter, the free pepton can be obtained, and resembles, both in its chemical and physiological behaviour, the natural pepton from albumen. The analytical data corresponded with those given by natural pepton."

From this it is evident that Dr. Lilienfeld claims not the synthesis of albumen, but that of pepton, a digestion product of albumen, which, in spite of the statements of Henninger and others, does not seem so far to have been reconverted to its parent substance. In the absence of exact details, it is impossible to say how far the claim to the synthesis of pepton is justified, but it may be as well to recall previous work in the same direction.

Grimaux published in the *Comptes rendus*, about fourteen years ago, several papers on the formation of colloids from inorganic materials. Among others he obtained two: (1) by heating meta-amidobenzoic acid with phosphorus pentachloride, and (2) by the action of ammonia on solid aspartic anhydride heated at 170°. Although it was not to be expected that albumen would be obtained from such materials, it is remarkable how close was the resemblance between these colloids and the proteids when judged solely by their reactions.

A little later Schützenberger attempted the synthesis of proteids from the products of their decomposition. He had been engaged for some years on the study of the products of the hydrolytic decomposition of albumen by barium hydrate solution at varying temperatures. Among the substances obtained were various amido-acids of both the fatty and the aromatic series. He therefore dehydrated a mixture of these acids and urea with phosphoric anhydride, hoping thus to reverse the hydration process. Without giving details of the method employed, it is sufficient to say that he obtained a colloid which gave the reactions usually considered diagnostic of a proteid.

In 1897 Dr. J. W. Pickering (in continuation of a series of papers published in conjunction with Prof. Halliburton in the *Journal of Physiology*) contributed an interesting paper to the Royal Society's *Proceedings* (Nature, 1897, 341), in which, besides confirming Grimaux's results, he added many valuable observations of his own. Among the most remarkable of these is the fact that the colloid obtained from aspartic anhydride is digested by pepsin-hydrochloric acid, and then gives the colour reactions for pepton, and, further, that it closely resembles the nucleo-proteids in its physiological action.

Dr. Pickering, moreover, greatly extended Grimaux's work, and prepared several new colloids, such as one from a mixture of tyrosine, biuret, and phosphorus pentachloride, a second from para-amidobenzoic acid and phosphorus pentachloride, and a third from alloxan, meta-amidobenzoic acid and phosphoric anhydride. These, together with several others, gave the reactions of the proteids, coagulated at definite temperatures, and produced intravascular coagulation of the blood. Still more noteworthy is the fact that according to the author they are optically active, like the natural proteids. Should this statement be confirmed, these would be the first optically active substances produced directly from inactive materials. As this feat has hitherto been regarded by chemists as improbable, if not impossible, these colloids are certainly worthy of closer investigation from this point of view.

Dr. Lilienfeld, too, has synthesised a substance giving the reactions of a proteid by condensation of a base which he called biuretdimethylene, with different amido-acids. It should, however, be noted that these workers, so far, have not claimed that the products obtained were actually proteids, but only that they bore a striking resemblance to them; and in this they were doubtless correct.

It is well known that the so-called "tests" applied to the detection of a proteid are purely empirical. Such colour tests as Millon's, nitric acid, &c., have no real value; the colour developed *may* be due to the proteid molecule as a whole, but more probably to some decomposition product, and, as already mentioned, some colloids which bear no relation to actual proteids give reactions considered characteristic of these substances. Again, the peptons in their reactions strangely recall the alkaloids, especially in the precipitates they give with mercuric chloride, potassium periodide, phosphotungstic and phosphomolybdic acids, &c., while elementary analysis is of little value, as all the proteids give very similar figures, which in nowise indicate the striking differences met with in their physiological behaviour. When, in addition, it is remembered how extremely complex and mobile the proteid molecule must of necessity be, and the readiness with which changes in its constitution are brought about, something more than a few empirical colour and physiological tests will be required to convince chemists that pepton has been actually synthesised. Dr. Lilienfeld's results evidently need further investigation, and in the meantime the question raised by his announcement is distinctly one that calls for suspended judgment.

SIDNEY WILLIAMSON.

THE TOXICITY OF EEL-SERUM, AND FURTHER STUDIES ON IMMUNITY.

THE investigation of poisons, both bacterial and animal, has been pursued with such enthusiasm in so many parts of the world during the past decade, and the public have been brought into such close touch with some of the practical applications which have followed in the track of these investigations, that the term toxin and anti-toxin, unknown in the days of Dr. Johnson's colossal dictionary, may now without exaggeration be said to form part of the vocabulary of every well-ordered household.

But whilst the more striking beneficent results obtained in the study of immunity have become public property, so to speak, a mass of important and most interesting researches remain concealed from the layman's view, locked away, as far as he is concerned, in the pages of divers scientific journals.

Of such researches we may cite those which have relegated the blood-serum of eels to the category of poisons. This remarkable discovery was made as long ago as the year 1888 by A. Mosso,[1] of Turin, who found that the serum of eels, when subcutaneously and intravenously inoculated into animals produced fatal results, although it was quite harmless when introduced *per os.* Half a cubic centimetre of eel-serum inoculated into a dog weighing 14 lbs. killed the animal in seven minutes; and Mosso obtained similarly lethal results in the case of rabbits, guinea-pigs, frogs, and pigeons.

But little further attention appears to have been paid to this subject until Calmette,[2] in 1895, and Phisalix,[3] in 1896, carried out further experiments on the toxic character of such serum from an immunising point of view, and this year we have had quite a crop of memoirs on eel-serum treated from various sides, and our information is consequently greatly extended concerning both the character of this poison and its antidote.

It appears that the toxic effect of this eel-serum varies according to the manner in which it is introduced into an animal, and the different quantities required to produce lethal subcutaneous, intravenous, and intraperitoneal inoculations respectively have been elaborately determined by Maglieri,[4] who states that for every 2-lb. weight of

[1] *Archives Italiennes de Biologie*, vol. x., 1888.
[2] "Venins, toxines et sérums antitoxiques" (*Annales de l'Institut Pasteur*, vol. ix., 1895).
[3] *Comptes rendus de l'Académie des sciences*, 1896.
[4] "Sull'azione tossica immunizzante e battericida del siero di sangue di anguilla." (*Annali d'Igiene Sperimentale*, 1897.)

rabbit employed from ·02 to ·025 c.c. of serum is required in intravenous inoculations, ·4 to ·45 c.c. in subcutaneous inoculations, and ·20 to ·25 c.c. in intraperitoneal inoculations. Héricourt and Richet[1] mention that in their experiments ·1 c.c. intravenously introduced was fixed as the lethal dose of serum for a rabbit weighing 4 lbs.

Wehrmann,[2] however, remarks that it is in reality very difficult to lay down a general law as to the exact quantity of this serum which will constitute a fatal dose, for it not only varies in toxic strength at different times of the year, but in eels of different origin; and it is, therefore, necessary to determine the toxic value of such serum each time a fresh supply is collected.

Before passing on to the experiments which have been carried out on modifying the lethal activity of this eel-serum, and on artificially protecting animals from its toxic action, we may refer to some interesting investigations made by Maglieri (*loc. cit.*) to ascertain whether such serum is endowed with any bactericidal properties. For this purpose tubes containing eel-serum were inoculated with colon bacilli (*B. coli communis*), cholera vibrios, and dipththeria bacilli respectively; after different intervals of time, varying from fifteen minutes up to twenty-four hours, gelatine and broth tubes were inoculated from all the serum-tubes. In every case a positive result was obtained; that is to say, growths of the three different microbes employed subsequently appeared in all the gelatine and broth tubes, indicating that, however lethal this eel-serum may be in regard to animal life, these minute vegetables—or, at any rate, the three varieties above mentioned—enjoy a natural immunity from its toxic action.

The quantity of blood which is procurable from even a large eel weighing about 5 lbs. is very small, never more than 25 cubic centimetres, and this only yields from 10 to 12 c.c. of serum, whilst in the case of vipers a relatively large quantity of blood is obtained. This eel-serum, according to Wehrmann, can be kept in a fit experimental condition for two weeks if stored over ice and in the dark, but Maglieri states that its toxicity declines gradually after the eighth day of its collection even when protected from light.

As regards the artificial modification of the lethal properties of eel-serum, U. Mosso,[3] a brother of the Mosso already referred to, mentions, amongst other devices, that heating the serum to from 68° to 78° C. removed its toxic character. Phisalix (*loc. cit.*) also found that heating it to 58° C. for a quarter of an hour destroyed its toxicity, and that such heated serum was capable of endowing animals with immunity towards ordinary eel-serum, this immunity being, however, of a very transitory character. Wehrmann found that exposing it to this temperature for a quarter of an hour removed the greater portion of its toxic powers, and when animals were inoculated with serum thus treated, a somnolent state, sometimes accompanied by a depression of temperature, followed, but that they recovered their normal condition at the end of from two to three hours, having meanwhile acquired a certain degree of immunity from the effect of ordinary eel-serum inoculations, which was retained for three days. Maglieri found that preserving eel-serum at a constant temperature of only 37° C. for the space of twenty-four hours was sufficient to greatly modify its toxicity. Very interesting is the observation recorded by Wehrmann that by subcutaneously inoculating anti-venomous serum[4] into eels the toxicity of their blood is considerably reduced. Thus an eel weighing about half a pound was inoculated with 5 cubic

[1] *Comptes rendus de la Société de Biologie*, 1897.
[2] "Recherches sur les propriétés toxiques et antitoxiques du sang et de la bile des Anguilles et des Vipères" (*Annales de l'Institut Pasteur*, p. 810, 1897.)
[3] *Archives Italiennes de Biologie*, 1889.
[4] Serum derived from an animal rendered artificially immune to the poisonous action of snake-venom.

centimetres of anti-venomous serum, after twenty-four hours it was killed, and instead of ·2 c.c. of serum sufficing to kill as usual a guinea-pig, ·4 c.c. of this particular eel's serum was required.

In this connection we may quote an observation of Calmette's,[1] made in the course of his classical experiments on the toxic character of the blood of venomous serpents, that the toxicity of the blood of such reptiles may be entirely removed by inoculating them with anti-venomous serum. Thus a large specimen of the *naja tripudians* received a series of anti-venomous serum inoculations, and two weeks after the last inoculation it was killed, and its blood was found to have lost all its toxic character,[2] whilst that of another untreated *naja tripudians* exhibited its customary complement of lethal qualities.

It would be interesting to determine in the case of eels and vipers the relative quantity of anti-venomous serum which is required to remove the toxicity of their blood respectively, for, curiously, the blood of eels is three times more toxic than that of vipers; and whilst the blood of eels acts as a preventive, protecting an animal from the lethal action of vipers' blood, the latter has no corresponding power to protect an animal from the fatal effect of eels' blood.

Of great interest are the numerous investigations which have been carried out by Wehrmann to ascertain the action of various other serums as well as biles of different origin upon this eel-serum. Anti-venomous serum, it appears, acts as an antitoxin towards eel-serum, for it not only protects animals from a subsequent otherwise fatal dose of eel-serum, but if administered even *after* the eel-serum has been introduced into the animal, it nullifies its effect, and the animal lives, whilst it also neutralises the action of eel-serum outside the animal's body *in vitro*. Different varieties of serum did not, however, all operate as successfully as anti-venomous serum. For example, anti-tetanic serum produced no effect upon the toxicity of eel-serum; neither did the normal serums of horses and rabbits. Anti-diphtheritic serum, on the other hand, acted as a preventive, and also neutralised the toxicity of eel-serum *in vitro*, but was not endowed with any curative power in respect to its toxic action.

Wehrmann has next studied the effect produced by bile derived from eels, from oxen, and from vipers, not only on the toxicity of eel-serum, but also on that of viper-serum and viper-venom. Now Fraser (*British Medical Journal*, July 1897) has recently asserted that the bile of serpents and other animals is antitoxic as regards serpent-venom, that it not only has a neutralising action *in vitro*, but that it has also a distinct, although feebly marked, *curative* power in respect to this venom. Fraser mentions the interesting fact, in support of his observations, that in some countries the natives have a practice of administering the bile of a serpent to people who have been very badly bitten by poisonous snakes.

According to Wehrmann, viper-bile has a preventive as well as neutralising action with respect to viper-venom; but he does not say that he has found it to possess, as Fraser has done, a *curative* power. This viper-bile has also a preventive and neutralising action as regards the toxic properties of viper-serum and eel-serum.

Ox-bile, on the other hand, was found to possess no antitoxic action in the doses employed by Wehrmann on viper-venom, neither was it endowed with any preventive or curative powers in respect to eel-serum.

Eel-bile, again, was devoid of all preventive or curative powers in regard to eel-serum and to viper-venom. It was able to neutralise the toxicity of both these toxins *in vitro*, and had a greater degree of neutralising power in respect to the venom than to the eel-serum. Thus, according to Wehrmann, the biles he has employed are not endowed with strictly antitoxic powers, as was claimed for serpent-bile by Fraser, but act apparently as a digestive more than anything else upon the serums and venoms with which they are mixed.

We now come to the experiments which have been carried out on the artificial production of immunity in animals from the toxic action of eel-serum.

Although heated eel-serum can afford protection to animals, yet immunity thus acquired, as we have already seen, is of so temporary a character that this method is not, as a rule, employed. The plan usually adopted by investigators consists in inoculating increasingly large doses, either intraperitoneally or intravenously, of ordinary eel-serum into the animal it is desired to render immune. By this means Maglieri and Wehrmann have both succeeded in immunising rabbits against the effects of ten, twelve, up to twenty (Maglieri) otherwise fatal doses of toxic eel-serum. The period over which the treatment has to be extended is somewhat lengthy before the requisite stage of immunity is reached. Thus, about three months must elapse before a rabbit's serum has acquired the degree of protective power to render it of use for experimental purposes. Héricourt and Richet have succeeded also in immunising a dog against eel-serum, and have obtained a protective serum from this animal.

According to Wehrmann, the serum of a rabbit immunised against eel-serum acts both as a preventive and curative with regard to the serum of vipers, and to the serum of eels, as well as to the *venom* of vipers. This observation supports the opinion frequently expressed by Calmette in his memoirs, that the idea of the specific character of toxins and their antitoxins is not justified by experiment; that, on the contrary, the serums of animals immunised against one poison may be, and frequently are, curative as regards other poisons.

It will be remembered, however, that Calmette's assertion, that the serum of an animal which had attained a high degree of immunity against cobra venom was equally valuable as a remedy against the poison of *all* snakes, has not been supported by other observers; for as regards the venom of the Indian daboia, for example, Cunningham,[1] of Calcutta, has found that Calmette's serum is inoperative, and therefore useless.

C. J. Martin, of Melbourne,[2] has still more recently tested Calmette's serum for antidotal action in the case of the venom of the tiger snake (*Hoplocephalus curtus*) and the venom of the black snake (*Pseudechis porphyriacus*), and in the matter of both these venoms he obtained no antidotal action with Calmette's serum.

Some interesting experiments were also made by Martin to ascertain if Calmette's serum possessed antidotal action in respect to one of the two proteid constituents to which, according to Mitchell and Reichert,[3] the venoms of snakes are supposed to owe their poisonous properties. Apparently, if the serum is introduced under the most advantageous circumstances, *i.e.* injected in considerable quantities directly into the circulation before the poison (in this case *one* of the proteids separated out from the venom of the Australian tiger snake is inoculated), the serum exhibits decided protective properties; but the immunity thus produced is so slight, that Martin is of opinion that it is practically valueless as a remedial agent, even against one only of the poisonous

1 "Contributions a l'étude des venins des toxines et des serums antitoxiques." (*Annales de l'Institut Pasteur*, vol. ix., 1895.)

2 The toxic properties of the *venom* of this *naja tripudians* were not in any way affected, indicating, as Calmette points out, that the lethal principle of which the venom consists is not elaborated in the blood, but in the cells of the venom glands of poisonous reptiles.

1 "Scientific Memoirs, by Medical Officers of the Army of India," vol. ix., 1895.

2 "The Curative Value of Calmette's Anti-Venomous Serum in the Treatment of Inoculations with the Poisons of Australian Snakes" (*Intercolonial Medical Journal of Australasia*, August 1897).

3 "Researches upon the Venoms of Poisonous Serpents" ("Smithsonian Contribution to Knowledge," vol. xxvi., 1886).

constituents of this venom. It is only just to Calmette to add that Martin's criticism, of course, only applies to the serum as he was able to obtain it as imported into Australia; and Martin himself is careful to add that the specimens he had access to were only possessed of very feeble powers.

Wehrmann's valuable memoir, to which we so frequently have referred in the foregoing brief *résumé* of some of the latest contributions to the ever-increasing domain of preventive medicine, is a record of experiments carried out under the inspiration of Calmette in the Institut Pasteur at Lille. It is full of experimental data, and no attempt is made to formulate theories on the facts recorded, only at the close the following suggestion is to be found:—"Enfin nous voyons que les sérums des animaux immunisés contre l'un quelconque des poisons que nous avous étudiés sout fréquemment curatifs à l'égard des autres.

"Ces phénomènes d'action réciproque préventive, neutralisante *in vitro* et curative, apportent un argument de plus en faveur de la théorie cellulaire de l'immunité. . . . Il faut bien en conclure que la notion de spécificité des toxines et des sérums antitoxiques est loin d'être aussi étroite qu'on l'avait cru jusqu'à ces derniers temps." G. C. FRANKLAND.

THE RECENT PERSEID METEORIC SHOWER.

THIS display appears to have been of rather a special character on August 11, and to have attracted a considerable amount of attention. At any rate, during the thirty years in which I have witnessed returns of the shower, I have never known it to have been so generally observed. Many people, quite unaware that such a phenomenon was in progress, on looking up and admiring the singular beauty of the night, noticed the meteors. They were so numerous and occasionally so brilliant that they were watched for a considerable time.

Usually the maximum of the shower occurs on August 10, but on that date the atmosphere was, on the whole, unfavourable this year, and at the majority of stations not many Perseids appear to have been observed. The following evening came in under vastly improved conditions, the stars shone with remarkable lucidity, and it was quite an ideal night for the observation of meteors. To this circumstance, and to the fact that the shower was really a strong one, perhaps coming a little later than usual, is to be ascribed its marked prominence.

In the twilight at 8h. 58m. a splendid meteor brighter than Jupiter was seen in the S.S.W. sky, moving very slowly and almost horizontally westwards amongst the stars of Ophiuchus and Serpens. It threw off a thick train of yellow sparks, but, when near ϵ Serpentis, the nucleus, after a sudden accession of brilliancy, collapsed, and I thought the whole thing had vanished until, in the same direction of motion, a star-like fragment became visible and travelled some 8° further. It moved very much slower than the earlier and brighter part of the meteor had done, and looked like a mere spark sailing along on the wind. This meteor was also observed at Slough and other places, and it will be possible to obtain some interesting deductions respecting it. It was manifestly not a Perseid; its leisurely flight being directed from the region of Pisces and Aquarius.

At 10 p.m. I began watching the eastern sky, and immediately found that the Perseids, with their swift motions and phosphorescent streaks, were in strong evidence. During the $4\frac{1}{2}$ hours ending 2.30 a.m. on August 12 I saw 106 of them, but I believe that a continuous watch of the sky would have enabled twice this number to have been counted. Whenever bright meteors appeared, or others were observed with great exactness, they were carefully registered; and during these intervals, when attention was distracted from the sky, many Perseids must have escaped my notice. I think that one observer might have counted quite 50 meteors per hour in an uninterrupted view of the sky on the night of August 11.

I endeavoured to ascertain the position of the radiant point as precisely as possible, and obtained it at hourly intervals from the best observed paths in the region immediately surrounding it. The results were as follow:—

	h. h.	Radiant. ° °	
Aug. 11,	10 to 11	47 + 58	21 meteors
,,	11 to 12	$46\frac{1}{2}$ + 58	22 ,,
,,	12 to 13	46 + 57	20 ,,
,,	13 to 14	46 + $57\frac{1}{2}$	18 ,,

The mean is at $46°.4 + 57°.6$, which I believe is well within 1° of probable error. The centre was defined with tolerable sharpness, for all the registered paths intersect within an area of about 4° diameter.

Some conspicuous meteors were observed during the night, though no really large fireballs appeared. It may be advisable to give the apparent courses of the brighter objects, for some of them must certainly have been seen by other observers, many of whom were watching the sky on the same night.

G.M.T.	Mag.	Path		Length of path.
		From	To	
h. m.		° °	° °	°
8 58	> ♃	259 − 2	231 − $1\frac{1}{4}$	28
10 9	1	56 + 64	65 + 67	5
10 16	♃	200 + $61\frac{1}{2}$	206 + $44\frac{1}{2}$	17
10 45	♃	$240\frac{1}{2}$ + $62\frac{1}{2}$	237 + 47	$15\frac{1}{2}$
10 49	1	$37\frac{1}{2}$ + 66	30 + $70\frac{1}{2}$	5
10 57	> 1	21 + 26	16 + $11\frac{1}{4}$	$15\frac{1}{2}$
11 12	1	359 + $78\frac{1}{2}$	$295\frac{1}{2}$ + $77\frac{1}{4}$	13
11 26	> 1	$12\frac{1}{2}$ + 15	7 + $0\frac{1}{2}$	$15\frac{1}{2}$
11 35	1	50 + 67	54 + 71	$4\frac{1}{2}$
12 $15\frac{1}{2}$	1	$27\frac{3}{4}$ + 37	25 + $30\frac{1}{2}$	7
12 $19\frac{1}{2}$	1	$2\frac{1}{2}$ + $57\frac{1}{2}$	348 + 54	9
12 $23\frac{1}{2}$	♃	$14\frac{1}{2}$ + 29	6 + 13	$17\frac{1}{2}$
12 39	1	$13\frac{1}{2}$ + 19	9 + 8	12
13 11	♃	$20\frac{1}{2}$ + 1	18 − 11	$12\frac{1}{2}$
13 29	> 1	46 + 31	46 + 19	12

With the exception of the first, all these were Perseids.

It is satisfactory to note that reports from other quarters show that the display was very successfully observed. Prof. Herschel, at Slough, describes the rate of appearance and general brightness of the meteors on the night of August 11 as considerably greater than on other dates, and mentions having mapped 80 observed paths between $10\frac{1}{2}$h. and 14h. Four of the Perseids observed at Bristol were also recorded by him at Slough, and he finds their radiants very definitely and distinctly marked at about 46° + 58°.

At Paris, it appears that very favourable conditions prevailed on August 10, so that Mlle. Klumpe, at the Observatory, succeeded in observing 200 shooting stars. The display is stated to have begun at sunset and to have continued with "amazing rapidity" until sunrise. It is estimated that altogether at least 600 shooting stars were noticed. W. F. DENNING.

NOTES.

THE proposal made at the Toronto meeting of the British Association last year, for a marine biological station in the Dominion of Canada, is taking practical shape. Such a proposal has been in the minds of Canadian biologists for many years, and Prof. Prince, the Dominion Commissioner of Fisheries, reported at length upon the necessity for such a marine station for Canada in the Marine and Fisheries Blue Book, 1894, and the Royal Society of Canada also urged the importance of the matter; but it was not until the British Association appointed a Committee consisting of Prof. E. E. Prince (Ottawa), Chairman; Prof. Penhallow (Montreal), Secretary; and Prof. A. B. Macullum (Toronto), Prof. John Macoun (Ottawa), Prof. Wesley Mills (Montreal), Prof. E. W. MacBride (Montreal), and Dr. W. T. Thiselton-Dyer, that active steps were taken to carry cut the scheme. An influential deputation waited upon the Hon. Sir Louis Davies, Minister of Marine and Fisheries, in April last, and during the recent session of the Canadian Parliament a vote of 3000*l.* was practically sanctioned, 1400*l.* being granted for the year 1898–99. A Board of Management has been chosen as follows: Prof. E. E. Prince (nominated by Sir Louis Davies to represent the Department of Marine and Fisheries) to act as Director, Profs. Penhallow, MacBride (McGill University), Ramsey Wright (Toronto University), L. H. Bailey (New Brunswick University), Rev. F. A. Huart (Laval University, Quebec), and members from Queen's University, Kingston and Dalhousie University, Halifax, Nova Scotia.

IN the death, on August 7, of Prof. James Hall, of Albany, the United States loses its most distinguished geologist at the ripe age of eighty-seven. Born at Hingham, Massachusetts, on September 12, 1811, James Hall became attached to the study of natural history in early life, and gained much instruction at the Polytechnic Institute at Troy. In 1836 he was appointed one of the geologists on the Cadastral Survey of the State of New York, and was charged later on with the palæontological work. Eventually he became State Geologist and Director of the Museum of Natural History at Albany. His published papers date from 1836, and he is the author of numerous reports on the geology and palæontology of various portions of the United States and Canada. His chief work has been the description of the invertebrate fossils of New York, a work comprising eight quarto volumes published 1847–94. Forty years ago he was awarded the Wollaston Medal by the Council of the Geological Society of London, and it was then pointed out how he had shown that the organic remains of the earliest rocks in America bore strong resemblance to those of this country. Ten years previously (1848), he had been elected a Foreign Member of the same Society. Prof. Hall was a man of great energy and untiring industry, and only last year he journeyed as far as St. Petersburg to take part in the meeting of the International Geological Congress.

AN appeal which should be given the active and generous support of the scientific world has been made by Dr. F. T. Bond, of Gloucester, Secretary of the Jenner Society. The Vaccination Bill, which received the Royal Assent on Friday last, makes it incumbent upon those who believe in vaccination to establish an organisation which will systematically defend it against the assaults of anti-vaccinatists. "It was to carry on this work" (explains Dr. Bond) "that the Jenner Society was established more than two years ago, in the year of the Jenner centenary, both as a memorial of that great investigator and as a means of meeting the agitation against vaccination which the Anti-Vaccination League had for so many years been, without opposition, carrying on. During that time the Society has distributed a large amount of literature; it has procured the insertion in newspapers in all parts of the country of some hundreds of articles and letters in reply to the correspondents whom the Anti-Vaccination League maintains to disseminate its views; it has organised two important manifestoes on the subject of vaccination, one from the medical officers of health of the country, and the other from the county of Gloucester, and it has done its best to promote the emendation of the Vaccination Bill. Want of funds alone restricts its efforts. It has a large amount of instructive material ready for publication and circulation, which it cannot bring forward for want of means, and if it had not been for the liberality of the representatives of the medical profession it could not have carried on its work at all. If that work is to be maintained and extended, as it ought to be, the non-medical public must support it with at least as much liberality as the opponents of vaccination have hitherto subsidised the Anti-Vaccination League." It is to be hoped that this appeal will meet with every encouragement, so that the Society shall be able to make its operations felt over an extensive field.

THE fiftieth anniversary of the foundation of the American Association for the Advancement of Science will be held next week at Boston. The meeting promises to be a very successful one, and a large number of papers have been received for reading in the various sections. The general programme has already been described in NATURE (July 7), but a few new items may be referred to here. In the Section of Chemistry the papers will be taken in groups as follows:—Analytical Chemistry, led by Dr. P. De P. Ricketts, Columbia University; Teaching of Chemistry, Dr. F. P. Venable, University of North Carolina; Inorganic Chemistry, led by Dr. H. L. Wells, Yale University; Organic Chemistry, Dr. Ira Remsen, Johns Hopkins University; Physical Chemistry, Dr. T. W. Richards, Harvard University; Physiological Chemistry, led by Dr. E. E. Smith, New York; Agricultural Chemistry, led by Dr. H. A. Weber, Ohio University; Technical Chemistry, Dr. N. W. Lord, Ohio State University. The Section of Mathematics and Astronomy is to be favoured with the following reports on recent progress (accompanied with statements of some of the "standing problems"), prepared on the special invitation of the officers and committee, "with a view to obtaining at this anniversary meeting such a survey of the field as may lead to a possible co-operation of effort": Report on the recent progress in the dynamics of solids and fluids, by Dr. Ernest W. Brown; report on theory of invariants—the chief contributions of a decade, by Prof. Henry S. White; Report on the recent progress in the mathematical theory of electricity and magnetism, by Prof. Arthur G. Webster; Report on the modern group-theory, by Dr. G. A. Miller; meteorology from a mathematical and physical point of view, by Prof. Cleveland Abbe. There will be several joint meetings of sections for the discussion of subjects of mutual interest, and every effort is being made to make the meeting worthily commemorate the Association's jubilee, and at the same time advance the interests of science in the United States.

THE retirement of Prof. J. R. Eastman, of the United States Naval Observatory, is announced in *Science*. Prof. Eastman has been continuously connected with the observatory since 1862.

THE death is announced of M. J. M. Moniz, known by his investigations of the natural history of Madeira, where he died on July 11 at the age of sixty-six.

DR. WILLIAM PEPPER, of Philadelphia, the author of many works on medical and other scientific subjects, died a few days ago. Dr. Pepper was prominent in many of the public institutions in Philadelphia, and did much to assist scientific, educational and medical progress in that city.

WE regret to see the announcement of the death of Mr. J. A. R. Newlands, to whom belongs the credit of the discovery of the periodic relations between the atomic weights of the elements. In the year 1887 Mr. Newlands was awarded the Davy Medal of the Royal Society in recognition of his work.

The death is announced, at Oran, of a distinguished French mining engineer, M. Pomel. He was professor of geology at the Algiers Scientific School, director of that school from 1883 to 1888, and ex-president of the French Geological Society. M. Pomel leaves a number of special works, among which may be mentioned "Le Sahara" and "La Carte Géologique de la Province d'Oran."

The young male giraffe from Senegal, which was one of the latest additions to the menagerie in the Zoological Society's Gardens, has just died. This rare animal cost the large sum of 900*l.*

A Reuter telegram announces that the screw schooner *Godthaab* sailed from Copenhagen on Wednesday morning for Angmagsalik, in East Greenland, with an expedition under First Naval Lieutenant Amdrup. The expedition, which has been fitted out by a scientific institute at a cost of 150,000 kroner, is provisioned for two years. Its object is to explore the east coast of Greenland between the 66th and 70th degree north latitude, with Angmagsalik as its starting-point.

During the latter part of the last, and the beginning of the present week, some high shade temperatures have been recorded over the southern and central parts of England. The weather conditions have been generally anti-cyclonic, the barometer standing at about 30·5 inches over the eastern half of the Baltic, and exceeding 30 inches over the Continent and the south-east of England, with very little differences in the readings over considerable areas. On the 12th the shade temperatures at several stations varied from 80° to 85°, and these readings have been since reached or exceeded, 87° having been registered on several days in the neighbourhood of London, while in the sun's rays the thermometer has exceeded 140°. During the night of the 15th and 16th a sharp thunderstorm occurred over the south-eastern parts of England and in Yorkshire; but the rainfall reported to the Meteorological Office was nowhere heavy, the greatest amount (0·4 inch) being registered in Yorkshire.

A new genus, *Limnocarpus*, has been founded by Mr. Clement Reid for the fruit of an aquatic plant, which occurs throughout the Oligocene strata of the Hampshire Basin (*Journ. Linnean Soc.*, vol. xxxiii.). The type-specimens of this plant, which is allied to *Potamogeton* and *Ruppia*, were obtained from the Lower Headon beds of Hordle cliff.

The address delivered by M. Grimaux at the recent meeting of the French Association for the Advancement of Science at Nantes is printed in full in the *Revue Scientifique* of August 6. The subject of the address was "La Chimie des infiniments petits"—the new chemistry which was founded by Pasteur, who demonstrated that a host of obscure reactions are due, directly or indirectly, to micro-organisms. M. Grimaux indicated some of the chief results obtained in this branch of scientific inquiry, and pointed out the main features of the work of Pasteur and of the host of disciples who are developing, extending, and completing the work of the master. The meeting at which M. Grimaux was to have delivered the address was unfortunately marred by the expression of hostile public feeling against the distinguished president of the Association, on account of the position he had taken in a case which has lately caused much commotion in France. At the opening ceremony of the Association, M. Grimaux was unable to deliver his address, so violent and noisy were the manifestations against him. Finally, the address was delivered before members of the Association in one of the local schools, to which the public were not admitted. It is deeply to be regretted that a man of scientific distinction and high reputation should have received such an unpleasant reception merely on account of his support of M. Zola in the protest against the sentence on ex-Captain Dreyfus. The words used by M. C. A. Laisant, the secretary of the Association, in concluding his report upon the work and progress of the year, should have been taken to heart by that section of the Nantes public which have brought discredit upon the city by the recent manifestations; they are:—"Soit dans l'étude de ces questions si importantes pour l'intérêt du pays tout entier, soit dans les excursions qui charmeront les uns par l'attrait de la nouveauté ou qui rappelleront à d'autres les souvenirs de leur jeunesse, soit enfin dans vos travaux de sections, consacrés à la science pure, vous vous sentirez de plus en plus attachés à notre chère Association, qui nous rapproche tous dans un culte commun de la vérité, et qui nous permet d'oublier en passant les divisions et les discordes, trop fréquentes, hélas! parmi les hommes, en dehors du monde de la science."

A number of members of the French Association were the recipients of honours during the year covered by the report presented by the Secretary to the recent meeting at Nantes. Among the nominations to professorships are:—M. Maquenne, as professor at the Muséum; MM. Moussous and Denigès, as professors at the Faculté de Bordeaux; MM. Bordier, Broca, Launois and Sambuc, as Fellows of the Faculty of Medicine; MM. Bourquelot, Perrier, Peyrot, Richer and Richet, as members of the Academy of Medicine; and M. Schlagdenhauffen, as associé libre. In the Order of the Légion d'honneur the dignity of Grand Officer was conferred upon MM. Dislère and Himly, de l'Institut; the grade of Commander upon Colonel Renard; the grade of Officer upon MM. Chavanon, Claude Lafontaine, Dubar, Faisans, H. Filhol, Ch. Gauthiot, Dr. Hayem, G. Payelle, Dr. Raymond, Georges Rolland, and Dr. Zaepffel. Among the Chevaliers the Secretary mentions MM. Arnavon, Dr. Barth, Blin, Arth, Boudin, Fernand Faure, A. Gatine, Jules Grouvelle, Dr. Heydenreich, Lebois, Macé de Lépinay, Dr. Alf. Marchand, E. A. Martel, A. Molteni, Pralon, Dr. Jean Rivière, A. Taillefer, Dr. J. Teissier, and Aug. Wallaert. Among the lauréats de l'Académie des sciences, the names are mentioned of Beauregard (prix Godard), Bourquelot (prix Montagne), André Blondel (prix Planté), Durante and Henri Meunier (prix Lallemand), Gaucher and Rémy (prix Montyon), Hébert (prix Cahours), P. Pruvot (prix Bordin), Paul Sabatier (prix Lacaze), Joseph Vallot (grand prix des sciences physiques), Gosselet (prix d'Ormoy). In the Academy of Medicine prizes have been awarded to MM. Censier, Denigès, Destot, Ducor, Grasset, Hallion, Lalesque. This list shows that the Association numbers many active investigators among its members.

The publications of the Royal Alfred Observatory, Mauritius, have been distributed somewhat irregularly, and most European libraries have only incomplete sets. The announcement in *Symons's Monthly Meteorological Magazine*, that, for convenience of distribution, all surplus copies have been sent to Mr. G. J. Symons, F.R.S., ought, therefore, to be widely known. A list of the publications available is given in that magazine, and applications for any of them should be sent to Mr. Symons, 62 Camden Square, London, N.W., by October 15, when the remaining copies will be allotted.

The University of Upsala continues to issue a well-printed and well-illustrated *Bulletin* of its Geological Institution. In part 2 of its third volume the *Bulletin* deals with a variety of topics relating to Swedish geology: with graptolites, corals, and mammals; with minerals and mineral veins, and with subjects of chemical and structural geology. A paper by

H. Munthe treats of the vexed question of the interglacial submergence of Great Britain; and being printed in English, it will more readily attract the attention of British geologists. The author first deals with the marine clay at Cleongart, on the western coast of the Mull of Kintyre; and he shows that the idea of the mixed character of the fauna, both as to climate and bathymetrical conditions, arose from considering the fauna generally, whereas in reality there is a distinct series of layers which were deposited under different conditions. He regards the strata as *in situ*, and as indicating a maximum submergence of over 300 feet. He gives reasons, also, for believing that the marine clay at Clava, near Inverness, is likewise a marine deposit *in situ*, and that it indicates a submergence of at least 540 feet. In other localities in Great Britain and Ireland he is disposed to think that certain shelly gravels may have been transported by an ice-sheet from lower to higher levels.

THE water question being temporarily in abeyance, the London County Council have employed the interval in issuing a report on the "Bacteriological examination of London crude sewage." It only purports to be an introduction to reports on experiments which are in progress on the filtration of sewage through coke, and contains nothing of significance from a scientific point of view. The flora of sewage has been repeatedly studied before, and that the *B. coli communis* is present in great numbers is hardly news to those acquainted with the subject; on the other hand, some of the statements made are liable to a highly misleading interpretation. We would especially refer to the remark that the presence of the *B. coli communis* in water may be regarded as a "bacteriological method of detecting the pollution of water with minimal quantities of sewage which is of very great delicacy." This organism is, like the poor, always with us, and that its presence is necessarily due to the access of sewage is a quite unwarranted assumption. Again, because a liquid contains bacteria capable of liquefying gelatine, does it follow that this liquid is "also rich in ability to dissolve solid or suspended organic matter"? To justify such statements more than words are necessary, and in a scientific report surely experiments should take precedence of conclusions. Experiments on coke filters in relation to sewage treatment are being vigorously prosecuted in various parts of the country, and the London County Council are showing their appreciation of the importance of the question in likewise directing investigations in this direction; and we trust that the united efforts of so many independent bodies will ultimately yield data which will materially lessen the stupendous difficulties now surrounding the satisfactory disposal of sewage.

THE Deutsche Seewarte has issued its twentieth yearly volume of *Aus dem Archiv*, for 1897. Among the various investigations, which are always of a painstaking and valuable character, we would refer to one by Dr. Neumayer and Dr. v. Hasenkamp, entitled "Anemometer Studies." The results confirm those obtained by Mr. Dines and others, with regard to the high values recorded by the Robinson cup-anemometer, and also show that anemometers of similar pattern and size cannot be depended upon to give precisely similar records, but that the constants of each individual instrument must be separately determined. Another important discussion, by Dr. G. Schott, refers to the "bottle-notices" collected by the Seewarte up to the end of the year 1896. The drift of 643 bottles has been examined, and with one or two exceptions the routes have been plotted on charts. Some of the tracks taken are very interesting, and go to disprove the statement sometimes made that the bottles are driven by the prevalent winds. Some instances are given showing that the bottles follow even a weak current, against the wind. About seventy per cent. of the notices refer to the North Atlantic ocean.

IN *Das Wetter* for July, Dr. R. Hennig, of Berlin, concludes an interesting investigation of the well-known "cold days" of May, which has appeared in the last four numbers of that journal. In carrying on the discussion the author has examined all the weather charts for the last twenty years, and has given a summary of the special conditions in each of those years. The principal results are arrived at are: (1) That the "cold days" are, with rare exceptions, a yearly recurring phenomenon, but by no means affect the same parts of Europe. (2) The period of the occurrence varies considerably. It may embrace the whole month, but most frequently takes place during the second decade, and mostly lasts for three or four days. (3) The phenomenon generally commences during the occurrence of stormy north-west winds, accompanied with frequent showers of rain, snow or hail. Night frosts and formation of hoar frost sometimes occur during the early period of this unsettled weather, but generally take place after the passage of areas of low barometric pressure. (4) During this cold period an extensive area of high barometric pressure obtains over the ocean adjacent to the western or north-western shores of Europe. This subject has engaged the attention of meteorologists for a number of years, and among the various investigations we would especially refer to those of Dove in 1856, and v. Bezold in 1882.

IN consequence of the great development which the study of earthquakes has received in Europe, and especially in Italy, during the last ten years, the need has been felt of a journal devoted exclusively to seismology. Accordingly, in the beginning of 1895, Prof. Tacchini, the well-known Director of the Central Office of Meteorology and Geodynamics at Rome, founded the Italian Seismological Society. Three volumes of the *Bollettino* published by the Society are now complete. Their value will be evident from the notes which we have inserted from time to time. Besides the important notices of earthquakes recorded in Italy, the three volumes contain altogether seventy-six papers, chiefly on earthquakes, though the active volcanoes of the country receive a large share of attention. Most of the papers are in Italian, but a few are written in French; and, as those in other languages are also admissible, it is evident that the *Bollettino* possesses an international character. The Society has at present fifty-three Italian and foreign members, and stands in need of a considerable increase in their number, in order that its usefulness may be maintained and extended.

THE Report of Mr. W. E. Hoyle, Keeper of the Manchester Museum, Owens College, shows that much useful work was accomplished during the year 1897-8 in spite of inadequate funds. Specimens of minerals and fossils which could be spared were arranged by Mr. H. Bolton in sets and presented to schools in which they will prove of service. Series of short addresses upon natural science topics were given on Saturday and Sunday afternoons, and were so successful that similar lectures will be delivered during the ensuing session. A museum which carries on work of this character, in addition to publishing useful handbooks—one on the nomenclature of the seams of the Lancashire Lower Coal Measures, by Mr. Herbert Bolton, is now before us—and furnishing material to aid naturalists in their investigations, ought to be given every encouragement. In regard to the acquisition of specimens, Mr. Hoyle points out that the sum of 75*l*. a year, which has for some time been allotted for this purpose, is absurdly inadequate for the principal museum of the city of Manchester, especially when compared with the sum of 2000*l*. expended in the same manner by the city of Liverpool. The Free Library Committee of the Manchester Corporation has shown its appreciation of the work of the Museum by contributing the sum of 400*l*. per annum towards its maintenance, but beyond this no assistance is received from the Corporation. The sum expended on the Manchester Museum, including special donations, is only 2785*l.*, whilst the neighbouring city of Liverpool spends 5700*l.* Bearing this comparison in mind, the citizens of Manchester would do well to consider the following words of a recent American writer on the subject of museums referred to by Mr. Hoyle:—"It is not too much to assert that the level reached in intelligence and organisation by any community may be gauged most accurately by the attention and support afforded to its museums."

THE fifth edition of Mr. L. Cumming's "Electricity treated Experimentally" has just been published by Messrs. Longmans, Green, and Co. A few slight additions and alterations have been made to this useful little work, in order to bring it into touch with the present state of knowledge of the subjects surveyed in it.

THE May number of the *Journal of the Federated Institutes of Brewing* contains an interesting paper on the water supplies of Yorkshire, by Mr. Thomas Fairley. The great variety of waters existing in Yorkshire is remarkable, even when the size of the county is taken into consideration. Mr. Fairley classifies them in convenient tables, and makes useful comments on their origin and properties, both from the hygienic and technical point of view.

IN reference to recent discussions and decisions on the vaccination question, it will be of interest to note that Messrs. Macmillan and Co., Ltd., have now in the press, and will publish early in the autumn, the Milroy lectures on "Vaccination, with special reference to its natural history and pathology," by Dr. Monckton Copeman, Medical Inspector to the Local Government Board, whose name is so widely and favourably known in connection with the new glycerine treatment of vaccine, the use of which is prescribed in the Bill which has now been approved by both Houses of Parliament.

DR. W. GROSSE, of Bremen, has written a small book entitled "Der Aether und die Fernkraefte," compiled from various sources, as a short history of the more recent developments of the researches of Hertz and Roentgen. The remarkable stimulus to scientific investigators produced by the publication of Roentgen's great discovery is indicated by the fact that within a few months the *Beiblätter* was devoting no less than eighty pages per volume to X-rays. "Telegraphy without wires" is treated of by Dr. Grosse with a brave attempt to do equal justice to all who have, or think they have, priority.

"ASTRONOMY for the Young" (London: G. Stoneman, 1898) is the title of a small book of sixty-two pages by Mr. Thynne Lynn. The author describes in very popular and elementary language a few general notions about the earth, her satellite the moon, the sun, the planets, comets and meteors, and lastly the stars, giving the young reader a general notion, in a few words, of the bodies which we see in the heavens by day and night. The book is simply written, and few, if any, technical terms are used, so that it is well adapted to the readers for whom it is intended. Perhaps it might have been better to have omitted the illustration on p. 31, displaying the "phenomena of the heavens;" as a rainbow, halo, aurora, waterspout, a lightning flash, &c., are all jumbled up together, and are more inclined to puzzle than enlighten a young reader.

MR. A. H. EVANS'S volume on "Birds," for the Cambridge Natural History, is now so well advanced that Messrs. Macmillan and Co. hope to publish it in the course of September. With few exceptions the illustrations have all been specially drawn for the book by Mr. Lodge, and engraved on wood by O. Lacour. The treatment of the subject throughout is systematic, and the author has taken special pains to describe each bird so minutely that a naturalist or sportsman in the field will have no difficulty in identifying any specimen. The next volume to appear will be the completion of Dr. Sharp's admirable treatise on insects. This may be looked for not later than January.

THE *Revue Scientifique* for July 30 contains a summary of M. Berthelot's recent researches on the relations existing between the energy of light and chemical energy. M. Berthelot's leading idea is that the true chemical equivalent of light energy can only be measured by means of an endothermic irreversible reaction—that is to say, by a reaction which progresses with absorption of energy, and with the formation of products which cannot re-combine spontaneously under the circumstances of the experiment. These conditions exclude many actinometric methods hitherto used. Thus a mixture of hydrogen and chlorine cannot be employed, for in this case the action induced by light is exothermic; the energy liberated is not that which has been received as light, but is almost wholly due to the chemical energy pre-existing in the uncombined hydrogen and chlorine. Photographic actinometers are also excluded for the same kind of reason, as well as from the fact that in some cases the products of the reaction tend to re-combine. Thus metallic silver or silver subchloride and free chlorine produced by the action of light on silver chloride can re-combine spontaneously. The reactions studied by M. Berthelot are the decomposition of nitric acid into nitrogen peroxide, oxygen and water, and the decomposition of iodic acid, hydriodic acid, and oxide of mercury respectively into their elements. It was observed incidentally that the more refrangible rays only are effective in the cases of nitric and hydriodic acid, and that in the decomposition of hydriodic acid a periodide of hydrogen is formed intermediately. Carbon dioxide, and a mixture of carbon monoxide and oxygen were not affected by exposure to sunlight. M. Berthelot is engaged in a deeper study of the energy relationships.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. H. Page; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. C. E. Bashall; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. M. Titford; a Smooth-bellied Snake (*Homalosoma lutrix*), a Rufescent Snake (*Leptodira hotambaia*), two Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), five Crossed Snakes (*Psammophis crucifer*), three Puff Adders (*Bitis arietans*) from South Africa, presented by Mr. J. E. Matcham; two Pinche Monkeys (*Midas œdipus*) from Columbia; a Grey Parrot (*Psittacus erithacus*) from West Africa, deposited; two Three-toed Sloths (*Bradypus tridactylus*) from British Guiana, purchased; an Humboldt's Lagothrix (*Lagothrix humboldti*) from the Upper Amazons, a Red-backed Saki (*Pithecia chiropotes*) from Guiana, received in exchange.

OUR ASTRONOMICAL COLUMN.

WOLF'S COMET.—The following is a continued ephemeris for this comet, the positions being stated for Berlin midnight:—

	R.A. h. m. s.	Decl. ° ′	Br.
August 18	5 13 12	+15 20	2·49
22	22 52	14 29	2·50
26	32 13	13 36	2·53
30	5 41 13	+12 39	2·55

On June 18, Prof. Hussey, who rediscovered the comet on the previous day with the Lick 36-inch refractor, found the comet an easy object with the 12-inch telescope (*Ast. Jour.*, 439).

FALL OF A METEORITE IN BOSNIA.—A correspondent has sent us the following extract from the *Foreign Office Annual*, 1898 (No. 2167, "Trade of Bosnia and the Herzegovina for the year 1897," p. 7):—It may be interesting to mention that shortly before noon on August 1 last year a large meteorite fell at Zavid near Rožanj, in the district of Zvornik. Unfortunately, as soon as it cooled, peasants of the neighbourhood knocked off pieces of it, but about 80 per cent. of the mass remained. It buried itself a yard deep in the ground, with the so-called breast uppermost. Eye-witnesses of its fall say that it was accompanied by a noise like thunder, lasting several minutes and audible a long way off. It left a fiery streak behind, which a short way above the horizon divided in two, and above this streak or tail was a thick cloud of smoke. This meteorite is now in the museum of this town, and measures 55 by 35 by 28 centims. It was broken by the fall in several pieces, but has been joined together again. This is the first aerolite which has been found in Bosnia.

THE NEW OBSERVATORY AT HEIDELBERG.—The opening of the new observatory at Heidelberg, on June 20, is an event of no little importance, more especially as the instrumental equipment is designed for the pursuit of both of the great branches of astronomy. The astrometric department is in the capable hands of Prof. Valentin, who, in addition to more purely scientific problems, is charged with the determination of time and its communication to the railways and various other establishments. The most important instrument is a meridian circle by Repsold, of 6 inches aperture.

Prof. Max Wolf, who has achieved such brilliant success in celestial photography, is in charge of the astrophysical work of the observatory, and we are glad to know that the buildings have been specially arranged to facilitate the continuation of his researches. The equatorial, which has served Prof. Wolf so well, is placed under a dome of nearly 18 feet diameter, the construction of which is so perfect that it can be turned completely round in 8 seconds. Another dome of nearly 20 feet diameter will shelter the astrophotographic instrument, which the observatory will owe to the generosity of Miss Bruce. The lenses for this instrument are being made by Brashear.

AN ASTRONOMER'S REMINISCENCES.—In the first of a series of "Reminiscences of an Astronomer," which Prof. Simon Newcomb contributes to the August number of the *Atlantic Monthly*, several incidents and opinions of interest to astronomers are related. Referring to Cayley, Prof. Newcomb says: "His life was that of a man moved to investigation by an uncontrollable impulse; the only sort of man whose work is destined to be imperishable." After a short description of the work of Leverrier and Adams, which led to the discovery of Neptune, we read: "Adams's intellect was one of the keenest I ever knew. The most difficult problems of mathematical astronomy and the most recondite principles that underlie the theory of the celestial motions were to him but child's play." Airy is regarded as "the most commanding figure in the astronomy of our time. He owes this position not only to his early works in mathematical astronomy, but also to his ability as an organiser." Experience in the United States led Prof. Newcomb to anticipate a difficulty in getting the various telegraph stations between Gibraltar and Greenwich connected for longitude operations, and in discussing the work he asked Airy how the connections could be made from one end of the line to the other, at the same moment. "Nothing is simpler," replied Airy. "I set a moment, say eight o'clock Greenwich mean time, at which signals are to commence. Every intermediate office through which the signals are to pass is instructed to have its wires connected in both directions exactly at the given hour, and to leave them so connected for ten minutes, without asking any further instructions. At the end of the line the instruments must be prepared at the appointed hour to receive the signals. All I have to do here is to place my clock in the circuit and send on the signals for ten minutes commencing at eight o'clock. They are recorded at the other end of the line, without further trouble." This incident is a good lesson in astronomical method.

THE FORTHCOMING INTERNATIONAL CONGRESS OF ZOOLOGY.

THE following is the programme of the fourth International Congress of Zoology, which begins at Cambridge on Monday next, under the patronage of H.R.H. the Prince of Wales, and the presidency of the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S.:—

The Reception Room (Masonic Hall, Corn Exchange Street) will be open from 9 a.m. to 7 p.m. on Monday, August 22, and on the four following days; and from 9 a.m. to 1 p.m. on Saturday, August 27.

Monday, August 22, 9 p.m. to 11 p.m.—Reception at the Guildhall by the Mayor of Cambridge. Members of the University and of the Town Council are requested to wear gowns; Doctors and Aldermen, scarlet.

Proceedings of the Congress.

Tuesday, August 23, 10.30 a.m., at the Guildhall.—Opening of the Congress by the President. Election of officers. Receipt of reports of Committees appointed by the third Congress, and other business. 2 p.m.: Meetings of the Sections.

Note.—The Sections will be: (*a*) General Zoology, at the Guildhall (No. 1 on the plan of the museums on the members' tickets); (*b*) Vertebrata, in the Lecture Room of the Cavendish Laboratory (No. 2 on the plan); (*c*) Invertebrata (except the Arthropoda), in the Lecture Room of the Chemical Laboratory (No. 4 on the plan); (*d*) Arthropoda, in the Lecture Room of Comparative Anatomy (No. 6 on the plan). 5.50 p.m.: Organ recital in King's College Chapel. 9 p.m. to 11 p.m.: Reception by the Vice-Chancellor at Downing College.

Wednesday, August 24, 10.30 a.m., at the Guildhall.—General meeting of the Congress to discuss the position of sponges in the animal kingdom. The discussion will be opened by Prof. Yves Delage, of Paris, and Mr. Minchin, of Oxford.

Note.—There may also be meetings of the Sections. 2 p.m.: Meetings of the Sections. 9 p.m.: Conversazione in the Fitzwilliam Museum in conjunction with the International Congress of Physiologists.

Thursday August 25, 10.30 a.m., at the Guildhall.—General meeting of the Congress to discuss the origin of Mammals. The discussion will be opened by Prof. Seeley, of London, and Prof. H. F. Osborn, of New York.

Note.—There may also be meetings of the Sections. 2.15 p.m., at the Senate House: The conferring of honorary degrees. 4–6.30 p.m.: Garden party in the Botanic Garden of the University.

Friday, August 26, 13.30 a.m., at the Guildhall.—General meeting of the Congress to hear an address by Prof. Haeckel, "On our present knowledge of the Descent of Man." The Right Hon. Sir Herbert Maxwell, Bart., M.P., will afterwards read a paper "On recent Legislation on the Protection of Wild Birds in Britain."

Note.—There may also be meetings of the Sections. 2 p.m.: Meetings of the Sections. 7.30 p.m.: Dinner in the hall of Trinity College. Tickets, price 15*s*., must be applied for in the Reception Room not later than 1 p.m. on Wednesday, August 24.

Saturday, August 27, 9.30 a.m., at the Guildhall.—General meeting of the Congress to settle the time and place of the Fifth International Congress.

Arrangements for the Congress in London.

Saturday, August 27, 4 p.m. to 7 p.m.—Reception by the President and Council of the Zoological Society of London in their gardens in the Regent's Park, London. Tea and light refreshments will be served. 9 to 11.30 p.m.: Reception by the Right Hon. Sir John Lubbock, President of the Congress, of the members of the Congress, at the Natural History Museum, Cromwell Road.

Sunday, August 28, 2.30 p.m. to 7 p.m.: The Natural History Museum, Cromwell Road, will be open. Tea and light refreshments will be served to members of the Congress from 4 p.m. to 6 p.m. 9 p.m.: The President and Committee of the Royal Societies' Club, St. James's Street, S.W., will hold a reception in honour of the Congress (gentlemen only).

Monday, August 29.—Visit to Tring Museum. Visitors will be received by the Hon. Walter Rothschild, who will entertain them at lunch.

Note.—Notice of intention to visit Tring must be given in writing to the Secretaries not later than noon on Wednesday, August 24.

Tuesday, August 30.—His Grace the Duke of Bedford will be glad if such zoologists as are interested in the study of the Cervidæ will visit his parks at Woburn on Tuesday, August 30. Mr. R. Lydekker, F.R.S., has promised to conduct the party, which should not exceed in number sixty. Further information may be obtained by applying to Mr. Lydekker, at The Lodge, Harpenden, Herts.

Monday and Tuesday, August 29 and 30.—The museum of the Royal College of Surgeons will be open to members of the Congress on production of their ticket. An official of the museum will be present to receive visitors.

Tuesday, Wednesday and Thursday, August 30 and 31, and September 1.—Dredging expeditions at Plymouth with the Director of the Marine Biological Laboratory, and at Port Erin, Isle of Man, under the direction of Prof. Herdman, F.R.S.

Note.—Visitors to either of these dredging expeditions should give notice to the Secretaries in writing as early as possible.

The gardens of the Zoological Society of London will be open to members of the Congress on showing their tickets and writing their names in the book at the gates every day, including Sunday, from Thursday, August 18, to Thursday, September 1, inclusive.

The Committee of the Royal Societies' Club, St. James's Street, S.W., will extend the privileges of honorary membership to members of the Congress (not ladies) on presentation of their cards of Congress membership, from August 18 to September 1, inclusive. Members of the Congress making use of the Club must enter their names in the visitors' book.

The President and Council of the Linnean Society, Burlington House, Piccadilly, will throw open their apartments to the members of the Congress of Zoology from August 27 to September 1, inclusive.

The gardens of the Royal Zoological Society of Ireland will be open to members of the Congress who visit Dublin on presenting their cards of membership at the gate.

A YORKSHIRE MOOR.[1]

I.

THE Yorkshire moor is high, ill-drained, peaty, and overgrown with heather. Moors of this type abound in Scotland, and creep southward along the hills into Yorkshire and Derbyshire, breaking up into smaller patches as the elevation declines. In the south of England they become rarer, though famous examples occur in Dartmoor and Exmoor. In the north they may cover great stretches of country. It used to be said that a man might walk from Ilkley to Glasgow without ever leaving the heather. That was never quite true, but even to-day it is not far from the truth; a man might walk nearly all the way on unenclosed ground, mostly moorland.

Neither peat nor heather is confined to high ground. Peat often forms at sea-level, and may contain the remains of sea-weed. In some places it is actually submerged by change of sea-level, and the peasants go at low water and dig through the sand to get it. Heather ranges from sea-level to Alpine heights.

Peat may form because there is no fall to carry off the water, or because the soil, though high and sloping, is impermeable to water. A few feet of stiff boulder-clay constitute such an impermeable floor, and a great part of our Yorkshire moors rests upon boulder-clay, which is attributed to ice-action, because it is often packed with ice-scratched pebbles, some of which have travelled far, and because the rock beneath, when bared, exhibits similar scratches.

The rocks beneath the boulder-clay of a Yorkshire moor are chiefly sandstones and shales. Where the sandstones crop out, they form tolerably bold escarpments with many fallen blocks, such as we call "edges" in the north; the shales make gentler slopes. Both the surface-water and the spring-water of the moors are pure and soft; they may be tinged with peat, but they contain hardly any lime, potash, or other mineral substance except iron-oxides.

The wettest parts of the moor are called *mosses* (in some parts of Scotland they are called *flow-mosses*) because the Sphagnum-moss grows there in profusion. The Sphagnum-swamps are an important feature of the moor, if only because they form a great part of the peat. Not all the peat, however; some is entirely composed of heather and heath-like plants, while now and then the hair-moss (Polytrichum) and certain moorland lichens contribute their share, but the Sphagnum-swamps play the leading part, especially in starting new growths of peat. If we walk carelessly over the moor, we now and then step upon a bed of Sphagnum. We have hardly time to notice its pale green tint and the rosy colour of the new growths before all close observation is arrested by the cold trickle of water into the boots. The practised rambler takes care to keep out of the Sphagnum swamps altogether, knowing that he may easily sink to the knees or further. Sphagnum sucks up water like a sponge, and if you gather a handful, you will be surprised to see how much water can be squeezed out of it. This water abounds in microscopic life; Amœbæ and other Rhizopods, Diatoms, Infusoria, Nematoids, Rotifers and the like can be obtained in abundance by squeezing a little Sphagnum fresh from the moors.[1] As the stems of Sphagnum grow upwards, they die at the base, and form a brown mass, which at length turns black, and in which the microscope reveals characteristic structural details, years, perhaps centuries after the tissues ceased to live.

An old Sphagnum moss is sometimes a vast spongy accumulation of peat and water, rising higher in the centre than on the sides, and covered over by a thin living crust. The interior may be half-liquid, and when the crust bursts after heavy rain, the contents of a hillside-swamp now and then pours forth in an inky flood, deluging whole parishes. In 1697 a bog of 40 acres burst at Charleville, near Limerick. In 1745 a bog burst in Lancashire, and speedily covered a space a mile long and half a mile broad. A bog at Crowhill on the moors near Keighley burst in 1824, and coloured the river with a peaty stain as far as to the Humber. In December 1896, a bog of 200 acres burst at Rathmore near Killarney, and the effects were seen ten miles off. Nine persons perished in one cottage.

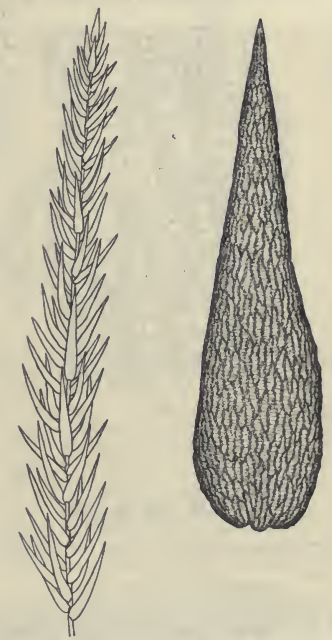


FIG. 1.—Leafy branch of Sphagnum, magnified; one leaf of ditto, further magnified.

The soaking-up of water is essential to the growth of the Sphagnum, which employs several different expedients for this purpose. Its slender stems give off numerous leafy branches, and also branches which are reduced to filaments. These last turn downwards along the stem, which they may almost conceal

[1] A discourse given at the Royal Institution, February 1898. By L. C. Miall, F.R.S.

[1] It is interesting to note that the same abundance of animal life characterises the mosses of Spitzbergen, where not a few of the very same species are found. (D. J. Scourfield, "Non-marine Fauna of Spitzbergen," *Proc. Zool. Soc.*, 1897.)

from view. The crowded leaves have in-folded edges. There are thus formed innumerable narrow chinks, in which water may creep upwards. The microscope brings to light further contrivances, which answer the same purpose. Many of the cells of the leaf lose their living substance, and are transformed into water-holding cavities with thin, transparent walls, which are prevented from collapsing by spirally wound threads. But the water must not only be lodged; it must ascend, and supply the growing branches above. Accordingly the water-holding cells are not closed, but pierced by many circular pores, which allow liquid to pass in and out freely. Perforated water-cells also form the outer layers of the stem. Thus the whole surface of the plant, whether immersed or not, is overspread by a water-film, which is easily replenished from below as it evaporates above. It is the water-spaces which render the Sphagnum so pale. The green living substance forms only a thin network, traversing the water-holding tissue.

Now and then we are lucky enough to see the bed of a Sphagnum-swamp. Quarrying, or a land-slip, or the formation of a new water-course, may expose a clean section. I have known the mere removal of big stones, time after time, from the bed of a stream fed by a Sphagnum-swamp, gradually increase the cutting-power of the running water, until the swamp is not only drained, but cut clean through down to the solid rock. Then we may see that the peat rests upon a sheet of boulder-clay, and this upon the sandstones and shales. Between the peat and the boulder-clay there is sometimes found an ancient seat-earth, in which are embedded the mouldering stumps of long-dead trees. Oak, Scotch fir, birch, larch, hazel, alder, willow, yew and mountain-ash have been met with.[1] Where a great tract of peaty moorland slowly wastes away, the tree-stumps may be found scattered thick over the whole surface. Above the seat-earth and its stumps, if these occur at all, comes the peat, say from 5 to 20 feet deep, and above the peat the thin crust of living heather.

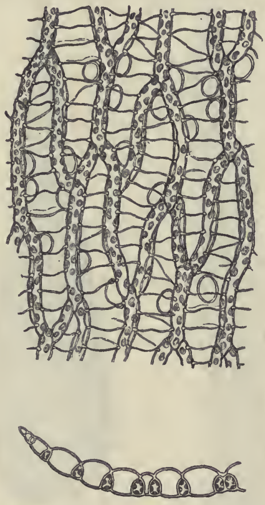


FIG. 2.—Detail of Sphagnum-leaf; green cells with corpuscles, and water-cells with spiral threads and pores. Below is a section (from Sachs) of part of a leaf.

Every part of the moor has not, however, the same kind of floor. Streams in flood may excavate deep channels, and wash out the gravel and sand into deltas, which often occupy many acres, or even several square miles. The outcrops of the sandstones crumble into masses of fallen blocks. Instead of the usual impervious bed of boulder-clay, we may get a light sub-soil. The verges of the moor have commonly this character; they are by comparison dry, well drained, and overgrown with furze, bilberry, crowberry, fern, and wiry grasses; such tracts are called "roughs" or "rakes" in the north of England. A similar vegetation may be found far within the moor, though not in places exposed to the full force of the wind. Even on the verges of the moor there are very few earthworms, and at most a scanty covering of fine mould; in the heart of the moor there is no trace of either. The Nematoid worms which are so common in most soils, and easily brought to the surface by pouring a few drops of milk upon the ground, seem to be absent from the moor. Insects and insect-larvæ are very seldom found in the humus.

In a country where population and industry grow steadily, it is rare to find the moor gaining upon the grass and woodland. We have to go back some centuries to find an example on anything like a large scale. The Earl of Cromarty (*Phil. Trans.* No. 330, p. 296), writing in 1710, says that in 1651 he saw a "firm standing wood" of dead fir-trees on a hill-side in West Ross-shire. About fifteen years later he passed the same spot, and found no trees, but a "plain green moss" in their place. He was told that the trees had been overturned by the wind, and afterwards covered by the moss, and further that none could pass over it because it would not support a man's weight. The Earl "must needs try it," and fell in up to the arm-pits.

A section through a thick bed of peat will sometimes reveal the manner of its growth. The lower part is often compact, the upper layers of looser texture. It is not uncommon to find by microscopic examination that while the lower part is made up entirely of Sphagnum, the more recent growth is due to heather, crowberry, grasses, hair-moss, and lichens. In some places the whole thickness is of Sphagnum only; in others there is no Sphagnum at all. Peat formed of Sphagnum only has no firm crust, and from the circumstances of its growth it is likely to be particularly wet. Sphagnum often spreads over the surface of pools or even small lakes, not nearly so often in Yorkshire, however, as in a country of well-glaciated crystalline rocks, where lakes abound. In such cases a peculiar kind of peat is formed as a sediment at the bottom of the water, which may in the end fill up the hollow altogether. A very slight cause is enough to start a Sphagnum bog, such as a tree falling across a stream, or a beaver-dam. When a pool forms above the dam, the Sphagnum spreads into it, and the peat begins to grow. Long afterwards, when the hollow is completely filled with peat, there may be a chance for grasses, rushes, crowberry and heather.

In our own time and country the moors waste faster than they form; it is much commoner to find the grass gaining on the heather than to find the heather gaining on the grass. There is no feature of the Yorkshire hills more desolate than ground covered with wasting peat. The surface is cut up by innumerable channels, with peaty mounds between. These are either absolutely bare, or thinly covered with brown grasses and sedges. The dark pools which lie here and there on the flats are overhung by wasting edges of black peat. It is cheerful to step from this dismal territory to ground clothed with close-growing grasses of a lively green, such as we find where the peat has disappeared altogether.

The moors are commonly wet, very wet in places. In certain parts and during certain seasons of the year they are, however, particularly dry, and subject to a severity of drought which the lower slopes and the floor of the valley know nothing of. At lower levels trees give shelter from sun and wind; night-mists check evaporation, and even return a little moisture to the earth; the deep, finely divided soil lodges water, which is given off little by little, and in our climate never fails to yield an effective supply to the roots; pools and streams dole out sparingly the water which fell long before as rain. But the moor lies fully open to sun and wind. In March it is exposed to the east wind; in June to hot sun and cold, clear nights; in August there is perhaps a long spell of drought; in November heavy gales with abundance of rain. The summer is late; the moorland grasses make little growth before the beginning of June; even then the heather bears few young leaves, while the fronds of the bracken are only beginning to push through the soil. Whatever the weather, there is no protection against its extremes; there is no shelter and no shade. The air is cold; wind and the diminished pressure due to height favour rapid evaporation. Though the Sphagnum-patches form permanent bogs, a great part of the moor becomes far drier in a hot summer

[1] In Yorkshire I think that birch and alder are the commonest of the buried trees.

than any pasture or meadow. The top of the peat crumbles, and is blown about as dust, the loose sand can hold no moisture, bared surfaces of clay become hard as iron. Another feature which must profoundly affect the vegetation of the moor is the poverty of its water in dissolved salts. It is pure and soft, like distilled water, and contains hardly any mineral food for plants. The plants of the moor are subject to the extremes of wet and dry, to cold and to famine.

The best-known and most characteristic of the moorland plants are the heaths. Ling, the common heather, is the most

FIG. 3.—Ling (*Calluna vulgaris*). A leafy branch, a single leaf, seen from beneath, and a cross-section of the base of the leaf.

abundant of all; it sometimes covers many square miles together to the almost complete exclusion of other plants. Ling is a low shrub, whose wiry stems creep and writhe on the surface of the ground. When sunk in deep peat the stems are often pretty straight, but among rocks you may follow the twisted branches for many yards, and at last discover that what you took for small plants rooted near the surface are really the tops of slender trees, whose roots lie far below. Bilberry too wriggles among

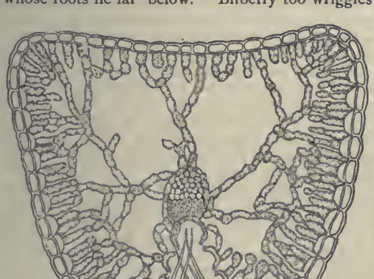


FIG. 4.—Transverse section of leaf of Ling, showing large air-spaces, the reduced lower epidermis which bears the stomates, and the long hairs which help to close the cavity into which the stomates open.

loose stones or fallen blocks till you grow weary of following it. The leaves of ling are dry, hard and evergreen. They last for two or three years, and do not fall off as soon as they die, but crumble slowly away. They are very small, densely crowded, and ranged on the branch in four regular rows. A good thin section through a leaf is not easy to cut; when you get one, you find that the interior is largely occupied by irregular air-spaces, and that the stomates are sunk in a deep groove on the under side of the leaf, where they are further sheltered by hairs.

Ling is a plant of slow growth, and a stem which showed seventeen annual rings was only a centimetre in diameter. Stems of greater age than this are rare. After ten or twelve years the plants flower scantily, and exhibit other signs of age. Then the common practice is to burn them off.

As we travel south, we find the ling getting smaller and smaller. In Scotland it is often waist-deep, in Yorkshire knee-deep, on Dartmoor only ankle-deep. On the moors of the south of England the ling is generally much mixed up with grasses, as

FIG. 5.—Cross-leaved Heath (*Erica tetralix*), with part of a branch, enlarged; a leaf seen from the under side, and a section of a leaf.

also on the verges of the Yorkshire moors. In Cornwall it may grow so close to sea-level that it is wet with salt spray in every storm, and its tufts are intermingled with sea-pink and sea-plantain. At the Lizard, wherever the serpentine comes to the surface, ling ceases, and the Cornish heath (*Erica vagans*) takes its place.

Here and there we find among the ling the large-flowered heaths with nodding pink or purple bells (Scotch Heath, Cross-leaved Heath). The leaves of these plants are much larger and

FIG. 6.—Transverse section of rolled leaf of cross-leaved Heath (*Erica tetralix*).

thinner than those of ling; they are called "rolled leaves," because the edges curve downwards and inwards, partly concealing the under surface, which bears the stomates. All our native heaths agree in possessing wiry stems, long roots, and narrow, evergreen leaves, with a glossy cuticle and small transpiring surfaces. The tissues are very dry, and burn readily even when green or drenched with rain. It is possible by good management to set acres of heather in a blaze, even in mid-winter, with a single lucifer match. The heaths wither very slowly when gathered, and change little in withering.

Some of these features are characteristic of desert-plants. Many desert-plants have reduced transpiring surfaces and hidden stomates. They often have very long roots, as was particularly observed in the excavations for the Suez canal.[1] The leaves are often small and crowded, the stems woody, much branched and tufted. Bright sunlight retards growth, and green tissues hardly ever present a large absorbing surface when they are habitually exposed to bright light. Accordingly the young shoots and branches do not push out freely, but try to hide one behind another. The tissues of desert-plants may be remarkably dry; they are often, however, remarkably succulent; the plant either learns to do without water for a long time together, or to store it up.

It is not without surprise that we learn how similar are the effects of tropical drought and of Arctic cold. The facts of distribution would in themselves suffice to show that our moorland heaths are well-fitted to endure great cold. Ling extends far within the Arctic circle, though it seldom covers large surfaces there, and it rises to 2000 metres (6600 feet) on the north side of the Alps It extends southward to the shores of the Mediterranean. Our large-flowered heaths have not been traced quite so far north as ling, and they are not found on the Alps, though they inhabit the Pyrenees. Many representatives of the heath family, with like structure of leaves, are found in the extreme north of the American continent. Those features which assimilate our heaths to desert-plants, and which seem to be obvious adaptations to a situation of extreme drought, are equally serviceable to plants which have to face boisterous winds and low temperature. The shrubs of the far north are low, tufted, small-leaved, evergreen, and dry—just like the heaths of our moors. Middendorff[2] shows how the Dahurian larch becomes stunted in proportion to increasing cold. Before it disappears altogether, it is cut down to a prostrate, creeping shrub. One such dwarf larch, though 150 years old, was only a foot or two across. Plants much exposed to biting winds must make the most of any shelter that can be had; their branches push out timidly, and for a very short distance; the leaf-surface is reduced to a minimum; since the warm season is short, evergreen leaves are profitable, for they enable the plants to take advantage of early and late sunshine.

The heaths and many other moorland plants bear the marks of the *Xerophytes*, or drought-plants. Xerophytes grow under a considerable variety of conditions, some of which do not suggest drought at first sight, but their tissues are always ill-supplied with water. It may be that water is not to be had at all, as in the desert; or that water must not be imbibed in any quantity because of low temperature, as in Arctic and Alpine climates; or that the water is mixed with useless and perhaps injurious salts, from which it can only be separated with great difficulty, as in a salt-marsh. Whatever may be the reason for abstinence, xerophytes absorb water slowly, part with it slowly, and endure drought well.

In the case of moorland plants there is an obvious reason why many of them, though not quite all (Sphagnum is one exception) should rather thirst and grow slowly than pass large quantities of water through their tissues. The water contains hardly any potash or lime, and very little that can aid the growth of a plant. But it is probable that this is not the sole reason. Except where special defences are provided, it is dangerous for a plant which may be exposed to wind or low temperature to absorb much water.

(*To be continued.*)

INDIAN COALS AT THE IMPERIAL INSTITUTE.

THE Imperial Institute has been subjected to much adverse criticism. Its commercial collections, refreshment catering, fellows' club, limelight lectures by eminent men, continental orchestras, library, exhibitions, journal, and commercial intelligence department have all in turn been disparaged. The scientific and technical department has alone escaped attack. There, in well-equipped laboratories, with an enthusiastic staff of experts, valuable research work on new products has been carried on quietly and continuously for some years past. A striking example of the value of the work done is afforded by the exhaustive report just published on the coal supply of India by Prof. Wyndham R. Dunstan. This report embodies the results of the examination of a large number of selected samples from the principal seams. Methodically arranged, well printed, and written in a style that is not too abstruse for the general reader, it is a model of what such a report should be.

The examination was undertaken at the instance of the Government of India. The results are shown in a tabular form, and the chief points in connection with the occurrence, distribution, production and character of Indian coal are summarised. Unlike the English and Welsh coals, the Indian coals are chiefly of Upper Palæozoic and Lower Jurassic age. They are widely distributed, and only a small portion of the known coal area is as yet worked. The increase in coal production in India of late years is very remarkable, and, as the household consumption is inappreciable, practically the whole output is used for steamships, railways, and factories. The output for 1896 was as follows:—

	Tons.
Assam	177,351
Baluchistan...	10,572
Bengal	3,037,920
Burma	22,993
Central India	115,386
Central Provinces	141,185
Nizam's dominions	262,681
Madras } Punjab }	79,925
Total	3,848,013

The results of the examination of the various coals have been plotted in curves, and a table of previous analyses of Indian coal is also given. The coals vary greatly in composition and in quality. Most of them are quite suitable for ordinary purposes, whilst some of the samples from Bengal and Central India are of excellent quality, quite equal to that of many English or Welsh coals. Among the many samples described are two from Hyderabad, which are of fair quality. Neither of the samples, however, gave such good results as those recorded by Mr. Tookey in Mr. J. P. Kirkup's monograph on the Singareni coalfield, published in the *Transactions* of the Federated Institution of Mining Engineers in 1894 (vol. vi. pp. 421-448). This valuable memoir appears to have escaped Prof. Dunstan's notice in drawing up his useful list of works of importance in connection with Indian coal. The Bengal coal is that most largely mined, and a great deal of it is a serviceable steam-coal. Many samples cake well, and contain but little sulphur. The coke made from this coal appears, therefore, to be suitable for iron-making. In view of the occurrence of rich deposits of iron and manganese ores in India, this is a matter of great importance, for, owing to difficulties connected with fuel supply, the records of iron manufacture in India have been disastrous. Attempts to manufacture steel in Southern India were made in 1818, in 1830, in 1833 and in 1853, but in each case the want of suitable fuel was an unsurmountable difficulty. Charcoal was exclusively used; and in order to supply one blast-furnace it was necessary to clear no less than two acres of moderately heavy forest per day. For every ton of charcoal made, five tons of wood were consumed. The information contained in Prof. Dunstan's report should therefore show that the difficulties in the way of creating an Indian iron industry presented by the fuel supply can easily be overcome. Indeed, the supply of coal is so enormous that this report should be the means of directing attention to the possibilities of many other branches of industrial enterprise. BENNETT H. BROUGH.

THE INTERNATIONAL AERONAUTICAL CONFERENCE.[1]

THE second meeting of the International Aeronautical Committee (which was appointed by the Paris Meteorological Conference of 1896) was held at Strassburg, Germany, March 31 to April 4, inclusive. Besides the President, Prof. Hergesell of Strassburg, and the Secretary, M. de Fonvielle of Paris, there were present the following members of the committee: Messrs. Cailletet and Besançon of Paris, Assmann and Berson of Berlin, Erk of Munich, Rykatcheff and Kowanko of

[1] Examples are quoted by Warming, *Lehrb. d. ökol. Pflanzengeographie*, p. 198.

[2] "Sibirische Reise," vol. iv. p. 605.

[1] By A. Lawrence Rotch. (Reprinted from the U.S. *Monthly Weather Review* for April.)

St. Petersburg, and Rotch of Boston, U.S A. Regrets were sent to Messrs. Hermite and Violle, whom illness detained, and thanks were tendered to those governments and friends of science who proposed to search for André, a member of the committee. A number of physicists, meteorologists, and aeronauts were present as guests. The welcome of the German Government was extended by Von Schraut, Minister of Finance for Alsace-Loraine, who summarised the results achieved in exploring the atmosphere, and predicted a brilliant future. Prof. Windelband, Rector of the University of Strassburg, emphasised the importance of these researches for the progress of humanity as well as for science. M. de Fonvielle replied for the Committee.

The discussion of the provisional programme was then begun, with the questions relating to the *ballons sondes*. It was agreed that the introduction of a mechanical ballast discharger was necessary, and that all precautions should be taken to prevent derangement of the instruments; the stoppage of the clockwork was attributed to the contraction of the plates carrying the pivots, from the effect of great cold. As regards the calculation of the ascensional force of balloons and the influence of the temperature of the gas, it was resolved that—

For each unmanned ascent the weight of the aerostatic material and the ascensional force at the start should be measured, and during the whole voyage the true temperature of the gas should be recorded.

Since the study of the meteorological conditions of the air in a vertical line is important it was considered advisable, in certain cases, to limit the length of the voyage by emptying the balloon automatically.

The instrumental equipment of *ballons sondes* was first considered. M. Teisserenc de Bort presented a report on the determination of height by the barometer.

Drs. Assmann and Berson said that the usual methods gave considerable errors, and they recommended the calculation of the height by successive strata, applying a correction for the change of temperature of the lower stratum during the ascent. The Conference decided that—

All nations should adopt the same formula of reduction, whatever method might be chosen ultimately.

M. Teisserenc de Bort analysed the errors of the aneroid with respect to the mercurial barometer, but in regard to the latter it was pointed out by Dr. Berson that the mercurial column only represents the atmospheric pressure at the moment when the balloon has no vertical velocity. It was resolved that—

Simultaneous observations should be executed at the different stations, and that the instruments should be controlled by taking them in manned balloons. Besides this, the instruments ought to be interchanged among the different stations in as short a time as possible.

The determination of the temperature of the air in *ballons sondes* was introduced by a report of M. Teisserenc de Bort. Dr. Hergesell remarked that the temperature of the air varied so rapidly that it was necessary to apply a correction-formula which he had developed in the *Meteorologische Zeitschrift*, December 1897. M. Cailletet exhibited a thermometer of his invention, which had for its bulb a spiral silver tube soldered to a glass tube, both being filled with the liquid toluene. He stated that it acquired the surrounding temperature in fifteen seconds. M. Teisserenc de Bort exhibited a self-recording thermometer, having a thin blade of German silver fixed in a frame of Guillaume's invariable steel. This instrument takes the temperature of the air rapidly (9° F. in fifteen seconds), and it is not affected by shocks. The ventilation in a balloon is secured by a fan driven by a weight on a wire, which falls 5000 feet in an hour and a half. Drs. Hergesell and Assmann described their attempts to construct a sensitive metallic thermometer, which the latter thought might be ventilated by the agitation of the air through a jet of liquid carbonic acid, but M. Cailletet pointed out that at low temperatures the tension of carbonic acid is too slight to produce ventilation. Dr. Berson remarked that in his high ascent, the upper clouds, at an altitude of 24,000 to 29,000 feet, radiated upon the instruments in the same way as does the surface of the earth at a moderate height. As a result of the discussion it was resolved—

(1) The rapidity of the thermometric variation is so great in *ballons sondes* that to record it thermometers must be employed which have much less thermal inertia than those hitherto employed, and (2) an efficient ventilation of the thermometers is indispensable.

The testing of thermometers at temperatures below those to which they would be exposed in *ballons sondes* was advised, and Dr. Erk described the apparatus of Dr. Linde, of Munich, for the production of a considerable quantity of liquid air. This means of refrigeration enables temperatures lower than 200° C. below zero to be obtained. The Conference recommended that—

Before the ascensions of *ballons sondes* the instruments be verified by varying the temperature and pressure under conditions similar to those to which they would be subjected in the atmosphere.

The equipment of manned balloons was next considered. Some remarks of Dr. Berson on the difficulty of reading a mercurial barometer, owing to the continual oscillations of the mercury, led to the following resolution:

During ascents, the mercurial barometer is the standard instrument for the comparison of aneroids, but for its observations to be trustworthy the acceleration must be zero; it is evident that this condition is fulfilled when the trajectory traced by the self-recording aneroid is horizontal.

In consequence of the statement that it was possible to verify the instruments by reproducing the curves traced by them, the Conference advised that—

There should be reproduced in the laboratory, with the aid of pneumatic and refrigerating apparatus, similar curves to those traced by the barometer and thermometer during balloon ascents.

Furthur discussion followed as to the methods of obtaining the height of the balloon. M. Cailletet described his apparatus for automatically photographing together, from time to time, the ground vertically below the balloon and the face of an aneroid barometer. From a map the route of the balloon as well as its true altitude are determined; the pressure is deduced from the barometer, and thus the law connecting atmospheric pressure with altitude can be studied. Photographs have been taken from a balloon 7000 feet high, which was moving forty to sixty miles an hour. The accuracy of these measures was said to be within 1/250 of the height. It is proposed to photograph a mercurial barometer in the same way. The Conference recommended the use of M. Cailletet's apparatus for both manned balloons and *ballons sondes*. The determination of the height by observations at the ground was brought to the attention of the Conference, and especially the "dromograph," invented by MM. Hermite and Besançon, for automatically registering the azimuths and angular altitudes observed, and the heliometer used by Dr. Kremser, of Berlin, for measuring the apparent diameter of the balloon.

Dr. Erk called attention to the fact that in the case of a large difference of temperature between the wet and dry bulbs of the aspiration psychrometer, the wet bulb always had in its immediate neighbourhood a warmer body, which is the interior cylinder surrounding it. The resulting error may be avoided by covering the interior cylinder with muslin, so that the dry bulb is protected by a cylinder having a temperature, t, and the wet bulb by a cylinder having a temperature, t'. The Conference thought it necessary that—

The instrumental equipment of manned balloons should be uniform, so far as possible. A recommendation has been made in regard to the barometers; concerning thermometers, the opinion is expressed that the aspiration psychrometer placed at the proper distance of at least 5 feet from the basket is the only instrument which should be employed in manned ascents. Simultaneous comparisons with the sling thermometer are recommended.

Drs. Berson and Hergesell urged the importance of simultaneous ascents in the different countries when a centre of barometric depression existed over the European Continent. From a purely meteorological point of view the manned ascents have an importance which the *ballons sondes* do not, because the temperature of these high regions can have no influence on the meteorological elements near the surface of the earth. M. de Fonvielle, however, insisted upon the interest of deducing experimentally, from thermometric measures at a very great elevation, the temperature of the supra-atmospheric medium.

He called attention to the possibility of choosing in this way between the kinetic theory of gases, which supposes a temperature of 273° C. below zero, and Fourier's theory which assumes that the temperature of space above the atmosphere is near that of the minima observed in the polar regions of the earth.

Future international balloon ascensions were next considered. It was deemed advisable that—

For each *ballon sonde* an instrument should be provided to serve as a basis of comparison with perfected instruments whose construction may change from one ascent to another on account of the improvements which may be attempted.

It was announced that in the next international ascent of *ballons sondes* Austria, Italy and Belgium would participate, besides the countries which had already co-operated. This ascent was appointed for the beginning of June with certain stations of the international system to be chosen as starting points. The balloons should be as nearly as possible like those approved by the Conference, and the directors of the various meteorological systems were requested to institute observations on the days of the ascents according to the principles fixed by the President of the Committee. It was recommended that—

For the simultaneous study of the lower air strata, the observations from high stations be used, and especially those from kites and kite balloons.

After a presentation of various methods for effecting the safe landing and the recovery of *ballons sondes*, resolutions looking to these ends were adopted. Balloons may be protected against explosion caused by atmospheric electricity by covering their interior surface with a solution of potassium chlorate, which renders the fabric a conductor. For the measurement of atmospheric electricity the methods of Le Cadet, Börnstein and André are recommended, especially the former.

Mr. Rotch read the report which he had been requested to prepare on the use of kites at Blue Hill Observatory, U.S.A., to obtain meteorological observations. He showed the advantages which kites possess over balloons up to heights exceeding 10,000 feet, whenever there is wind.

A letter from the Chief of the Weather Bureau explained the proposed use of kites to obtain data for a daily synoptic weather chart over the United States at the height of a mile or more. M. Teisserenc de Bort is equipping a kite station at Trappes, near Paris, after the model of Blue Hill, and General Rykatcheff stated that an anemograph of his invention was being raised with Hargrave kites at St. Petersburg. The Conference recommended the use of the kite in meteorology, and expressed the wish that all central observatories should make such observations, which are of prime importance for meteorology. On account of the favourable position of Mounts Cimone and Etna it is desirable that at the observatories on these mountains kites should be used in connection with the international balloon ascensions. The Conference expressed the desire that the chief observatories should be provided with the kite balloon of von Parseval and von Siegsfeld (see description hereafter) in order that there may be a certain number of permanent aerial stations, and following the idea of M. Tacchini it is hoped that kite balloons will be used in Italy on Mounts Viso and Etna, and also at the Military Park at Rome.

The following new members of the Committee were elected: M. Teisserenc de Bort and Prince Roland Bonaparte, of Paris, Prof. Hildebrandsson, of Upsala, Prof. Pernter and Lieut. Hinterstoisser, of Vienna, Captain Moedebeck, of Strassburg, and Lieut. von Siegsfeld, of Berlin. The next meeting was appointed for 1900, at Paris, during the Universal Exposition.

The Committee had the opportunity of witnessing two trials of the captive kite balloon, invented by Lieuts. von Parseval and von Siegsfeld, and constructed by Riedinger, of Augsburg, at a cost of 1000 dols., for Prof. Hergesell and Captain Moedebeck. Although this form of balloon is used in the German army for reconnoitring, it was now employed for the first time to lift self-recording meteorological instruments. The cylindrical balloon is so attached to the cable that its upper end inclines towards the wind, which thus raises instead of depressing it, as in the case of captive spherical balloons. The wind enters an auxiliary envelope at the lower extremity and maintains the cylindrical form, notwithstanding any loss of gas. This wind bag also serves as a rudder, while lateral wings prevent rotation about the longer axis. The Strassburg balloon has a diameter of 14·7 feet, a length of 55·7 feet, and a volume of 7770 cubic feet. The gas bag is varnished linen, and was filled with a mixture of hydrogen and coal gas. The weight of the balloon complete is 230 pounds, and the steel cable holding it weighs 2 pounds per 100 feet. The azimuth, altitude, and traction of the cable are recorded by a dynamometer invented by Riedinger. The meteorological instruments are contained in a basket (with open ends, through which the wind blows, but covered elsewhere with nickeled paper as a protection against insolation), suspended some 40 feet below the balloon. The self-recording instruments were a barometer and thermometer of Richard and a Robinson anemometer recording electrically. Although the kind of gas employed was hardly sufficient to lift the unnecessarily heavy basket and its contents, weighing 80 pounds, yet the trials made in rainy and windy weather were fairly successful, and a height of about 1000 feet was reached. Without instruments the balloon had remained for several days above the city, and had withstood a gale.

The Committee also saw a hastily organised ascent of the *ballon sonde*, "Langenburg," which is a silk balloon of about 14,000 cubic feet capacity. When filled with coal gas it had an initial ascensional force of about 440 pounds in excess of its own weight and that of the instruments, contained in a cylindrical basket, which was open at top and bottom for ventilation, and was also covered with nickeled paper. They comprised a barometer and thermometer of Richard, and the metallic thermometer of Teisserenc de Bort, which all recorded on smoked paper. Owing to the premature launch of the balloon the ballast was left behind, and the escape of gas, owing to the too rapid ascent, prevented a great height from being reached. The balloon rose at about 6 p.m. with a velocity of nearly 23 feet per second, and disappeared in the strato-cumulus clouds in five minutes. It attained an altitude exceeding 6 miles, and fell about 60 miles south-east of Strassburg, where it was found the next day. Unfortunately the shock caused by the breaking loose of the balloon stopped the clocks of the thermographs and prevented records of temperature from being obtained.

An official account of this Conference will be published in the French and German languages, together with the special reports prepared by the experts.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AMONG the measures which received the Royal consent on Friday was the London University Commission Bill.

MR. A. J. HERBERTSON, Lecturer on Geography in the Heriot-Watt College, Edinburgh, has taken the degree of Ph.D., *multa cum laude*, in the University of Freiburg, Baden, in the special subject of geography. The subject of his thesis was the mean monthly rainfall of the globe, illustrated by twelve original maps.

THE resident professorship of Physics and Mechanics in the Royal Agricultural College, Cirencester, has been filled up by the election of Mr. John Alexander Johnston. At Edinburgh Mr. Johnston was first medallist in advanced honours class of mathematics, and first medallist in advanced honours class of physics, and in 1894 he graduated M.A. with first class honours in mathematics and physical science, and afterwards obtained the Drummond scholarship for proficiency in physical science, as well as other open honours. At Pembroke College, Cambridge, he was awarded both minor and foundation scholarships, and graduated fourteenth wrangler in the mathematical tripos.

A SPECIAL and valuable feature of the Museum of the Peabody Institute at Salem, Mass., is referred to by Mr. W. E. Hoyle in the course of a description of museums in the United States and Canada, contained in the report of the Manchester Museum, Owens College (1897–8). Mr. Hoyle mentions that at close intervals throughout the entire collection special coloured labels are displayed, calling attention, by title and shelf number, to books in the public library referring to the immediate group, so that a student or pupil from the public schools need only transcribe on a bit of paper a set of numbers and present it at the delivery window of the public library to be provided at once with the books on the special subject desired.

The following list of candidates successful in this year's competition for the Whitworth Scholarships and Exhibitions, has been issued by the Department of Science and Art:—Scholarships of 125*l.* a year, tenable for three years—Charles E. Goodyear, Devonport; John H. Grindley, Oldham; Harry E. Wimperis, Bath; George Service, Cambuslang. Exhibitions of 50*l.* a year, tenable for one year—William V. Shearer, Glasgow; William Alexander, Glasgow; Albert Hall, London; Aidan N. Henderson, Edinburgh; Alec W. Quennell, London; Victor G. Alexander, Portsmouth; George S. Taylor, Devonport; Joel J. Lee, Portsmouth; George Donington, Lincoln; John E. Jagger, Manchester; George A. Inglis, Glasgow; Leslie H. Hounsfield, London; William M. Selvey, Devonport; Ernest A. Forward, London; James J. Mills, Plumstead; Robert M. Neilson, Glasgow; William A. Barnes, Horwich (Lancs.); Francis P. Johns, Torpoint; Herbert H. Johnson, Liverpool; William T. Williams, London; Frederick Charlesworth, Crewe; William A. Craven, Birkenhead; George A. Barber, Manchester; Hugh M. Macmillan, Govan; James C. Macfarlane, Cathcart; George G. Sumner, Manchester; Charles L. Vaughan, Plumstead; William E. M. Curnock, Liverpool; Francis D. Moulang, Inchicore (Dublin); John Webster, Gateshead.

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 9.—"On the Position of Helium, Argon, and Krypton in the Scheme of Elements." By Sir William Crookes, F.R.S.

It has been found difficult to give the elements argon and helium (and I think the same difficulty will exist in respect to the gas krypton) their proper place in the scheme of arrangement of the elements which we owe to the ingenuity and scientific acumen of Newlands, Mendeléef and others. Some years ago, carrying a little further Prof. Emerson Reynolds's idea of representing the scheme of elements by a zigzag line, I thought of projecting a scheme in three dimensional space, and exhibited at one of the meetings of the Chemical Society[1] a model illustrating my views. Since that time, I have rearranged the positions then assigned to some of the less known elements in accordance with later atomic weight determinations, and thereby made the curve more symmetrical.

Many of the elemental facts can be well explained by supposing the space projection of the scheme of elements to be a spiral. This curve is, however, inadmissible, inasmuch as the curve has to pass through a point neutral as to electricity and chemical energy twice in each cycle. We must therefore adopt some other figure. A figure-of-eight will foreshorten into a zigzag as well as a spiral, and it fulfils every condition of the problem. Such a figure will result from three very simple simultaneous motions. First, an oscillation to and fro (suppose east and west); secondly, an oscillation at right angles to the former (suppose north and south); and thirdly, a motion at right angles to these two (suppose downwards), which, in its simplest form, would be with unvarying velocity.

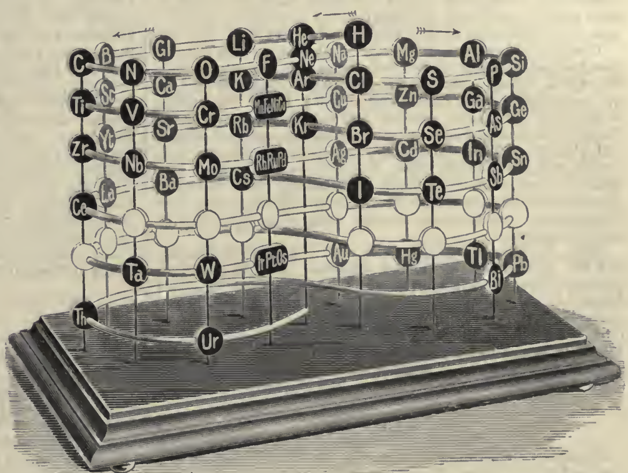
I take any arbitrary and convenient figure-of-eight, without reference to its exact nature; I divide each of the loops into eight equal parts, and then drop from these points ordinates corresponding to the atomic weights of the first cycle of elements. I have here a model representing this figure projected in space; in it the elements are supposed to follow one another at equal distances along the figure-of-eight spiral, a gap of one division being left at the point of crossing. The vertical height is divided into 240 equal parts on which the atomic weights are plotted, from H = 1 to Ur = 239·59. Each black disc represents an element, and is accurately on a level with its atomic weight on the vertical scale.

The accompanying figure, photographed from the solid model, illustrates the proposed arrangement. The elements falling one under the other along each of the vertical ordinates, are—

H	He	Li	Gl	B	C	N	O	F	Na	Mg	Al	Si	P	S
Cl	Ar	K	Ca	Sc	Ti	V	Cr	Mn·Fe·Ni·Co	Cu	Zn	Ga	Ge	As	Se
Br	Kr	Rb	Sr	Yt	Zr	Nb	Mo	Rh·Ru·Pd	Ag	Cd	In	Sn	Sb	Te
I	—	Cs	Ba	La	Ce	( )	( )	( )	( )	( )	( )	( )	( )	( )
( )	—	( )	( )	( )	( )	Ta	W	Ir·Pt·Os	Au	Hg	Tl	Pb	Bi	—
—	—	—	—	—	Th	—	Ur	—	—	—	—	—	—	—

The bracketed spaces between cerium and tantalum are probably occupied by elements of the didymium and erbium groups. Their chemical properties are not known with sufficient accuracy to enable their positions to be well defined. They all give coloured absorption spectra, and have atomic weights between these limits. Positions marked by a dash (—) are waiting for future discoverers to fill up.

Let me suppose that at the birth of the elements, as we now know them, the action of the *vis generatrix* might be diagrammatically represented by a journey to and fro in cycles along a figure-of-eight path, while, simultaneously, time is flying on, and some circumstance by which the element-forming cause is conditioned (*e.g.* temperature) is declining; (variations which I have endeavoured to represent by the downward slope). The result of the first cycle may be represented in the diagram by supposing that the unknown formative cause has scattered along its journey the groupings now called hydrogen, lithium, glucinum, boron, carbon, nitrogen, oxygen, fluorine, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, and chlorine. But the swing of the pendulum is not arrested at the end of the first round. It still proceeds on its journey, and had the conditions remained constant, the next elementary grouping generated would again be lithium, and the original cycle would eternally reappear, producing again and again the same fourteen elements. But the conditions are not quite the same. Those represented by the two mutually rectangular horizontal components of the motion (say chemical and electrical energy) are not materially modified; that to which the vertical component corresponds has lessened, and so, instead of lithium being repeated by lithium, the grouping which forms the commencement of the second cycle is not lithium, but its lineal descendant, potassium.



It is seen that each coil of the lemniscate track crosses the neutral line at lower and lower points. This line is neutral as to electricity, and neutral as to chemical action. Electro-positive elements are generated on the northerly or retreating half of the swing, and electro-negative elements on the southerly or approaching half. Chemical atomicity is governed by distance from the central point of neutrality; monatomic elements being one remove from it, diatomic elements two removes, and so on. Paramagnetic elements congregate to the left of the neutral line, and diamagnetic elements to the right. With few exceptions, all the most metallic elements lie on the north.

Till recently chemists knew no element which had not more or less marked chemical properties, but now by the researches of Lord Rayleigh and Prof. Ramsay, we are brought face to face with a group of bodies with apparently no chemical properties,

[1] Presidential address to the Chemical Society, March 28, 1888.

forming an exception to the other chemical elements. I venture to suggest that these elements, helium, argon, and krypton in this scheme naturally fall into their places as they stand on the neutral line. Helium, with an atomic weight of 4, fits into the neutral position between hydrogen and lithium. Argon, with an atomic weight of about 40, as naturally falls into the neutral position between chlorine and potassium. While krypton, with an atomic weight of about 80, will find a place between bromine and rubidium.

See how well the analogous elements follow one another in order: C, Ti, and Zr; N and V; Gl, Ca, Sr, and Ba; Li, K, Rb, and Cs; Cl, Br, and I; S, Se, and Te; Mg, Zn, Cd, and Hg; P, As, Sb, and Bi; Al, Ga, In, and Tl. The symmetry of these series shows that we are on the right track. It also shows how many missing elements are waiting for discovery, and it would not now be impossible to emulate the brilliant feat of Mendeléef in the celebrated cases of Eka-silicon and Eka-aluminium. Along the neutral line alone are places for many more bodies, which will probably increase in density and atomic weight until we come to inert bodies in the solid form.

Three groups are seen under one another, each consisting of closely allied elements which Prof. Mendeléef has relegated to his eighth family. They congregate round the atomic weight 57, manganese, iron, nickel and cobalt; round the atomic weight 103, ruthenium, rhodium and palladium; while lower down round atomic weight 195 are congregated osmium, iridium and platinum. These groups are interperiodic because their atomic weights exclude them from the small periods into which the other elements fall; and because their chemical relations with some members of the neighbouring groups show that they are interperiodic in the sense of being formed in transition stages.

[*Note, June* 22.—Since the above was written, Prof. Ramsay and Mr. Travers have discovered two other inert gases accompanying argon in the atmosphere. These are called Neon and Metargon. From data supplied me by Prof. Ramsay, it is probable that neon has an atomic weight of about 22, which would bring it into the neutral position between fluorine and sodium. Metargon is said to have an atomic weight of about 40; if so, it shares the third neutral position with argon. I have marked the positions of these new elements on the diagram.]

PARIS.

Academy of Sciences, August 8, 1898.—M. Wolf in the chair.—On the theory of the zenithal telescope, by M. Hatt. An exposition in reply to some objections raised by M. Verschaffel.—Some points in the normal and pathological physiology of the heart, revealed by radioscopic examination, by M. Ch. Bouchard. This paper treats of the movements of the heart during respiration, both in the normal state and in the presence of diseases of the respiratory organs.—The double embryo of *Diplosomides* and tachygenesis, by MM. Edmond Perrier and Antoine Pizon.—The number and symmetry of the libero-ligneous bundles of the petiole as a measure of the gradation of vegetable species, by M. Ad. Chatin. The monocotyledons are dealt with in this article.—Experiments on the production of Alpine characters in plants by the alternation of extreme temperatures, by M. Gaston Bonnier. Comparative experiments were made with a number of plants cultivated under three different sets of conditions, the first being maintained at a constant low temperature (4° to 9° C.), the second subjected to the normal variations in temperature in the neighbourhood of Paris, and the third maintained at a very low temperature during the night and exposed to the sun in the day. Under the last-named conditions the plants exhibited the stunted growth, the short internodes, the small thick leaves, and the speedy efflorescence characteristic of Alpine species.—On the preparation of cultures of Koch's bacillus, most favourable for the study of the phenomena of agglutination in the blood-serum of tuberculous subjects, by MM. S. Arloing and Paul Courmont.—On the infinitely small deformation of an elastic ellipsoid, by MM. E. and F. Cosserat.—On simple kathode rays, by M. E. Goldstein.—On the superposition of two stereoscopic couples, by MM. T. Marie and H. Ribaut.—On monopyrocatechin glyoxal, by M. Ch. Moureu. The compound of the formula $C_8H_8O_4$, recently described by M. Julius Hesse, and obtained by him from a derivative of monopyrocatechin glyoxal, is shown to be identical with the orthohydroxyphenoxy-acetic acid produced by hydrolysis of ethane-dipyrocatechin (dipyrocatechin glyoxal). This result confirms the author in his supposition that monopyrocatechin glyoxal is an intermediate product in the hydrolysis of dipyrocatechin glyoxal.—Action of oxygen upon yeast, by M. Jean Effront. On exposure of yeast to air, absorption of oxygen takes place, accompanied by a considerable rise of temperature. This is due to the presence of an oxidising enzyme which will be subsequently described.—Study of the phosphoric acid dissolved by the water of the soil, by M. Th. Schlœsing fils. As has been already pointed out, the percentage of phosphoric acid held in solution by the water of the soil depends only on the nature of the latter, and is independent of the absolute amount of water present. On this fact is based a simple and expeditious method of determining the dissolved phosphoric acid in soils. The sample is agitated for ten hours with a large volume of water and the phosphoric acid estimated in an aliquot part of the clarified liquid. The result thus obtained, combined with a determination of the moisture in the soil, gives the information required.—On the mechanism of immunisation against the globulicidal action of snake serum, by MM. L. Camus and E. Gley.—Transmission of toxines from the fœtus to the mother, by M. A. Charrin. Experiments were made upon rabbits.—Influence of carbonic acid on the form and structure of plants, by M. Em. C. Téodoresco. Plants were grown in air deprived of carbonic acid, and in air to which a definite amount of the gas had been added. Certain morphological differences were observed.—"Jaundice," a bacteriological disease of the beetroot, by MM. Prillieux and Delacroix. The bacterial nature of the disease has been demonstrated, and confirmed by inoculation experiments.—Apparatus for taking radiographs of the thoracic cage during inspiration and expiration: results obtained, by M. Guilleminot. The construction of the apparatus was suggested by the experiments of M. Bouchard, whose observations are confirmed.—A luminous meteor, observed at Bourg-d'Ault (Somme), by M. C. Rozé.

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THURSDAY, AUGUST 25, 1898.

COMPARATIVE ALGEBRA.

A Treatise on Universal Algebra, with Applications. By Alfred North Whitehead, M.A. Vol. I. Pp. xxvi + 586. (Cambridge: at the University Press, 1898.)

THIS work affords a sad illustration of the spirit of lawlessness which has invaded one of our ancient Universities since the time when she rashly began to tamper with her Tripos Regulations. In the good old times two and two were four, and two straight lines in a plane would meet if produced, or, if not, they were parallel; but it would seem that we have changed all that. Here is a large treatise, issued with the approval of the Cambridge authorities, which appears to set every rule and principle of algebra and geometry at defiance. Sometimes ba is the same thing as ab, sometimes it isn't; $a + a$ may be $2a$ or a according to circumstances; straight lines in a plane may be produced to an infinite distance without meeting, yet not be parallel; and the sum of the angles of a triangle appears to be capable of assuming any value that suits the author's convenience. It is a pity that we have not had an opportunity of showing the book to some country rector who graduated with mathematical honours, say, forty years ago; it is easy to imagine his feelings of surprise, bewilderment, possibly of indignation, as he turned over the pages and encountered such a variety of paradoxical statements and unfamiliar formulæ.

Seriously, Mr. Whitehead's work ought to be full of interest, not only to specialists, but to the considerable number of people who, with a fair knowledge of mathematics, have never dreamt of the existence of any algebra save one, or any geometry that is not Euclidean. Its title, perhaps, hardly conveys a precise idea of its contents. It is, in fact, a comparative study of special algebras, exclusive of ordinary algebra, the results of which are taken for granted throughout. Such an undertaking has necessarily involved a very great deal of time and labour; for, in order to carry it out with any degree of success, it is needful, not only to master each separate algebra in detail, but also to adopt some general point of view, so as to avoid the imminent risk of composing, not one work, but a bundle of isolated treatises. Mr. Whitehead has, happily, overcome this difficulty by viewing the different algebras, in the main, in their relation to the general abstract conception of space. Whether this plan can be consistently followed throughout may be open to question: it certainly works very well in this first volume, the keynote of which is Grassmann's Extensive Calculus.

The first special algebra dealt with, however, appeals to a much simpler range of spatial ideas; it is the Algebra of Symbolic Logic, which only requires the conception of closed regions of space which may or may not overlap. This algebra is charmingly simple: it does not involve any arithmetical calculations, or even the use of digits, because both $a + a$ and aa are equivalent to a; and it enjoys a perfect dualism, so that from every proposition (not self-reciprocal) another may be at once inferred. On its value in its logical applications, it would be unwise for a mere mathematician to express an opinion, and the moral philosophers themselves appear to be of different minds on this as on some other questions; but this does not detract from its merits as an algebra of extreme simplicity, combined with symmetry and grace.

The next three Books (III.–V.) deal with positional manifolds, the calculus of extension, and extensive manifolds of three dimensions. In this very important section the reader will find a systematic development of the extensive calculus, with abundance of illustrative applications; so that English mathematicians will no longer have any excuse for ignoring Grassmann's magnificent conceptions. Time alone can show whether, as an instrument of discovery, Grassmann's calculus will prove superior to the ordinary methods; but of its power as a means of expression there can only be one opinion. To see this the reader has only to turn, for example, to the chapters on line geometry (Book V., Chapters i.–iii.), where the properties of null systems, the linear complex, and the invariants of groups of line systems (or, as the author prefers to call them, systems of forces) are proved with extreme directness and simplicity. The *crux* of the calculus is the theory of regressive and inner multiplication, which is discussed in Book IV., Chapters ii., iii.: the reader may be recommended to study these chapters in connection with the applications which follow, especially in Book V., Chapter i., where the formulæ for three dimensions are recapitulated. The idea of intensity is introduced at the outset, and the exposition follows mainly the *Ausdehnungslehre* of 1862: this procedure certainly has its advantages, but makes the extensive calculus appear more closely allied to the barycentric calculus than it naturally is.

Book VII., on the application of the extensive calculus to geometry, is largely concerned with vectors. From Grassmann's point of view a vector, or, as he called it, a "Strecke," is the difference between two extensive magnitudes of equal weight; with an appropriate law of intensity, it may also be regarded, in a sense, as a point at infinity. But there is a certain convenience, when working with vectors, in regarding them as independent elements, after the manner of Hamilton: this method is explained in Chapter iv. of the Book, which contains a number of kinematical and dynamical formulæ. Chapter iii., on curves and surfaces, illustrates very fairly both the strong and the weak points of the calculus.

Book VI. contains a detailed account of the theory of metrics. It is very refreshing to find that this theory is treated by the author in a thoroughly satisfactory way, without any of the sham metaphysics and faulty psychology which so often disfigure it, especially when an attempt is made to expound these abstract ideas to a popular audience. Starting with the purely abstract definition of a positional manifold, it is possible to construct a theory in which there is associated with any two elements of the manifold a numerical quantity called their distance, which may be finite or infinite, real or imaginary, but which only vanishes when the elements coincide. In order to satisfy certain axioms which are analogous to some of the assumptions tacitly or explicitly made in ordinary geometry, and the fundamental theorem of projective geometry that if three points of a row of points are congruent to the three corresponding points of a homographic range, then the two rows are congruent, it is necessary and sufficient that the distance between two elements a, b is $\kappa \log (abij)$, where κ is a constant and $(abij)$ is the cross-ratio of a, b, i, j, the last two being two fixed elements on the "line" ab, the so-called absolute point-pair of the line. This leads to Cayley's theory of the absolute quadric, and the classification of metrical geometry into the three kinds, elliptic, parabolic, and hyperbolic. The theory of angles between lines or planes, the theory of parallels, and the general definition of perpendicularity follow in due course. In all this there is no hocus-pocus whatever; we have an analytical theory, based upon precise definitions, which is quite independent of any appeal to the senses. But the question is bound to arise: "What is the relation of this to real geometry? What has it to do with the space of which we have experience, with the practical measurements which we are making every day?" To answer this inquiry in anything like a satisfactory way it is necessary to clear our mind of prejudices and misconceptions which obscure the whole matter until they are removed.

First of all it must be remembered that we cannot distinguish between real and imaginary space in the same sense as we do, for instance, between a real experience and an hallucination, or between a photograph and a landscape composition. Space is *essentially* an ideal conception, and strictly speaking we have no experience of space at all; we evolve, each of us probably with his own degree of precision or vagueness, a scheme to which we relate certain aspects of our sense-impressions. To attempt to define real space as the space in which real things exist is, of course, mere playing with words and avoiding the true issue: when we say that a thing "exists in space," we refer an actual (or imagined) objective experience to an ideal scheme, and our statement has a meaning for us simply so far as the scheme is clearly developed *in subjecto*. Again, to say that real space is of three dimensions, as contrasted with the n-dimensional space of abstract analytical geometry, merely means that, hitherto, a three-dimensional scheme has proved sufficient for the classification of those sense-impressions which admit of a spatial interpretation. It is a very interesting experiment to walk along a street and attend exclusively to one's visual impressions; this gives a consistent experience of a *two*-dimensional space with a time-series of continuous projective transformations. The exhibitions of "animated photographs" afford a similar experience; the conclusion seems obvious that the properties of "real" space are conditioned by the range of sensations that we refer to it. Supposing that we could develop a new sense, it is quite possible that we might experience a "real" space of four dimensions.

From the purely mathematical side these discussions are more or less irrelevant. The definition of a positional manifold of n dimensions is perfectly clear and intelligible; and it is quite legitimate to assume such postulates of construction as will make the corresponding geometry just as much a true geometry as the elements of Euclid. Of course, if $n > 3$, we lose the help of "intuition," that is, the suggestions of sense-impressions; but these suggestions are not essential, and the modern development of geometrical theory is, in fact, chiefly due to a sceptical criticism of the crude results of merely objective experience.

Then, again, as to the metrical properties of space. The analytical theory leads, as we have seen, to three distinct varieties. No conceivable experiment can decide whether "real" space is elliptic, hyperbolic, or parabolic: one sufficient reason is that it is pure assumption to suppose that we can move a ruler about without altering its length. It is enough for all practical purposes to know that the hypothesis of parabolic space is comparatively simple, and serves nearly enough for the interpretation of physical measurements. In this connection, special attention may be directed to Mr. Whitehead's notes on pp. 499 and 451. The last is particularly important, as pointing out that a space of one type may be a locus in a space of one more dimension and of a different type: thus ordinary Euclidean space of three dimensions may be regarded as a limit-surface in a hyperbolic space of four dimensions.

On p. 369 will be found a very useful bibliography of treatises and memoirs dealing with the general theory of metrics; one omission that may be noted is that no reference is given to Lie's large treatise on transformation-groups, which contains a section on this subject, with detailed criticism of the theories of Riemann, Helmholtz and others.

It would not be right to conclude this notice without saying a word or two in appreciation of the spirit of thoroughness and of independence in which Mr. Whitehead's valuable book has been written. It possesses a unity of design which is really remarkable, considering the variety of its themes; and the author's own contributions, not only in illustrative detail, but in additions to the general theory, are well worthy of attention. All who are interested in the comparative study of algebra will look forward with pleasurable anticipation to the appearance of the second volume, and wish the author all success in bringing his formidable task to a conclusion.

G. B. M.

EARLY GREEK ASTRONOMY.

The First Philosophers of Greece. An edition and translation of the remaining fragments of the pre-Sokratic philosophers, together with a translation of the more important accounts of their opinions contained in the early epitomes of their works. By Arthur Fairbanks. Pp. vii + 300. (London: Kegan Paul, Trench, and Co., Ltd., 1898.)

THE histories which we possess and to which we readily turn for information concerning the early science of the ancients have been prepared mainly by two kinds of writers, having in view two different objects. We have on the one hand, works like those of Delambre, or in later times of Mr. Narrien, authors possessing a comprehensive knowledge of mathematical analysis, and who, writing for the benefit of physicists, are most interested in exhibiting the scientific connection existing between the older philosophers and modern science. As an example of the other kind, we may refer to such works as that by Sir G. C. Lewis, whose classical attainments were probably in advance of his knowledge of physics, and who looked upon the writings of the ancients from the point of view of a student of ethics and philosophy. He addressed a wider and less specially educated class, whose interest in his book was perhaps more literary than scientific. Neither method of exhibiting the extent of ancient knowledge is free from objection. In either case the original is liable to be coloured or distorted by the views of the commentator. The modern serious student desires to consult original authorities, and takes but little interest in compilations, however thorough, by authorities, however competent. The work of Mr. Fairbanks will therefore be welcome to that class of students, who are anxious to know what the various authors have said themselves, not merely the interpretation which later writers have put upon these utterances. These original sources of information are too often only to be found in short fragments scattered liberally throughout Greek literature in the form of quotations from the earliest writers, or more or less complete epitomes of the masters' teaching, prepared by later writers. German criticism has been busy with these fragments, determining the relation of these writers to each other as well as to the source of the whole series, in order that we may estimate their relative value. The Greek text of these fragments has been published in numerous short monographs, most of which, however, are not easily accessible, and a competent guide is necessary. This essential service Mr. Fairbanks has rendered to the student by placing the materials ready to his hands. He has, moreover, prepared a carefully constructed text, enriched it by critical notes, and added an English translation. Important passages from Plato and Aristotle bearing on these early writers are also given, so that even the better known authorities gain some illumination. Mr. Fairbanks puts before us all the material for the survey of the history of early Greek thought; we necessarily confine our attention to the physical side.

It is interesting to inquire whether the reputations of certain philosophers, and the estimate we have formed of their scientific insight, should be modified by a critical study of the original description apart from the interpretation which later authors have given to these expressions. We are too apt to quote over and over again the expressed opinions of writers of repute, without re-examining the grounds on which those opinions rest. We may unconsciously attach too much weight to the comments of later writers who have been swayed by tradition, and who, in the absence of exact information, drawn from trustworthy sources, have inserted their own views in the place of the original. Unfortunately, in some cases, and these the most interesting, no fresh information is forthcoming. Thales, the founder of the Ionian school, for instance, remains as mythical and unsubstantial as ever. He looms large on the distant background owing to his connection with the famous eclipse to which his name is attached, and the part it has played in scientific chronology, but neither ingenuity nor research seems likely to afford a satisfactory answer to the several enigmas connected with his history. Anaximandros and Anaximenes scarcely fare better. It is generally agreed that two short phrases have been taken directly from the writings of the former, but even admitting the probability, neither of these expressions is calculated to throw much light on his teaching or illustrate any distinctive feature in the cosmical tenets which he propounded. It is not till we come to Herakleitos that we meet with any large number of original extracts. The preservation of these quotations may be due to chance, or may be held as evidence of the greater veneration in which his teaching was held. The student of Plato is acquainted with a few of his sayings which had passed into the character of proverbs, and attest the popularity of the author The complete collection presented to us by Mr. Fairbanks does not appear very edifying. Some, indeed, have the solemnity of the Proverbs of Solomon, while others well maintain that reputation for obscurity which the author early acquired and consistently retained. As an acute observer and scientific teacher, Herakleitos falls far behind Thales, or rather behind the position popularly assigned to Thales, for which, however, we get here little additional support. The suspicion that Herakleitos believed the sun to be no larger than a human foot is confirmed, and it seems probable that he taught that the sun and moon were both bowl-shaped. Eclipses were produced by the turning of these bowl-shaped bodies, so that the concave side was turned upwards and the dark convex side was seen by the observer. Following, however, the reconstructed "Placita of Aetios," probably the original work from which both Stobaeos and Plutarch copied, the earlier master taught that the eclipses of the sun took place when the moon passed across it in direct line, and that eclipses of the moon proved that it came into the shadow of the earth: the earth coming between the two heavenly bodies and blocking the light from the moon. Whether Thales really taught these advanced views himself is immaterial; the fact remains that these correct notions did obtain at a very early date, and it is very difficult to understand how, in any enlightened society, they were supplanted by the childish formulas recited by Herakleitos and his admirers. The scientific teaching of the school of Thales seems to have been at its best at its birth and to have rapidly deteriorated, authority possibly usurping the place of observation.

The Eleatic school, however, had much to learn. Xenophanes, the founder, was not happy in his scientific suggestions. According to the authority just quoted, this philosopher taught that the stars were formed of burning cloud, extinguished each day and re-kindled at night. This seems to be a fair sample of his teaching, and his name and his work may be rapidly passed aside. Parmenides, probably the disciple of Xenophanes, is entitled to more respectful consideration, both by reason of the regard in which he was held by Plato and by the correctness of his views on certain scientific points. From a passage in Stobaeos he has been credited with having taught that the earth was spherical in shape, but some doubt has existed, inasmuch as the same writer attributes the same discovery to Anaxagoras. Modern research seems to declare on the side of Parmenides, but the evidence is by no means clear.

Other teachers come under review, notably Pythagoras, from whom we have no preserved quotation, though the doxographists have much to say of him, and of Empedocles, who has much to say, both in his own words and those of others. But the reading of even the longest extracts does not leave a very satisfactory impression. It is impossible to feel that the quotations that have been preserved are those that are most characteristic of the master, or those by which he himself would wish to be judged. Some happy expression, some lucky chance may have attracted the attention of a pupil or a commentator, with the result that we get transmitted to us a very imperfect view, and consequently we utterly fail to reconstruct any adequate picture of the philosophical teaching as a whole. If Plato, writing of Parmenides, almost a contemporary, could say "I fear lest we may not understand what he said, and that we may fail still more to understand his thoughts in saying it," how much more difficult is it for us to obtain a clear conception. But this difficulty does not detract at all from the value of Mr. Fairbanks' work, or of those who have laboured in the field of literary criticism. In entering into their labours we learn with clearer precision the extent and the trustworthiness of the materials that exist for the study of early Greek thought.

A HUNDRED AND FIFTY NORTH AMERICAN BIRDS.

Bird Neighbors: an Introductory Acquaintance with One Hundred and Fifty Birds commonly found in the Gardens, Meadows, and Woods about our Homes. By Neltje Blanchan; with Introduction by John Burroughs. Pp. viii + 234. Coloured plates. (London: Sampson Low, Marston, and Co., Ltd., 1898.)

AT the first glance this volume might well be mistaken for an addition to the already extensive literature relating to British birds; but the spelling of the second word in its somewhat cumbersome title at once proclaims its Transatlantic origin. And, as a matter of fact, it is really a popular account of some of the commoner birds of the United States. Since it is confessedly printed in New York, it is doubtless an English edition of a work first published in the States; and although it may be most useful in the land of its birth, we may perhaps be permitted to suggest that it would have been better had its issue been restricted to that country.

On first opening the book the reader is confronted with a frontispiece purporting to represent the "Goldfinch," but instead of seeing the bird properly so denominated, he finds the so-called American Goldfinch (*Spinus tristis*). And, although the bird's proper title is given in the text, the plate, for issue in this country, ought to have been similarly lettered. This is by no means a solitary instance as regards the legends to the plates; while in the systematic part it is even worse. We find, for instance, the Hangnests, or *Icteridæ*, popularised under the names of blackbirds and orioles; while in the family (*Turdidæ*) to which the birds properly so-called belong, we have, in addition to thrushes, bluebirds and robins. Doubtless this is good enough for a country in which bison are miscalled buffalo, and stags of the red deer group elk, but it will scarcely commend itself to English readers.

In her preface the lady author lays great stress on the circumstance that "her knowledge has not been collected from the stuffed carcasses of birds in museums [as if any one examined *stuffed* specimens for descriptive purposes], but gleaned afield." And in the introduction it is written:—"The pictures, with a few exceptions, are remarkably good and accurate, and these, with the various groupings of the birds according to colour, season, habitat, &c., ought to render the identification of the birds, with no other weapon than an opera-glass, an easy matter."

It would be distinctly interesting to know which were the exceptions above referred to. Was the plate of the Yellow-throated Vireo, facing p. 189, one of them? In this plate we have an obviously stuffed example (and not a very well stuffed one at that) of the bird in question, mounted upon one of the conventional museum perches. The bird thus mounted has been fixed in the most glaringly obvious manner to one of a series of twigs of apple in blossom, and the whole reproduced as a picture. Apart from the perch, the general effect might not have been utterly bad, were it not that the twigs are placed in the vertical when they should have been in the horizontal position!

But there are even things artistically worse than this. Many of the plates, such as those of the Bobolink and the Brown Thrasher, appear to have been produced by taking a landscape and placing in front of it either a single (apparently stuffed) bird or a group of birds, and then, by some process unknown to us, reproducing the whole. And the effect is not pleasing. Either the objects in the background stand out as though they formed the middle distance, or they are hopelessly out of focus and form a confused blurr. As already said, the author inveighs against stuffed "carcasses," but if the Blackcap-Tit, or "Chickadee," forming the subject of the plate facing p. 76, does not come under such designation, we shall be greatly surprised.

Neither can we commend the arrangement of the birds described. At the commencement of the book these are placed under their proper families, and to our thinking no better arrangement could have been followed in the sequel. But this by no means suits the author. And after a little preliminary skirmishing in the way of classing by habitats, season, and size, she finally settles down to arrange the species by coloration! Consequently we have closely allied forms widely separated, and incongruous species placed in juxtaposition, without, so far as we can see, one single advantage gained over the ordinary system. To take an example, we have two species of woodpeckers placed among birds "conspicuously black and white," where they are flanked on each side by a passerine, but a third woodpecker (the "flicker") finds a far distant place among "brown, olive, or greyish-brown, and brown and grey sparrowy birds." Surely this is making confusion for confusion's sake.

Much more sympathy may be expressed for the author's attempt to divide the birds of New York according to whether they are permanent residents, or make their appearance at particular seasons only; and this list may prove of use not only to the ordinary bird-lover, but likewise to the student of migration and distribution. As regards the descriptions of the different species, these appear fairly accurate; and many little anecdotes of habits, &c., are related in a manner which can scarcely fail to attract attention.

Although both from the artistic and the strictly scientific standpoints, the volume, in our judgment, is somewhat of a failure, yet as an earnest and brightly-written attempt to popularise the study of the commoner North American birds, it is deserving of attention on the part of residents in the States who want to know more about the ways of the feathered creatures with which they meet. R. L.

OUR BOOK SHELF.

Symons's British Rainfall, 1897. By G. J. Symons, F.R.S., and H. Sowerby Wallis. Pp. 58 + 239. (London: Edward Stanford, 1898.)

AN interesting article on the mean annual rainfall in the English Lake district appears in this new volume of "British Rainfall," in continuation of articles published in the volumes for the years 1895 and 1896. The earlier contributions showed the rainfall at Seathwaite from 1845 to 1895, and the rainfall within an area of about thirty square miles having Seathwaite nearly in the centre. In the present volume a much larger area—about 650 square miles—is dealt with from the point of view of rainfall, and a number of noteworthy conclusions are reached. The paper is accompanied by an orographical map, and a map showing by means of isohyetal lines—that is, lines of equal mean annual rainfall—the distribution of the precipitation in the district. This map shows that annual rainfalls exceeding 100 inches occur over more than seventy square miles. A high rain fall appears to be established at the head of the Langdales, trustworthy observations giving a mean of 129·7 inches at Mickleden, which value is within five inches of the rainfall at Seathwaite.

Mr. Symons points out that the rainfall differs very greatly, even within a few miles. An examination of the records of three pairs of stations, separated by 3½, 2½, and 1¼ miles respectively, showed the increase per mile to be 28 inches, 21 inches, and 71 inches respectively, the last-named representing a difference of 0·04 inch per yard.

Heavy rains in short periods appear to have been more frequent in 1897 than they generally are. Large rainfalls in twenty-four hours were also noteworthy. One of the heaviest rains on record in the United Kingdom occurred at Seathwaite on November 12, 1897, the fall in twenty-four hours ending at 9 a.m. on November 13 being 8·03 inches—that is, more than half an inch greater than any diurnal record during fifty-three years. As to the relation which the total fall of rain in 1897 bears to the average amount, Mr. Symons finds that, for England and Wales, and Scotland as a whole, the fall in 1897 was the same as the average fall for the period 1880–89, but in Ireland it was twelve per cent. in excess.

The number of observers who now send their records to Mr. Symons is 3318, and credit is certainly due to him for the organisation of this vast staff, and to the authors combined for their work of reducing the observations to law and order.

Storia Naturale, per la gioventù Italiana. By Achille Griffini, Assistant at the Royal Zoological Museum, University of Turin. Pp. 720. (Milan: Ulrico Hoepli, 1898.)

ENCYCLOPÆDIAS in one volume are not much in vogue in England, and this one needs but a short notice. It embraces the whole range of zoology, botany, and mineralogy, and seems to be the result of much laborious compilation and condensation. But surely such labour is all but thrown away; such a book can never really interest young people, or train them in the habit of attention and observation. If a new butterfly or fossil be met with, the book may perhaps be consulted, but will in all likelihood be found either to have omitted the species altogether, or to have given so inadequate a description as to make identification a mere guess-work. This is no fault of Dr. Griffini, who has worked conscientiously, and has been obliged, as he says with a sigh, to suspend all his scientific research during the composition of the book: it means simply that it is impossible in the given space to deal with any one species in a way that can be called either scientific or interesting. Here is an example—a description of one of the most singular and beautiful birds in Europe:—

"*Tichodroma muraria* (the wall-creeper), length 17 cm., of an ash-grey colour with red and black wings: the male has a black throat, but in the female this is whitish. It lives on the tops of the Alps and Apennines, climbs with agility, often poises itself on its wings during flight, and feeds on insects."

This account may be said to be devoid of all the qualities which should attract the "gioventù Italiana," or fix this curious bird in their memories: it is incomplete and inaccurate, as well as uninteresting; and it is obvious that the writer had never seen the bird alive. But many species are much more minutely described, and illustrated by very fairly good woodcuts, which are better than the coloured plates containing each a large number of species crammed into a small space. And there is no doubt a certain advantage to beginners in having a survey of the whole field of natural history for purposes of classification as well as ordinary reference. Yet for helping the beginner and awakening his interest, our own plan of issuing a series of handy volumes seems far better both for authors, readers, and publishers.

Iowa Geological Survey. Vol. vii. Annual Report, 1896, with accompanying papers. Pp. 555. (Des Moines: Iowa Geological Survey, 1897.)

THE papers in this report contain descriptions of the geological characteristics of six counties in Iowa, namely, Johnson and Cerro Gordo Counties, described by Dr. Samuel Calvin, State Geologist; Marshall County, by Dr. S. W. Beyer; Polk and Guthrie Counties, by Mr. H. F. Bain; and Madison County, by Prof. J. L. Tilton and Mr. H. F. Bain. These counties are geologically important in regard to both indurated rocks and superficial deposits, and the report upon them, with the many maps and diagrams, will be found of interest and service to the people of Iowa.

In addition to the counties reported upon in the present volume, a large amount of other work is referred to in the administrative report. Thus, investigations undertaken with the object of determining the distribution of certain types of soil and their relation to the drift-sheets covering the State, have incidentally demonstrated that the succession of Pleistocene deposits is more complete and more clearly indicated in Iowa than in any other corresponding area of the North American Continent so far studied. Another interesting subject referred to is the discovery of a remarkable fish fauna in an old slate quarry in Johnson County. The beds in which the remains occur are of Devonian age; but it is said that no such assemblage of Devonian fishes has hitherto been found in North America, or in the world. The material has been placed in the hands of Dr. C. R. Eastman, of the Museum of Comparative Zoology, Cambridge, Massachusetts, who has undertaken to study it.

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.*]

What is "Anlage"?

THE necessity of finding an adequate translation of this indispensable German expression becomes more, rather than less, pressing as time goes on. To be obliged, on every occasion, to write "Anlage" in inverted commas, is a standing testimony to the deficiency of our scientific nomenclature, and a constant offence to our æsthetic susceptibilities. It is true that there are other terms which have been spasmodically employed to convey the conception contained in "Anlage." But these terms are either inadequate, unsightly or inaccurate. "Forecast" is inadequate, "fundament" is unsightly, while "rudiment" is inaccurate. I will not insist further upon the impropriety of the use of the words "forecast" and "fundament," but will proceed to explain why, in my opinion, "rudiment" is an inaccurate rendering of "Anlage" It is not so much that an "Anlage" of an organ is not a "rudiment" of that organ, as that the rudiment of an organ is generally something different from its "Anlage."

This point is best illustrated by considering a somewhat extreme case, or at least one which is a matter of common observation. The budding limbs of the embryo of a quadrupedal vertebrate are rudiments of the pentadactyle appendages which have their origin in the internal "Anlagen" of those structures. Thus the "Anlagen" are aggregations of embryonic cells which, by their growth and division, give rise to rudiments, and the latter, in their turn, give rise to the finished organs. So that, far from being identical with an "Anlage," a rudiment arises from an "Anlage," and is the middle stage in organogeny.

As the organs of the animal body are built up of tissues, and these of cells, so, in their development, they spring from rudiments, and these from "Anlagen."

This analogy may be represented as follows:—

Anatomy.	*Development.*
Organs—tissues—cells.	"Anlagen"—rudiments—organs.

In some cases, no doubt, it would not be necessary to make a fine distinction between "rudiment" and "Anlage," but in others it is undoubtedly necessary; and it is for such cases that one has to be prepared with a suitable technical term.

The essentials of a good term are that it should be new, precise and Latin.

The word that commends itself to me as being at once accurate and well-sounding is *primordium*, and I trust some of your readers will criticise it whether favourably or unfavourably.

The conception embodied in the word "Anlage" recurs so frequently in our science, that it seemed of sufficient importance to invite attention to the matter in the columns of NATURE.

New Museums, Cambridge, August 16. ARTHUR WILLEY.

"Animal Intelligence."

IN a review of my monograph on "Animal Intelligence," in a recent number of NATURE, Mr. Lloyd Morgan credits me with upholding the theory that we have sensations caused by outgoing currents which innervate muscles, and with depending on that theory in some of my own statements about the nature of animals' consciousness. A careless and ambiguous sentence of mine was responsible for this. I believe with Mr. Morgan that the feelings which go with innervations of the muscles are due to currents *coming back from* the muscles or joints and tendons, and do not think that any of my conclusions in any way involve an acceptance of the other theory. Such sensations due to return currents (together with the images built up from them) were just what I meant by the phrase which he quotes, "the consciousness accompanying a muscular innervation apart from that feeling of the act which comes from seeing oneself move, &c." It was because I presupposed general agreement in accepting the return-current theory that I was so careless as to leave the obvious ambiguity. EDWARD L. THORNDIKE.

Cambridge, Mass., U.S.A., August 3.

I NEED hardly say that I sincerely regret the unwitting misrepresentation of Mr. Thorndike's meaning. But I may be allowed to add, in self-defence, that the "careless and ambiguous sentence" forms part of the *definition* of "impulse," and that the exclusion of "feeling one's own body in a different position, &c.," is emphasised by italics. I am glad to find that Mr. Thorndike's interpretation and my own are thus yet more closely in accord than I supposed, and shall look forward to more experiments and further discussion in the field of "Animal Intelligence" from him. C. LLOYD MORGAN.

A Tooth of *Hybodus grossicornis* from the Inferior Oolite.

SOME time ago I found in one of the lowest strata of the Inferior Oolite, a tooth of the *Hybodus grossicornis.* The bed occurred at Haresfield Beacon, near Gloucester. The following section of this hill is given by Mr. E. Witchell, of Stroud:—

Freestone: Ferruginous concretionary marl, 1 foot 6 inches; ferruginous brown hard sandstone, 8 feet; oolitic ferruginous bed, 2 feet; Cephalopoda beds, 2 feet 6 inches.

Below these beds are the Cotteswold Sands, resting upon Upper Lias. The tooth was found in the freestone bed, the characteristic fossils of which are Ostrea, Lima, Terebratula, various small Gasteropoda and Crinoids

The species of the fossil has been kindly determined by Prof. Newton. THOS. BEACALL.

Quedgeley, Gloucester, August 19.

Iridescent Clouds.

YOUR correspondent Mr. W. Larden, writing on the subject of solar halos (p. 344), referred also to rose-crimson and green colours on clouds. It is quite unnecessary to be at 6000 feet altitude to observe iridescent clouds, for we do so frequently here during the summer months, at about 350 feet above sea-level. They appear generally about an hour before sunset and cease at sunset, and we always look out for them when seeing the suitable kind of delicate cirrus cloud in fine wavy fleecy streaks in the sky near the sun at the right hour; and are generally rewarded by the sight of the exquisite rose and green ripples of nacreous brilliancy, affording a striking contrast to the ordinary sunset colouring. E. ARMITAGE.

Dadnor, Herefordshire, August 16.

Distant Thunderstorms affecting Flowers.

AT Malvern we felt none of the thunderstorms of Thursday, August 18, and the following night; but some freshly-cut sweet peas shrivelled, and did not recover their beauty until the morning of the 19th. The nearest storms must have been at Cardiff and Bristol. ROSEMARY CRAWSHAY.

INTERNATIONAL CONGRESS OF ZOOLOGISTS.

THE Fourth International Congress of Zoology, which opened at Cambridge on Tuesday morning, August 23, promises to be the most successful meeting yet held. This is the first occasion that the Congress has met in England, and the proportion of English members assembled to extend a welcome to the foreign zoologists is, as it should be, considerable. The Congress is a triennial one, and has already met at Paris, Moscow and Leyden. The increasing popularity with which the meetings are regarded by zoologists may be gauged by the progressive increase in the number of members attending. Only sixty members were present at the Paris Congress in 1889, 120 at Moscow, and 200 at Leyden; the number participating at the present meeting has already exceeded 280. Among the distinguished visitors present are Dr. Anton Dohrn (Naples), Prof. E. Ehlers (Göttingen), Prof. L. von Graff (Graz), Prof. Haeckel (Jena), Prof. E. L. Mark (Cambridge, Mass.), Prof. O. C. Marsh (New Haven), Prof. A. Milne-Edwards (Paris), Prof. K. Mitsukuri (Tokyo), Prof. Ramsay-Wright (Toronto), Prof. W. Salensky (St. Petersburg), Prof. F. E. Schulze (Berlin), and Prof. J. W. Spengel (Giessen). Much disappointment is felt at the absence through ill health of Prof. Carus, Prof. Ray Lankester and Sir William Flower. Sir William Flower, it will be remembered, was, at the conclusion of the Leyden Congress in 1895, made President-Elect for this Cambridge meeting; but he relinquished the presidency in favour of Sir John Lubbock, in the early part of the present year, on account of failing health. Sir John Lubbock opened the Congress on Tuesday morning by a short address, which is here printed in full. The members of the Congress who arrived at Cambridge on Monday evening were received at the Guildhall by the Mayor of Cambridge and by the Vice-Chancellor of the University, who, in a short speech begun in English, continued in German, and concluded in French, welcomed the visitors and expressed the best wishes of the town and the University for the success of the meeting.

The following is the President's address:—

My first duty to-day is to welcome our foreign friends who have done us the honour to attend the Congress. I may do so, I know, on behalf of all English zoologists. They will, I hope, find much to reward them for their journey. It will have been to them, as it is to us, and to no one more than myself, a matter of profound regret that Sir W. Flower, who had been nominated as our President, found himself unable to accept the post. Our regret is the keener on account of the cause, but I am sure that we all hope that rest and change of air will secure him a renewal of health. I am painfully conscious how inadequately I can fulfil his place, but my shortcomings will be made up for by my colleagues, and no one could give our foreign friends a heartier or more cordial welcome than I do.

The first Congress was held at Paris in 1889, and was worthily presided over by Prof. Milne-Edwards, whom we have the pleasure of seeing here to-day. The second Congress was held at Moscow in 1892, under the Presidency of Count Kapnist, and under the special patronage of his Imperial Highness the Grand Duke Serge. The third Congress was at Leyden in 1895, under the Presidency of Dr. Jentink, Director of the Royal Museum, and under the patronage of the Queen Regent. We assemble here to-day under the patronage of H.R.H. the Prince of Wales, with the support of Her Majesty's Government, and under the auspices of the University of Cambridge.

Such meetings are of great importance in bringing together those interested in the same science. It is a great pleasure and a great advantage to us to meet our foreign colleagues. Moreover, it cannot be doubted that these gatherings do much to promote the progress of science.

What a blessing it would be for mankind if we could stop the enormous expenditure on engines for the destruction of life and property, and spend the tenth, the hundredth, even the thousandth part, on scientific progress. Few people seem to ealise how much science has done for man, and still fewer how much more it would still do if permitted. More students would doubtless have devoted themselves to science if it were not so ystematically neglected in our schools; if boys and girls were not given the impression that the field of discovery is well-nigh exhausted. We, gentlemen, know how far that is from being the case. Much of the land surface of the globe is still unexplored; the ocean is almost unknown; our collections contain thousands of new species waiting to be described; the life-histories of many of our commonest species remain to be investigated, or have only recently been discovered.

Take, for instance, the common eel. Until quite recently its life-history was absolutely unknown. Aristotle pointed out "that eels were neither male nor female," and that their eggs were unknown. This remained true until a year or two ago. No one had ever seen the egg of an eel, or a young eel less than 5 centimetres (1¼ inches) in length We now know, thanks mainly to the researches of Grassi, that the parent eels go down to the sea and breed in the depths of the ocean, in water not less than 3000 feet below the surface. There they adopt a marriage dress of silver and their eyes considerably enlarge, so as to make the most of the dim light in the ocean depths. In the same regions several small species of fish had been regarded as a special family, known as Leptocephali; these also were never known to breed. It now appears that they are the larvæ of eels; the one known as *Leptocephalus brevirostris* being the young of our common fresh-water eel. When it gets to the length of about an inch, it changes into one of the tiny eels known as elvers, which swarm in thousands up our rivers. Thus the habits of the eel reverse those of the salmon.

I will only take one other case, the fly of the King Charles oak apple so familiar to every schoolboy. In this case the females are very common; the eggs were known. But no one had ever seen a male. Hartig in 1843 knew twenty-eight species of Cynips, but in twenty-eight years' collecting had never seen a male of any of them. He and Frederick Smith between them examined over 15,000 specimens of *Cynips disticha* and *C. Kollari*, and every one was female. Adler, however, made the remarkable discovery that the galls produced by these females are quite unlike the galls from which they were themselves reared; that these galls produced flies which had been referred to a distinct genus, and of which both males and females were known. Thus the gall-flies from the King Charles oak apple (which are all females) creep down and produce galls on the root of the oak from which quite a dissimilar insect is produced, of which both sexes occur, and the female of which again produces the King Charles oak apple. This is not the opportunity to go into details, and I merely mention it as another illustration of the surprises which await us even in the life-history of our commonest species.

Many writers have attributed to animals a so-called sense of direction. Some species of ants and bees certainly have none. Pigeons are often quoted, but the annals of pigeon-flying seem to prove the opposite; they are "jumped," as it were, from one point to another. We know little about our own senses—how we see or hear, taste or smell; and naturally even less about those of other animals. Their senses are no doubt in some cases much acuter than ours, and have different limits. Animals certainly hear sounds which are beyond the range of our ears. I have shown that they perceive the ultra-violet rays, which are invisible to us. As white light consists of a combination of the primary colours, this suggests interesting colour-problems. Many animals possess organs apparently of sense, and richly supplied with nerves, which yet appear to have no relation to any sense known to us. They perceive sounds which are inaudible to us, they see sights which are not visible to us, they perhaps possess sensations of which we have no conceptions. The familiar world which surrounds us must be a totally different place to other animals. To them it may be full of music which we cannot hear, of colour which we cannot see, of sensations which we cannot conceive.

There is still much difference of opinion as to the mental condition of animals, and some high authorities regard them as mere exquisite automata—a view to which I have never been able to reconcile myself. The relations of different classes to one another, the origin of the great groups, the past history of our own ancestors, and a hundred other problems, many of extreme practical importance, remain unsolved. We are, in fact, only on the threshold of the temple of science. Ours is, therefore, a delightful and inspiring science.

We are fortunate in meeting in the ancient University of Cambridge, a visit to which is, under any circumstances, delightful in itself from its historic associations, the picturesque beauty of the buildings, and as the seat of a great zoological school under our distinguished colleague, Prof. M. Foster.

The University has given us a most hospitable reception, for which we are very grateful. This morning will be devoted to business and the receipt of reports. In the afternoon will be held the first meeting of Sections, and to-night the Vice-Chancellor has been good enough to invite us to Downing College. To-morrow morning will be devoted to a discussion of the position of sponges in the animal kingdom, and in the evening there will be a conversazione in the Fitzwilliam Museum. Thursday we are looking forward to a discussion on the origin of Mammals. For Friday we have a number of interesting papers. On Saturday morning we shall have to determine the time and place of the next meeting, and then we adjourn to London.

The President and Council of the Zoological Society have invited us to visit their gardens in the afternoon; and in the evening, by the kind permission of the Trustees, I am permitted to invite your presence to a party at the Natural History Museum.

The Central Hall only will be open that evening, but on the following day you will have the opportunity of visiting the whole Museum.

In the evening the President and Committee of the Royal

Societies' Club hope to have the pleasure of seeing you at their house in St. James-street.

Monday the Museum of the College of Surgeons will be thrown open, and will be found well worth a visit. Mr. Rothschild has also kindly invited us to see his rich museum at Tring.

Tuesday the Duke of Bedford will show his collection of Cervidæ at Woburn, and there will be excursions under the auspices of the Director of the Marine Biological Laboratory at Plymouth, and of Prof. Herdman at Port Erin.

I trust, therefore, that you will have a delightful and interesting week, and that our foreign friends will carry back with them pleasant recollections of their visit here, which may induce them to return again in some future year.

THE BRITISH ASSOCIATION.

THE preparations for the meeting in Bristol are well in hand, and by September 7 everything will be in order for the reception of visitors. It is, of course, impossible to say at present whether the meeting will be a big one, but it is expected to be, and the Executive Committee are prepared for any emergency which may arise on this score. It is not improbable, taking all things into consideration, that many will avail themselves of coming to Bristol. Owing to the distance that the meeting was held from London last year, some certainly could not spare the time for a visit to Canada, and so will take special pains to be present this year. There happen, too, to be several unusual attractions. The opening of the Cabot Tower, though not strictly speaking connected with the Association, has been fixed for Tuesday, September 6, and will no doubt influence many Canadians and other American visitors to come to Bristol. The Marquess of Dufferin will perform the ceremony, and be present at the dinner in the evening. The International Conference on Terrestrial Magnetism will also meet during the Association week, and there will also be a Biological Exhibition in the Clifton Zoological Gardens, which cannot fail to be of interest. Lastly, and by no means leastly, the high reputation Bristol and the neighbourhood has for objects of interest—geological, botanical, and archæological—together with the well-known beauty of the place and the hospitality of its citizens, will induce many to attend the 1898 meeting, combined with the additional attraction of a visit from part of the Channel Fleet.

The reception room will be at the Victoria Rooms in the large hall, and will contain the usual counters for obtaining tickets, &c., post office, and conveniences for writing; this latter being in the gallery, access to which is obtained by a wide staircase. The small hall will be devoted to the gentlemen's smoking room, where tea and coffee can be obtained. The room known as Alderman Daniel's, with two others, will be given over to the ladies, the rooms being suitably furnished. The local hon. treasurer and secretaries will also have their office in the Victoria Rooms.

The Directors of the Victoria Rooms Company have, in reply to a request, redecorated a large part of the building, so that the appearances are all that could be desired. Cloak room for gentlemen, typewriting rooms, telephone, and a newspaper stall are all provided.

Luncheons can be obtained at the Grammar School, hard by the Victoria Rooms, and at the premises of the late Salisbury Club, which latter building will also accommodate the press and General Committee at their meetings. Lunch can also be obtained at several restaurants near.

In the Drill Hall will be an exhibition of pictures, ancient armour, and Bristol china and other objects of interest; while the band of the Royal Horse Artillery will play there each afternoon from 4 to 6. In the event of wet weather this place will be very convenient; but wet or fine, it will form a comfortable lounge for those who do not wish to go to garden parties.

The section rooms are well situated, and are mostly near the reception rooms, the furthest not being any considerable distance.

Section A will meet in the Lecture Theatre of the Museum, kindly lent by the Corporation; Section B in the British University College; Section C in the Hannah More Hall, Park Street; Section D in the Victoria Chapel Schoolroom; Section E in the Concert Room of the Blind Asylum; Sections F and G in the Merchant Venturers' Technical College; Section H in the Roman Catholic Schoolroom; Section K in the Fine Arts Academy.

All the Bristol and Clifton Clubs have thrown their doors open to visitors, and at the Clifton College and Corporation Baths members can have an early swim if they desire it.

The presidential address and evening lectures will be delivered in the Colston Hall; the working men's lecture in the hall of the Young Men's Christian Association, St. James Square.

Two conversaziones will be given: one by the Chairman of the Council (the Lord Bishop of Hereford), the head master of Clifton College, and Mrs. Glazebrook, at Clifton College, on September 8; the other by the local committee, in the Colston Hall on the 13th.

As well as the Cabot dinner two others will be given: the Chamber of Commerce on the 10th, the Master and Society of Merchant Venturers on the 13th; and a smoking concert will be given in honour of the President at the Merchant Venturers' Technical College on the 9th.

During the week, eight garden parties will be given to the members of the Association, several of the houses where they are to be held having most beautiful views of the Avon and Severn. As regards the usual literature that will be distributed, the handbook will not be of the bulky though excellent type of the 1875 one; it will be a more compact work, printed on thin but strong paper, and the articles, which are written by local authorities on the various subjects, as complete and full as space will permit. This work was completed more than a month ago.

The excursions guides are being framed on the lines laid down by the Manchester Committee a few years ago. Each of the eighteen excursions is printed as a separate booklet, but all are enclosed in a stout cloth cover and held by a band. The map, for only one will be given, is a new one, just published by Philip, of Liverpool, and will be coloured to show the geology of the district.

GLYPTIC AND GRAPHIC ART APPLIED TO PALÆONTOLOGY.[1]

THE Trustees of the American Museum of Natural History have undertaken a most useful work, in providing casts of a number of vertebrate fossils, obtained during recent years, from the Tertiary and Secondary deposits of North America, many of which can only be represented by this means in foreign museums.

But they have done even more than this; for, possessing on their staff men of artistic talent, as well as anatomical knowledge, they have set to work and produced a series of models of some of the extinct monsters of the Permian, Cretaceous and Tertiary rocks of North America, restored by Mr. Charles Knight with suggestions and criticisms by the late Prof. E. D. Cope, and by Prof. Osborn and Dr. Wortman. These models (which are on a scale suitable for a small museum or lecture-table), have been executed in plaster by Mr. Jacob Gommel. Only five are at present ready for dis-

[1] "Casts, Models, Photographs, and Restorations of Fossil Vertebrates," Department of Vertebrate Palæontology, American Museum of Natural History; Central Park, New York, U.S.A. Henry F. Osborn, Curator; J. L. Wortman and W. D. Matthew, Assistant Curators. 8vo. Pp. 24 7 illustrations).

tribution, at prices varying between ten dollars and thirty dollars each; they represent:—

Fig. 1, *Agathaumus* (*Triceratops*) *sphenocerus* (Cope), a large heavily armed herbivorous Dinosaur from the Laramie Upper Cretaceous of Western America; the length of the animal being about 25 feet.

Fig. 2, *Hadrosaurus mirabilis* (Leidy), a huge Dinosaur 38 feet in length, with a head like an *Ornithorhynchus*, with small fore-limbs and heavy hind-limbs and tail. Like *Triceratops* it was found in the Laramie Cretaceous beds. *Hadrosaurus* was probably of amphibious habits, feeding on soft water-plants or small mud-loving organisms. Its body was covered with a thick rhinoceros-like hide, parts of which were found preserved with the skeleton in Prof. Cope's specimen.

Fig. 3, *Megalosaurus?* (*Lælaps*, *Dryptosaurus*), *aquilunguis* (Cope). A carnivorous type of Dinosaur, about 15 feet in length, 8 feet of which was represented by its tail; light and agile in form, and armed with powerful teeth and claws. The disproportionately long hind-limbs and heavy tail remind one of the kangaroo, which it may also have resembled in its mode of progression, by leaps instead of walking or running. It probably used its powerful hind feet armed with heavy claws in attacking its enemies. The jumping powers, as represented in the model of two fighting *Lælaps*, was suggested by Prof. Cope. *Lælaps* was first described by Cope from the Cretaceous beds of New Jersey. The name (*Lælaps*) being preoccupied, Prof. Marsh substituted that of *Dryptosaurus;* but in order to avoid the use of this name, it is here suggested to place it in Buckland's genus *Megalosaurus!*

Fig. 4, *Nanosaurus claviger* (Cope) is from the Permian beds of Texas, and is a highly-specialised form belonging to the primitive reptilian order *Pelycosauria* of Cope, and to the sub-order *Rhynchocephalia*, "beak-headed" reptiles. As to the precise object of the extraordinary rigid fin-like crest upon the back, it is not easy to conjecture. Prof. Cope humorously suggested that it might have been used as a sail. Again, it might have asisted the creature in swimming, or was perhaps only ornamental. It was supported upon enormously elongated ladder-like processes of the dorsal vertebræ, a structure probably unique amongst the Reptilia or even amongst Vertebrates.

The last model is that of *Cervalces americanus*, a Pleistocene form of the American elk, which was of the same size and proportions as the living moose, but

No. 1. Agathaumus sphenocerus Cope.

No. 2. Hadrosaurus mirabilis

No. 4. Nanosaurus claviger

had horns almost as large as those of the extinct gigantic Irish deer, expanded in three planes of growth nearly at right angles to each other. The model is based upon a remarkably perfect skeleton found in New Jersey, and mounted in the Princeton University Museum. Prof. Scott, who described it in 1885, suggested that it possessed characters intermediate between those of the deer and moose.

The other casts executed embrace the fore and hind foot of *Coryphodon radians*; the fore-foot of *Palæosyops paludosus*; the front of skull and lower jaw of *Diplacodon* *emarginatus*; the lower jaw of *Dromatherium sylvestre*, described by Emmons from the Trias of North Carolina in 1854; the lower jaw of *Microconodon tenuirostris*; and the brain-casts of *Periptychus rhabdodon*, and of *Pantolambda*.

Interesting as are these casts, we venture to think that the most valuable work achieved by Mr. Osborn is the production of the fine series of photographs (bromide enlargements from the original negatives, size 18 inches × 22 inches).

These excellent pictures, of which a number may be seen mounted and exhibited in the galleries of the British Museum (Natural History), Cromwell Road, London, consist (1) of photographs of eleven mounted skeletons of rare fossil mammals, as *Metamynodon*, *Titanotherium*, *Hyrachyus*, *Patriofelis*, *Protohippus*, *Hoplophoneus*, *Palæosyops*, *Phenacodus*, *Coryphodon*, *Teleoceras*, and *Acerátherium*; and (2) photographic restorations, of the same size as the skeletons, depicting the animals clothed in their flesh, and represented in different attitudes according to their known habits and surroundings.

No. 3. Megalosaurus (Lælaps, Dryptosaurus) aquilunguis (*Cope*).

They are taken from a series of large water-colour drawings executed by Mr. Charles Knight, the animal painter, with the object of increasing the popular interest in these extinct animals, and to give a fuller and truer idea of their anatomy and external form than is afforded by the skeleton alone. The position of all the joints and angles of the feet and limbs is true to life, being governed by the skeleton itself. The lips, nostrils, and gape of the mouth are determined by comparison of the length of the nasals, size of the interior nares, character and position of the teeth, with similar parts in the remotely-related living forms. The eyes are carefully located and proportioned. Up to this point the animal is a fairly correct representation of the original. On the other hand the shape of the ears, the colour and epidermic characters of hair and hide are largely imaginative, except in so far as they are suggested by relationship to modern allies, as of *Protorohippus* to the horse, or of *Acerátherium*, *Metamynodon*, and *Hyracodon* to the rhinoceros. (The price of these photographs is fixed at four dollars each). These restorations include *Patriofelis*, an aquatic Middle Eocene carnivore with broad flat plantigrade feet with spreading toes, well adapted for swimming. He was not, perhaps, as expert a swimmer as the seals are now, but was sufficiently active in the water to capture turtles.

This is, perhaps, the least original and successful of the restorations, being modelled somewhat too closely upon the existing otter.

The second restoration is that of the little four-toed Lower Eocene horse (*Protorohippus venticolus*). This animal in life was about four hands or sixteen inches in height at the withers. The mane is left upright; the forequarters and neck are striped. The body is, perhaps, too large for such very slender and graceful legs.

The third restoration is based on a study of the mounted skeleton of the *Aceratherium*, a hornless form of rhinoceros from the Upper Oligocene formation.

The next picture represents the six-horned *Protoceras*, a Tertiary ruminant from South Dakota, not unlike the North American prong-horn antelope, with soft snout and fleshy upper lip as in the modern saiga.

Metamynodon, an aquatic hornless rhinoceros from the same deposits, affords the subject for a fifth cartoon. The giant pig (*Elotherium*), from South Dakota lake deposits, forms a sixth illustration. The head in the male is of enormous size, but the chest is small and the limbs are extremely tall and stilted. The great projecting flanges below the cheeks, for the attachment of the masseter muscles, presented peculiar difficulties to the artist to represent correctly.

FIG. 5.—Anterior view of a single dorsal vertebra of *Nanosaurus claviger* (nat. size), Cope. Permian, Texas (*Ce*, centrum).

Another striking group is that of the Titanothere, a huge horned pachyderm, of which the male, female and young are depicted. There is no doubt that the females were smaller, and possessed imperfectly-developed horns and narrow zygomatic arches; the males had a pair of extremely long recurved horns, placed transversely on the nasals. In the general structure of the skull, as well as in its dentition, *Titanotherium* (except in the peculiar position of the horns) suggests the modern rhinoceros.

The most striking of these large early Tertiary mammals is undoubtedly the *Uintatherium*, of which Mr. Knight has made an excellent picture. There are quite a number of species of this huge many-horned ungulate, for which the sub-order Dinocerata was proposed by Prof. O. C. Marsh, and on which that author founded an admirable quarto monograph in 1884. Like many American forms it enjoys several generic names, as *Dinoceras*, *Tinoceras*, and *Uintatherium;* the last, being that proposed by Prof. Leidy in 1872, has no doubt the strongest claim to priority.

Three pairs of bony, rounded horn-like protuberances mark the skull; the tusks, which are large, are thought to have been used to draw the branches and leaves of shrubs into the mouth; the skeleton at once suggests that of the elephant, and presupposes a similar hide. A papier maché (life-size) restoration of the skeleton of *Uintatherium* (*Tinoceras*) *ingens*, presented by Prof. O. C. Marsh, in addition to Mr. Knight's restoration of *U. cornutum*, grace the Natural History Museum in Cromwell Road.

To these we may add the restoration of *Hyracodon*, a small running form of rhinoceros of as light a build as a modern zebra, but lacking its grace of head.

The tenth restoration is that of a large carnivore *Mesonyx*, which, from the blunted condition of its teeth, suggests that the animal was omnivorous in diet, and that it might have lived partly upon turtles or decaying animal food. The body is represented as large and the legs very short, and therefore not well adapted for the pursuit of living prey.

Palæosyops, a Middle Eocene Titanothere resembling the tapir in habits, with an elongated prehensile upper lip and slender fore-feet, is believed to have inhabited the low marshy lands, feeding entirely upon the softer kinds of leaves and grasses, since its teeth are unadapted to hard vegetable food.

The last restoration is that of the *Mastodon*, which, being so much akin to the elephants of to-day, affords little scope for the imagination in depicting him as a living animal.

The feet are larger and more projecting than in the existing species of elephants, the limbs are relatively shorter, and the head has the low flat skull of the African rather than the high prominent forehead of the Indian elephant.

We cannot fail to congratulate Prof. Osborn on the work upon which he is engaged, and to express the hope that many more of these restorations may be evolved from the fertile invention of the artist, tempered by the careful and chastening influence of the comparative anatomists of the American Museum of Natural History, New York.

JOHN A. R. NEWLANDS.

WE regret to have to record the death of Mr. John Newlands, as a consequence of an attack of influenza, at the comparatively early age of sixty-one. While probably no subject in the whole range of theoretical chemistry has received a greater amount of attention than the numerical relations among the atomic weights of the elements, few among the younger generations of chemists are acquainted with the circumstances attending the establishment of the remarkable generalisation usually known as the "Periodic Law." The contemporaries of Newlands, however, and all who have taken the trouble to look into the literature of the subject, know that it was he who discovered the fundamental relation embodied in this so-called law, and that he clearly expressed the connection between atomic weight and properties about five years before any publication of their views either by Mendeléef or Lothar Meyer. Fortunately the facts stand out from the records clearly enough, but it is difficult now, after a lapse of more than thirty years, to explain the indifference of the chemical world to an observation so remarkable as that to which Newlands drew attention first in the *Chemical News*, August 1864, again more fully in the same journal, August 1865, and a third time more emphatically in a communication to the Chemical Society, March 9, 1866. For many years previously the subject had been, so to speak, in the air. Numerous papers by Dumas, Gladstone, and latterly by Odling, had appeared in which various arrangements of the atomic weights had been adopted, but none of a comprehensive kind; yet when a scheme which consisted not of a number of isolated groups, but which supplied a system covering the whole of the known elements, was brought forward, all that the Chemical Society could do was to reject it with ridicule and contempt, and to decline to print a word of the new doctrine in the then scanty pages of its *Journal*. The unsettled state of opinion in reference to the numerical values of many atomic weights can be the only excuse for what seems like stupidity and prejudice, for Newlands' arrangement required the adoption of the atomic weights standardised as recommended by Cannizzaro in 1864-66, and these values were still unknown to, or ignored by many chemists. Newlands called his scheme the "Law of Octaves," and he showed that the fifty-six well-established elements which he was able to consider, when arranged in the order of the magnitudes of their atomic weights, formed eight octaves, each eighth element exhibiting a recurrence of the same or closely similar chemical and physical properties. All this is now acknowledged, but the Chemical Society never did Newlands full justice in the matter; and while the Royal Society awarded the Davy Medal jointly to Profs. Mendeléef and Lothar Meyer for their work on the periodic scheme, it was only some years later, namely in 1887, that the same distinction was conferred, we believe in consequence of Dr. Frankland's representations, upon the discoverer of the law.

They order these things better in France. If Newlands had been a Frenchman, the Academy of Sciences and the Chemical Society, even if they had at first fallen into error, would have taken care that in the distribution of honours their own countryman should not come in last.

John Alexander Reina Newlands, to give him his full name, was the second son of the Rev. William Newlands, M.A. Glasgow, a minister of the Established Church of Scotland, and was born in Southwark in 1837. He was educated privately by his father, and, having early imbibed a taste for chemistry, he entered the Royal College of Chemistry as a student under Hofmann, in October 1856. After a year at College he became assistant to Prof. Way, then chemist to the Royal Agricultural Society. His mother, though born in England, belonged to an Italian family, and the insurrectionary movement under Garibaldi roused the enthusiasm and sympathy of the young chemist to such a pitch that, on the call for volunteers in 1860, he left Way, and went to fight in the cause of Italian freedom, and only returned home at the end of the campaign. He then rejoined Way for a time till, in 1864, he began practice on his own account as analytical chemist in the City. About this time, and for some years later, he taught chemistry at the Grammar School of St. Saviour's, Southwark, at the School of Medicine for Women, and at the City of London College. In 1868 he became chief chemist at Mr. James Duncan's extensive sugar refinery at the Victoria Docks, and remained in that position till 1886, when, in consequence of the decline of the business owing to foreign competition, he joined his brother, Mr. B. E. R. Newlands, in independent practice as analytical and consulting chemists. Mr. Newlands' name was associated with the invention of several important improvements in the refining of sugar, especially, we believe, the so-called alum process for the purification of beet molasses.

In 1884 Mr. Newlands published a small volume containing a reprint of all his papers on atomic weights, with some additions embodying his later views on the same subject. He is also author, jointly with his brother, of a treatise on "Sugar, a Handbook for Sugar Growers and Refiners," and of some articles on "Sugar" in Thorpe's Dictionary.

Mr. Newlands left a widow, a daughter, and a son, Mr. W. P. R. Newlands. The latter studied chemistry at the Royal College of Science, and will take his father's place in the firm.

A kindly courteous man, his face will be much missed by the older Fellows of the Chemical Society, where he had been a familiar figure for so many years.

W. A. T.

PROFESSOR GEORGE EBERS.

PROF. EBERS, the well-known Egyptologist, whose death has recently been announced, will be long remembered in connection with the papyrus which bears his name. Dr. Ebers was born in 1837 at Berlin, and his friendship with Brugsch and Lepsius led him to take a keen interest in Egyptology. In pursuit of his studies he visited Egypt, and it was during the winter of 1872-73, while staying at Thebes, that he had the good fortune to purchase from a native dealer at Luxor the hieratic medical papyrus which made him famous. On his return from Egypt he deposited the papyrus in the University Library at Leipzig, and two years later he published a facsimile of the text, with a description, glossary, &c., in collaboration with his friend Dr. Ludwig Stern. The "Papyrus Ebers," which is in a perfect state of preservation, is the most important medical papyrus that has been found in Egypt, and has thrown considerable light on the medical knowledge of the ancient Egyptians. In addition to his numerous publications on Egyptian archæology, Dr. Ebers gained a considerable reputation as a novelist. In 1889 ill health compelled Dr. Ebers to relinquish his duties as Professor of Egyptology at Leipzig, and from that time till his death he was a confirmed invalid.

NOTES.

THE death is announced of M. N. A. Pomel, of Algiers, Correspondant of the Section of Mineralogy of the Paris Academy of Sciences.

THE Paris Academy of Medicine has received information that a legacy of fifty thousand francs has been bequeathed to it by Mme. C. E. Bragayract.

DR. EVERT JULIUS BONSDORFF, formerly Professor of Anatomy and Physiology in the University of Helsingfors, has just died at the age of eighty-eight years.

M. BROUARDEL will be the president of the French Association for the Advancement of Science, at the meeting to be held next year at Boulogne. General Sébert has been elected vice-president of the Association, and will succeed to the presidency in 1900, when the meeting will take place in Paris.

A REUTER telegram from Naples announces that Mount Vesuvius is in a state of active eruption. The lava is flowing in four streams, its progress being at the rate of 100 yards an hour. The chestnuts on Mount Somma have been burned. Constant explosions are heard from the central crater, which is throwing out volcanic ash, and giving other evidence of activity.

A CONGRESS of the Astronomische Gesellschaft will be opened at the Academy of Sciences at Budapest on September 24. Meetings will also be held on Monday and Tuesday, September 26 and 27. The Hungarian members of the Society have prepared a cordial reception for the astronomers who attend the Congress, among the hospitable features being a luncheon to be given by the Minister of Public Instruction (Dr. Julius von Wlassitz), a dinner by the town of Budapest, visits to places of interest in the town and neighbourhood, and excursions to the O'Gyalla Observatory and the Danube Cataracts—the Iron Doors. The Congress will certainly give a prominent place to the discussion of questions concerning the international zone-catalogue of the Astronomische Gesellschaft; and the resolutions of the Paris Conference, which have given rise to a large amount of criticism, will also be dealt with. Prof. F. Porro will present a preliminary report on the revision of the Piazzi Catalogue of Stars, undertaken by Dr. H. S. Davis and himself.

A COMMITTEE, having upon it many distinguished men of science in Australia, has been formed to secure the establishment of some permanent memorial to commemorate the services rendered by the late Baron von Mueller. This movement is entirely distinct from that which the executors of the late Baron have initiated with the object of obtaining funds for the erection of a tombstone. The object of the Committee of the National Memorial Fund is to secure sufficient funds to allow of the establishment of some permanent memorial which shall worthily perpetuate Baron von Mueller's name; and whilst it is not possible as yet to state definitely the form which the memorial will take, it is hoped that sufficient funds will be forthcoming to provide for (1) the erection of some form of statue, and (2) the endowment of a medal, prize or scholarship, to be associated with Baron von Mueller's name, and to be awarded from time to time in recognition of distinguished work in the special branches in which he was most deeply interested, and which shall be open to workers throughout the Australasian Colonies. Subscriptions to the fund may be sent to the Hon. Treasurer, addressed to the College of Pharmacy, Swanston Street, Melbourne, or to the Hon. Secretaries (Mr. W. Wiesbaden and Prof. Baldwin Spencer), addressed to the University of Melbourne, and will be duly acknowledged.

Science states that Prof. Simon Newcomb will next year resume the active superintendence of the work in mathematics and astronomy in Johns Hopkins University. He expects to give a course of lectures on the Encyclopædia of the Mathematical Sciences, and will especially direct students pursuing advanced work in celestial mechanics.

THE Antarctic expedition, equipped and sent out by Sir George Newnes, sailed from London in the *Southern Cross* on Monday. Mr. Borchgrevink is in charge of the expedition, and with him are Lieut. Colbeck, Mr. Bernacchi, Mr. Hanson Nicolai, Dr. Sharp and Mr. H. B. Evans, all of whom will carry on scientific studies in the Antarctic regions. There are thirty-three men on board, all told. The ship, which has been built with the special object of Antarctic exploration, is barque-rigged, and is a modified form of the *Fram*. If all goes well, she may be expected to return in the year 1900.

THE Berlin correspondent of the *Times* states that the German Polar expedition which in the spring of this year started, under the direction of Herr Theodor Lerner, with the object of defining more closely the topography of the Polar regions and, if possible, of discovering some traces of the Andrée expedition, has just returned to Hammerfest, where a short stay will be made in order to allow the ship *Helgoland* to be refitted and the crew to take a temporary rest. The following particulars of observations made during the voyage have been published:—King Charles Islands were reached towards the end of July, and a halt of a few days was made. Observations there made show that the group consists of three big islands—namely, Swedish Foreland, Jena Island, and a third lying between these two, which has been christened August Scherl Island in honour of the promoter of the expedition. There the explorers came upon the breeding grounds of the ivory gull, very few specimens of whose eggs have hitherto been discovered. Two small islands in the southern bay of Jena Island received the names of Tirpitz and Helgoland respectively. Captain Rüdiger took special observations of the exact position of King Charles Islands. An attempt to push on to Franz Josef Land failed owing to bad weather. The *Helgoland* then was able to coast round the island on the north-east and from the south, in spite of the difficulties caused by fog and ice, thereby proving that it is possible to go northwards notwithstanding the contrary Polar currents. The exact position of the island of Störö is given as being 10′ further north than it is at present indicated in maps. The most northerly point reached was latitude 81° 32′, where the boundary of pack ice was determined. Much hitherto unknown ground was fished with drag nets, especially round the east point of King Charles Islands, and at the extreme end of Spitsbergen in water of over 1000 metres deep. A good deal of interesting material for future study was obtained. No signs of the Andrée expedition were discovered. The expedition will start on another voyage of exploration as soon as the ship has been refitted and the necessary stock of victuals been taken on board.

THE journey to Tomsk, in Siberia, promises to become quite a pleasant one under the new organisation of the direct trains. The train, which left St. Petersburg on July 31, offered even more comforts to the travellers than the best American trains. It consisted of one first class and two second class sleeping cars, one dining car, and one kitchen and electrical machinery car. It had also, in addition to the usual luxurious fittings of the best Pulman saloon cars, a piano in the first class saloon, a free library provided with a good selection of works on Siberia, as well as with all the papers which appear in the towns passed by the train during the journey; a pretty outlook-saloon at the back of the train, with meteorological instruments in it; and even a dark room for amateur photographers, arranged in the second class lavatory. All the furniture is covered with a special material which can be washed with a disinfecting fluid without being injured.

THE annual Congress of the Royal Institute of Public Health was opened on Thursday last in Dublin. There was a very large and representative gathering of delegates, including the Lord Mayor of Dublin and the Mayors of many towns in England and Ireland. The President, Sir C. Cameron, Medical Officer of Health for Dublin, delivered an inaugural address, in which he dealt chiefly with the improvements effected within the past thirty years in urban sanitation, the most important of which he described, pointing out the extent to which they had affected the death-rate in London, Dublin, and other urban centres of the United Kingdom. The members of the Congress were subsequently present at the formal opening, by the Lord Lieutenant, of the usual Health Exhibition in connection with the Congress. The sectional sittings began on Friday, and a large number of papers, covering a wide range of subjects concerning public health, were read and discussed. On Saturday afternoon a special meeting of the Fellows of the Royal College of Physicians of Ireland was held for the purpose of conferring the honorary Fellowships in connection with the Congress, and the occasion was also taken advantage of to confer honorary diplomas in State Medicine conjointly with the Royal College of Surgeons in Ireland. The following are the names of those on whom the honours were conferred:—Honorary Fellowships: Dr. Alexander Crum Brown, F.R.S.; Sir Charles Cameron; Dr. Mathew Hay; and Sir Richard Thorne Thorne, K.C.B., F.R.S. Honorary Diploma in State Medicine: Dr. T. W. Grimshaw, C.B.; Sir Henry Littlejohn; Dr. John W. Moore; Dr. W. R. Smith; Dr. T. J. Stafford; and Dr. J. C. Thresh.

THE spell of hot weather which set in over the southern portion of our islands about a fortnight ago has continued without interruption, and at the beginning of the present week the heat was even greater than previously. The London reporting station of the Meteorological Office gave 89° as the shade temperature on Monday, and in parts of the southern suburbs the thermometer touched 90°. There have already been at least ten days in the neighbourhood of London with a temperature of 80° and above, and on nine nights already the thermometer has not registered a lower reading than 60°. The warm nights are quite phenomenal, and the Greenwich orbservations for the previous twenty Augusts only show, in all, eleven such warm nights. The weather has for the most part been much cooler over the northern portion of our islands than in the south. Fog or mist has been very prevalent on ou coasts, and this has occasioned much delay and inconvenience to shipping. Thunderstorms have occurred in the western and central districts of England, and lightning has occurred over nearly the whole kingdom. Very little rain has fallen, except in a few isolated parts, where the thunderstorms have yielded a fair amount.

THE British Pharmaceutical Conference, which opened at Belfast on August 9, was a very successful meeting at which the science of pharmacy was well represented, and many papers of high merit were communicated. The presidential address, delivered by Dr. Charles Symes, was a comprehensive survey of affairs and advances in which pharmacists are interested. Synthetic compounds used in medicine and for various industrial purposes were described, the president pointing to the ever-growing lists of physiologically active synthetic organic compounds as evidence for the necessity for pharmacists to keep up with the developments of modern chemistry. Many of these compounds, which have been built up on theoretical considerations, have become valuable medicinal remedies. The fancy names given to them, however, rarely afford any definite idea of their composition, and without this pharmacists handle them in a very mechanical way, and lose much of interest that would otherwise attend the dealing with them. Dr. Symes expressed the hope that pharmacists would familiarise themselves as far as possible with the numerous class of substances which he had mentioned, for although they are of a complex nature, they are capable of much simplification by a consideration of the theoretical constitutions ascribed to them. Mr. Hodgkin read a paper on this subject at a meeting of the Conference held at Leeds in 1890. More recently Dr. Kohn, in an address delivered at a meeting of the Liverpool section of the Society of Chemical Industry, dealt with the relation which exists between the physiological action and the chemical structure of these bodies. The scientific chemist, remarked Dr. Symes, is now the architect and builder, using certain atoms and molecules to build up chemical structures to meet the wants of the medical profession in the treatment of disease. In Germany, where there are fewer restrictions on experimenting with animals than in this country, the chemist and physiologist work together—the one altering the molecules and molecular arrangement in the chemical, and the other testing and noting most carefully the effects obtained thereby; hence most of these remedies are produced in that country, and this manufacture has become an extensive chemical industry. Since the publication of Mr. Hodgkin's paper, referred to above, many new synthetic remedies have been introduced, and Dr. Symes gave a list of some of them, pointing out that of the fifty substances enumerated, a large percentage possess antiseptic, antipyritic, and analgesic properties; so that their rapid growth would seem to be due more to commercial enterprise than to meeting a real want in medical practice.

ANOTHER chemical industry, which has considerable interest for the pharmacist, was referred to by Dr. Symes at the Pharmaceutical Conference; it is the production of synthetic esters and odorous substances closely related to the odours of flowers, plants, and animal substances. With artificial musk and vanillin pharmacists have been long familiar, as also with the amyl, butyl, and ethyl compounds resembling fruit flavours, but of more recent date they have heliotropine (heliotrope), ionone and iraldine (violet), cumarine (new-mown hay), terpineol (lilac), bergamiol or linaloyl acetate (bergamotte), nerolin (neroly), jasmin oil, anisic aldehyde (hawthorn), geranol (rose geranium), carvol (caraway oil), safrol (oil of sassafras), &c. So much has this industry grown that not only are these products used for toilet soaps, but they also enter largely into the composition of the essences named after the flowers. They are more persistent than the natural odours, and it is said that the very popular essence of "Parma Violets" is, as a rule, quite innocent of the flowers, and is prepared from ionone mellowed down with small quantities of other extracts; and this the public really prefer. To those, however, who are accustomed to handle delicate perfumes, there is not so much difficulty in distinguishing between the artificial and the real, and it still taxes the skill of the chemist and the art of the perfumer to obtain that subtle delicacy of fragrance manufactured and elaborated in nature's own laboratory.

AN observation recorded by Mr. B. B. Osmaston in the *Journal* of the Asiatic Society of Bengal (vol. lxvi. Part 2, No. 4) indicates that, in some birds at least, the social instinct is present in a highly developed form. A young "Shikra," the Indian Sparrow-Hawk (*Astur badius*) trained to catch Mynahs and other birds, was sent after a party of "seven sisters" (the Jungle Babbler, *Crateropus canorus*) feeding on the ground. The Shikra captured one after a short chase, but the rest of the Babblers, however, hearing the cries of their captured "sister," came down to the rescue without the slightest show of hesitation, and in a short time were engaged in a spirited attack on the Hawk, apparently using both beak and claws in their effort to make her relinquish her hold, which she eventually did. Mr. Osmaston says that he has many times flown a Shikra at *C. canorus* always with the same result, viz. that so long as he kept out of the way the Babblers would attack the Hawk *en masse*.

THE article upon William Turner, the "Father of British Zoology," contributed by the Rev. H. A. Macpherson to the August number of the *Zoologist*, appears at an opportune time, for it draws attention to the important part which Cambridge, where the International Zoological Congress is now in progress, played in training the first naturalists bred upon English soil. Turner was born about 1507, took his degree at Cambridge in 1529–30, and was elected a Fellow of Pembroke Hall in the latter year. He spent the next ten years of his life as a Cambridge don, and during that time acquired an intimate knowledge of the habits of British wildfowl by personal observation. He did not, however, confine his field work to the neighbourhood. In 1542 he went abroad, and became acquainted with the habits of birds which he had never met in England. Turner travelled in Italy, and attended the botanical lectures of Lucas Ghinus at Bologna before he journeyed to Zürich, the home of Conrad Gesner, who alludes to him in terms of sincere admiration. On quitting Zürich, we learn from Mr. Macpherson's article, the English traveller journeyed to Basle, and thence to Cologne. During his residence in the latter city, in 1544, he printed the first ornithological work that the New Learning was destined to produce. Turner was still comparatively young, probably on the right side of forty, but his scholarly taste had already induced him to apply his critical skill to the difficult task of determining the particular species of birds described by Aristotle and Pliny. Accordingly, he entitled his little book, "Avium præcipuarum quarum apud Plinium et Aristotelem mentio est, brevis et succincta historia ex optimis quibusque scriptoribus contexta." Trifling as this may appear beside the ponderous tomes of Gesner and Aldrovandus, the fact remains that it forms a very important contribution to the science of the sixteenth century. Turner did not confine his attention to ornithology; he was also keenly interested in the fish fauna of these islands. His Catalogue of British Fishes, compiled when residing in Wissenburg in 1557, was a remarkable production for the middle of the sixteenth century. His Herbal was completed in 1568, and on July 7 of that year the great naturalist quietly passed away.

THE *Electrical Review* gives particulars of the experiments in telegraphy without intervening wires, which have been made during the past few weeks by the Wireless Telegraph Company, between the Royal yacht *Osborne* and Osborne House. Perfect signals are stated to have passed both ways during the whole ten days of the trials, no hitch occurring from first to last. Numerous messages passed between the Queen and the Prince of Wales, and between the Prince and a number of other members of the Royal family, and one or two Cabinet Ministers. Mr. Marconi had charge of the trials. Every morning a bulletin on the condition of the Prince was sent to the Queen by wireless telegraph. The height of the mast on shore was 105 feet, and that of the top of the wire from the deck of the *Osborne* was 83 feet. The yacht was moored in Cowes Bay, at a distance of nearly two miles from Osborne House, the two positions not being in sight of one another, as they were intercepted by a hill to the rear of East Cowes, which would have rendered signalling impossible between these two stations by means of any optical system. The messages varied in length, some having as many as 100 to 150 words. Towards the end of the period over which the experiments extended, the yacht went on a cruise towards Sandown, and the messages were received correctly close off the *Nab* lightship, which is moored off Bembridge. On the way there, when under steam, a lengthy message was received by the Prince from the Duke of Connaught, and the reply was successfully despatched, though well out of sight of Cowes and Osborne. Upon another occasion the yacht cruised as far as the Needles, or rather outside, and went on till the instruments picked up Alum Bay station—the Needles Hotel—continuing in communication with them all the way. Communication was kept up throughout the cruise with either the Osborne station or the Wireless Telegraph Company's station at Alum Bay. During the whole of the cruise the Osborne pole was obscured, and all the messages had to pass overland, and the Alum Bay pole was also obscured until coming right into the Bay, on account of the station being situated very much below Heatherwood. The messages were sent to Alum Bay from a distance of nearly seven and a half miles, although the ground lying between was exceedingly high; in fact, it was about the highest land met with during the time. It was so high, that the poles were screened by hundreds of feet of land.

HERR EDUARD ZACHE contributes a short article to the *Naturwissenschaftliche Wochenschrift*, on the identification of tectonic structures in the Mark region in Prussia. The problem is one of some difficulty in all parts of the North German Plain, on account of the uniformity of the diluvial covering. The results of the examination are exhibited in a sketch-map.

THE *Revue Générale des Sciences* (No. 13) contains a valuable paper by M. J. Machat, on the scientific basis of the Chinese Question. The physical and economic geography of China is sketched under the headings of soil, climatic conditions in relation to vegetation, animal life, and hydrography, agriculture, industries, internal commerce, demography, and foreign commerce. A series of extremely interesting maps illustrates these sections.

WE have received a reprint of a paper read at the Toronto meeting of the British Association by Mr. J. B. Tyrrell, on the glaciation of North Central Canada. The conditions supposed to prevail during the existence of the great central continental ice-sheet—or, as it is now called, the Keewatin glacier—are described, and its life-history is traced as far as possible. The glacier appears to have been similar in character to the great glacier of north-western Europe, but with the difference that while the centre of the latter was over a high rocky country from which the ice naturally flowed outwards, the centre of the former was over what was probably then, as now, a low-lying plain.

IN order to make known the scientific value of the collections in the South African Museum and the original work done by the staff, as well as to promote the increase of the library by means of exchange with museums and scientific societies, the Trustees have commenced a serial publication entitled "The Annals of the South African Museum." The first part of this addition to scientific serials contains descriptions of new South African Scorpions in the collection of the South African Museum, by Dr. W. F. Purcell; description of some Mutillidæ in the Museum, by Mr. L. Péringuey; list of the reptiles and batrachians of South Africa, by Mr. W. L. Sclater; and a catalogue of the South African Hispinæ (Coleoptera), by Mr. Péringuey.

DR. FRIEDRICH KATZER contributes to *Globus* a paper on the volume of the Amazon at Obydos. Below Obydos the Amazon flows through so many channels that accurate measurements of its total discharge are impossible, and even there—900 kilometres from the mouth—a considerable fraction of its waters does not pass through the main channel. Dr. Katzer discusses former measurements, and gives new ones of his own; he finds as mean values—breadth, 1890 metres; rate of current, 1·2 metres per second; discharge, 120,000 cubic metres per second. Analyses of two samples of water, taken at depths of 0·5 metres and 25 metres, gave 0·056 and 0·039 grammes per litre as total dissolved matter; suspended matter, three to four times as much; thus placing the Amazon amongst the purest river-waters of the globe.

IT is reported in the *Times* that MM. Dex and Dibos, two French aeronauts, who recently submitted their scheme for the exploration of Africa by means of a balloon to the French Academy and the Smithsonian Institution, which bodies are stated to have approved of the plans, have now, in conjunction with M. Hourst, the African traveller, invoked the aid of the Paris Municipality in support of the great undertaking. They do not profess to be able—and in this they are in accord with workers in the same direction—to construct a completely dirigible balloon; but they believe in the practicability of their scheme, assuming the air currents of tropical Africa are fairly regular, at least at certain seasons. The balloon they intend to construct is to be 92 feet in diameter, with a capacity of 406,134 cubic feet. It is to be made of silk, and covered with an eight-fold coat of varnish, so that only a very small quantity of gas will be lost per day. The car will be in two storeys, connected by a rope ladder, the upper storey providing living and sleeping accommodation for six travellers, the lower being reserved for the apparatus used in manœuvring the balloon. Another smaller car, anchored to the balloon, is to serve as a means of communication with *terra firma*, and to be lowered when the balloon has been anchored. The sum of 15,000 francs, for which the Paris Municipality has been asked, is intended for preliminary trials, as the cost of the actual journey through Africa, it is hoped, will be defrayed by rich members of the Committee for French Africa. M. Dex describes the scheme in the current number of the *Revue Scientifique*.

THE U.S. Pilot Chart of the North Atlantic Ocean for August contains a type of the summer chart of that ocean, representing the conditions of wind, cloud and barometric pressure, compiled from Greenwich noon reports returned to the Hydrographic Office at Washington. The chart shows very clearly the right-handed or clock-wise circulation of the winds around the region of high barometric pressure, the central area of which, at this season of the year, is in the region of the Azores. Another special chart shows the drifts of floating bottle-papers returned to the Hydrographic Office during the year ending July 1 last, and referring to the Atlantic Ocean. Some of the present papers offer interesting particulars; one, which was cast adrift off Nantucket Shoal, and recovered near Campbelton after the lapse of 512 days, giving an average daily velocity of 5·1 miles. Three other bottles, which were thrown overboard in mid-ocean at the same time, were all recovered within a short distance of each other in the same week after a drift eastward of 1200 miles, the mean rate of travel being 9·9 miles a day.

TWO sphygmograph curves, obtained by Mr. R. De C. Ward at altitudes of 15,700 feet and 19,200 feet, are reproduced in a short paper in the *Journal* of the Boston Society of Medical Sciences (June). The curves derive interest from the fact that they are the first from so great altitudes to be reproduced, and also because the peculiarities of heart action shown in them are the result of altitude pure and simple, as absolutely no physical was taken in making the ascents.

IN the current number of the *Zeitschrift für physikalische Chemie*, Mr. S. L. Bigelow describes some interesting results of experiments made in Prof. Ostwald's laboratory on the catalytic action of organic substances on the oxidation of sodium sulphite. It has been known for a considerable time that the rate of oxidation of sulphurous acid is increased by the presence of many inorganic salts. In beginning a closer investigation of this subject, Mr. Bigelow was accidentally led to the discovery that the oxidation of a sodium sulphate solution by a current of air is hindered to a remarkable extent by the presence of a small quantity of alcohol. One part of alcohol in ten thousand of a one-hundredth normal solution of sodium sulphite had a perceptible influence. In another case it was found that the admixture of mannitol with sodium sulphite in the proportion of one molecule to eight hundred, diminished the rate of oxidation 50 per cent. Great difficulty was experienced in obtaining constant results, and it was found that the small quantities of impurity in the water used as solvent, and in the aspirated air, produced large variations : it was, in fact, not found possible to obtain perfectly constant conditions. An extension of the inquiry to other organic substances led to the discovery of some regularities, but not to the establishment of any general theory of the action. The phenomenon obviously bears some relation to the well-known inhibitory action of organic substances on the oxidation of phosphorus.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Miss E. Sandell ; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Madam Giorgi ; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss Leathers ; a Sykes' Monkey (*Cercopithecus albigularis*, ♀) from East Africa, presented by Mr. C. Carter ; a Grand Eclectes (*Eclectus roratus*) from Molluccas, presented by Mrs. Peter Watson ; a Corai's Snake (*Caluber corais*) from British Guiana, presented by Mr. C. W. Lilley ; a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, a Tiger (*Felis tigris*) from Eastern Asia, a Leopard (*Felis pardus*) from Africa, a Red-bellied Wallaby (*Macropus billardieri*) from Tasmania, two Elephantine Tortoises (*Testudo elephantina*) from Aldabra and Mahe Islands, a Reticulated Python (*Python reticulatus*) from the East Indies, deposited ; two Maximilian's Aracaris (*Pteroglossus uredi*), three Lettered Aracaris (*Pteroglossus inscriptus*), six Superb Tanagers (*Calliste fastuosa*), four Brazilian Hangnests (*Icterus jamaicai*), three Merrem's Snakes (*Rhachnœa mirrimi*) from Brazil, two Red Under-winged Doves (*Leptoptila rufaxilla*), a Little Guan (*Ortalis motmot*) from Guiana, three Golden-headed Conures (*Conurus aureus*) from South-east Brazil, two Red-ground Doves (*Geotrygon montana*) from South America, purchased ; a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens ; six Californian Quails (*Callipepla californica*), a Crested Pigeon (*Ocyphaps lophotes*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET PERRINE (MARCH 19).—Dr. Berberich communicates to *Ast. Nach.* (3510) the following elliptical elements for Comet I. 1898 (Perrine, March 19) :—

$$T = 1898 \text{ March } 17{\cdot}11244 \text{ Berlin M.T.}$$

$$\left.\begin{array}{l} \omega = 47^\circ\ 15'\ 4''{\cdot}0 \\ \Omega = 262\ 24\ 37{\cdot}1 \\ i = 72\ 32\ 45\ 2 \end{array}\right\} 1898{\cdot}0$$

$$\log q = 0\ 040842$$
$$\log e = 9{\cdot}9897755$$
$$\text{Period} = 322{\cdot}56 \text{ years.}$$

An ephemeris for Berlin midnight, computed from these elements, is also given ; but seeing that the brightness is now only about one-twentieth that at the time of discovery, we give only the following abstract :—

1898.		R.A. h. m. s.		Decl. ° ′		Br.
August 26	...	6 25 22	...	+51 13·4	...	0·055
Sept. 1	...	29 22	...	51 0·9	...	0·053
„ 7	...	32 14	...	50 50·9	...	0·050
„ 13	...	33 56	...	50 43·1	...	0·048
„ 19	...	34 27	...	50 37·4	...	0·047
„ 25	...	33 39	...	50 33·5	...	0·046
Oct. 1	...	6 31 33	...	+50 30·4	...	0·044

During the above period the comet passes from the north-eastern part of Auriga into the constellation of the Lynx.

PARALLAXES AND MASSES OF γ VIRGINIS AND γ LEONIS. —The mass and dimensions of a binary system can be readily calculated if the parallax as well as the apparent size of the orbit be known, but there is another possible method of arriving at the same facts without a previous knowledge of the parallax. This consists in a measurement of the relative velocities of the two components, from which, the period being known, the circumference or semi-axis major of the orbit at once follows, so that, in addition, the parallax itself can be determined in the case of telescopic binary stars. In spectroscopic binaries, where the velocities are usually very great, the spectroscopic measurement of the relative orbital velocity is easy, but it becomes a much more difficult matter in the case of slowly moving telescopic binaries. Dr. Belopolsky, however, has had the courage to attack the problem, and has applied the spectroscopic method to γ Virginis and γ Leonis (*Ast. Nach.*, 3510). The 30-inch refractor at Pulkowa, he tells us, permits the investigation of the spectra of stars down to magnitude 4·5, and enables him to separately photograph the spectra of the components of double stars which are not less than 3″ apart.

In the case of γ Virginis the mean values of the velocities of the components in the line of sight, with respect to the sun, were found to be − 2·926 g.m. (13·49 Eng. miles) per sec. and − 2·648 g m. (12·21 Eng. miles) per sec. respectively for the northern and southern components. It follows, then, that the velocity of the northern component with respect to the southern one is − 0·278 g.m. (1·28 Eng. miles) per sec., from which the relative orbital velocity can be deduced. Following the methods of Lehman-Filhes, and adopting Doberck's elements of the orbit, which give a semi-axis major of 4″ and a period of 180 years, Dr. Belopolsky arrives at the following results for the system of γ Virginis :—

Semi-axis major ...	=	79·4 astronomical units.
Combined mass ...	=	15 sun's mass.
Parallax	=	0″·051
Velocity of system in line of sight ...	=	− 2·79 g.m. (12·86 Eng. miles) per sec.

In the case of γ Leonis, where the components are 3″·2 apart, and have magnitudes of 2·0 and 3·5 respectively, the mean velocity in the line of sight of the brighter component, including the Potsdam measurements, is − 5·32 g.m. (24·53 Eng. miles) per sec. with respect to the sun, while that of the companion, as measured at Pulkowa, is − 5·03 g.m. (23·19 Eng. miles) per sec. The relative velocity is therefore + 0·29 g.m. (1·34 Eng. miles) per sec., if the brighter component be regarded as the central body. Adopting Doberck's elements, giving the semi-axis major as 2″·0 and the period as 402·6 years, Dr. Belopolsky finds the following results :—

Semi axis major ... = 102 astronomical units.
Combined mass ... = 6·5 sun's mass.
Parallax ... ... = 0″·0197.
Velocity of system in line of sight ... = − 5·18 g.m. (23·88 Eng. miles) per sec.

The investigation is one of such delicacy that considerable uncertainty remains as to the data deduced; but the individual results appear to be sufficiently consistent to warrant the publication of the foregoing provisional values. The results are especially interesting as being the first practical outcome of a suggestion first made by Fox-Talbot in 1871, and developed mathematically by Dr. Rambaut and Dr. See (NATURE, vol. liii. p. 15).

A CATALOGUE OF FOURTH-TYPE STARS.—The Rev. T. E. Espin has recently revised his valuable catalogue of stars of the fourth type (Group VI.) which are at present known, including stars discovered at Harvard and Arequipa, and not before published (*Monthly Notices*, vol. lviii. p. 443). The following summary shows the distribution of the stars in magnitude and in the two hemispheres, the magnitudes of variable stars being entered according to their maxima:—

Mag.	N.	S.	Total.
to 6·0	3	4	7
6·1 ,, 7·0	12	11	23
7·1 ,, 8·0	19	20	39
8·1 ,, 9·0	51	25	76
Below 9·0	69	11	80
Mag. not given	1	11	12
Total ...	155	82	237

It is considered probable that our knowledge of the number of stars of this type is complete for the northern heavens as far as 8·9, and for the southern heavens as far as 8·5. The catalogue contains twenty-eight variables to which letters have been assigned, twenty-two being north and six south. "It would appear that almost all the stars of Type IV. are subject to fluctuations in brightness, though the red colour makes it not easy to decide when the variation is small."

A YORKSHIRE MOOR.[1]

II.

THE Bilberry (or Blueberry, as we ought to call it) is one of the few exceptions to the rule that moorland plants are evergreen; it casts its leaves in early winter. But the younger stems are green, and take upon themselves the function of leaves, when these are absent. Kerner has described one adaptation of the Bilberry to seasons when water is scarce. Many plants, especially those of hot and wet climates, throw off the rain-water from their tips, and so keep the roots comparatively dry; others direct the water down the branches and stem to the roots. Bilberry is one of the latter sort. The rounded leaves slope downwards towards the leaf-stalk, and from the base of every leaf-stalk starts a pair of grooves, which are sunk in the surface of the stem. A light summer shower is economised by the guiding of the drops towards the roots. Bilberry abounds on the loose and sandy tracts of the moor, and especially on its verges; it is seldom found upon a deep bed of peat.

There is a moorland plant which may be said to mimic the heaths, as a Euphorbia mimics a Cactus, or Sarracenia a Nepenthes. Similarity of habit has brought about similarity of structure. The plant I mean is the Crowberry, which is so like a true heath in its foliage and manner of growth, that even the botanists, who did not fail to remark that the flowers are altogether different, long tried to bring the Crowberry and the heaths as near together in their systems as they could. Crowberry has the long, dry, wiry stems, the small, narrow, rolled, clustered, evergreen leaves of a true heath. The leaf-margins are turned back till they almost meet, and the narrow cleft between them is obstructed by close-set hairs, so that the transpiring surface is effectually sheltered. Crowberry is a peat-loving shrub, and is often found with ling and other heaths in the heart of the moor. The berries are a favourite food of birds, which help to disseminate the species. Crowberry has an uncommonly wide distribution, not only in the Arctic and Alpine regions of the Old World, but also in the New. It abounds in Greenland, where the Eskimo use the berries as food, and extract a spirit from them. A very similar species, with red berries, occurs in the Andes.

The heaths, Bilberry, Crowberry, and many other peat-loving shrubs or trees, have a peculiar root-structure. The usual root-hairs are wanting, and in their place we find a peculiar fungus-growth, which invades the living tissues of the root, sometimes penetrating the cells. There is often a dense mycelial mantle of interwoven filaments, which covers all the finer roots. This looks like parasitism, but the fungus is apparently not a mere parasite, for the tree or shrub shows no sign of injury, but thrives all the better when the fungus is plentiful, and may refuse to grow at all if the fungus is removed. Rhododendron, Ling, most heaths, Bilberry, Crowberry, Broom, Spurge-laurel, Beech and Birch are among the plants which have a mycelial mantle.

FIG. 7.—Crowberry (*Empetrum nigrum*). A staminate branch, slightly enlarged; *a*, part of a pistillate branch; *b*, one staminate flower; *c*, one pistillate flower.

If the native soil which clings to the roots of any of these is completely removed, if the fine roots with the mycelial mantle are torn off by careless transplanting, or if peaty matter is withheld, the plant dies, or struggles on with great difficulty until the mycelial mantle is renewed. Such plants cannot, as a rule, be propagated by cuttings, unless special precautions are taken. Frank maintains that the mycelial mantle is the chief means of absorption from the peaty soil, and that the tree or shrub has come to depend upon it. The known facts render this interpretation probable, but thorough investigation is still required. In some cases at least the plant can be gradually inured to the absence of a mycelial mantle. I have repeatedly planted crowberry in a soil devoid of peat. It generally succumbs, but when it survives the first year, it maintains itself and slowly spreads. Microscopic examination shows that the roots of crowberry grown without peat contain no mycelial filaments or very few.

[1] A discourse given at the Royal Institution, February 1898. By Prof. L. C. Miall, F.R.S. Continued from p. 380.

The special function of the fungus may be to reduce the peat to a form capable of absorption as food by green plants. It is likely that the fungus gains protection or some other distinct advantage from the partnership. Most of the species of green plants which have the mycelial mantle are social. It is obvious that the fungus will be more easily propagated from plant to plant, where many trees or shrubs of the same species grow together.

The grasses of the moor are marked xerophytes, with wiry leaves, whose look and feel tell us that they have adapted themselves to drought and cold by reducing the exposed surface

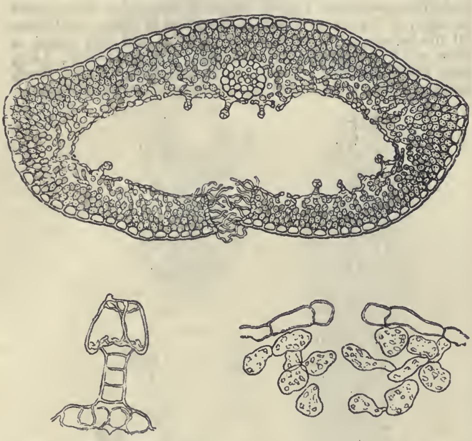

FIG. 8.—Cross-section of leaf of Crowberry. The lower figures show one of the peculiar hairs and one of the stomates. Both are confined to the inner, which is properly the under surface.

to a minimum. A section of the leaf of Nardus, Aira flexuosa, or Festuca ovina shows that the upper surface, which in grasses bears the stomates, is infolded, and sometimes greatly reduced. Advantage has been taken by these grasses of a structure which was apparently in the first instance a provision for close folding in the bud. The upper, stomate-bearing surface is marked by furrows with intervening ridges, and where the folding is particularly complete, both furrows and ridges are triangular in section, and the leaf, when folded up longitudinally, becomes an almost solid cylinder. In the grasses of low, damp meadows, the power of rolling up may soon be lost by the leaves. Other grasses, which are more liable to suffer from drought, retain in

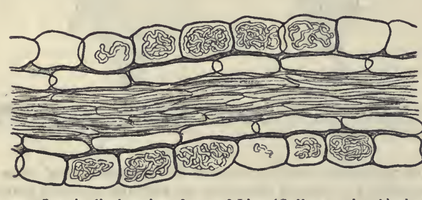

FIG. 9.—Longitudinal section of root of Ling (*Calluna vulgaris*), showing mycorhizal filaments in outer cells.

all stages the power of rolling up their leaves. Sesleria cærulea, for instance, which covers large tracts of the limestone hills of Yorkshire, can change in a few minutes from closed to open, or from open to closed, according to the state of the air. The leaves of the true moorland grasses (Nardus, Aira flexuosa, Festuca ovina) are permanently inrolled, and flatten out very slowly and imperfectly, even when immersed in water for many hours.

Our moorland grasses are all arctic, and occur both in the old and the new worlds; Festuca ovina is also a grass of the steppes; it is world-wide, being found in all continents, especially on mountains, and even reaching Australia and New Zealand.

It may seem paradoxical to count the Rushes as plants which are protected against drought, for they often grow in the wettest part of the moor. They are common, however, in dry and stony places, and their structure is completely xerophytic. The leaves are often reduced to small sheaths, which wither early, while the stems are green, and perform the work of assimilation;

FIG. 10.—Transverse section of leaf of *Nardus stricta*, showing permanent in-rolling.

or else, as happens in certain species, the leaves assume the ordinary structure of the stem. The cylindrical form of the Rush-stem is significant, for of all elongate solid figures the cylinder exposes the smallest surface in proportion to its volume. Moreover a cylindrical stem, without offstanding leaves, and alike on all sides, is well suited, as Jungner points out, to the circumpolar light, which shines at low angles from every quarter

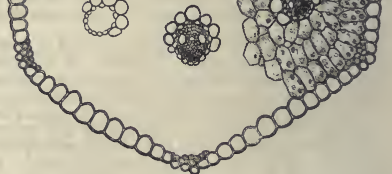

FIG. 11.—Transverse section of leaf of *Aira flexuosa*.

in succession. A Rush-stem is singularly dry, the centre being occupied by an abundant pith of star-shaped cells, which entangle much air.

The Hair-moss (Polytrichum commune) of the moor has a defence against sun and wind, which has been described by Kerner. The leaf has wings, like an altar-piece, which can open and shut. The assimilating surface occupies the centre, and rises into many green columns. In wet or cloudy weather the wings open wide, but when the sun shines they fold over the columns, and protect them from scorching.

All the most characteristic plants of the moors are Arctic. Ling, bilberry, crowberry, certain rushes, Nardus, Festuca ovina, most of our club-mosses, the hair-moss, and Sphagnum range within the Arctic Circle; while the large flowered Heaths get close up to it. Most of them are found on both sides of the Atlantic, and some, like the crowberry and Festuca ovina, have a singularly wide distribution.

It has often been pointed out that great elevation above sea-level produces a similar effect upon the flora to that of high latitude. In the Alps, the Pyrenees, the Himalayas, and even in the Andes, the forms characteristic of northern lands reappear, or are represented by allied species. Where, as in the case of the Andes, nearly all the species differ, it is hard to draw useful conclusions, but whenever the very same species occur across a wide interval the case is instructive. In the Alps we find our moorland and arctic flora almost complete, though Rubus Chamæmorus, Erica Tetralix, and E. cinerea (both found in the Pyrenees), Narthecium ossifragum and Aira flexuosa have disappeared.

A favourite explanation rests upon the changes of climate to which the glaciation of the northern hemisphere bears emphatic witness. When the plains of Northern Europe were being strewn with travelled boulders, when Norway, Scotland, and Canada were covered with moving ice, the vegetation of Siberia and Greenland may well have extended as far south as Switzerland.

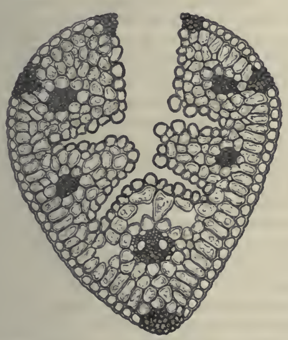

FIG. 12.—Transverse section of leaf of *Festuca ovina*. In thick sections hairs are seen to point inwards from the inner epidermis.

I do not doubt the general truth of what we are taught respecting the glacial period, but I think that we are apt to explain too much by its help. We know very little for certain as to its effect upon vegetation. Our information concerning the preglacial flora is extremely meagre, nor are we in a position to say positively what sort of flora covered the plains of Europe after the severity of glacial cold had passed away, and before men had changed the face of the land by tillage.[1] We know rather more about the animals of these ages, for animals leave more recognisable remains than plants, but the indications of date, even in the case of animals, are apt to be slight and uncertain. On the whole, I doubt whether the glacial period marks any great and lasting change in the life of the northern hemisphere.[2] I think it probable that since the glacial period passed away the countries of Central Europe possessed many species both of plants and animals which we should now con-consider to be Arctic, and that these Arctic species endured until many of them were driven out by an agent of which geologists usually take little notice. I shall come back to this point.

The animal life of the Yorkshire moors is not abundant. Hares, shrews, stoats, weasels, and other small quadrupeds, which are plentiful on the rough pastures, cease where the heather begins. There are a good many birds, some of which, like the grouse, the ring-ouzel, the twite, or mountain-linnet, the curlew, and the golden plover, seek all their food on the moor, except in the depth of winter, when some of them may visit the sea-coast, or the cultivated fields, or even southern countries. The kestrel, blackbird, whinchat, stonechat, night-jar, and lapwing abound on the "roughs" or border-pastures rather than on the moor itself. Owing to the absence of tarns and lochs there are practically no waterfowl. Gulls are hardly ever seen, though they are common enough on the Northumberland moors. Now that the peregrine, golden eagle, and hen-harrier are exterminated, the chief moorland birds of prey are the merlin, kestrel, and sparrowhawk. Of these only the merlin is met with in the wilder parts of the moor, where it flies down the smaller birds. The kestrel hovers over the roughs, on the look-out for a mouse or a frog. The sparrow-hawk preys upon small birds, but rarely enters the heart of the moor.

To most people the interest of the moor centres in the grouse. There are many things about grouse which provoke discussion, such as its feeding times, or the grouse-fly, and what becomes of it during the months when the grouse are free of it. But the absorbing topic, on which every dweller by the moor is expected to have an opinion, is the grouse-disease.

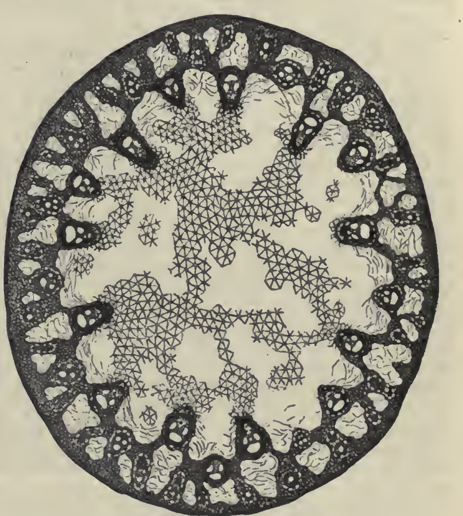

FIG 13.—Transverse section of stem of Rush (*Juncus conglomeratus*), showing the stellate pith-cells, and very numerous air-spaces.

All sorts of causes have been assigned, such as over-stocking of the moors, destruction of the large hawks which used to kill off ailing birds, parasitic worms, cold, deficiency of food, and so on. Some Yorkshire sportsmen have attributed the disease to the scarcity of gritty sand. On shale-moors, they maintain, the gizzard of the grouse is filled with soft stones, which will not grind up the heather-tops effectively, except when they are young and tender. On sandstone moors the grouse can deal with tougher food, and there the disease, it is said, is unknown. Dr. Klein's researches[1] show that the disease is really due to the multiplication within the body of a specific germ, which is fungal, but not bacterial. The infection is conveyed, or may be conveyed, by the air.

The viper is rare, and until quite lately I had never heard of its presence on our Yorkshire moors. Lizards are also rare, but efts are not uncommon. Among the moorland moths are many small Tineina (allied to the clothes-moth). The caterpillar of the emperor moth is characteristic, and seems to be protectively coloured, for it wears the livery of the heather—green and pink.

[1] Some information has been gained by investigation of plant-remains found beneath the bogs of Denmark, and beneath the palæolithic brick-earth at Hoxne.

[2] It is well known that this position has been strongly maintained by Prof. Boyd Dawkins ("Early Man in Britain," p. 123, &c., *Q. J. Geol. Soc.*, vol. xxxv., p. 727, and vol. xxxvi., p. 399). On the other side, Dr. James Geikie may be consulted ("Prehistoric Europe," ch. iii., &c.).

[1] "The Etiology and Pathology of Grouse Disease, &c." (1892).

The moths which issue from these larvæ are captured in great numbers by Sunday ramblers, who resort to the base contrivance of bringing a female moth in a cage. The self-styled "naturalist" sits on a rock, and captures one by one the eager moths which come about him, afterwards pinning out the expanded wings to form grotesque patterns, or selling his specimens to the dealers. Certain wide-spread Diptera are plentiful, and there are a few which pass their larval stages in the quick-running streams which flow down from the moor. The small number of good-sized insects partly explains (or is explained by) the paucity of conspicuous scented or honey-bearing flowers. In this the moor contrasts strongly with the higher Alps. Bees, however, get much honey from the large-flowered heaths and ling; heather-honey is considered better than any other. A little scale insect (*Orthesia uva*) has been found plentifully on the Sphagnum of the moors, particularly in Cumberland.[1] A big spider (*Epeira diadema*) spreads its snare among the heather, and may now and then be seen to deal in a particularly artful fashion with a wasp or other large insect which may have blundered into the web. The spider cuts the threads away till the struggling insect dangles; cautiously on outstretched leg holds out and attaches a new thread, and then sets the wasp spinning. The silken thread, paid out from the spinneret, soon binds the victim into a helpless mummy.[2] I have never found gossamer so abundant as on the verges of the moor.

In our day the Yorkshire moor harbours no quadrupeds, and the grassy hills none but small quadrupeds. It was not always so. At Raygill, a few miles from us across the moors, a collection of bones was discovered a few years ago in quarrying. A deep fissure in the rock had been choked ages before with stones and clay. This fissure was cut across by the working face of the quarry. Many bones were brought out of it, bones of the ox and roebuck among the rest. But mixed up with these were teeth and bones of quadrupeds now altogether extinct or no longer found in Britain, such as the straight-tusked elephant (*E. antiquus*), the hippopotamus, a southern rhinoceros (*R. leptorhinus*), the cave hyæna, and the European bison. The Irish elk is often dug up in Yorkshire, the reindeer and the true elk now and then. Not very long ago these and other large quadrupeds grazed or hunted a country which can now show no quadruped bigger than a fox.

It is evident that the moors, valleys and plains of Yorkshire have been depopulated in comparatively recent times. The disappearance of so many conspicuous species is commonly attributed to the glacial period, but I think that the action of man has been still more influential. The extinct animals are such as man hunts for profit or for his own safety. Many of them, among others the cave-bear, Machairodus, Irish elk, mammoth, and straight-tusked elephant, are known to have lasted into the human period. That so many of them were last seen in the company of man is some proof that he was concerned in their death.

Central Europe, before man appeared within its borders, or while men were still few, little resembled the Europe which we know. Much of it was covered with woods, morasses or wastes, and inhabited by animals and plants, of which some ranged into the Arctic circle, others to the Mediterranean, Africa and India. The worst lands of all—cold, wet, and wind-swept—had doubtless then, as now, the greatest proportion of Arctic species. But it is likely that the passage from the bleak hills to the more fertile valleys and plains was not then so abrupt as at present. All was alike undrained and unenclosed; and what we know of the distribution of life in Pleistocene Europe shows us that a large proportion of our European animals and plants are not restricted by nature within narrow limits of latitude or climate. Species which are now isolated, at least in Central Europe, occupying moors or other special tracts, and surrounded by a population with which they have little in common, were formerly continuous over vast areas. In the early days of man in Europe many plants, birds, and quadrupeds which are now almost xclusively Arctic may well have ranged over nearly the whole of Europe.

As men gradually rooted themselves in what are now the most populous countries of the world, the fauna and flora underwent sweeping changes. The forests were cleared, and trees of Imported species planted here and there. The land was drained, and fenced, and tilled. During the long attack of man upon wild nature many quadrupeds, a few birds, some insects, and some plants are known to have perished altogether. Others have probably disappeared without notice. Certain large and formidable quadrupeds, though they still survive, are no longer found in Europe, but only in the deserts of the south or the unpeopled northern wastes. Thus the lion, which within the historic period ranged over Greece and Syria, and the grizzly bear, which was once an inhabitant of Yorkshire, have disappeared from every part of Europe. Tillage and fencing have checked the seasonal migrations of the reindeer and the lemming. Useful animals have been imported, chiefly from the south or from Asia. Useful plants have been introduced from ancient centres of civilisation, and common farm-weeds have managed to come in along with them. Many species of both kinds are southern, many eastern, none are Arctic. In our day the cultivated lands of Europe are largely occupied by southern or eastern forms, and the wastes appear by contrast with the imported population more Arctic than they really are. Even the wastes are shrinking visibly. The fens are nearly gone, and we shall soon have only a few scattered moors left to show what sort of vegetation covered a great part of Europe in the days of choked rivers and unfenced land. The moors themselves cannot resist the determined attack of civilised man. Thousands of acres which used to grow heather are now pastures or meadows.

What we call the Arctic fauna and flora of to-day is apparently only the remnant of an assemblage of species varying in hardiness, which once extended from the Arctic circle almost to the Mediterranean. If climate and soil alone entered into the question, it is likely that the so-called Arctic fauna and flora might still maintain itself in many parts of Central Europe. This Arctic (or ancient European) flora includes many plants which are capable of withstanding extreme physical conditions. Some thrive both on peat and on sand, in bogs and on loose gravel. They may range from sea-level to a height of several thousand feet. They can endure a summer glare which blisters the skin, and also the sharpest cold known upon this planet. Some can subsist on soil which contains no ordinary ingredient of plant-food in appreciable quantity. Such plants survive in particular places, even in Britain, less because of peculiarly appropriate surroundings, or of anything which the microscope reveals, than because they can live where other plants perish. Ling, crowberry, and the rest are like the Eskimo, who dwell in the far north, not because they choose cold and hunger and gloom, but because there only can they escape the competition of more gifted races. The last defences of the old flora are now being broken down; it is slowly giving way to the social grasses, the weeds of commerce, and the broad-leaved herbs of the meadow, pasture, and hedge-row. The scale has been turned, as I think, not so much by climatic or geographical changes, as by the acts of man.

Every lover of the moors would be glad to know that they bid fair to be handed down to our children and our children's children without diminution or impoverishment. The reclaiming of the moors is now checked, though not arrested, and some large tracts are reserved as open spaces. But the impoverishment of the moors goes on apace. The gamekeeper's gun destroys much. Enemies yet more deadly are the collectors who call themselves naturalists, and the dealers who serve them. A botanical exchange club has lately exterminated the yellow Gagea, which used to grow within a mile of my house. Whenever a kingfisher shows itself, young men come from the towns eager to slay it in the name of science. No knowledge worth having is brought to us by such naturalists as these; their collecting means mere destruction, or at most the compilation of some dismal list. If the selfish love of possessing takes hold of any man, let him gratify it by collecting postage-stamps, and not make hay of our plants and mummies of our animals. The naturalist should aspire to study live nature, and should make it his boast that he leaves as much behind him as he found.

[1] Shaw (1806), quoted by R. Blanchard in *Ann. Soc. Ent. Fr.*, tom. lxv. p. 681 (1896).

[2] Blackwall's "Spiders," vol. ii. p 359.

THE MARINE FAUNA IN LAKE TANGANYIKA, AND THE ADVISABILITY OF FURTHER EXPLORATION IN THE GREAT AFRICAN LAKES.

THERE is a story which redounds to the sagacity of a certain Dutch farmer, who, on the sudden appearance of herrings in the ditches on his property, sold it, on account of the indisputable evidence which such fish afforded, of the leaky condition of the dykes. The Dutchman's inference will serve to indicate how much surprise the discovery of jelly-fish in Lake Tanganyika, by Dr. Boehm, created in the minds of those who were interested in the past history of the great lakes in Africa, for, in the presence there even of a single organism so typically marine, and so unlike any real fresh-water form as a medusa, there was as good, indeed far better, evidence for the former access of the sea to those regions, than that which was afforded by the herrings in the Dutchman's ditch.

It was partly because I held this view, in regard to the presence of jelly-fish in Tanganyika, more especially because Prof. Lankester pointed out to me that where there were jelly-fish one might reasonably expect to find other marine organisms, similarly cut off, that I went to Tanganyika in 1895. The results of that expedition have fully justified these views, and during the past year, in which the zoological material obtained has gradually been overhauled, it has become more and more apparent that in Tanganyika we have not only a jelly-fish, but the remains of an entire fauna, which can be regarded as nothing but the relic of the former extension of some ancient sea.

Thus besides the jelly-fish there exist on the rocks about the shores, and in the deep water of the lake, numbers of molluscs, which not only in their shell structure, but also in their organisation, show clearly that they belong to those groups which have generally remained marine, and which have never given rise to any of the colonising fresh-water types. Besides these there are at least two forms of prawns, a deep-water crab, and several forms of protozoa, all possessing like marine affinities.

At the same time it is most important to remember that Tanganyika contains its full complement of recognised fresh-water forms, which are similar to those constituting the entire fauna of lakes such as Nyassa, Mwero, and the like, and that these fresh-water types in Tanganyika differ from those in Lake Mwero and Nyassa only to the same extent that those in Lakes Mwero and Nyassa differ from each other. It is thus obvious, and one of the most important results hitherto obtained, that the fauna of Lake Tanganyika is to be regarded as a double series, one half consisting of forms which are found everywhere in the African fresh waters, the other of what we may call *halolimnic* organisms, which are found living nowhere else in the world, at least so far as is at present known.[1]

In the incomplete state of our knowledge of the Halolimnic fauna, it is undoubtedly the mollusca belonging to this group, which are the most instructive at the present time; for among these organisms there are a considerable number of types which are widely different from each other, and all of which can be compared with living oceanic forms. We have here, therefore, a basis of comparison broad enough to give a clear and trustworthy conception of their nature and their actual affinities.

In this way it is clearly seen that in several genera of the Halolimnic molluscs, such as *Typhobia*, *Bathanalia*, and others, we have forms which individually do not correspond exactly to any single living oceanic species, but which at the same time, in the curious character of their organisation, do very distinctly foreshadow and combine the anatomical features not of one, but of several living oceanic species which are now quite distinct from one another. The only conclusion, therefore, that can be drawn from this remarkable character of the Halolimnic forms, is that they have been cut off approximately all at the same time from their original marine associates at an extremely ancient date. In fact, that they still retain combined the original characters of the organisms whose progeny in the ocean has become completely differentiated into forms that are now specifically and even generically distinct.

These Halolimnic molluscs stand, therefore, to such oceanic species in the relation of ancestral types.

This inference respecting the great antiquity of the marine fauna in Tanganyika, which we gather from the peculiarities of the organisation of the individual Halolimnic forms, is in exact accord with what we should expect when contemplating the vast physical changes which must have been produced since there was any possibility of Lake Tanganyika communicating freely with the sea. But although from both these sources of evidence we are assured that the Halolimnic fauna is certainly a "hoary relic" of the past, they are neither of them capable of affording any indication of the particular geological period during which the marine contamination of this part of the African interior actually took place.

Quite recently, however, there has come to hand a series of observations which appear to be of the highest interest in this connection, and capable of throwing a considerable amount of light upon the perplexing question of the relative antiquity of the Halolimnic forms. It has been found, after comparing the peculiar shells of many of the Halolimnic molluscs, such as those of the two forms of *Limnotrochus*, the genus *Bathanalia*, *Spekia*, *Paramelania*, and so forth, with the fossilised remains of the molluscs occurring in successive geological periods, that there exists a wonderful similarity between the general facies of the shells belonging to the marine fauna of Lake Tanganyika and those of the old Jurassic seas. This is no merely superficial resemblance between single types, but a substantial conchological identity between so many Halolimnic genera and species and an equal number of forms occurring in the Lias and Inferior Oolitic rocks, that it at once arrests attention, and requires us to consider very carefully, whether we are to regard this similarity of the two series as merely a coincidence, or the expression of some real community of nature and descent.

Without entering too fully into the details of this subject, it may be stated, as the result of a careful comparison of these forms, which will be found fully described in a paper in the *Quart. Journ. Micro. Sci.*, vol. xli. No. 162, June 1898, that the comparison is so striking and so complete in detail, that had the Halolimnic molluscs been known only in some fossiliferous bed, there is not the slightest doubt that even the most fastidious palæontologist, unless he had a particular theory to support, would regard them as unquestionably belonging to Jurassic seas.

Taking, therefore, a retrospective view of the whole matter, it will be seen that the original discovery of jelly-fish in Tanganyika has led us a long way beyond the mere demonstration of the existence of a marine animal in the African interior. It has brought to light the existence of a long series of other marine organisms, which, judged by the nature of their organisation, are unquestionably very old, while, finally, we have obtained evidence which appears to indicate that, at any rate, the molluscs still living in this marine oasis in "terra firma," are relics from Jurassic seas.

Thus the purely scientific interest of the Halolimnic fauna consists mainly in the way in which the different forms composing it afford an insight into the structural peculiarities of a number of types of organisation which were thought to have long since become extinct; but at the same time the presence of this fauna in Tanganyika is destined to throw a world of light on the past history of the continent in which it lives, and it is all the more interesting in this latter sense, because the past history of the African lakes, as read in the light of the Halolimnic group, is not that which many geologists, particularly Sir Roderick Murchison, have supposed it to have been.

I have thus briefly outlined the extent and nature of the latest information which has been acquired respecting the zoology of the African lake districts, and the extent to which these observations may change existing preconceptions, and throw old problems into new perspective, will constitute their value from a philosophic point of view. But for the practical ends and advancement of zoology, it will be obvious that the conclusions which have been attained respecting the vast antiquity of the Halolimnic forms, foreshadow the possibilities of almost infinite developments, and that the value of further exploration of these lakes, as a zoological speculation, has become immense.

It is therefore greatly to be regretted that during my recent expedition, under the circumstances in which I found mysel. (without a steamer, and consequently unable to use deep-water dreging apparatus), it was quite impossible to form even an approximate estimate of the range of animals one might expect to encounter in the Tanganyika, and more exasperating than this was the fact that the most interesting Halolimnic forms, the *Typhobias*, *Bathanalias*, and their associates, only appeared just at the limit of my dredging powers, about 1000 to 1200 feet. It was thus only when the dredging capacities of the expedition, so to speak, were giving out, that the more interesting representatives of the Halolimnic fauna were beginning to come in, and there is no doubt that with a steamer and efficient apparatus for great depths, many entirely new forms would be obtained. To show how incomplete our knowledge of the fauna of Lake Tanganyika at present really is, it may be pointed out that although twenty-eight entirely new species of fish were obtained during my expedition, of the four species previously known from this lake I only re-discovered one (see Appendix).

It should, however, be clearly understood that the zoological and geological interest which the possible existence of new

[1] See my papers, *Proc. Roy. Soc.*, vol. lxii., 1898, pp. 452–458; and *Quart. Journ. Micr. Sci.*, vol. xli. pp. 159–180.

Halolimnic forms naturally excites, is not necessarily restricted to the particular basin in which Tanganyika lies; indeed, we have to thank Prof. Süss[1] for collecting the existing observations in such a manner that we are now not only able to separate the lakes into two distinct series, of which the Victoria Nyanza and Tanganyika are types respectively, but to show clearly that the singular Tanganyika valley is geologically related to the similar valleys in which numerous other long and narrow lakes are found to lie. Süss showed that the continued existence of these valleys could be traced north and south in Africa, from the Nyassa region to the Red Sea, and that the narrow gulf in which the Red Sea is itself contained, must be regarded as of the same nature and construction.

Now the fact that there exists a marine fauna in Tanganyika, at the one extremity of the same series of valleys in which the Red Sea lies at the other, would rather lead us to expect that we may encounter the Halolimnic fauna, or something similar to it, in the Albert Edward and Albert Nyanza, which lie along the same depressions in between.

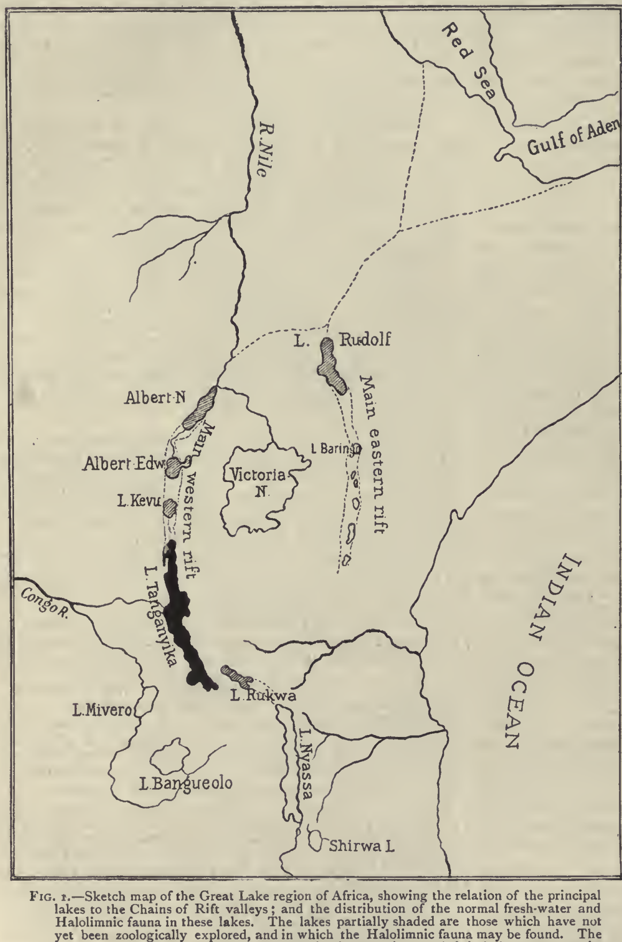

FIG. 1.—Sketch map of the Great Lake region of Africa, showing the relation of the principal lakes to the Chains of Rift valleys; and the distribution of the normal fresh-water and Halolimnic fauna in these lakes. The lakes partially shaded are those which have not yet been zoologically explored, and in which the Halolimnic fauna may be found. The one Lake Tanganyika, in which the Halolimnic fauna is now definitely known to coexist with the ordinary freshwater stock, is represented quite black; while those lakes, such as Nyassa, in which there are certainly no marine forms, are left entirely white.

The facts of distribution which have actually been obtained are, however, merely these. I showed that the Halolimnic fauna does not exist in Lake Nyassa, nor in any of the subsidiary lakes which occur within the British Central African Protectorate. It is, further, certain that this fauna does not exist in Mwero or Bangweolo, the two lakes which form the western boundary of North Charterland.

In the accompanying map, these lakes are therefore represented blank. It may, however, be yet found in Rukwa, east of Tanganyika (which is consequently shaded), and it is still more likely to occur in Lake Kivu, the Albert Edward, and the Albert Nyanzas, all of which lie actually in the same valley as Tanganyika, immediately to the north, and concerning the fauna of which practically nothing is known.

Passing to the more westerly series of faults, it is certain from the collections of shells brought back by Dr. Gregory from the small lakes Naivasha, Elineteita and Baringo, that the Halolimnic fauna is not present in these districts, while the collections of Messrs. Donaldson Smith and Cavendish, from Lake Rudolf in the north, seem to tell the same story.[1] It would appear therefore, that unless some marine extension formerly existed, which was quite independent of the Rift valleys, up some such depression as that of the Rufigi and Ulanga rivers, in which case the remains thereof will be exceedingly difficult to find, both the living and dead representatives of the Halolimnic group, may be expected in the great depression north of Tanganyika, *i.e.* in the three lakes which I have named. Mr. Scott-Elliot, who descended into the northerly extension of the Tanganyika valley, between Ruanda and Mwezi's country, speaks of old lake-bottoms occcurring there above the present level of Tanganyika, as sandy plains, with banks of drifted shells! An immense amount of interest, therefore, attaches to the exploration of these lake-bearing districts immediately to the north of Tanganyika.

Referring to the map, I would therefore direct special attention to the fact that Lake Kivu is about four days' march from the extreme north of Tanganyika, along the same valley and up the lake's effluent, which flows back into the Tanganyika basin. From Kivu it is certainly not more than five days' journey to the Albert Edward, which is on the other side of the north and south watershed, and overflows into the Nile. The effluent appears, so far as I can ascertain, to be navigable for boats; and if this be so, the Albert Nyanza could be reached without trouble in five or six days.; in any case, and allowing ample time for zoological work in these lakes, the whole series could be explored, in something less than two months from the time of leaving the north of Tanganyika, and all that it would be necessary to take in order to do as much as, and a good deal more than I have already done in the case of Tanganyika, would be a few suitable dredges and a couple of collapsible boats.

There is, however, another direction in which evidence bearing upon these subjects can be sought. At the present time the geology of this part of the African interior is almost entirely a

[1] "Die Brucke des Ost Afrika."

[1] I have, however, shaded Rudolf, as very little is known about the fauna it ontains.

blank; but it has been rendered evident from my expedition, as well as by those of Joseph Thomson, and Burton and Speke, that there exist all over these regions west of the Victoria Nyanza immense areas of sedimentary deposits, which extend without interruption to the north of Lake Nyassa, and here they have been proved to be fossiliferous, and it is a fact (which is on no account to be ignored) that the remains of ganoid fishes, discovered there by Henry Drummond, are not regarded by Prof. Troquhair, who described them, as being at all necessarily fresh-water forms. With the same caution, Prof. Rupert Jones, who described the Lamellibranchs occurring in these beds, intentionally placed them among those estuarine forms which might be regarded either as salt water or fresh. Still more important is the existence of what appears to be an oligocene sea-urchin, which certainly came from some portion of this region, and probably from the same fossiliferous beds.

We are thus already in possession of information which indicates the extension of fairly modern seas, far into the African interior. The ascertained existence of marine organisms in Tanganyika is certainly, therefore, in no way opposed to such geological observations as actually exist, but only as new facts usually are, to the perpetuation of crude theoretical anticipations. Our inability to account for their appearance in Lake Tanganyika, is due simply to a complete want of information respecting the geological character of the country which surrounds the lake; but it will have been rendered obvious, that sufficient information on these points can easily be obtained by a properly equipped expedition, which should travel up Tanganyika from the south, and reach, as it could do, the Albert Edward and Albert Nyanzas, by passing up the continuation of the Tanganyika valleys to the north. Now that there are steamers running both on Nyassa and Tanganyika, the deep-water dredging and sounding of both these lakes could be accomplished without much difficulty, and there is no reason, that I can see, why a geologist accompanying such an expedition should not make something of the materials of which the surrounding country is composed. At all events an amount of information would be accumulated, which would mark an epoch in our acquaintance with the zoology and geology of the African interior. What I conceive, however, to be of the first importance is this, that such an exploration is well within the limits of practicability, for the work, entailed under the different heads which I have just discussed, could be carried out by a party properly organised and properly led, well within two years from the time that it set out.

J. E. S. Moore.

Appendix.

In order to exemplify the productive character of properly conducted zoological exploration in these regions, I have appended, under separate headings, a list of those Halolimnic molluscs, the empty shells of which were known before the present expedition was undertaken, and of the forms which have now been obtained with the animals preserved in a fit state for zoological work. In the same way I have added similar lists of the species of fish previously known to inhabit Tanganyika, and the numerous and almost entirely new forms which have now been brought back. In the older list of molluscs the conchological classification of their empty shells has been retained, in order that it may be seen how completely the acquisition of the animals has changed our views.

I.

List of Empty Shells previously known.

Fam. *Melaniidæ.*
Genus *Typhobia* (Smith).
T. Horei (Smith).
Genus *Paramelania* (Smith).
P. Damoni (Smith).
M. nassa (S. P. Woodw.).
Fam. *Hydrobidæ.*
Genus *Syrnolopsis* (Smith).
S. Lacustris (Smith).
Genus *Spekia* (Bourginnat).
S. zonata (S. P. Woodw.).
Genus *Tanganyicia* (Cross).
T. rufofilosa (S. P. Woodw.).
Genus *Limnotrochus* (Smith).
L. Thomsoni (Smith).
L. Kirkii (Smith).

List of entire Molluscs obtained during the Expedition of 1895 and 1896.

Fam. *Typhobidæ* (Moore).
Genus *Typhobia* (Smith).
T. Horei (Smith).
Genus *Bathanalia* (Moore).
B. Howesei (Moore).
Genus *Limnotrochus* (Smith).
L. Thomsoni (Smith).
Fam. *? Planaxidæ.*
Genus *Tanganyicia* (Cross).
T. rufofilosa (S. P. Woodw.).
Fam. *Xenophoridæ.*
Genus *Chytra* (Moore).
C. Kirkii (Smith).
Fam. *Purpurinidæ.*
Genus *Paramelania* (Smith).
P. Damoni (Smith).
P. crassigranulata (Smith).
Genus *Nassopsis* (Smith).
N. nassa (S. P. Woodw.)
Genus *Bythoceras* (Moore).
B. iridescens (Moore).
Fam. *Naticidæ.*
Genus *Spekia* (Bourginnat).
S. zonata (S. P. Woodward).

II.

List of Fishes known previously.

Acanthopterygii.
Fam. *Cichlidæ.*
Genus *Tilapia* (Gthr.).
T. Tanganyicea (Gthr.).
T. Burtoni (Gthr.)
Genus *Mastacembelus.*
M. Tanganyicea (Gthr.)
M. Ophictium (Gthr.).

List of Fishes obtained during the Expedition.

Acanthopterygii.
Fam. *Serranidæ.*
Genus *Lates.*
L. microlepis, sp. n.
Genus *Lamprologus*, nov. gen.
L. fasciatus, sp. n.
L. compressus, sp. n.
L. Moorei, sp. n.
L. modestus, sp. n.
L. elongatus, sp. n.
L. fuscifer, sp. n.
Genus *Telmatochromis*, nov. gen.
T. vitatus, sp. n.
T. temporalis, sp. n.
Genus *Julidochromis*, nov. gen.
J. ornatus, sp. n.
Genus *Paratilapia*, nov. gen.
P. pfifferi, sp. n.
P. macrops, sp. n.
P. ventralis, sp. n.
P. fuscifer, sp. n.
P. lep'osoma, sp. n.
Genus *Bathybates*, nov. gen.
B. ferox, sp. n.
Genus *Eretmodus*, nov. gen.
E. cyanosticus, sp. n.
Genus *Tilapia.*
T. labiata, sp. n.
Genus *Tropheus*, nov. gen.
T. Moorei, sp. n.
Genus *Petrochromis*, nov. gen.
P. polyodon, sp. n.
Genus *Perissodus.*
Genus *P. microlepis*, sp. n.
Fam. *Mastacembelidæ.*
Genus *Mastacembelus.*
M. Moorei, sp. n.
Physostomi.
Fam. *Siluridæ.*
Genus *Clarias* (L.).
C. angularis (L.).
C. biocephalus, sp. n.
Genus *Anoplopterus* (Gthr.).
A. platychir (Gthr.).
Genus *Anchinaspis* (Cuv.).
A. biscutata (Cuv.).
Genus *Synodontis.*
S. multipunctatus, sp. n.
Genus *Malapterurus.*
M. electricus.
Fam. *Characinidæ.*
Genus *Alestes.*
A. macrolepidotus (C. and V.).
A. macrophtralmus (Gthr.).
Genus *Hydrocyon* (C.).
H. forskalii.
Fam. *Cyprinidæ.*
Genus *Labio.*
L. ?
Fam. *Cyprinodontidæ.*
Genus *Haplochilus.*
H. tanganicanus, sp. n.
Fam. *Polypteridæ.*
Genus *Polypterus.*
P. Bichir ?

From the above list of fishes, which has been courteously supplied to me by Mr. Boulenger, and which are themselves now in the British Museum, it will be seen that there has been added from this single locality an extraordinary number of entirely new types. In fact, almost the entire fish population of Tanganyika, so far as at present known, is composed of forms which are quite peculiar to the lake. When, therefore, we remember that all these fishes were obtained without deep or even rough water nets and trawls, and that I was only able, as it were, to scratch round some 150 miles of the shallow coast line of a lake over 350 miles in length, and of unknown depth, it will be evident to all, how much must remain there in the way of fishes which have not yet been obtained. But what is true of Tanganyika in this respect, is almost equally true of Lake Nyassa, for no deep-water work of any kind has hitherto been accomplished there, nor is the depth of this lake known. It has been shown to extend to 300 fathoms, but no bottom was obtained; and it consequently follows that wherever the deep floor of Nyassa really is, it is far below the level of the sea.

Thus although it is obvious that we know next to nothing of the zoological contents of Nyassa and Tanganyika, our comparative ignorance of the fauna of these two great lakes is as nothing compared to the absolute want of information appertaining to the aquatic zoology of Lake Rukwa, or of the great Nyanzas north of Tanganyika, the interesting relations of some of which to the Tanganyika valleys I have already pointed out. I hope, therefore, it will become apparent how huge a field for further zoological investigation the energy and enterprise of the great African companies, and the administration of the African Protectorate has opened up to us, as a sort of unconscious gift to science, wherein the problems raised originally by Boehm's jelly-fish may be followed up, not in imagination only, but with the pleasant certainty of tangible results. J. E. S. M.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. LUCIANI, Professor in Human Physiology in the University of Rome, whose work on the functions of the cerebellum is well known throughout the scientific world, has (says the *British Medical Journal*) been elected Rector of the Rome University for the academic year 1898–99. Dr. Corona, Professor of Experimental Physiology and President of the Faculty of Medicine of the Parma University, has been elected Rector of this University.

THE following list of this year's successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships (Science), has been issued by the Department of Science and Art:—Royal Exhibitions—George S. Taylor, Devonport; Leslie H. Hounsfield, London; William McG. Wallace, Crewe; William W. Firth, Oldham; Henry J. Round, Cheltenham; Sidney A. Main, Brighton; James Davidson, Newcastle-on-Tyne. National Scholarships for Mechanics—Aidan N. Henderson, Edinburgh; John E. Jagger, Manchester; William Alexander, Glasgow; Victor G. Alexander, Portsmouth; Ernest A. Forward, London; George E. Parker, Denholme, Bradford; Percy W. Kelsey, Brighton; Frank H. Phillips, Crewe; Joel J. Lee, Portsmouth. Free Studentships for Mechanics—George Walker, Bradford; Marshall H. Straw, Sneinton, Nottingham. National Scholarships for Physics and Chemistry—George M. Norman, Brighton; William S. Tucker, Kidderminster; John Satterly, Ashburton; Robert J. Bartlett, London; Joe Stephenson, Linthwaite, Huddersfield; Lewis L. Fermor, London; Robert Gillespie (junr.), Glasgow; Frederick C. Clarke, Plymouth; Thomas Stenhouse, Rochdale. Free Studentships for Physics and Chemistry—Arthur E. Garland, London; Stanley C. Dunn, London; Harold V. Capsey, Wellington, Salop; Isidore Tom, London. National Scholarships for Biology—Stanhope E. Baynes-Smith, Sheffield; Stafford E. Chandler, London; Arthur Pickles, Burnley; William E. Clarke, London.

THE Scottish Education Department has issued a circular containing a series of proposals for the recognition of a distinct class of higher grade science schools by the Department. For the further encouragement of instruction in science and art in combination with a sound scheme of general education, a grant will be made on the following conditions to the managers of schools which provide a satisfactory course of instruction extending over not less than three years to pupils who have obtained a merit certificate or otherwise satisfy the Department of their capacity to profit by such advanced instruction: (1) The Department must be satisfied that the school possesses a proper equipment for instruction in science and art, namely, sufficient laboratory accommodation, with the necessary apparatus for instruction in science, suitable drawing tables or desks, and an adequate provision of examples for instruction in art, and, as a rule, a workshop or room specially adapted and equipped for instruction in the use of tools. (2) A course of instruction extending over at least three years must be submitted to and approved by the Department, and this course shall make provision for the following:—Experimental science—Not less than four hours a week, of which at least two hours must be spent by each pupil in practical work. Drawing.—At least two hours a week. The course in its earlier stages should embrace instruction in freehand drawing, model drawing from common objects as well as from geometrical models, and drawing to scale of plan elevation and section. Mathematics.—At least four hours a week. (*a*) Geometry and mensuration—practical and theoretical. (*b*) Higher arithmetic and algebra. History and English literature.—The first two years in the latter subject should be devoted to cultivating a taste for good literature by the reading of interesting works of good style and elevation of sentiment. Geography.—A revisal of previous knowledge; the reading of maps (*e.g.* of contour lines) and their construction; elementary exercises in surveying and mapping; a thorough regional survey, by means of excursions, of the physical geography, flora, fauna, and historical antiquities of the district in which the school is situated; a study of commercial geography, based largely upon the shipping and trade news of the daily papers. Manual instruction.—At least three hours. Girls—needlework and dressmaking, cookery. Boys—woodwork, ironwork, clay modelling. In the latter subjects, and in dressmaking for the girls, the pupils will be expected to make a practical application of the drawing taught in the school, and the knowledge acquired in the science lessons can, to some extent, be turned to account for the explanation of the processes in cookery. The Department must be satisfied that the teachers have a competent knowledge of the subjects which they are to teach, and, in the case of science, that they have had experience in treating the subject experimentally. As a rule not more than forty pupils in a class may be instructed by one teacher at one time, nor more than twenty-five in practical work.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 16.—M. Wolf in the chair.—The Perpetual Secretary announced to the Academy the death of M. Pomel, Correspondant in the Mineralogy Section.—On continuous groups of movements in three dimensions of any variety whatever, by M. G. Ricci.—On the differential invariants of a system of $m + 1$ points with respect to projective transformations, by M. E. O. Lovett.—On the representation of varieties of three dimensions, by M. Émile Cotton.—On commutators, by M. P. Janet.—Atmospheric carbon dioxide, by MM. Albert Levy and H. Henriet. After complete removal of carbon dioxide by baryta water, by the prolonged contact of air with caustic potash, fresh quantities of the gas are formed by the slow oxidation of some organic matter existing in the air. Under certain atmospheric conditions, the amount thus formed may amount to nearly as much as the carbonic acid originally present

CONTENTS.

THURSDAY, SEPTEMBER 1, 1898.

MORPHOLOGY OF VERTEBRATES.

Elements of the Comparative Anatomy of Vertebrates. Adapted from the German of Dr. Robert Wiedershein by W. N. Parker, Ph.D. Second edition. Pp. xvi + 488. (London: Macmillan and Co., Ltd., 1897.)

ELEVEN years have elapsed since we had occasion to review in these pages the first English edition of Prof. Wiedersheim's "Elements of the Comparative Anatomy of Vertebrates," adapted and modified from the first German edition by Prof. W. N. Parker. During this interval zoology, like every other branch of science, has been making steady progress, with the almost necessary result that theories and views which were held only a few years ago, have with increased knowledge become untenable or required modification. Prof. Wiedersheim has accordingly had on two occasions to bring up his text-book to date by the issue of new editions; not that in the earlier editions extreme views were set forth which have had to be abandoned, but simply to keep pace with the natural growth of knowledge of the forms of animal life. It is not before it was necessary that a second English edition has been undertaken if the work was to maintain its place amongst our comparative anatomy manuals of the day.

It happens in most cases where further editions are called for, that the author of the original work in his subsequent issues not only brings them up to date, but also considerably enlarges the modest dimensions of his first edition by the introduction of new matter. This has been the case with Prof. Wiedersheim's book, and in preparing the work now under review, Prof. Parker has had to select between the alternative of making a translation of a greatly enlarged German edition, and consequently modifying the scope of the new English edition, thereby bringing it into competition with the larger works on the subject already in the field and within the reach of English students, or of adapting Prof. Wiedersheim's latest text, and thus maintaining the original character of the English edition, which has proved to have a distinct sphere of usefulness to the English student. Prof. Parker has, we think, been well advised in adopting the latter alternative. But, notwithstanding his attempt to keep down the size of the new English edition, it contains 143 pages more than the first edition. This is not, however, all additional text, because in the present edition the bibliography of the subject has received considerably more additions to it than any other part, and instead of being a short list of the principal monographs placed after each section throughout the work, and when taken together occupying not more than nine pages, it now forms an appendix of 92 pages at the end of the book. Although no one appreciates more than we do the advantages of a good bibliography, we consider that in a work like this under review, which deals only with the elements of the subject, such a bibliography is entirely superfluous and useless. While it would have been a useful feature in a text-book of comparative anatomy of vertebrates to which one would naturally go for references, it is quite out of place in a work essentially for junior students. Prof. Parker would, therefore, have been much better advised to have kept this portion well within the limits of the space assigned to it in his earlier edition. When the portion of the book just referred to is left out of account, the text proper shows an increase of little over 60 pages. Some of these are occupied by new and additional illustrations, which are distinctly useful and an improvement. As examples selected at random, we may mention the new diagram inserted on p. 219, showing the shifting of the lachrymal gland which has taken place in the course of phylogeny, that on p. 240, of the development of a tooth, and those illustrating the anatomy of the organs of generation. There are also several new illustrations which replace older and less perfect ones, amongst which may be noticed those illustrating the anatomy of amphioxus, on p. 274, and the respiratory apparatus in fishes, on p. 277. The number of illustrations is a marked and useful feature of the work, and the manner in which they have been executed by the publishers is very commendable, as they show a great improvement on those usually met with in English text-books.

The arrangement of the text corresponds with that adopted in the earlier edition, and begins with a general introduction, in which the meaning and scope of comparative anatomy, the development, structural plan of the vertebrate body, the main classification of the principal vertebrate groups, and their gradual development in geological deposits, and therefore in time are briefly explained. The comparative anatomy of the various organ-systems is next described in the following order: the integument, the skeleton, the muscles and electric organs, the nervous system and sense organs, the organs of nutrition, respiration, circulation, excretion, and reproduction, beginning in each case with those of the lower forms of vertebrates and working up to the higher. A glance at the first page is sufficient to show the correctness, as regards it, of Prof. Parker's statement in his preface to this edition, that much of the book has been entirely re-written; and this we have been able to confirm, from examination of subsequent pages, is the case throughout. He has also been at some pains to make the treatment of the different sections more approximately equal, and to deal with well-ascertained and essential facts rather than take up space with doubtful theories and special details. Hence we find that the views associated with the name of Prof. Wiedersheim as to the derivation of the limbs of higher vertebrates from the fins of fishes have been judiciously omitted in this edition, and the theories of Gegenbaur and others are not referred to, presumably for the same reason. When the morphological significance of a part is doubtful it is, we consider, far better to state so openly, as has been done regarding the derivation of the diaphragm, where, after mentioning its morphology in vertebrates generally, the author concludes with the following remark: "The evolution of the mammalian diaphragm is not yet thoroughly understood."

The section of the comparative anatomy of the brain and nervous system is considerably improved in the new edition, both in the text and the illustrations. The description of the suprarenal bodies no longer poses between the description of the sympathetic nervous system and the sensory organs, but is relegated to the end of the genito-urinary system until something more is known about them.

From this brief sketch it will be gathered that the author has considerably improved the work in most respects; but we regret to see the terms *epi* and *hypo* still used in describing the embryonic layers, instead of the prefixes *endo* and *ecto* used by German zoologists, which are greatly preferable, especially in teaching students. We would have liked also to have seen less clarendon type used in the text and restricted to headings only, also the retention of the German system of emphasising words and passages by means of double spacing between the letters of the type.

Doubtless the new edition of the "Elements of Comparative Anatomy of Vertebrates" will continue, and that deservedly, to retain its place amongst students' manuals. J. G. G.

ANIMAL PLAY.

The Play of Animals; a Study of Animal Life and Instinct. By Karl Groos. Translated by Elizabeth J. Baldwin; with a Preface and Appendix by J. Mark Baldwin. Pp. xxvi + 341. (London: Chapman and Hall, Ltd., 1898.)

THIS interesting little work, the preface to the original German edition of which is dated 1895, presents one very unusual peculiarity. The editor, with the author's approval, has acted the part of the candid friend, and in his preface has given not only a valuable synopsis of the chief contents and object of the book, but has added such careful criticisms on the author's theories as to render further critical observations almost superfluous, Prof. Baldwin being a well-known authority on subjects akin to those treated by Prof. Groos.

Not only is the book practically unique in its subject, but it appeals to two distinct classes of readers. In the first, second, and fifth chapters it appeals to the philosophical student of animal play as a serious subject; while the third and fourth chapters are devoted to actual illustrations of this play, and, as charmingly written and authentic anecdotes, will delight a much wider circle. Indeed, to both classes of readers the work may be commended with every confidence.

The author takes, so to speak, a very serious view of the importance of play in animal development, and treats it with the profundity of research characteristic of the German investigator. He says, for instance (p. 291), that

"it seems a very mistaken proceeding to characterise play as aimless activity, carried on simply for its own sake. Energetic action may be provocative of pleasure, but it is by no means the only source of the pleasure produced by play."

And the view that play is a veritable instinct is elaborated with great wealth of detail in the second chapter. Here, as the editor remarks, we have full details of such interesting topics as imitation in its relation to play, the inheritance of acquired characters in relation to the rise of instincts, and the plan and function of intelligence in the origin of these primary animal activities. And here, perhaps, the humanitarian may derive a mitigated satisfaction from the theory (pp. 121 and 122) that the cat's treatment of the captured mouse is not due to the love of torture for torture's sake, but is owing to an instinctive exercise for acquiring skill in the chase, turned later into practical account by the captor.

The first chapter is an examination of Mr. Herbert Spencer's theory of the "surplus-energy" origin of play, which, if we accept the author's views, must for the future be put aside. Chapter ii., which deals with the biological theory of play, must be read in connection with Chapter v., of which the physiology of play forms the subject; these three chapters, as already stated, supplying the theoretical and philosophical matter of the book, while the two intermediate chapters afford the detailed facts on which the superstructure rests.

Some of the author's main theoretical positions are concisely summarised in the following extract from his editor's preface:—

"He holds play to be an instinct developed by natural selection, . . . and to be on a level with the other instincts which are developed for their utility. It is very near, in its origin and function, to the instinct of imitation, but yet they are distinct. . . . Its utility is in the main twofold. First, it enables the young animal to exercise himself beforehand in the strenuous and necessary functions of its life, and so to be ready for their onset; and, second, it enables the animal by general instinct to do many things in a playful way, and so to learn for itself much that would otherwise have to be inherited in the form of special instincts; this puts a premium on intelligence, which thus comes to replace instinct. Either of these utilities, Prof. Groos thinks, would ensure and justify the play instinct; so important are they, that he suggests that the real meaning of infancy is that there may be time for play."

For the difficulty the editor sees in this conception of play as a pure instinct, the reader must be referred to the work itself, which is long likely to maintain the leading position in a new and important field of inquiry.

The data on which the author relies as his basis for theorising are necessarily in great part drawn from the writings of others. In the selection of these he appears to have exercised a wise discrimination. His great obligations to Brehm's "Tierleben" are fully acknowledged, and we are glad to see that he accepts all the observations of Mr. W. H. Hudson, some of which we believe there has elsewhere been a tendency to discredit. In the main the animals referred to are rightly named, but we shall be surprised if the creatures termed "badgers" on p. 113 of the translation are not really ratels. R. L.

OUR BOOK SHELF.

The Study of Man. By Alfred C. Haddon. Pp. xxxi + 512. (London: Bliss, Sands, and Co. New York: C. P. Putnam's Sons, 1898.)

THE publication of this volume will doubtless be the means of exciting interest in anthropological inquiries, and adding to the number of scientific students of human-kind. The work is not a systematic treatise on anthropology, but a collection of articles upon various subjects of anthropological study, containing much that is interesting to the serious student, for whose benefit numerous references are given to original papers, and written in a style which should prove attractive to every intelligent reader.

After an introductory account of the scope and aims of anthropology, Prof. Haddon describes the usual anthropological measurements, and then surveys such features as the colour of the hair and eyes, the form of the head, and the character of the nose, drawing instructive conclusions from the facts as to the distribution of these characteristics. To illustrate the value of blending anthropological investigations with the records of history, he devotes a short chapter to an abstract of Dr. Collignon's work on the ethnography of the Dordogne district of West Central France. Following this are two interesting chapters on the evolution of the cart, and the origin of the Irish jaunting car, which latter conveyance Prof. Haddon shows was evolved at the end of the last century, or more probably within the first few years of this century. A series of popular articles on the history and literature of toys and games are used as the basis of the succeeding eight chapters, the chapter on "bull-roarers" being particularly noteworthy. Finally, instructions are given for conducting ethnographical investigations, based upon those issued by the British Association Committee on the Ethnographical Survey of the United Kingdom. It will be understood from this outline that Prof. Haddon's work, which, we may add, is illustrated by a number of good figures, will interest the public in anthropological science, and thus assist in the preservation of vanishing knowledge.

A School Geography. By George Bird, B.A., F.G.S. Pp. x + 294. (London: Whittaker and Co., 1898.)

THIS volume is distinctly in advance of the usual school-books of geography; for it belongs to the steadily increasing class of works which aim at making the study of scientific subjects educative as well as informing. The long lists of capes, rivers, mountains, &c., which still frequently figure in school geographies, and have to be committed to memory by the unfortunate pupils of teachers behind the times, have been omitted, and instead of pages of unnecessary statistics we have a logical statement based upon a rational scheme of geographical teaching. In the author's words: "While trying to make the book interesting, I have also tried to make it of educational value by continually referring to the influence of the geographical position and surroundings upon the climate, productions, industries, and trade of the various countries."

Every geographer admits that these are the right lines to follow, but opinions differ as to the amount of astronomical geography which should be studied before the pupil passes to the description of the various countries. Mr. Bird commences with a chapter on astronomical geography, and then deals in successive chapters with land, water, air and climate, before passing to general geography. With the exception of the first chapter, these introductory descriptions will be easily understood by the pupils of about twelve or thirteen years of age, for whom the book is intended. Teachers of geography know how very difficult it is to give young pupils clear and accurate ideas concerning the movements of the earth and the phenomena produced by these motions, and many of them will probably take Mr. Bird's hint to touch but lightly upon topics in the opening chapter in going through the book for the first time. If more prominence had been given to apparent phenomena, which the pupils can observe for themselves, and less to the actual conditions which produce them, this chapter would have gained in educational value. But this is a minor point, and the book as a whole represents a creditable attempt to improve the teaching of geography in this country.

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 Case of Inherited Instinct.

THREE species of cave locusts are found in New Zealand, belonging to three different genera. (1) *Pachyrhamma speluncæ* is allied to *Gymnoplectron longipes*, which lives among the branches of trees, both genera being known only from the north island. (2) *Pleioplectron edwardsii* inhabits caves in the south island, and has close allies, belonging to the same genus, living amongst old wood in both islands. (3) *Macropathus filifer* is allied to *Pharmacus montanus*, which lives in the open among rocks, both genera being from the south island. *Macropathus* and *Pleioplectron* may have originated from a common ancestor in New Zealand, but *Pachyrhamma* belongs to another section, and is more nearly related to European and American species than to the other cave locusts of New Zealand. These three genera belong to that group of the *Stenopelmatidæ*—distinguished by having no pads on the tarsi—to which all the cave locusts of North America, Europe, and Burma belong; the habit of living in caves appearing to be an instinct found only in that group among the whole of the *Locustodea*.

So much for the facts: now for the inference. We cannot suppose that the ancestors of the New Zealand cave locusts, who migrated to that country through what is now called the Malay Archipelago, lived in caves during the whole of the migration; partly from the impossibility of their having passed from one cave to another, and partly because each species has allies which do not live in caves. If this be so, we have here a most interesting case of an instinct which has not only been transmitted through many generations, but which must, in at least two cases, have remained dormant during the greater part of the southerly migration, and reappeared when favourable conditions enabled it to do so. For we are compelled to assume that none of the first *Stenopelmatidæ* which came to New Zealand lived in caves, and that some of the descendants of the northern cave locusts reverted to that curious mode of life.

F. W. HUTTON.

Christchurch, N.Z., July 20.

Transference of Heat in Cooled Metal.

YOUR issue of June 30, containing a letter from M. Henry Bourget under the above heading, has only just come into my hands. In 1889, when working at the Cavendish Laboratory, Cambridge, I was interested in the phenomenon described by M. Bourget, and made a few preliminary experiments in connection therewith, but, owing to other work, I was unable to proceed very far with the investigation, and probably shall not have the opportunity of doing anything further. My notes, taken at the time, show that the following experiments were made and results obtained:—A large well-used soldering bolt had a hole drilled nearly through the iron shank at the end remote from the copper portion; into this hole, and surrounded with mercury, was placed the bulb of a thermometer with small thermal capacity; a bunsen flame was then placed beneath the copper portion, and the heating continued until the thermometer indicated a steady temperature. The flame was then removed, and a vessel containing water brought up over the hot end, upon which the thermometer showed a rise of 1·5° C. There was a considerable film of copper and iron oxides, &c., at the junction of the iron and copper.

After this a copper rod ⅜ inch diameter and 18 inches long, and with a bend of about 45°, 4 inches from one end; at the end of the 14″ portion, close to but just not touching, was placed a sensitive thermopile connected up to a low-resistance reflecting galvanometer. The rod was set up with the longer portion horizontal, and the 4-inch portion depending. The end of the rod and the thermopile were well shielded by means of asbestos and dusters, and the rod passed tightly through a hole in a large vertical sheet of asbestos millboard in order to protect the thermopile further from any chance currents of heated air or steam.

As before, a bunsen flame was placed at the centre of the depending portion of the rod, and when the galvanometer spot showed that the temperature gradient along the rod had become steady, the galvanometer was adjusted to false zero; the flame was then removed, and after waiting a second or so until the spot was beginning to move in the cooling direction, a vessel of water was brought up over the hot end, the galvanometer spot *at once* moved nearly across the scale in a direction indicating a rise in temperature. Further experiments seemed to show that this heating effect was greater when the temperature of the heated end was sufficiently high to produce the spheroidal state; when this was not the case, the movement of the spot in the cooling direction was decreased or altogether stopped, but no increase in temperature was indicated. With the copper rod arranged as described, no perceptible movement of the spot in the heating direction took place until about thirty seconds after the application of the bunsen flame. An attempt was made to see if an opposite effect could be obtained when a heated metal sleeve was slid over the 4" portion, but nothing definite was observed. In connection with the apparently instantaneous manifestation of a rise of temperature at the cooler end of the bar following the cooling of the hotter end, other experiments suggested themselves. For although the experiments described were only preliminary and somewhat rough and ready, yet I think it was established by them that the velocity of transmission of the effect is very much higher than that of heat by ordinary conduction or convection. The objects of the further experiments were to find out, if possible, to what the effect is due and what is its mode of propagation. In order to ascertain if the effect could be obtained in liquids, a piece of thin weldless steel tube, closed at one end and about 9 inches long, was filled with mercury and the bulb of a thermometer was just submerged beneath the mercury. On experimenting in the manner already described a very slight heating effect was observed, which might have been due to a sudden cooling of the glass bulb, and no definite results were obtained. Here the writer had to drop the investigation.

When a heated sphere is plunged into water, a rise of temperature in the inner portion might take place owing to the work done on it by the cooled and contracting envelope, but in the case of the copper rod this does not seem a sufficient explanation.

If, as I hope, some of your readers undertake to investigate this very interesting phenomenon, I would be pleased, if it be of any service, to give them particulars of the experiments I had proposed carrying out, but for which, unfortunately, I have neither time nor opportunity. ALBERT T. BARTLETT.

Old Charlton, S.E., August 22.

The Use of Digraphs.

IF all writers, or, better still, all printers followed the rule of Mr. Horace Hart, and never permitted the use of æ and œ, but always spelled them out ae and oe, many happy results would ensue. Authors would cease to confuse editors and printers with undecipherable attempts to represent a diphthong; 5 per cent. of the misprints that have to be corrected in technical biological papers would disappear; zoological names, if no others, might at last be written correctly, and the student no longer confused with *coelatus* when *caelatus* was meant, and so forth. There need be no confusion with those rare words in which the vowels are distinct, since the custom of printing "aërated," "oölogy," and the like already prevails. If the only evil in sight is that Mr. Montagu Browne will feel impelled to the exceedingly unnecessary task of rewriting his museum labels, by all means let us entreat the printers to reform. F. A. BATHER.

Natural History Museum.

THE APPROACHING MEETING OF THE BRITISH ASSOCIATION AT BRISTOL.

THE EXCURSIONS.

IN a district so rich in geological and antiquarian, as well as industrial, interest as that of which Bristol forms the centre, it is to be expected that the excursions will form an attractive feature of the approaching meeting. A brief synopsis will serve to indicate some of the salient points of the varied programme.

Taking first the Saturday excursions, that (1) to Bath will occupy the whole day and will include the Roman Baths and Remains, the Moore Museum (geological), the valuable collection of local antiquities at the Institution, and the fine Abbey Church. Geologists will have an opportunity of visiting sections of White Lias and Rhætic, under the guidance of the Rev. H. H. Winwood. In the afternoon the party will drive to Claverton Down and Manor, returning by Widcombe and Beechen Cliff, where a bird's-eye view of Bath is obtained. Another whole-day excursion (2) includes the Severn Tunnel, with its pumping apparatus of fourteen engines on the Cornish type capable of lifting eighty million gallons per diem; Chepstow Castle, which still retains some of the original eleventh century masonry and an Early English chapel; the Chepstow railway bridge, in which the tubular and suspension principles are combined, and the Severn Bridge with its swing-bridge weighing about 400 tons. A half-day excursion (3) is arranged to Aust Cliff, which presents a section of great interest to geologists. This will be examined with Mr. H. Pentecost of Clifton College as guide. It is hoped that enough of the Rhætic bone-bed, with its rich store of saurian and fish remains (including the teeth of *Ceratodus*) may be brought down to the beach to give the geologists of the party an opportunity of securing good specimens. This excursion also includes a visit to Over Court and Knowle Park. Another half-day excursion (4) is to Stanton Drew with its striking megalithic remains, including three stone circles, two "avenues," a dolmen (if such it be), and several outlying stones included in the scheme of construction. Prof. Lloyd Morgan will here be guide. The drive also includes Sutton Court, the residence of Sir Edward Strachey, and, if the weather be clear, Dundry Hill, whence a fine and extensive view, comprising scenic features of formations from the Old Red Sandstone to the Chalk, is obtained. Those who are interested in docks, lairage, chill-rooms, and granaries, may devote the afternoon to Avonmouth (5) and see, under the guidance of Messrs. Girdlestone and McCurrich, the floating pontoon dock and cold storage installation. Those for whom architecture has stronger attractions will perhaps select either Raglan Castle and Tintern Abbey (6), to which the whole day will be devoted, or Bradford-on-Avon (7), with its unique and perfect little Saxon Church of St. Lawrence, its quaint old Town Bridge, its fourteenth century Tithe Barn, and its residential houses, including that in which Dr. John Beddoe, F.R.S., now resides. Those, again, who seek an impressive lesson in physical geology and the origin of scenery, may drive from Yatton to Cheddar (8), through the Vale of Wrington, and Burrington Combe, over the arched dome of Mendip, and beneath the splendid mural bastions of Carboniferous Limestone in the Cheddar gorge, visiting the interesting stalactitic caves near the little village of Cheddar. While those who wish to see one of the best examples of an ancient dry-walled camp, with a number of curious pits, probably for storage of grain, in which skeletons with ugly gaps in their dolicho-cephalic skulls have been found, may take the afternoon excursion to Weston-super-Mare and Worlebury.

On Thursday, as on Saturday, there is a wide range of choice. One party will have an opportunity of driving to the Barrow reservoirs and Chelvey pumping station of the Bristol Water Works (10). The supply of water comes from springs on the Mendip Hills, about sixteen miles from Bristol, from others at Barrow Gurney, and wells at Chelvey, near Nailsea. The storage reservoirs at Barrow Gurney have a water-area of about 130 acres, and extensive filter-beds. At Chelvey there are pumping engines of the rotary beam type, with single and compound cylinders, variable expansion, surface and jet condensers, and bucket and plunger pumps. The aggregate horse-power is 660. Another party will visit Wells and Glastonbury (11). Apart from the architectural and historic interest of these places there is the special attraction of the marsh-village, which will be visited under the guidance of Mr. Arthur Bulleid, whose name is so intimately associated with its discovery. On the edge of the ancient (but now reclaimed) meres stood a village consisting of about seventy dwelling-mounds covering some 3½ acres. The foundation of the village is composed of layers of timber and brushwood resting on the peat, and is surrounded by a palisade. On the wood circular areas of clay are spread, and on these wattle huts were erected, the clay forming the floor of the dwelling. A number of interesting relics of the old British community who dwelt there are preserved in the little museum at Glastonbury. The excursion to Stroud and Nailsworth (12) combines a visit to an industrial district of considerable importance, and a drive through some of the finest scenery of the Cotteswold district. At the Stanley and the Dudbridge Mills all the processes of making raw wool into the finest plain and fancy coloured materials can be seen, and the best and most improved textile machinery can be inspected. Sir W. H. Marling, Bart., gives in the guide-book a concise history of the industry in the district. Minchinhampton Common, with its so-called "pit-dwellings" and ancient encampments, Nailsworth, Woodchester Park, Uleybury and Frocester Court are included in this excursion. The excursion to Swindon Works, Marlborough and Savernake (13), again combines industrial processes and scenery, while the inspection of Marlborough College, and its mound, will no doubt prove an additional attraction; while that to Frome, Longleat, and Shearwater (14), combines a visit to the Art Metal Works of Messrs. Singer and Sons; an inspection of the residence of the Marquis of Bath, built in the middle of the sixteenth century, on the site of an Augustinian Priory, and containing a fine collection of pictures; and a charming bit of Wiltshire scenery. The excursion to Bowood and Avebury (15) affords, besides a visit to the residence of the Marquis of Lansdowne, with its pictures and mementoes of the owner's sojourn in India and Canada, an opportunity of seeing the megalithic remains and enclosing earth-bank and ditch (the latter on the *inner* side) at Avebury, and the huge mound, 126 feet high, of Silbury. The moat or fosse surrounding this hill has been silted up by fine detrital matter from the Kennet. Avebury Church, with its Saxon work, Norman work, twelfth century font, and later fifteenth century rood-loft, is of considerable interest and most picturesquely situated. Salisbury, Stonehenge, and Old Sarum (16), including the Blackmore Museum in Salisbury, open up, in one long day, a perhaps unparalleled range of historic and prehistoric retrospect; while for those who seek the yet earlier records of geological times the excursion to Tortworth (17), by special invitation of Earl Ducie, is of special interest. Strata of Silurian age, with remarkable beds of trap-rock in the Upper Llandovery series, quarries in Old Red Sandstone and Carboniferous Limestone, and pits for the winning of Celestine (sulphate of strontium) in the Keuper beds, provide a sufficiently varied geological bill of fare. The approach to Tortworth Court, through a picturesque, well-wooded valley in the Carboniferous Limestone, occupied by an artificial lake, is remarkably beautiful. Some of the Silurian quarries have been specially opened up by Earl Ducie. Prof. Lloyd Morgan has written the guide to the excursion, and Mr. Edward Wethered will describe the micro-organisms which occur in the limestones.

At the close of the meeting a long excursion (18), specially arranged for our colonial and foreign visitors, will comprise Exeter, Torquay (including Kents Cavern), Dartmouth, Plymouth, Mount Edgcumbe, Devonport, and a trip across Dartmoor.

For all these excursions guide-books have been prepared by the leaders and those specially acquainted with the localities. And it need hardly be added that, largely through the courteous hospitality of many hosts, corporate and private, there will be no lack of refreshment by the way.

THE BERLIN GEOGRAPHICAL SOCIETY'S GREENLAND-EXPEDITION.[1]

In 1891 Dr. Drygalski and Herr Baschin visited Greenland under the auspices of the Geographical Society of Berlin, and the results they obtained were so interesting and suggestive that the Society was encouraged to despatch another expedition in the following year. On this second and longer visit Dr. Drygalski was accompanied by Dr. E. Vanhöffen as zoologist, and Dr. Hermann Stade as meteorologist. They left Copenhagen on May 1, 1892, and returned on October 14, 1893. The principal object of the expedition being the study of the ice of Greenland, it was desirable that selection should be made of some region in which both the "inland ice" and the independent glaciers of the west coast mountain-tracts could be conveniently examined. On the advice of those experts, Dr. K. J. V. Steenstrup and the late Dr. Rink, Dr. Drygalski proceeded to the region of the Umanak Fiord, which he found admirably suited for his purpose. There the land lying between the margin of the "inland ice" and the coast attains its greatest width, and the mountains nourish a number of independent glaciers. Broad areas over which the "inland ice" had formerly passed could be traversed with ease, and the terminal edge of the ice was readily examined. Again the numerous branches of the fiord, penetrating the territory occupied by the ice-sheet, are invaded by great tongues protruded from the latter, so that the calving of icebergs and other phenomena could be closely studied. That Dr. Drygalski would make good use of his opportunities was only to be expected, and the elaborate monograph he has produced is unquestionably a most important contribution to our knowledge of the physics of ice and glacial action.

The author, we need hardly say, finds himself unable to agree with Dr. Rink, who believed that the "inland ice" is essentially a product of the low grounds—that it originated in the valleys by the freezing of the streams and rivers, and thus gradually increased from below upwards, until eventually it overtopped the water-sheds and covered the whole land. Dr. Drygalski takes the generally accepted view that the "inland ice" had its origin in the mountains, descending from these at first in the form of separate glaciers which gradually coalesced, and so filled up the valleys and smothered height after height until the whole land disappeared. Rink's notion appears to have been suggested to him by the structure of the ice, which he thought was rather like that of lake- or river-ice than snow-ice. But Dr. Drygalski shows that this is not the case. According to his observations river-ice and snow-ice have the same structure. He is inclined also to dissent from Dr. Nansen who, as is well known, holds that the general form of the great ice-sheet is independent of that of the underlying land-surface—and that the ice-shed need not coincide at all with the buried water-shed. Dr. Drygalski, on the contrary, is of opinion that the ice-shed is determined by the presence of a mountain-range, supposed by him to be connected with the mountains of the east coast, and to extend in a parallel direction between them and the centre of the

[1] "Grönland-Expedition der Gesellschaft für Erdkunde zu Berlin, 1891-93," unter Leitung von Erich von Drygalski. 2 vols. royal 8vo; with 53 plates, 10 maps, and 85 illustrations in the text. Pp. 556 and 571. (Berlin: W. H. Kühl, 1897.)

country. Dr. Nansen, however, might reply that, after all, the existence of this mountain-range is problematical, and that neither in Scandinavia nor the British Islands did the ice-shed and the height of land coincide. Thus, in the north of Ireland the ice-shed of Pleistocene times lay over the central low grounds, while in the north-west of Scotland it occurred east of the water-shed, and the same in a more marked degree was the case in Scandinavia.

Turning to the much-discussed subject of glacier motion, we find that Dr. Drygalski comes to the conclusion that movement is the result of variations in the mass of the ice. Numerous observations and measurements demonstrated that there is both a vertical and a horizontal movement in the "inland ice," the former being the primary movement of the two. Over the marginal zone he observed a well-marked bulging of the surface, while further inland, where the ice is thicker, the surface appears relatively depressed—a condition sometimes obscured, however, by the heaping-up of snow. These differences in the configuration of the ice-sheet are due to variations of mass within the ice, the sinking or depression being the result of internal shrinkage, which is always greatest at the bottom, and progressively diminishes upwards. Had the whole mass shrunk in the same proportion as the ice at the bottom, the sinking at the surface would have been more pronounced.

The stratified or bedded structure of the ice has the same tale to tell. That structure is the result of the freezing of water under pressure, and since the individual layers diminish in thickness from below upwards, while the cold at the same time increases, it is clear that the internal shrinkage under which refreezing takes place must likewise lessen towards the surface. It is evident, indeed, that the layers must become thinner upwards, seeing that the pressure necessary for their formation diminishes in that direction. Melting, no doubt, does take place at the surface, and the released water trickling downwards is again frozen, but stratification does not result from this process. It is at lower levels in the ice that the structure is developed. And as water cannot possibly filter down from the surface through a compact ice-mass, the obvious conclusion is that the water necessary for the production of the structure in question originates within the "inland ice" as the result of pressure. The presence of stratification, then, shows that liquefaction and re-solidification take place in the "inland ice." But the water set free under pressure cannot, as a rule, refreeze in exactly the same place, otherwise it would be difficult to account for vertical movement in the ice.

Depression of the surface indicates a diminution, and bulging of the surface an increase in the volume of the ice. Under the weight of the overlying mass material is squeezed out from the thicker into the adjacent thinner portion of the ice. In short, an outflow takes place, and will continue as long as a sufficient degree of melting is kept up in the former, and the same degree of mobility is not attained in the latter. The ice-sheet, therefore, moves from the interior, where it is thickest, to the marginal area, where it is thinnest. And observation showed that under these conditions it could move up slopes.

Dr. Drygalski points out that many complications arise from the varying distribution of heat in the ice-masses, and from other causes which need not be referred to here. He found that the temperature of the thinner ice of the marginal area was generally lower than that of the thicker ice stretching inland. In the latter the ice is at, or nearly at, the melting-point. There is thus again a tendency to movement from the interior outwards. Water is forced from the thicker into the thinner masses, but, because of the low temperature of the latter, it quickly freezes, and thus gives rise to the formation of new ice-layers. The abundant presence of stratification in the thinner ice of the marginal area shows that this process is very active there, while the bulging of the surface proves that the bedded structure is intimately connected with increase of volume.

Sometimes the horizontal movement is so pronounced as to obscure the vertical movement more or less completely. In other places only the latter may be noticeable. The rate of the former depends on the thickness of the ice and the intensity of the vertical movement. The greater these are the more rapid it becomes. In the independent glaciers of the coastal tracts it was found that the rate of motion diminished as the rock débris included in the ice increased in quantity. This was to have been expected, since the mass of the ice, and therefore the whole thickness of the glacier, diminished at the same time. In the longitudinal section of such a glacier the rate of motion lessens towards the end, but with the "inland ice" the reverse is the case—it increases. In the former the ice loses bulk absolutely owing to ablation at the surface, and relatively because of the inclusion of rock-rubbish. But the great ice-streams that flow from the interior into the deep fiords increase in thickness towards the end. In glaciers and "inland ice" alike the horizontal movement of the surface depends upon that of the lowest layers. At Asakak, for example, the horizontal movement at the bottom was measured and compared with that of the surface, and this proved to be less than it ought to have been if all the layers of like thickness between the bottom and the surface had been moving at the same rate. The differential movement of the individual layers, therefore, decreases from below upwards.

The movement at the surface of a great ice-stream coming from the "inland ice" increases towards the end. Were it not for the rapid movement of its lower layers, therefore, the ice-flow would lose its continuity. When the ice enters the sea, it eventually reaches a point where the pressure of the mass itself no longer affects the lower layers—the primary vertical and secondary movements cease, the squeezing-out process comes to an end, and true glacier motion is succeeded by the purely passive movement of the iceberg.

In his discussion of the mechanics of glacier motion, Dr. Drygalski, as will be seen, upholds the well-known theory of Prof. James Thomson. He points out how the water set free under pressure is transfused into air vesicles, cracks, &c., in the ice, where it freezes again, so that the ice eventually becomes clearer. As this process goes on most rapidly at the greatest depths, the ice at the bottom is necessarily the clearest—clearness, in short, increases from the surface downwards. Further, since refreezing takes place under pressure, the ice crystals arrange themselves with their chief optic axes perpendicular to the lamination or bedding of the ice. As a result of these changes, the volume of the ice is diminished—the shrinkage being greater in the thick than the thin layers, and more marked in the inland tracts than in the marginal area of the ice-sheet. But we need not follow the author further into this part of his discussion. When he states that the horizontal motion depends upon the movement of water within the ice, he will not be misunderstood. He does not mean free flowing streams of water, but mechanical changes in the mass and transference of conditions. Perhaps also it may be as well to add that, although measurements prove that differential movement of the ice-layers increases from the surface to the bottom, it is not to be supposed that one layer flows out from under the layer above it. There is a certain loosening of the connection between them, the author remarks, but not an actual separation. In consequence of this some of the motion of the lowest layer is added to that of the next above, the rate of which is thereby increased. And so the process continues from layer to layer up to the surface, the motion of which is not the sum of the differential movements of all the underlying layers, but of part of the same. The surface as a whole, therefore, has the greatest motion, although the proper motion of the superficial stratum itself is the least of all.

Helmholtz would appear to have been the first physicist abroad to recognise the significance of Thomson's theory, and he set forth its application in such a form as could not fail to attract attention. Since the publication of his "Populäre Wissenschaftliche Vorträge," however, so much has been written on the subject of glacier motion—so many conflicting explanations and criticisms have appeared—that laymen may be excused if they confess to a feeling of confusion in regard to the whole question. We feel sure, therefore, that Dr. Drygalski's work will be welcomed not by physicists only, but by all who desire to have clear views on the subject with which it deals. They will find in its pages excellent descriptions and illustrations of the varied glacial phenomena, so that even those who may not quite agree with some of his conclusions will yet thank the author for the abundant data he has supplied.

To geologists, not the least interesting portions of Dr. Drygalski's work are those that deal with glacial action. He shows that the conclusion reached by them as to the former existence of a great ice-sheet in Northern Europe is justified, and that the conditions under which they believe the "diluvium" was accumulated are reproduced in Greenland at the present time. In Europe the ice-sheet occupied the basin of the Baltic, its source being in the lofty heights of Scandinavia to the north-west, and its termination in the regions lying south and east—regions that slope up to heights of several hundred metres and more above the bottom of the Baltic basin. In Greenland the "inland ice" fills the depression between the mountains of the east and west coasts, the former of which constitute a broad belt of high ground that possibly extends into the very heart of the country. This mountain-tract is the source of the "inland ice," the terminal front of the latter thinning off upon the slopes of the less elevated mountains of the west coast. The numerous deep fiords by which that coast is indented, penetrate to the inland depression, and into these, therefore, enormous ice-streams make their way. To the great fiord-glaciers of Greenland there was nothing analogous along the southern and eastern margins of the old "inland ice" of Northern Europe. Between the fiords of Greenland, however, the ice-sheet thins out upon the mountain slopes in the same way as the European *mer de glace* must have done upon the flanks of the Riesengebirge and other ranges of Middle Germany.

The smoothed and striated surfaces observed underneath the edge of the "inland ice," and in the areas from which it has retired, exactly recall those of Europe. Their origin, Dr. Drygalski remarks, is not hard to understand when we remember that the chief work of ice-movement is carried on at the bottom, where the relative motion is greatest. The bottom-layers of the ice are crowded with rock-débris, which under glaciostatic pressure is carried from areas where the ice is thickest to regions where it is thinnest, and in this way it often travels from lower to higher levels. Armed with this material, the "inland ice" is a most effective agent of erosion. As the included material increases in quantity, the relative thickness of the ice is correspondingly diminished, and thus changes in the direction of ice-movement must take place. Hence erratics, after travelling for some distance in some particular direction, may change their course again and again. And so in like manner divergent striæ may be engraved upon the rock-head over which the ice is moving. The varying configuration of the land-surface is thus not the only cause of changes in the direction of ice-flow.

The author is convinced that "inland ice" is quite capable of producing the contortion and disturbance which so frequently characterise the diluvial deposits of North Germany. Powerful pushing and shoving are effected by the horizontal movement of the lowest layers of an ice-sheet. Any water-saturated deposits underlying such a mass would be influenced in the same way and subjected to the same disturbance as the débris-laden portions of the ice itself. Where the ice is free from inclusions the internal changes which result in horizontal movement are not interfered with—the ice-layers remain undisturbed. But when débris is present the movements due to pressure are hindered and impeded, and the ice-layers amongst which it lies become bent and folded. In alluvial or similar deposits underlying the ice folding would be still more readily produced, since in their case pressure is no longer relieved, as in the ice, by transference of conditions, but is entirely converted into mechanical deformation.

The "inland ice" where it thins off upon the flanks of the west coast mountains is bordered by moraines. These are composed of materials derived from the bottom of the ice-sheet, and are continually being added to; the moraines, in short, are gradually heaped up at and underneath the thin edge of the ice-sheet. In other places where the ice is bordered by precipitous land no moraines are extruded, the steep rock-declivities causing a deflection of the ice-flow. The moraines, according to Drygalski, present the same appearances as the "end-moraines" of North Germany. Although for the most part unstratified, they yet now and again consist in part of water-arranged materials. Scratched and polished stones were common. It is clear, indeed, from the author's descriptions that the morainic matter extruded from the "inland ice" of Greenland has essentially the same character as our boulder-clays.

Dr. Drygalski draws attention to the interesting fact that not only in the marginal tracts of the "inland ice," but in certain independent glaciers the "blue bands," which are the result of pressure, trend in the general direction of ice-movement. This shows that there must be pressure in the direction of the high grounds overlooking the ice, and perpendicular to the trend of ice-flow. The author thinks it probable, therefore, that under these conditions subglacial morainic materials might well be heaped up in banks and ridges having a direction parallel to that of glacial movement.

With regard to the ground-moraine itself, there can be no question that this is partly carried in the lower portions of the ice, and partly pushed forward underneath, and, further, that the forward movement must result in the deformation of underlying unconsolidated formations. The moving force is, of course, in the ice itself. With the augmentation of included débris the mobility of the mass is impaired, internal friction increasing the more closely the materials are crowded together. It is only when débris is well-saturated that under pressure movements like those of the ice itself can take place. In a compact subglacial mass of débris the movement communicated by the flowing ice above must, owing to friction, quickly die out downwards. Only a relatively thin layer of ground-moraine, therefore, can travel onwards underneath the ice. Immense quantities of material, however, are interstratified with the lower layers of the "inland ice," and these are eventually added to the ground-moraine. The amount of this included or intraglacial débris depends upon the thickness of the ice, and must thus vary from place to place As the ice diminishes in thickness, its ability to transport rock-materials declines, and the rubbish begins to be deposited below. Dr. Drygalski thinks that the boulder-clays of North Germany were in all probability deposited in this way. Thus wide sheets of boulder-clay and the "end-moraines" of a great ice-sheet have had the same origin—they consist of ground-moraine accumulated under the thinner peripheral portions of the ice.

According to the author there is no doubt that the action of the ice favours the formation of rock-basins. Should a depression or hollow occur underneath an ice-sheet, and the ice be thicker in the hollow than over the adjacent tracts, the hollow will tend to be progressively excavated. He thinks, however, that the erosive work of the ice will tend rather to the lengthening of the hollow in the direction of glacial movement than to its deepening. Wherever the ice is thickest there erosion will be most pronounced, no matter what the form of the land-surface may be. Thus rock-basins may be hollowed out even in relatively flat land, as, for example, by a glacier upon the low ground opposite the mouth of a mountain valley.

Such are a few of the many interesting points connected with glacial action which are discussed by Dr. Drygalski. He concludes his work by some very suggestive remarks on the wonderful resemblances that obtain between the old gneiss-formation and the "inland ice"—the oldest and the youngest *Erstarrungsprodukte* of the earth's crust. When he had surveyed the steep gneiss-walls of the fiords, with their folded, contorted and confused bedding, their bands of crystalline schist, their veins and dykes, their fissures and fractures, he was astonished to encounter the same appearances in the "inland ice," and he follows the analogy into minute details of structure. But enough has been said to show that Dr. Drygalski's monograph is of no ordinary interest to geologists.

The chief object of the expedition being the study of ice in general and of the movement of the "inland ice" in particular, the opportunities for biological investigation did not at first appear to be very promising to Dr. Vanhöffen. But in this he was happily disappointed, for he succeeded in bringing home much material for study. His contribution to the work before us occupies the greater portion of the second volume. In this he does not confine himself to a mere description of his own investigations and their results, but gives us an exhaustive account of the fauna and flora of Greenland, including of course the life of the adjacent seas. For the benefit of those who are not specialists he illustrates his work with a number of beautiful coloured plates of some of the crustaceans, pteropods and jelly-fish which swarm in the waters of the far north. A copious bibliography is appended—great pains, indeed, have been taken to give a complete survey of the natural history of Greenland. A more special and detailed account of his own investigations is to appear in the *Bibliotheca Zoologica* and *Bibliotheca Botanica* (Stuttgart).

The concluding part of the second volume is devoted to the discussion of the magnetic, meteorological, astronomical and geodetic work of the expedition by Drs. Stade, Drygalski, and Schumann. Dr. Stade devotes a chapter to the föhn winds of West Greenland, which have long puzzled navigators and excited the superstitious fears of the Eskimo. Coming as these warm winds generally do from the ice-covered land, especially in the coldest time of the year, they seem hard to account for. According to Dr. Stade they owe their origin to depressions passing through Davis Strait from south to north. The approach of a depression is marked by strong to stormy winds from the south-east or east, the temperature of the atmosphere suddenly rising, while at the same time its relative humidity is reduced.

Altogether this most recent of Arctic expeditions has been fruitful in results, and the Geographical Society of Berlin must be congratulated on the great success which has attended the enterprise. JAMES GEIKIE.

THE PRODUCTION AND USES OF OZONE.

THOUGH it has been known for more than a century that air and oxygen acquire a peculiar odour when exposed to the action of electric sparks, and though Schönbein ascertained nearly half a century ago that this odour is due to a distinct form of matter, now called ozone, which is produced by the electrolysis of dilute sulphuric acid, by the action of electric discharge in air, and as a product of the slow oxidation of phosphorus, chemists are still trying to learn the exact conditions of the formation of this substance, and still investigating some of its simplest reactions; whilst inventors are but beginning the work of making it useful to man.

But if the wheels of science grind slowly, in the end they grind true, and various facts now distinctly suggest that ere long ozone will play a useful part in the service of medicine, of surgery, and in the arts.

Ozone has never yet been obtained as a gas in the pure state, but from the properties of mixtures containing it we cannot doubt that gaseous ozone would be blue in colour, and condense at low temperatures to an indigo-blue liquid, which explodes violently on contact with olefiant gas. The ozone in mixtures, such as are produced by the electrification of air or oxygen, is very instable, being resolved into common oxygen with explosive violence if suddenly compressed without previous cooling; and even under atmospheric pressure it cannot long be preserved except at rather low temperatures. This characteristic instability of ozone is at once the cause of its most interesting properties and of its possible usefulness. Molecules of common oxygen contain but two atoms of the element, whilst the molecules of ozone contain three such atoms, and it would seem that the atoms hold together much less firmly in the larger molecules than when they are united in pairs; consequently ozone acts as a powerful oxidiser, readily giving up part of its oxygen to oxidisable substances, whilst the rest returns to the ordinary form of the element, except in certain cases when it is completely absorbed.

Now chemists have, it is true, plenty of powerful oxidisers at their command, and many of them are inexpensive; but not even hydrogen peroxide, which can now be obtained comparatively cheaply, is quite so simple in its action as ozone, for this substance, which consists, as we have seen, of oxygen and of oxygen alone, when used as an oxidiser does not leave any inconvenient residue, such as accompany the action of many other oxidising agents. Hence a field for the employment of ozone may be found whenever a simple oxidising agent is required. Thus, for example, it has been suggested that it might conveniently be used for bleaching beeswax, starch or bones, in the manufacture of *dégras* for leather makers, in preparing drying oils for the manufacturers of varnishes, or again, according to Wiedermann, to hasten the ageing of whiskey.

There are, however, as might be expected, difficulties to be surmounted. Sometimes, as in its action as a bleaching agent, ozone is apt to act too slowly; whilst at others it is difficult to adjust the proper dose of the oxidiser. Thus we are told that port wine treated with ozone forms a deposit which quickly increases, so that the wine soon puts on an appearance which, under ordinary circumstances, it would only acquire in the course of years. But, alas! wine thus rapidly ripened is apt to fade with corresponding rapidity, owing, it is presumed, to the use of too much ozone, and hence, in the absence of any obvious method of estimating the proper dose, ozone does not yet recommend itself to wine makers or wine merchants. It has occurred to the writer, however, that it might possibly be made useful, even at the present stage, in judging unripened wine, since its use might enable the vintner to ascertain without delay how the wine of a given vintage will ultimately turn out. Unfortunately the experiment has not yet been tried, owing to the difficulty of finding a suitable colleague.

At a recent discussion on ozone at a meeting of the Society of Chemical Industry, the general opinion seemed to be that whilst there are, doubtless, possibilities of usefulness for ozone, nothing has yet been done which is likely to induce manufacturers to invest much capital in plant for its production; it is therefore interesting to learn that successful attempts have already been made to employ this interesting substance in medicine. It has long been known that ozonised air acts as a preservative of flesh, preventing and arresting putrefaction; and the simplicity of its mode of action, already alluded to, has naturally suggested its great suitability for use as an oxidiser and antiseptic in medical practice. Therefore one hears, without surprise, from those who have tried it, that in ozone we have an agent which is likely to be of real value in the treatment of diseases which are associated with the existence of organisms, or where the use of an oxidiser is indicated; for example, in the treatment of phthisis, of unhealthy wounds, and of some cases of anæmia, and for purifying the air of dwelling rooms, hospitals and public buildings.

But before ozone can play a really important part in the above or other directions, the earlier modes of making it must be improved upon, and its production cheapened.

Ozone, as has already been said, was first noticed in air which had been exposed to the sparks of electrical machines; but only very small quantities can be obtained in this way, and it is better to expose the air to a sort of electric rain composed of showers of very fine sparks, such as were employed by Andrews, or to the so-called silent discharge in one of the various forms of the "Siemens' induction tube." This in its simplest form consists of a long thin test-tube sealed at its open end into a slightly larger tube, the latter being provided with a narrow tube at each end, so that a current of gas may be passed between the two test-tubes. If the inner tube of such an apparatus be filled with dilute sulphuric acid and connected with one of the electrodes of an electrical machine, and if the outer tube be plunged in a bath of dilute acid which is connected with the other electrode of the machine, whilst air or oxygen is passed through the apparatus, a glow or a shower of fine sparks will act on the gas, and charge it more or less strongly with ozone ere it escapes.

Ozonisers such as the above have been employed in many of the chief researches on ozone, and probably give the best results when small or moderate volumes of oxygen are to be dealt with, but for work on the large scale this form of ozoniser does not give equal satisfaction. For such work it has been proposed to replace the glass tubes by sheets of glass coated with tinfoil or silvered; whilst recently a new departure has been made by Mr. Andreoli, who replaces one of the plane or curved electrodes by a conductor carrying numerous points. For manufacturing purposes Mr. Andreoli recommends the use of serrated grids made of aluminium, and carrying as many as 17,760 points on every grid. Each grid is placed opposite a sheet of aluminium with a sheet of glass interposed, the whole being bound together by wooden clamps (see Fig. 1). It is claimed that with such an arrangement of suitable dimensions, 10 kilos. of ozone can be produced at the small cost of thirteen shillings and fourpence. As the air and apparatus employed are not cooled, the charges of ozone are probably not very strong, but for many purposes this does not seem to be a matter of great importance. A more serious objection to the system lies in the fact that the employment of metallic point bearing grids seems not unlikely to favour the production of comparatively large sparks which, if they should occur, would undoubtedly cause the formation of

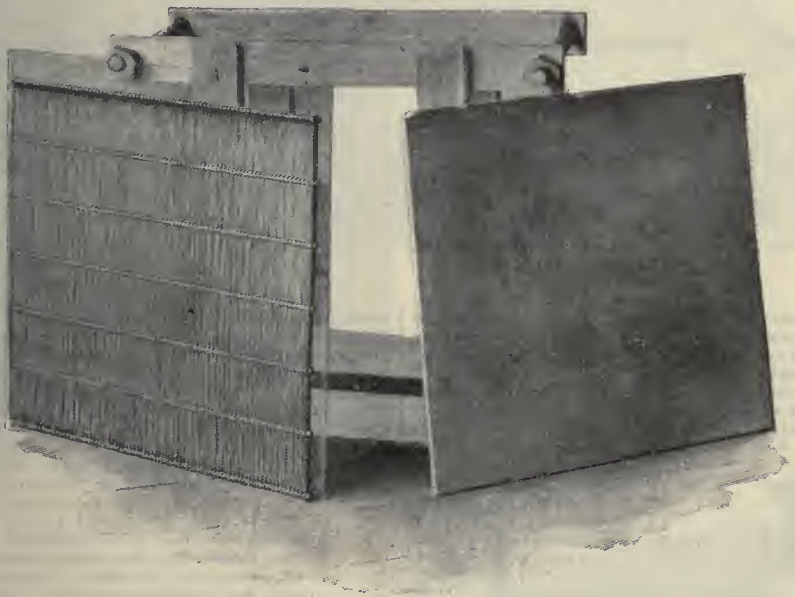

FIG. 1.

nitric peroxide. Now this gas, besides often being objectionable on its own account, would undoubtedly tend to reduce the yield of ozone. Mr. Andreoli does not, however, admit that nitric peroxide is formed in his apparatus, and if further experience should support his contention it would seem that he has really effected a substantial improvement.

this part of the apparatus, as india-rubber perishes with astonishing rapidity when exposed to the action of ozone.

It seems often to be supposed by inventors and others, that air and oxygen may be employed indifferently as sources of ozone. This, however, is not really the case. If moderately pure oxygen be used, nitrous fumes are far less likely to be formed than when air is employed; and this is so not only in the event of large sparks passing in the ozoniser, but also when the gas is subjected to the influence of the silent discharge. Unfortunately we do not yet know the exact conditions under which the silent discharge induces the formation of nitric peroxide, though the subject is being investigated; and therefore for the present, unless it can be shown that nitric peroxide is itself beneficial, or, at least, quite unobjectionable, ozone for medical use should certainly be prepared from oxygen whenever it is possible to do so.

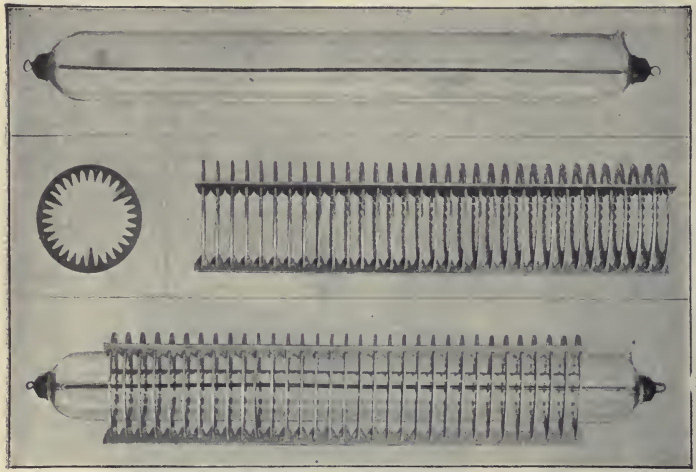

FIG. 2.

For medical purposes the new apparatus takes the form of a vacuum tube (I, Fig. 2), containing a metallic rod. This is surrounded by an armature (II and III, Fig. 2), made of aluminium and armed with points. When the latter and the metallic rod are joined up to a coil or to a step-up transformer a glow makes its appearance, and the air between the two electrodes is rapidly ozonised. If a stream of ozonised air is required for inhalation, or must be conveyed to any particular locality, the above little apparatus is surrounded by a glass jacket, as shown in Fig. 3.

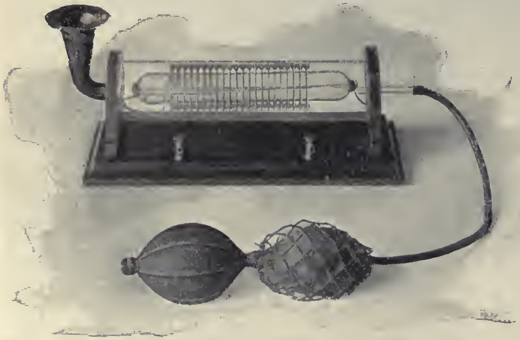

FIG. 3.

Air or oxygen can then be pumped through the apparatus, and thence delivered from a celluloid trumpet for inhalation, or conveyed by a tube to the required locality. The use of india-rubber should be avoided in

A DRAGON OF THE PRIME.

THE little Warwickshire village of Stockton, ploughed and excavated by three manufacturing cement firms, has long yielded to collectors choice specimens of Lower Middle Lias fossils. Its late rector educated the quarrymen by lectures and in conversation to understand and value the vertebræ and belemnites and limas and encrinites which they continually disinterred, forming with their help a collection which on his departure went to form the nucleus of a County Council museum. The Saurian remains have hitherto been always fragmentary, a fact due, perhaps, to the men's careless digging; but the rector left them with a prediction that a perfect monster would some day be unearthed, an entreaty that should they ever come across a head or a continuous backbone, they would drop pick and crowbar, and call in experts to direct and continue the search. A week or two ago the prediction was fulfilled, and the advice remembered. The wielder of a pickaxe suddenly announced that he was "grapplin' along a lot of backbones"; the work was stopped, the foreman summoned, and slowly with due precaution a noble Icthyosaurus was uncovered. He lies 45 feet below the surface; 20 feet in length, the head 2 feet across, and 3 feet 10 inches long. The paddles are unusually distinct, the front pair 2 feet 6 inches, the hind pair 1 foot 8 inches in length. The tail is abruptly curved, and some of the lumbar vertebræ are slightly displaced. The pelvic ring is missing, removed, perhaps, before the nature of the find was guessed, and still to be recovered. The quarry belongs to Mr. M. Lakin, of Leamington, who intends, I understand, to present the specimen to the Natural History Museum at South Kensington. Crowds from all parts of the county throng to see it;

and not a little vigilance is necessary to protect it from dishonest visitors, attempting to purloin teeth or fragments. It has been beautifully photographed by Mr. H. Elkington, of Broadwell, Rugby (a reproduction of the

photograph accompanies this notice), who will, on application, furnish copies to geologists and others desiring them.

W. T.

DR. JOHN HOPKINSON, F.R.S.

THE news that Dr. John Hopkinson, F.R.S., met his death in a terrible mountain accident on Saturday last, has been received with deep regret in the scientific world. His name is familiar to every student of electricity and its applications, and by his death electrical science has lost one of its most active and brilliant workers. It appears from the telegraphic reports that Dr. Hopkinson, who was a practised mountaineer, started from Arolla on Saturday morning, with his son John and two daughters, to ascend the Petite Dent de Veisivi, one of the striking points dominating Evolena, in the Val d'Hérens, running south from the Rhône Valley at Sion. The ascent is not considered a very dangerous one, and the party went without guides. Nothing having been seen of them on Saturday night, search parties were organised, and the melancholy discovery was made that a catastrophe had occurred, the dead bodies of Dr. Hopkinson and his three children being found roped together, but terribly mutilated, at the foot of the highest cliffs. How the accident happened is not known, but probably one of the party slipped whilst climbing a cliff, and all four then fell from rock to rock several hundred feet to the moraine below. Like Francis Balfour and Milnes Marshall, Dr. Hopkinson has lost his life while mountain climbing, and like them also he leaves behind a rich record of work done for the advancement of science.

Dr. Hopkinson was born at Manchester in 1849, and was the eldest son of Alderman Hopkinson, an ex-Mayor of that city. In his sixteenth year he went to Owens College, where he remained for two years and a half, and then went to Trinity College, Cambridge. In 1871 he was Senior Wrangler and First Smith's Prizeman, and was appointed fellow and tutor of his college. While at Cambridge he obtained the D.Sc. degree at London University. Referring some years later to the influences which helped to mould his career, he said:—

"My father cultivated in me a taste for science from a time before I can remember; my mother gave me the first systematic instruction of which I have any recollections. If my father gave me my first taste for science, you may be sure that taste was encouraged at Owens College. Mathematics is the most essential weapon of the physicist, and nowhere can mathematics be learned as at Cambridge. I owe to Sir William Thompson the first impulse to experimental work in electricity and magnetism. He has been to me for many years the kindest of friends, always ready to encourage and to help."

After leaving Cambridge Dr. Hopkinson was for six years with Messrs. Chance and Co., near Birmingham, as their engineer. He removed to London in 1878, and, after commencing practice as a general engineer, took up electrical engineering, in which branch of applied science his most valuable investigations have been accomplished. He was elected a Fellow of the Royal Society in 1878, and received one of the Royal Medals of the Society in 1890, for his researches in magnetism and electricity. In presenting the medal, the President pointed out that Dr. Hopkinson's researches comprised investigations of the effect of temperature upon the magnetic properties of iron, nickel, and various alloys of these metals. Before these investigations were published it was thought that increased temperature tended to diminish the magnetic susceptibility of iron. Dr. Hopkinson's experiments showed, however, that, on the contrary, the magnetic susceptibility increases enormously as the temperature increases, until the temperature reaches about 660° C.; beyond this temperature iron entirely ceases to be magnetic. He also made a series of determinations of the specific inductive capacities and refractive indices of a large number of transparent dielectrics, the results of which are of great importance in the theories of electricity and light. In addition to these researches, he introduced many improvements into lighthouse equipment, notably the "group flashing apparatus."

Dr. Hopkinson's contributions to the theory of dynamo-electric machinery are most important; and to him electricians owe the method, now so extensively used, of solving problems relating to dynamos by the use of the "characteristic curve." On the subject of dynamo-electric machinery Dr. Hopkinson was, indeed, a leading authority. A volume containing a number of his papers on this and allied subjects was published in 1892, and it constitutes a valuable testimony to the scientific and practical importance of his researches. The work contains an account of a very complete and exhaustive set of experiments on dynamo machines under working conditions, and graphical representations of the results. In referring to Dr. Hopkinson's work in these columns, the reviewer remarked: "No device in the whole history of the evolution of the dynamo has been of more general service than his plan of exhibiting the results of experiments in the well named characteristic curve of the machine. This did for the dynamo what the indicator diagram had long been doing for the steam engine, though not, of course, in the same way. With the most admirable simplicity this curve of electromotive forces as ordinates, and currents as abscissæ, gave just the information required regarding the action of the machine." Dr. Hopkinson also showed how the characteristic curve of the dynamo could be used to give the conditions under which an arc lamp could be made to work. He was, in fact, a pioneer in the scientific study of dynamo-electric machinery and its uses. In conjunction with his brother, Mr. E. Hopkinson, he was the first to apply the idea of the magnetic circuit, in a consistent manner, to the discussion of the results of experiments on different types of dynamo, and his contributions to this subject have been most valuable in suggesting new methods and machines. His papers on the behaviour and capabilities of direct current machines, and of alternators, have proved of the greatest service to practical electricians, and are counted among the classics of the subject

Dr. Hopkinson was professor of electrical engineering in King's College, London, and a member of the Councils of the Institutions of Civil and Mechanical Engineers. He was the "James Forrest" lecturer of the former Institution in 1894, and his discourse on the service mathematics has rendered and can render to engineers and engineering was printed at the time in these columns. In himself he represented the rare combination of mathematical and mechanical knowledge, and the results of his life's work stand out as the clearest evidence of the close relationships between pure and applied science. It is a mournful task to have to chronicle the death, in such tragic circumstances, of an investigator who has worked so well for the increase of knowledge and the advancement of electrical engineering.

NOTES.

THE Fourth International Congress of Physiologists held its meetings with great success at Cambridge last week from Tuesday, August 23, to Friday, August 27, inclusive. It was probably the largest assembly of the kind that has yet met. Prof. Michael Foster was President. The following nationalities were represented: Austria, Belgium, Canada, Denmark, Egypt, France, Germany, Great Britain and Ireland, Holland, Hungary, India, Italy, Japan, Roumania, Russia, Sweden, Switzerland, and the United States. The offer of Profs. Mosso (of Turin), and Golgi (of Pavia), for the reception of the Fifth Congress in Italy in 1901 was cordially accepted. The Organising Committee for the Fifth Congress was elected, to consist of the following names: Angelo Mosso (Turin), President. Chr. Bohr (Copenhagen), H. P. Bowditch (Harvard), A. Dastre (Paris), M. Foster (Cambridge), L. Fredericq (Liège), P. Grützner (Tübingen), P. Heger (Brussels), H. Kronecker (Bern), W. Kuhne (Heidelberg), C. S. Sherrington (Liverpool), and W. Wedenskij (St. Petersburg). The place of meeting that has been chosen for 1901 is the Physiological Institute of the University, Turin, and the time the latter half of September. The local arrangements for the present Congress proved very satisfactory. The opinion was generally expressed that the simultaneous session of the sister Congress of Zoologists at Cambridge, far from proving inconvenient, considerably enhanced the pleasure of the meeting.

THE Reale Accademia dei Lincei has recently elected the following men of science as associates and foreign members of the Academy:—National Associates: in physics, Profs. A. Righi, A. Roiti, and A. Pacinotti; in geology and palæontology, Signore G. Scarabelli; in zoology, Prof. C. Emery. Correspondent in mechanics, Prof. C. Somigliana. Foreign Members: in mechanics, Prof. A. G. Greenhill and V. Voigt; in physics, Prof. W. C. Röntgen; in geology and palæontology, Prof. A. Karpinsky and Sir Archibald Geikie; in zoology, Prof. E. Ray Lankester.

IN a special number of their *Atti*, the Reale Accademia dei Lincei, of Rome, announces the recent awards of prizes given by the King of Italy for the period ending in 1895. For the Royal prize for mathematics, eight competitors sent in no less than about ninety written and printed memoirs; and after a critical examination of these, the judges have now divided the prize equally between Prof. Corrade Segre and Prof. Vito Volterra. The papers submitted appear to have been of a very high standard of excellence, and are stated to form a worthy sequel to the works of Betti, Brioschi, and other illustrious Italian mathematicians. The award of the Royal prize for social and economic science has been deferred for a period of two years. A similar decision has been arrived at in the case of the prize for astronomy, but a sum of 3000 lire has been awarded to Prof. Filippo Angelitti in consideration of his valuable work in editing and discussing the unpublished writings of Prof. Carlo Brioschi. The prize for philology has been divided between Prof. Angelo Solerti and Prof. Remigio Sabbadini, and finally a Ministerial prize of 1500 lire for natural science has been awarded to Prof. L. Paolucci for his monograph on the fossil plants of the Ancona district.

PROF. BEHRING's action in applying for a patent in the United States as sole inventor of diphtheria antitoxin excited surprise, but the announcement that the authorities at Washington have recently decided to grant the patent has (says the *Lancet*) caused a feeling of something like consternation among the American manufacturers of antitoxin. It was in January 1895, that Prof. Behring—his assignees being the Höchst-Farbwerke, the manufacturers of the serum in Germany—first applied for a patent for his diphtheria antitoxin; the application was then refused, and has been refused four times since on the ground that Prof. Behring was not the sole inventor of diphtheria antitoxin, and had consequently no right to claim a monopoly of the manufacture and sale of the same. However, in June of this year the patent officials at Washington overlooked their objections and granted the patent. But although Prof. Behring has succeeded in gaining a patent for his diphtheria antitoxin, it is the intention of the American manufacturers of antitoxin and the several Boards of Health to contest at every step his right to create a monopoly.

PARTICULARS of the life and work of Dr. William Pepper, whose death at Pleasanton, in California, was recently announced, are given in the *Lancet*, and are here abridged. William Pepper was born in August 1843, so that at the time of his death he was not quite fifty-five years of age. His father, Dr. William Pepper, was a prominent physician and Professor of the Theory and Practice of Medicine in the University of Pennsylvania, and in 1881 the son was elected to the same chair. In the same year he was elected Provost of the University, a post which he held until 1894. On his retirement from office he gave practical and munificent effect to his views upon the extension of the medical curriculum by a donation of 50,000 dollars, with a promise of 1000 dollars as an annual subscription for five years, towards an endowment fund to pay for greater teaching facilities for science in the University. In the same year the course was extended to four years. Prof. Pepper is known to the medical profession chiefly by his contributions to, and able editing of, the "System of Practical Medicine by American Authors." This System, which was published in 1885, did for medical knowledge in America what Ziemssen's Cyclopædia had done ten years previously in Germany. It systematised and correlated the varying scientific opinions of persons all chosen to write because of their position and claims to know, and thus presented to the student a comprehensive account of disease in a series of authoritative monographs. As a benefactor to the city of Philadelphia Prof. Pepper's actions were almost innumerable. He gave to the University the William Pepper Laboratory of Clinical Medicine in memory of his father; he inaugurated a system of commercial museums, to be connected with other museums in different parts of the country, wherein people might see specimens of the produce of all parts of the world; he secured immense donations for the Philadelphia Public Art Gallery, and he founded the Free Library. This by no means exhausts the list of Prof. Pepper's public works, and in him Philadelphia is deploring one of the most generous as well as one of the most distinguished of her sons, while the medical world has to mourn the loss of an enlightened man of science, a wise teacher, and a liberal leader.

THE Indian Government has decided to send exhibits from the Forest and Geological departments to the Paris Exhibition, at a cost of about 3000*l*.

WE regret to see the announcement that Mr. E. E. Glanville, of Trinity College, an assistant to Mr. Marconi, has met with his death by falling over a cliff three hundred feet high, at Rathlin Island, off the Antrim coast where he was engaged in experiments in wireless telegraphy.

MUCH interest was excited among the zoologists of the International Congress at Cambridge last week by the announcement of the discovery of the "first known Hyracoid form of the Tertiary formation." The skull upon which this important addition to our knowledge of the Mammalia is based was obtained in Samos, and belongs to the Stuttgardt Museum. It will be described by Prof. Osborn, of New York.

A REUTER telegram from St. Johns states that the steamer *Hope* has arrived there from Greenland, having transferred Lieutenant Peary and party to the steamer *Windward* at Port Foulke. The latter vessel sailed on August 13 for Sherrard-Osborne Fiord, her destination, having taken on board sixty dogs, sixty walruses, and ten natives of North Greenland. It has taken enough provisions for three years.

THE ninth annual general meeting of the Institution of Mining Engineers will be held in Birmingham on September 13, 14 and 15, under the presidency of Mr. A. M. Chambers. Among the papers to be read at the meeting are:—"The Shelve and Minsterley Mining District of Shropshire," by Prof. Lapworth, F.R.S.; "The South Staffordshire Mines Drainage Scheme, with special regard to Electric Power Pumping," by Mr. E. B. Marten and Mr. Edmund Howl; "Treatment of Refractory Silver Ores by Chlorination and Lixiviation," by Mr. J. E. Breakell; "The Use of High-pressure Steam as a Possible Substitute for Gunpowder and other Explosives in Coal Mines," by Major-General H. Schaw.

THE Berlin correspondent of the *Times* states that Herr Theodor Lerner, commander of the German Polar expedition, on his return to Hammerfest, despatched the following telegram to the German Emperor:—"To your Majesty the most humble announcement that the German North Pole expedition, by means of topographical observations made during a circumnavigation of the Island of King Charles, was able to determine its exact position. The ship *Helgoland*, which carried the expedition, is the first ship which has ever yet succeeded in forcing a passage from the south round the eastern coast of the island, which was accomplished in spite of the great quantity of ice and in face of contrary conditions of weather—a feat hitherto considered impossible." The German Emperor, immediately on receipt of this telegram, caused the following reply to be sent to Herr Lerner:—"I send my congratulations to the German North Pole expedition for the splendid success which German determination and circumspection have just achieved under your command.—William, I.R."

A DECIDED change of weather has set in over our Islands during the past week, and the conditions now are quite normal to an ordinary summer. The excessive heat over the south-east of England lasted for about a fortnight, and hot as the days were in many cases they were, in comparison with average conditions, surpassed by the unusually warm nights. At the London reporting station of the Meteorological Office there were eleven nights in August during which the thermometer did not fall below 60°, and the Greenwich observations for the previous twenty years only show altogether eleven such warm nights. Fairly heavy rains have now fallen in all the northern and western districts, and rains of lesser intensity have gradually spread over the whole country. In the neighbourhood of London the rainfall has, as yet, been very small, and the total fall at present since the commencement of the month is only about one-third of the average. In many parts of England the rainfall has been very much below the average during the last eleven months, and there is at present no certainty that the lengthened period of dry weather is at an end. Cyclonic disturbances are just now arriving from the Atlantic with considerable frequency, and these are occasioning rains in many parts of our area. It is, however, not improbable that anti-cyclonic conditions with dry and warmer weather will again shortly set in.

DR. G. AGAMENNONE, in a recent paper in Gerland's *Beiträge zur Geophysik*, describes his attempt to calculate the velocity of the pulsations of the earthquake of Aïdin (Asia Minor), on August 19, 1895. They were registered by the Vicentini microseismograph at Padua, and the horizontal pendulum at Strassburg, the distances of these places from the epicentre being 1570 and 2010 km. respectively. Owing to the uncertainty of the best time-observations near the epicentral district, the estimates of the velocity are somewhat doubtful. The first recorded movements at the above places give velocities of 9·8 and 3·2 km. per sec. for the early vibrations, and 3·1 and 2·55 km. per sec. for those which gave rise to the maximum disturbance.

A FEW notes on the results of inquiries as to the effects and causes of the Indian earthquake of June 12, 1897, are given by Mr. R. D. Oldham in the general report just published on the work carried on by the Geological Survey of India during last year and the first quarter of this year, under the direction of Dr. C. L. Griesbach. An examination of available information leads Mr. Oldham to conclude that there is one, and apparently only one, supposition which will explain all the facts, and that is the existence, or the creation, of a nearly horizontal fracture or thrust plane along which the upper part of the earth's crust was pushed over the lower. This plane would nowhere come to the surface, and the movement of the upper layer against the undisturbed crust beyond the limits of the fracture would give rise to just that compression which would account for the conspicuous displacements of surface levels seen in the eastern part of the Garo Hills District, and less conspicuously to the east and the west. In this conclusion, Mr. Oldham thinks, an easy explanation of the area over which the shock had a maximum of destructive energy may be found without postulating an improbable depth for the focus. There is no necessity or reason to suppose that the thrust plane lies at any great depth from the surface, and it is possible that five miles may represent a maximum rather than a minimum value, but what the focus loses in depth it gains in area of action.

Machinery—the South African journal of engineering, mining, and science—announces that the State geologist, accompanied by Mr. David Draper, has gone to St. Lucia Bay to investigate the connection between the Karoo Beds of the Vryheid District with those of Natal and the High Veld. A geological section of the country will be made from Volkrust eastward, which should be of much value to geologists.

THE *Transactions* of the Edinburgh Geological Society (vol. vii. part 3) contains a large number of interesting papers and notes on geological subjects. Amongst the longer papers we notice two, by Mr. H. M. Cadell, on the geological features of the coast of Western Australia, and on the New Zealand volcanic zone, and one, by Mr. J. G. Goodchild, on desert conditions in Britain. In a footnote Mr. Goodchild states that during the past three years he has taught in his classes that the Torridonian rocks were formed under desert conditions, and that he is not aware that this idea has occurred to any other geologist. The point is important in view of Prof. Penck's recent discussion of the same subject.

IN the latest volumes of its *Memoirs* the Russian Geographical Society has published the diaries of three expeditions made in East Siberia many years ago, but the detailed accounts of which had hitherto remained unknown. Two volumes are given to two diaries of the mining engineer, I. A. Lopatin, who visited the northern parts of the Vitim plateau in the year 1865, and the next year travelled along the Lower Yenisei to Turukhansk. The former contains a wealth of minute descriptions of the granites, gneisses, and crystalline slates of the Vitim plateau, all described from Lopatin's samples by specialists, as well as of the mantles of basalt which cover large portions of the plateau along its north-western edge. The second volume is even more interesting, as on his journey down the Yenisei Lopatin met not only Laurentian and Huronian formations, but also widely-spread Silurian rocks, Quaternary deposits, and Post-Pliocene deposits of the Arctic Sea, very rich in sub-arctic shells (all fossils were described years ago by Fr. Schmidt in his "Mammuthexpedition"). The third volume of this series contains the diary of the remarkable explorer, A. L. Czekanowski, of whose expedition to the Lower Tunguska, the Olenek and the Lena, in 1873–75, Fr. Schmidt rightly says that it was richer in geological results than any of the expeditions that have explored Siberia. The results of this journey were well known through Czekanowski's preliminary reports, as well as through the descriptions of his palæontological and botanic collections by Oswald Heer, Lagusen, Moisisowicz, Fr. Schmidt, and Trautvetter. But a full description of the expedition was never published, and it is only now that Czekanowski's diary, which contains a mass of most valuable information, sees the light. Fr. Schmidt contributes to this volume a sketch of the tragic life of the author, who was exiled to Siberia after the Polish insurrection of 1863; then, after several years spent in hard labour, was allowed to make his memorable journeys, and was permitted to come to St. Petersburg in 1876. He was not allowed, however, to remain in the Russian capital, and being compelled to return to the land of exile, he poisoned himself at the age of forty-four. An excellent portrait of this remarkably energetic worker is given in the volume which contains his posthumous work.

A SUMMARY of recent advances in the photography of air waves, formed by flying projectiles, is given in *Engineering* for August 12, accompanied by a number of fine illustrations. Perhaps the most interesting recent development of the subject is to be found in the attempts of Mach to study the phenomena by means of interference bands. From these it is concluded that though the air is pushed forward and outward by the projectile, the compression does not, in the case of a steel shell, correspond to more than a pressure of a fifth of an atmosphere; further, there is, indeed, something like a vacuum immediately behind the projectile, but this vacuum only extends through a short distance.

A PRELIMINARY note on the influence of electricity on the sedimentation of turbulent liquids, is contributed to the *Bulletin de l'Académie royale de Belgique* by M. W. Spring. After observing that water will sometimes hold finely divided matter of greater density than itself in suspension for an indefinite time, but that the presence of small quantities of salts in solution, or heating the liquid, will suffice to bring about precipitation, M. Spring states that a medium formed of pure water containing finely divided silica, or other non-electrolytic matter, begins to clarify gradually as soon as two platinum electrodes are plunged into it and a current passed through them. From this experiment the author proposes to develop a theory according to which the turbulent state is caused by a modification of the electric state of the finely divided particles, caused by the change in the energy of attraction of the matter forming them, consequent on disintegration. The presence of a dissolved salt or acid renders the liquid a conductor, and the discharge of electricity causes the particles to collect in flocculent masses; an explanation in accordance with Bodländer's view, that only electrolytes are capable of producing clarification. Again, convection currents produced by warming the liquid give rise to electric currents which also have the same effect. M. Spring proposes to go further and explain the fall of rain accompanying thunderstorms on the same theory. We wonder if he has thought of trying the effect of Röntgen rays on turbulent liquids; if not, his present theory suggests that the results of doing so might be interesting.

IN Tasmania, writes Mr. Stuart Dove in *Nature Notes*, the "blue-tongued lizard," the *Tiliqua nigrolutea* of naturalists, takes the place of that noted cobra-destroyer, the Indian mongoose. The blue-tongued lizard is a stout formidable-looking animal much given to lying about the bush roads and tracks, asleep in the sun, which heaviness of disposition has earned for it the name of "sleeping lizard." But should a snake come in sight, the sleepiness disappears instantly and every nerve of the lizard seems on the alert, every sinew toughened to meet the enemy. The snake usually tries to get away, but the lizard prevents it, and a fight commences, the two reptiles darting and dodging and savagely snapping at one another. The snake soon shows signs of being exhausted, and the lizard then twists it over with a quick dexterous turn and gives it a *coup de grace*. The lizard afterwards takes the head of the snake between its strong jaws and slowly devours the dead reptile, after which he retires to the shelter of a hollow log to sleep off the repast.

A SHORT but interesting paper by Prof. W. C. McIntosh, on the memory of fishes, is referred to in the *Journal of the Royal Microscopical Society* (August). Prof. McIntosh refers to "the behaviour of a large grey skate in its endeavour to escape over a trawl-beam more than fifty feet long, which had been arrested in its rise—just above the surface of the sea—by a temporary block in the machinery. The dexterity with which it skimmed to and fro along the beam to find where it dipped sufficiently during the movements of the ship to enable it to glide over was a study. . . . If those who have given a green cod of six or eight inches a particular kind of 'scale-back' (a kind of worm), and noticed, firstly, how eagerly it seized it, then tested it in its pharyngeal region, and soon ejected it, never again taking that species into its mouth, they would be slow to deny that fishes, and even very young fishes, have a memory." A number of very suggestive cases are given, and the author concludes: "With regard to the absence of cortex of the brain in fishes, this is probably only a question of degree—easily understood by referring to the descriptions and figures of the brain in the salmon and the wolf-fish. Besides, who has proved that the function of memory depends on the brain-cortex of the human subject? I have seen many a curious case in the pathological room, the history of which would not have led us to this conclusion."

MR. W. L. SCLATER, Director of the South African Museum, reports that the state of the collections is satisfactory, and increasing use is being made of the museum by workers in different branches of natural science. The collections are now in the new museum building, which was formally opened on April 6. During the year covered by the report, 6380 specimens were added to the collections, 289 of them being species new to the museum. A complete list of the acquisitions to each department is given in the report. The number of insects received by the department of entomology was 2309, representing 766 species. As usual, the order Coleoptera predominates in the accessions, and Mr. L. Péringuey is able from the data now available to estimate that the number of South African Coleoptera will prove to be no less than 12,000. Mr. Péringuey refers to the interesting discovery of the existence of a representative of the curious family *Embiidæ* of the order Neuroptera, not before recorded in South Africa; and the curious parallelism of some coleopterous forms inhabiting the Cape and the Canary Islands, as exemplified by captures made by M. A. Raffray in the immediate vicinity of Cape Town. M. Raffray lately discovered a species of *Metophthalmus* (family Lathrididæ), three species of which are represented in the Canary Islands; he also discovered an eyeless species of Weevil (nov. gen.), and another the eyes of which have only six facets. These insects, belonging to the sub-family *Cossoninæ*, are very closely allied to similar ones occurring in the Canary Islands, and which are also found in the extreme south of Europe. Wollaston, as far back as 1861, described a Colydid (gen. *Cossyphodes*) from the Cape, belonging to a genus known at the time as occurring only at Madeira. Another species was later on discovered in Abyssinia, It is a singular coincidence that both *Cossyphodes* and *Metophthalmus* should be discovered in such opposite directions. Mr. Péringuey thinks the true explanation is that the minute insects of Africa have not yet been properly collected, and that the genera mentioned will be found to have a larger area of distribution than at first imagined.

SINCE the Liverpool Biological Committee transferred its headquarters to Port Erin, the station on Puffin Island has been worked by a committee of residents in North Wales, under the direction of Prof. White, of Bangor. The report for 1896 and 1897, which has recently appeared, shows that the Committee is extending its sphere of action to the study of the fauna and flora of the North Welsh *littoral*, as well as to the archæology of Puffin Island itself. It contains papers by Prof. Phillips on the brown seaweeds of Anglesey and Carnarvonshire, on an interesting form of *Ectocarpus confervoides*, and on a new variety of the alga *Epicladia flustræ*; by Mr. Daniel A. Jones, on the moss flora of the Harlech coast; by Prof. White, on some fishes observed in the Menai Straits, and on Welsh fishery exhibits at the Imperial Institute; by Mr. Harold Hughes, on excavations on Puffin Island; and a description, by Sir William Turner, of a skeleton recently discovered in the course of these excavations.

MR. BERNARD QUARITCH has just issued a catalogue of many rare and valuable works on zoology offered for sale by him.

IN addition to the usual bi-monthly summary of current researches relating to zoology, botany, and microscopy, the *Journal of the Royal Microscopical Society* for August contains several short papers of special interest to microscopists. The President, Mr. E. M. Nelson, contributes an article on the errors to be corrected in photographic lenses, and Mr. P. E. Bertrand Jourdain describes a new apochromatic objective constructed without the use of fluorite; a method of adjusting the sizes of the coloured images yielded by the Cooke lens; and the construction of the planar lens, and its use in low-power photomicrography.

IN his "Electricity and Magnetism," published at St. Louis by the John L. Rowland Book and Stationery Co., Prof. Francis E. Nipher gives a mathematical exposition of the fundamental principles of these subjects, for students who have commenced the calculus. A second edition of the volume, revised and with additions, has lately appeared, and the electrical engineer who is first of all a student, can acquire from it a sound knowledge of the machinery of mathematics, while the results may be safely applied to the work of designing electrical machinery.

WE have received a copy of a statement, being a report to the Lawes Agricultural Trust Committee, prepared by Sir J. Henry Gilbert, F.R.S., on the origin, plan, and results of the field and other experiments conducted on the farm and in the laboratory of Sir John B. Lawes, F.R.S. Other evidence of the activity of the investigators at Rothamsted is afforded by three papers, which have come to us with Sir Henry Gilbert's report, dealing with the growth of sugar beet and the manufacture of sugar in the United Kingdom; the valuation of the manures obtained in the consumption of foods for the production of milk; and, the Royal Commission on agricultural depression, and the valuation of unexhausted manures.

A VOLUME of "Agricultural Statistics of British India, for the years 1892–93 to 1896–97," compiled by the Statistical Bureau of the Government of India, has just been published. From the immense amount of material therein contained, we note one or two points of interest concerning the progress of cultivation of tea, coffee, and cinchona from 1885 to 1897 in British India and the native States. In 1885 the number of acres upon which tea was cultivated was 283,925, and the total production of tea was 71,525,977 lbs. In 1896 the number of acres under tea was 433,280, and the total production was 156,426,054 lbs. Coffee does not show the progressive increase of cultivation exemplified by tea. In the year 1885 the number of acres under coffee was 237,457, and the yield 34,959,295 lbs., but in 1896 the larger area of 289,084 acres only produced 26,086,902 lbs. As to cinchona, the number of acres under cultivation, and the number of trees in permanent plantations, have decreased since 1885, the quantity of bark collected in 1896-97, viz. 1,491,566 lbs., being the least obtained since 1889.

THE third part of vol. liv. of the *Quarterly Journal of the Geological Society* has just been published. From the large number of papers which are here printed, two or three are especially worthy of mention. Mr. T. Codrington discusses the submerged Rock-valleys in South Wales, Devon, and Cornwall. Mr. F. W. Harmer gives the results of a valuable series of borings which he has made with the object of arriving at a satisfactory conclusion as to the relation of the Lenham Beds and the Coralline Crag. Prof. Bonney deals with the Garnet-Actinolite schists on the southern side of the St. Gothard Pass. Mr. F. A. Bather elucidates the structural characters and affinities of *Petalocrinus*, and shows that its base is dicyclic and not monocyclic, as originally thought. Moreover, axial canals, covering-plates, the articular facet, and various minor structures are described in this genus for the first time. Miss G. L. Elles' exhaustive account of the Graptolite-fauna of the Skiddaw Slates confirms the chief conclusions of Prof. Nicholson and

Mr. Marr, though in several matters of detail different results are reached. Other important papers complete what is a particularly interesting issue of the *Journal*.

THE additions to the Zoological Society's Gardens during the past week include two Maholi Galagos (*Galago maholi*), a Bosch Bok (*Tragelaphus sylvaticus*, ♂), two Cape Zorillas (*Ictonyx zorilla*), a Hoary Snake (*Pseudaspis cana*), two Rough-keeled Snakes (*Dasypeltis scabra*), twelve Crossed Snakes (*Psammophis crucifer*), two Rufescent Snakes (*Leptodera hotambœia*), two Smooth-bellied Snakes (*Homalosoma lutrix*), two Puff Adders (*Bitis arietans*) from Port Elizabeth, Cape Colony, presented by Mr. J. E. Matcham; a Fat-tailed Sheep (*Ovis aries*, ♂, var.) from Cape Colony, presented by the Hon. Sir James Sivewright, K.C.M G.; an African Civet (*Viverra civetta*) from West Africa, presented by Lieut. Carroll and Major Arthur Festing; a —— Gannet (*Sula*, sp. inc.), captured at sea, presented by Captain Ernest W. Burnett; two Alligators (*Alligator mississippiensis*) from North America, presented by Mr. O. Moser; a Common Viper (*Vipera berus*), two Common Snakes (*Tropidonotus natrix*), British, presented Mr. W. F. Blandford; twelve African Walking Fish (*Periophthalmus koelreuteri*) from West Africa, presented by Dr. H. O. Forbes; a Reticulated Python (*Python reticulatus*) from Malacca, two Indian Pythons (*Python molurus*) from India, deposited; an Indian Chevrotain (*Tragulus meminna*, ♂) from India, purchased; a Burrhel Wild Sheep (*Ovis burrhel*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER:—

September 5. 16h. 44m. to 17h. 41m. Occultation of 66 Arietis (mag. 6·1) by the moon.

8. 10h. 52m. to 11h. 42m. Occultation of DM + 24° 1033 (mag. 6) by the moon.

9. 1h. 31m. to 2h. 19m. Occultation of Mars by the moon.

10. 14h. 5m. to 14h. 30m. Occultation of 79 Geminorum (mag. 6·5) by the moon.

12. 11h. 27m. Minimum of Algol (β Persei).

15. Venus. Illuminated portion of disc 0·521. Diameter 23″ 2.

15. Mars. Illuminated portion of disc 0 880. Diameter 6″·8.

15. 8h. 16m. Minimum of Algol (β Persei).

17. Saturn. Outer minor axis of outer ring, 16″·43.

21. 3h. Mercury at greatest western elongation (17° 51′).

21. 5h. Venus at greatest eastern elongation (46° 27′).

26. Vesta 20′ S. of Saturn.

28. 13h. 39m. to 14h. 44m. Occultation of 16 Piscium (mag. 5·6) by the moon.

The planet Mercury will be favourably presented as a morning star between about September 18 and 27. The time of his rising compared with that of the sun will be as under:—

Date.	Mercury rises. h. m.	Sun rises. h. m.	Interval. h. m.
September 18	4 3	5 40	1 37
19	4 3	5 42	1 39
20	4 2	5 43	1 41
21	4 3	5 45	1 42
22	4 4	5 46	1 42
23	4 6	5 48	1 42
24	4 9	5 49	1 40
25	4 13	5 51	1 38
26	4 16	5 53	1 37
27	4 20	5 55	1 35

THE GREAT TELESCOPE FOR THE PARIS EXHIBITION.—We gather from an article in *La Nature*, August 27, that M. Gautier, the well-known optician, is making good progress with the construction of the giant telescope intended for the Great Exhibition at Paris in 1900. The aperture will be 1·25 metres (49·2 inches), and the focal length 60 metres (196 feet 10 inches), while the estimated cost is 1,400,000 francs. An equatorial mounting and dome for such a gigantic instrument may well be considered impracticable, and accordingly the telescope itself will be rigidly fixed in a horizontal position on supports of masonry, and will receive the light of the heavenly bodies after reflection from a movable plane mirror 2 metres in diameter. The plane mirror is 13 inches thick, and weighs 3600 kilogrammes; and it is curious that of twelve discs cast for the purpose, the first one turned out to be the best. This has been in process of grinding for seven months, and is not yet finished.

There will be two objectives, one photographic and one visual, which will be easily interchangeable at will. It is expected that a magnifying power of 6000 will be usefully employed, and that occasionally a power of 10,000 may be used. As the highest power available in the largest existing telescope does not exceed 4000, the new instrument, if it be the success that every one will wish, should have a wide field of usefulness.

A NEW VARIABLE STAR.—In *Ast. Nach.*, No. 3512, Prof. Ceraski, Director of the Moscow Observatory, announces the discovery, by Madame Ceraski, of a new variable star. The variability was detected by a comparison of photographs, and has been confirmed by visual observations. Its estimated position is in R.A. 21h. 6·9m., Decl. + 82° 28′ (1855); that is, not far from 76 Draconis. The range of variation is not stated, but it is mentioned that on July 25 it was of the tenth magnitude.

MINOR METEORIC RADIANTS.—In view of the large amount of attention which will probably be directed to meteoric displays during the next few years, Mr. Denning summarises in *Ast. Nach.*, No. 3513, the positions of the radiant points of the minor showers visible during the principal meteoric epochs. The catalogue comprises fifty radiants observable at each of the six periods corresponding to the displays of Quadrantids, Lyrids, Perseids, Orionids, Leonids and Geminids. As the Andromedes fall near and between the Leonids and Geminids, a separate list is unnecessary for this epoch. It is seen from the table that some of the positions for radiants are almost the same at different epochs, and Mr. Denning again draws attention to his conclusion that "certain radiants are actively maintained (though possibly with varying or intermittent intensity) over considerable intervals of time, during which their positions are quite stationary among the stars." The list will be invaluable to those who take up observations of shooting-stars.

THE INTERNATIONAL CONGRESS OF ZOOLOGISTS.

THE fourth International Congress of Zoologists, under the patronage of H.R.H. the Prince of Wales and the presidency of the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., which met last week at Cambridge, may be chronicled as a success, as well from the social as the scientific point of view. The discussions were animated, the sectional papers of general interest, and the attendance was large and representative. The severity of the zoological discussions was relieved by frequent social festivities, of which the reception at the Guildhall by the Mayor of Cambridge on Monday, and the open air party at the Botanic Gardens on Thursday afternoon, were especially noteworthy.

The Congress is a triennial one, and has already been held at Paris, Moscow and Leyden. This is the first occasion that the Congress has met on English soil, and it is gratifying to find that more members were in attendance last week than were present at any of the three preceding Congresses. The programme for the week was drawn up in such a way that the topics of general interest were discussed in the mornings before the whole body of the members, while those of more limited interest were divided into four sections—(A) General Zoology, (B) Vertebrata, (C) Invertebrata, excepting Arthropoda, (D) Arthropoda, and were read in the afternoons.

Tuesday, August 23.—Sir John Lubbock, in opening the Congress, expressed his regret at the absence through continued ill-health of Sir William Flower, who, at the Leyden meeting in 1895 was made President-Elect for the present Congress.

He then delivered the presidential address, which was printed *in extenso* in our last week's issue.

Profs. Milne-Edwards, Jentink, Collett, Haeckel, von Graff, Hertwig, Marsh, Mitsukuri, Salensky and Vaillant were elected Vice-Presidents; and Dr. Hoek, Dr. Gadow, Dr. Plate and M. Janet were elected Secretaries of the Sections. The meeting then proceeded to receive the reports of committees appointed at the third Congress to consider various matters of zoological importance. The committee on zoological nomenclature, having been unable to come to a unanimous decision, applied for power to add to their number, which was granted. The question of zoological nomenclature was, therefore, not discussed at the Congress, but was referred back for consideration by the augmented committee. Dr. P. Hoek announced, on behalf of another committee, that favourable arrangements were about to be made with the international postal authorities for the transmission of animals and plants not intended as merchandise.

In the afternoon, in Section A, Mr. Stanley Gardiner read a paper on the "Building of Atolls," suggesting that the depths at which corals and nullipores live is determined by the depth to which light can penetrate sea-water, the food of corals being derived entirely from the commensal algæ. The form of the atoll-reef was shown to be due to the continuous addition of marginal buttresses and the dissolution of the central parts. In this, and in other respects, the author supports the theory of atoll-formation propounded by Sir John Murray. Prof. Mitsukuri, discoursing on "Zoological matters in Japan," pointed out that the transition from comparative barbarism to the present degree of scientific culture has not been as sudden as is generally supposed. He quoted some scientific works published in Japan in the ninth century, and called attention to the foundation of the Botanical Gardens of the University of Tokyo in 1681. He gave an account of the zoological laboratories at Tokyo, and of the marine station which has recently been erected near that town. Prof. Salensky read a paper on "Heteroblasty," by which name he designates the origin from different embryonic sources of organs, similar in position and function, in nearly related animals. He adduced as examples the development of the alimentary tract from the ectoderm in insects; the development of the peribranchial cavities in buds and embryos of Ascidians, and the development of the heart in Ascidians and Vertebrates.

In Section B, Prof. Milne-Edwards read a paper on the "Extinct Animals of Madagascar," in which he referred to the valuable collections made by M. Grandidier and Dr. Forsyth-Major. He compared the *Æpyornis* with the *Dinornis* of New Zealand, and drew a parallel between the extinct fauna of Madagascar and that of the Australasian area.

Prof. O. C. Marsh made a communication on the "Value of Type Specimens and the Importance of their Preservation," dealing more especially with the extinct Vertebrata. He pointed out that the value of type specimens depends on the maturity of the animal and the state of preservation and completeness of the parts. Type specimens must show characteristic features. The association of fragments to supplement an incomplete type is a practice fraught with great danger of confusion to subsequent investigators. Prof. Marsh advocated depositing types in large endowed museums as affording better chances of safe preservation than local museums; and he regarded it as a wise regulation that type specimens should not be permitted to leave the museum in which they are deposited.

Dr. Van Bemmelen showed that in *Ornithorhynchus* the temporal arch has two roots instead of one, a fact which suggests forcibly the articulation of the mandible with a persistent quadrate, as in reptiles. Prof. Seeley pointed out that the discovery had previously been made by himself.

Mr. Graham Kerr described the habits and development of *Lepidosiren*, and exhibited a splendid collection of specimens which he collected during his recent stay in Paraguay.

In Section C, Prof. Plate gave an account of the "Comparative Anatomy of the Chitons," showing that in these molluscs, generally believed to be the most primitive of existing Gastropods, there is a far greater diversity of internal organisation than might be suspected from their uniform appearance. Prof. Plate also described a newly discovered Protozoan which lives as a parasite in the mantle cavity of *Chiton*. Mr. E. S. Goodrich demonstrated the structure of the complex nephridial organs which occur in the Polychæte worm *Glycera*. Mr. C. F. Rousselet described a new method of preserving Rotifers in the extended condition, by narcotising them by the slow addition of a weak solution of cocain, and then killing them by a weak solution of osmic acid. The specimens are best mounted in formol. Some excellent specimens prepared in this way were exhibited.

In a paper read in Section D, on "Some points in the classification of Insects," Dr. David Sharp pointed out that in some insects the wings are developed outside the body, while in the others they do not appear at all, or are developed inside the body and are subsequently everted; and he claimed that in a classificatory scheme the perfection or imperfection of the metamorphosis should be subordinated to this feature. He proposed, therefore, to divide the insects into four groups, the *Apterygota*, quite wingless and in all probability descended from wingless ancestors, the *Anapterygota*, which, though wingless and parasitic, exhibit an acquired ametabolism as regards the wings, the *Exopterygota*, in which the wings are developed outside the body, and the *Endopterygota*, comprising the vast majority of existing hexapod insects, in which the wings develop inside the body. With regard to the geological antiquity of the groups, there is evidence to show that the exopterygotous insects are the most primitive, they only extending as far back as the Palæozoic.

Mr. M. C. Piepers summarised the results of his observations on the colours of insects in a paper entitled "Evolution of Colour in Lepidoptera," in which he concludes that there has taken place, and is still in progress, a process of colour-change affecting not only the metamorphosis of a given species, but also the evolution of the species and genera of a family. He would explain colour-polymorphism as a phenomenon of arrestation of this continuous evolution at varying stages, and sexual colour-differences as due to unequal advances by the two sexes in the same direction. The existing Pieridæ are, according to this view, evolved from a reddish ancestor. With advancing evolution the colour has become paler; first orange, then yellow, and in the most highly evolved species a pure white. Albino specimens of a species normally yellow are to be regarded as sports which have advanced further in this evolutionary scale than the majority. The progression of colour-change is not, however, the same in all families of Lepidoptera. In some, for instance, the primitive colour is red, and the successive stages are gradually darker, culminating in black.

A communication was also read from M. Bordage, giving the results of experiments made by him to determine the relation of the colour of the chrysalids of certain species of Lepidoptera to the colour of their environment. The chrysalids of *Papilio demolens* and *P. disparalis* appeared to be completely insensitive to the colour of their surroundings; but the experimenter has witnessed distinct, though feeble, efforts to respond on the part of *Atella phalanta*, *Euplœa goudotii*, and *Danais chrysippus*. The intensity of the light and the brightness or dulness of the surroundings appear to be more important factors than the actual colour of the latter. The age of the chrysalis also materially affects the result.

On *Wednesday* morning a general meeting of the Congress was held to discuss the position of the Sponges in the animal kingdom. Prof. Yves Delage, in opening the discussion, proposed to confine his attention to the determination of the value to be attached to the differences between the sponges and the Cœlenterates, with the object of deciding whether the sponges ought to constitute a subdivision of the Cœlenterates or to stand apart from them as a separate phylum. He dismissed shortly such features as the presence of collar-cells and the absence of nematocysts, but laid special stress upon the structure of the sponge larva and the relations of the parts of the blastula to the permanent tissues of the adult. He described how the sponge blastula consisted in its upper part of small clear cells with flagella, and in its lower part of larger, granular, brownish cells destitute of flagella; and how the former layer, having the histological characters of ectoderm cells, have the development of an endoderm, being invaginated into the interior of the other cells. After mentioning recent experiments on the effect of salts of lithium and of varying temperatures on the mode of invagination of the blastula in Echinoderms, he said he was inclined to regard the so-called ectoderm as really an ectoderm, and the cells which resemble endoderm cells as really endodermal. The sponges and Cœlenterates run parallel in their development from the ovum to the blastula stage, but then take diverging courses. He would advocate, therefore, the recognition of the sponges as a phylum distinct from the Cœlenterates.

Prof. Delage was followed by Mr. E. A. Minchin, who commenced with an historical review of the subject. After pointing out that the animal nature of sponges was not definitely established until the middle of the present century, he proceeded to explain that the early theory that sponges were Protozoa was abandoned as soon as histological methods improved, and it became known that sponges were composed of tissues, made up of differentiated cells. Three views are, he said, at the present day advocated by different authorities: (1) that sponges are Cœlenterates; (2) that they are Metazoa, but not Cœlenterates; and (3) that sponges are not Metazoa, but constitute a phylum independent of both the Protozoa and Metazoa. The question might be attacked by two methods, the comparative anatomy of adult forms and the tracing of the germ-layers of the larva into the permanent tissues of the adult. He then gave a minute account of the development of *Clathrina blanca*, based on his own researches, and indicated with the assistance of wall-diagrams the fate of the flagellated and the granular cells. The conclusion he arrived at was that the sponges cannot be considered as Cœlenterates; for, if the larvæ of sponges and Cœlenterates are assumed to correspond, neither the architecture nor the composition of the adults is in any way comparable; while if the comparison is based on adult structures, then the larval development of sponges is altogether anomalous and dissimilar to any other known development, since the ectoderm acquires an internal position and becomes surrounded by the endoderm. The evolution of the sponges from the Protozoa must therefore have been quite independent of that of the Cœlenterates; and it is probably in the direction of the Choanoflagellate Protozoa that we must look for the ancestral stock of the sponges, since collar-cells are not known to exist except in these groups. In the discussion which followed, Prof. Hæckel expressed himself as still in favour of the cœlenterate theory; Dr. Vosmaer regretted that he had been asked to speak, because it forced him into a confession of ignorance regarding the point at issue; and Mr. Saville-Kent urged that the vexed problem of sponge affinities should be fairly approached from the protozoic as well as from the cœlenterate basis. The very fact of the possession in common by the sponges and by the flagelliferous Protozoa of these very peculiarly modified cells, found nowhere else throughout the animal kingdom, suggested forcibly a close phylogenetic relationship between these two groups. Prof. Schulze doubted whether the recent embryological discoveries were sufficient to justify the removal of the sponges from the Cœlenterates.

In the afternoon in Section A, Prof. Haeckel, in a paper entitled "Phylogenetic Classification," developed the principles which he had first enunciated in his "General Morphology," and more recently in his "Systematic Phylogeny" (1896). He regarded the *Vertebrates*, *Tunicates*, *Echinoderms*, *Molluscs*, *Cnidaria*, and *Sponges* as true phyla (*i.e.* monophyletic groups, arising from a common stem), but grouped the Annelida with the Arthropoda in the phylum *Articulata*, and the Cestoda and Trematoda with the Cœlenterata.

Prof. von Graff then demonstrated with the aid of a large map the geographical distribution of the land Planarians; and Mr. G. C. Bourne gave an account of the "Structure and Formation of the Calcareous Skeleton in the Anthozoa," showing that the corallum of the madrepores is not formed by the calcification of ectoderm cells *in situ*, but is a secretory product of the cells.

In Section B, Profs. Heymans and Van der Stricht gave an account of the ultimate ramifications of the nerves of *Amphioxus*, which they had succeeded in tracing out by adopting the elaborate methods of staining which histologists have of late years found to yield such excellent results in the investigation of nervous tissues of mammals.

Prof. Ewart exhibited by means of the lantern some photographs of the zebra-horse hybrids which he has bred in his attempt to prove or disprove the theory of telegony. He described the striping of the various species of zebra and of his hybrids, and showed that the latter do not closely resemble their sire, a Somali zebra, in the pattern of their coat. The dams of three of these hybrids have since borne foals to horses of their own breed, and one of these foals, now dead, is plainly striped, the second faintly so, while the third shows no striping at all. Prof. Ewart is not yet prepared to accept telegony as a scientifically established fact, since the colour-markings of these foals might be explained on the hypothesis of "reversion."

A paper on the "Tsetze Disease in Mammals," by Prof. Kanthack and Mr. Durham, was read and illustrated by slides, showing the living hæmatozoan and its relation to the blood corpuscles. The rapid spread of the disease is due to the Tsetze-fly carrying the organisms from infected ungulates to healthy ones as they pass through those deadly regions of Africa known as "fly-belts." The organisms cannot live in the blood more than three or four days, but reproduction is rapid, taking place in the lymphatic glands and the red marrow; and thus a plentiful supply is kept up until the host succumbs. Death appears to be due either to the fatal action of some toxin excreted by the organism, or to direct interference with the corpuscle-forming organs of the body. The mere presence of the organisms in the blood is not sufficient to cause death. The authors have not been able to discover any means of securing immunity for domesticated animals; but, since the wild mammals of South Africa though frequently found to be infected do not die of the disease, they are sanguine of ultimate success in this direction.

Mr. W. Saville-Kent, who a few years ago showed that the lizard *Chlamydosaurus* had a habit of frequently running about upon its hind legs, explained that the habit was not confined to this genus. He had found it to be common to certain species of *Iguana*, *Tupinambis* and *Basiliscus*.

In Section C, Prof. F. Vejdowsky brought forward some observations on the ova of *Rhynchelmis*, substantiating the view expressed by him elsewhere, that the dynamic body known as the "centrosome" originates by the differentiation of the middle part of the "attraction sphere" of the preceding division. Prof. Hickson gave a demonstration on the medusæ of *Millepora*, and Prof. Pelseneer communicated two short papers.

In Section D, M. Ch. Janet propounded a theory that in the head of insects parts belonging to six primitive segments can be recognised. The anterior three are characterised by the protocerebrum, deutocerebrum and tritocerebrum respectively, and the other three by the appendages—mandible, maxilla and labium. The antennæ are regarded by the author as belonging to the second segment. These results are based mainly upon a minute study of the musculature of the head of the ant.

M. A. Dollfus discoursed on the geographical distribution of the Isopods of Northern Africa; M. E. Olivier gave a general account of the Lampyridæ of the Antilles; and Prof. E. Bouvier communicated the results of his studies on the external characters of *Peripatus*.

On *Thursday* morning, at the Guildhall, an interesting debate on the "Origin of Mammals" was opened by Prof. Seeley, of London, and Prof. Osborn, of New York. Prof. Seeley said that as the Iguanodont reptiles had been regarded as the ancestors of birds, so the Theriodont reptiles had been considered the ancestors of mammals. The discovery of the complete skeleton of *Pareiasaurus* showed that *Theriodesmus* was not a mammal, as had been supposed; and in the same way, the discovery of the Gomphodont reptiles had necessitated the removal of *Tritylodon* from the mammals to the reptiles. *Pareiasaurus*, *Dicynodon* and *Cynognathus* showed different affinities in different parts of the skeleton, and from the skull of the two former no indication could be inferred of the mammalian resemblances seen in other parts of their skeletons. The Anomodontia appeared to show affinities with the lower living reptiles as well as with more than one type of mammal. The form of the brain if it were available would be evidence of affinity of some value, but the brain-cavity of Anomodonts is imperfectly known, and there is no evidence that the brain filled it. Prof. Seeley invited comparison of the quadrate region of the skull in the Dicynodonts and *Ornithorhynchus*, but remarked on the absence of prepubic bones in the Anomodonts. He showed that the Theriodont division of the Anomodonts approached the mammalia in the characters of the teeth and the very small size of the quadrate bone; while, on the other hand, they suggested affinities with the Labyrinthodont reptiles in the presence of such cranial bones as the supratemporal, and of intercentra in the vertebræ. Although the parts of the pectoral and pelvic girdles bore a close comparison with those of the Monotremes, and although in many Theriodonts the skull was typically mammalian in form, the mandibular ramus never consisted of a single piece as in mammals. The Anomodonts were not the parents of mammals, but a collateral and closely related group; and the common parent of both might be sought in rocks older than the Permian, perhaps in Silurian or Devonian strata.

Prof. Osborn said that in order to clear the ground for a successful attack upon the difficult problem of the origin of mammals it was necessary first to reject the hypothesis, brilliantly formulated by Huxley in 1880, of a genetic succession between Monotreme, Marsupial and Placental types, since this could not be supported by either palæontology or comparative anatomy. He explained the law of adaptive or functional radiation whereby mammals have repeatedly diverged from small unspecialised focal types into aquatic, arboreal, volant, herbivorous and carnivorous orders, and pointed out that the balance of evidence among the mammals, as among the reptiles, is in favour of all aquatic types being secondarily evolved out of land types. All carnivorous and herbivorous types were over-specialised, or in a *cul de sac* of development, so that it was probable that the Promammal was a small terrestrial animal, either insectivorous or omnivorous in its habits. There was abundant evidence that many of the small mammals of the Middle and Upper Jurassic were not Marsupials, but insectivorous Placentals, fulfilling all the conditions required for the ancestry of the living Insectivora and the Creodonta, and, through the latter, of all the higher existing types of mammals, including man. Leaving the mammals, he remarked that the Theriodonts and Gomphodonts were surprisingly Promammalian in type, and that we were strongly tempted to connect the latter division, which is herbivorous, directly with the herbivorous Monotremes and Multituberculates. The large size and high specialisation of these types was, however, opposed to this view. In concluding he said that South Africa was at the present time a centre of the highest interest, and that for further developments of the problem of the origin of mammals we must probably look to the rich fauna of the Karoo beds.

In the discussion which followed, Prof. Marsh said that the mammals themselves comprised so many different groups that it was a fair question whether all these had a common origin. The supposed resemblance between the teeth of the Anomodont reptiles and those of mammals was not confined to one group. The extinct crocodile *Notosuchus* recently found in Patagonia has the three kinds of teeth well developed; and in the genus *Triceratops*, of the Dinosaurs, all the teeth have two roots—a supposed mammalian character; but no one had yet attempted to derive the mammals from the Crocodiles or the Dinosaurs. Prof. Marsh declined to admit that any reptiles possess a true double condyle, since in the known forms the two parts are in contact below, forming essentially a single cordate condyle, as in some of the Chelonia. Again, all reptiles have a quadrate bone, which may be small and partly enclosed in the squamosal, but never lost. No known mammal has a true quadrate, and the attempts to identify that bone in the mammalian skull have not been successful. Most important of all, the lower jaw of all reptiles is composed of several pieces, even the Anomodonts showing the sutures distinctly. There was, said Prof. Marsh, a great gulf between mammals and reptiles which it was at present difficult to bridge over. Prof. Haeckel then spoke in high terms of the excellent palæontological work which was being carried on in America, and the value of the recent discovery of annectent forms. He was inclined to adhere to the view of the origin of all Placental mammals from Marsupials. Mr. A. Sedgwick said that no assistance could be looked for in the direction of embryology, and in support of this statement showed that although we regard the horses as descended from pentadactyle ancestors, the embryos show no more details of limb structure than the adult; and that although birds are admitted to have lost their teeth in the process of evolution, no rudiments of teeth are found in the embryo. He referred to the profound modification of embryonic development which varying amounts of yolk in the egg may cause; and he doubted whether any of the extinct forms known to us ought to be considered as ancestors of existing forms. He would like to see all the lines of the genealogical tree running down to the Pre-Cambrian without joining. Prof. Hubrecht also spoke on behalf of the embryologists, and pointed out that the one great distinction between the Ichthyopsida on the one hand, and the Sauropsida and Mammalia on the other, was the presence of the amniotic envelope in embryos of the latter and its absence in the former. Our ignorance of the development of the extinct forms prevented him from accepting the doctrine of descent as propounded by palæontologists. He referred to Prof. Hill's discovery of a definite deciduous placenta in *Perameles*, and to the less complete placenta of *Phascolarctos*, and concluded by expressing his doubts as to the intermediate position occupied by the Marsupials between the Monotremes and the Placental mammals.

Prof. Newton said that he took a more hopeful view of the question than the last two speakers, and that he looked in the direction of comparative anatomy and palæontology, rather than embryology, for the solution of the problem of the "Origin of Mammals."

In the afternoon at the Senate House the honorary degree of Doctor of Science was conferred on several members of the Congress and of the Congress of Physiologists. The speeches delivered by the Public Orator upon this occasion are printed at the end of this report. Prof. Kowalevski, whom it was also proposed to honour, was unfortunately prevented from attending the Congress.

A paper on "Fishery Statistics," by Prof. McIntosh, was read in Section B.

On *Friday* morning, Prof. Haeckel, discoursing on "The Descent of Man," said that the monophyletic origin of all Mammalia from the Monotremata upwards to Man is at present no more a vague hypothesis, but a positively established fact. All the living and extinct Mammalia which we know, are descended from one single ancestral form, which lived in the Triassic or Permian period; and this form must be derived from some Permian or perhaps Carboniferous reptile (allied to the Progonosauria and Theriodontia), and the latter from a Carboniferous Amphibian (Stegocephalia). These latter are descended from Devonian fishes, and these again from lower Vertebrates. Much more difficult is the question of the origin of the great Vertebrate-Stem, and its descent from Invertebrates. But these questions are not so important as the fact that Man is a member of the Primate-Order (Linné), and that all Primates descend from one common stem (Huxley). Zoology may be proud to have proved this fact, based on the theories of Lamarck (1809) and of Darwin (1859).

Prof. Marey explained why the subject of animal locomotion could not be investigated from the physiological standpoint only, but that a minute study of comparative anatomy was also essential. He exhibited numerous instantaneous photographs of horses in successive phases of movement.

Mr. W. L. Duckworth gave an account of the anatomical researches he is at present making on the Gorilla and other Anthropoid apes.

M. E. Dubois made some "Remarks on the brain-cast of *Pithecanthropus erectus*." He called attention to the scaphocephalic nature of the skull, and the consequent narrowness of the frontal region of the brain and the strong impressions of the frontal convolutions on the interior of the calvarium. The author repudiated the suggestion that the skull was a microcephalic anomaly. The femur which was found associated with the skull suggested bipedal locomotion, but there were indications in that bone of an arboreal habit such as are not found in the human femur. He showed how by comparison of human thigh bones with known corresponding body-weight he had estimated from the size of the femur of *Pithecanthropus* that its body-weight must have been 70 to 75 kilos. He then deduced the size of the whole brain (850 c.c,) from that of the internal cast of the calvarium, and from this the weight of the brain (750 grams). His ultimate conclusion was that in a man, an anthropoid ape and a *Pithecanthropus* of the same body-weight, the brain of *Pithecanthropus* would be twice as large as that of the ape, and half the size of that of the man.

In the afternoon in Section A, Prof. MacBride read a paper on the "Origin of Echinoderms." He pointed out that the type of larva common to the Asteroids, Ophiuroids, Echinoids, and Holothuroids probably represented a free-swimming bilateral ancestor of simple organisation. The main object of his paper was to consider the transformation of the bilateral into the radial form. Since the right water-vascular rudiment remained small, a main factor in the metamorphosis was the unequal development of the two sides. Where, as in Crinoids, a fixed stage succeeded the pelagic stage, bilateral symmetry ceased to be of importance to the animal; but a radial arrangement of external organs was advantageous, and hence incipient inequalities in the sides would be made use of to produce the radial arrangement.

Sir Herbert Maxwell then read a paper on "Recent Legislation on Protection of Wild Birds in Great Britain," in which he pointed out that with regard to migratory birds the question of protection was of international importance, and he referred to the recent letters in *The Times* complaining of the diminution in the number of swallows in our southern counties owing to their wholesale slaughter in the south of France. He discussed the relative merits of absolute protection in certain areas, the establishment of a close time over the whole country, and the protection of the eggs, and concluded by an account of the efforts of the Wild Birds Protection Society.

In Section B, Prof. Hubrecht gave an account of his researches on the origin of red blood corpuscles in the placenta of *Tarsius*, and explained that the corpuscles are the liberated nucleoli of proliferating syncytia of the embryonic epiblast. The genesis of red corpuscles in the placenta had previously been described in the rabbit and bat; but the discovery had not been confirmed, and the fact was not credited. The figures already published by the opponents to the view now advocated show that the appearances presented in Prof. Hubrecht's slides had previously been seen. But while these observers regarded the imperfect corpuscles visible as undergoing disintegration, Prof. Hubrecht considers them as in process of formation. In the discussion which followed, Mr. A. Sedgwick pointed out the important bearing upon the phenomenon of telegony of this introduction into the maternal blood of corpuscles derived from embryonic tissue. Prof. Hubrecht, in replying to a question by Dr. Gadow, said that he still upheld the view that *Tarsius* should, on account of the peculiarity of its placenta, be separated from the lemurs and included among the monkeys. Prof. Osborn exhibited photographs of a fossil Hyracoid from the Lower Pliocene of Samos. The specimen consists of a fairly well preserved skull contained in the Stuttgart Museum, and Prof. Osborn proposes to name it *Pliohyrax fraasii*, after Prof. Fraas, who handed over the specimen to him for description. The skull is of large size, and is twice as long as that of *Dendrohyrax*, the largest living hyrax. The dental formula is complete, viz. *i* 3, *c* 1, *pm* 4, *m* 3. The large median incisors are separated by a diastema from the other two, which are small and in continuous series with the canine and pre-molars. The first tooth in the maxilla, identified by Prof. Osborn as the canine, closely resembles in shape the anterior pre-molar immediately behind it. It has two roots and two cusps. The zygoma appears to have been extremely short, and the infra-orbital foramen is as far back as the fourth pre-molar.

Prof. Vaillant then described the minute structure of the dermal spines of the Apogonini and some other acanthopterygian fishes.

Prof. Salensky read a paper on the development of the "Ichthyopterygium." After criticising the "Archipterygium" theory of Gegenbaur and the views of Balfour and Dohrn, he explained that his own researches on the cartilages and muscles of larval specimens of the Sterlet (*A. ruthenus*) brought him in accord with the views of Mollier, and concluded that the serial rays of the fin could be correlated with certain of the primitive body-segments.

In Section C, a paper on the tapeworms of the Monotremes and Marsupials was communicated by Dr. Zschokke (Basel), who proposed to create a new genus *Linstowia* for the reception of the parasites of *Echidna* and *Perameles*. MM. Mesnil and Caullery described the discoveries made by them on the polymorphism of the sedentary Polychæte *Dodecaceria concharum*, and concluded with a discussion of the phenomenon of "épitoquie" in Annelid worms generally. Six other short papers were also read.

On *Saturday* morning, at a general meeting convened at the Guildhall, it was decided that the fifth Congress, in 1901, should be held in Germany; the selection of the town and the president to be left to the German Zoological Society, acting in conjunction with the Permanent Committee of the Zoological Congress at Paris.

The following speeches were delivered by the Public Orator, Dr. Sandys, Fellow and Tutor of St. John's College, in presenting to the Vice-Chancellor the several representatives of the International Congresses of Zoology and Physiology, on whom honorary degrees were conferred on August 25.

(1) In ipso limine laudis nostrae nihil auspicatius arbitramur, quam tot viros, de zoologiae et physiologiae studiis bene meritos, a tot orbis terrarum partibus ad nos advectos, Academiae nomine iubere salvere. Dum omnibus Collegia nostra, omnibus etiam corda nostra pandimus, unum certe animo prope fraterno contemplamur, qui a fratribus nostris transmarinis ad nos transmissus, cordis praesertim de motu reciproco et olim et nuper plurima protulit. Idem in musculorum et "nervorum" (ut aiunt) physiologiam multum inquisivit, neque psychologiae provinciam vicinam inexploratam reliquit. Huius imprimis exemplo et auctoritate factum est, ut etiam trans aequor Atlanticum physiologiae studia nunc maxime floreant, utque matris almae Cantabrigiensis filia transmarina, nomine eodem nuncupata, studiorum illorum sedes iampridem constituta sit.

Duco ad vos HENRICUM PICKERING BOWDITCH.

(2) E Germanis quidam oriundus, partris iucundi filius, laudem ideo maximam est adeptus, quia, Italiae in litore hospitali, orbis terrarum in sinu amoenissimo, vivarium Oceani spoliis reservatum gentibus patefecit, quod quasi aquarum castellum appellaverim, unde doctrinae rivuli in omnes terras late diffluxerunt. Vivarii illius conditorem inter hospites nostros diu numeravimus; eidem alumnos nostros animo laeto commendavimus; ab eodem scientia varia instructos animo grato rursus accepimus. Ipse animalium in partu praesertim explorando laboris immensi prodigus, neque minorem quam in vivario illo condendo fortitudinem ostendit, neque fortunam minus prosperam expertus est. Per totam certe vitam feliciter confirmavit verba ab ipso Plinio, historiae naturalis auctore locupletissimo, vitae suae in die novissimo prope Neapolim pronuntiata:—"fortes fortuna iuvat."

Duco ad vos ANTONIUM DOHRN.

(3) Gallorum e gente insigni, non vicinitatis tantum vinculis nobiscum coniuncta, ad litora nostra advectum salutamus, patris doctrina multiplici ornati filium, quem ipsum talium conventuum non modo praesidem primum sed etiam auctorem principem atque adeo patrem nominaverim. Avium in scientia diu versatus, etiam ex ipsis saxis avium formas latentes quam sollerter elicuit; rerum naturae museo maximo inter Parisienses praepositus, navium bene nominatarum auxilio, etiam Oceani ipsius e profundo rerum naturae veritatem quam feliciter extraxit. Quid non potuit rerum naturae,—quid non potuit veritatis amor?

"Merses profundo, pulchrior evenit."

Duco ad vos ALPHONSUM MILNE EDWARDS.

(4) Italiam, olim scientiarum matrem, laetamur nunc quoque filiis physiologiae de scientia praeclare meritis gloriari. Unum ex eis hodie salutamus, in Academia Papiensi Ticini prope ripam posita, pathologiae professorem insignem, virum etiam in eis quae oculorum aciem fugiunt observandis perspicacissimum. Idem duas praesertim ob causas in honore merito habetur: primum, quod in corpore humano fila quaedam tenuissima sensibus motibusque transferendis ministrantia, argenti auxilio per ambages suas inextricabiles exploranda et observationi subtiliori praeparanda esse docuit; deinde, quod in sanguine humano parasitis quibusdam diligenter indagatis et inter sese separatis, aëris pestilentiam propulsare, febrium cohortes profligare audacter aggressus est. Camilli mortem pestilentia absumpti Camillus alter ultus est.

Duplex certe honos viro in uno conspicitur, CAMILLO GOLGI.

(5) Germania ad nos misit non modo maris animalium minutorum investigatorem indefessum, sed etiam operis immensi conditorem audacem, in quo animalium omnium ortum ab origine ultima indagare est conatus. Ergo Caroli Darwinii, alumni nostri magni, praedicatorem inter Germanos magnum salutamus. Salutamus etiam virum, qui in ipsa rerum omnium origine recordatus omnia muta mansisse, "donec verba, quibus voces sensusque notarent, nominaque invenere," idem in ipsa animalium origine exploranda ob eam inter alias causam laudatur, quod, ingenio vivido praeditus, tot nomina nova invenerit,—quod totiens (ut Horati verbis denuo utar) "sermonem patrium ditaverit et nova rerum nomina protulerit."

Duco ad vos virum quem nominare satis est, ERNESTUM HAECKEL.

(6) Vir Batavorum inter rura genio felicissimo natus, omnium corda ad sese allexit, Europae gentium prope omnium linguas sibi vindicavit, Oceani denique monstra (ut ita dicam) minutissima et tenuissima, quae *Nemertea* nominantur, accuratissime investiganda sibi sumpsit. Illa vero monstra, si poetis Graecis licet credere, satis antiqua et memoratu satis digna esse constat. Scilicet ipse Nereus erat *νημερτὴς τε καὶ ἤπιος*, Proteus autem *γέρων ἅλιος νημερτής*. Sed haec utcumque sunt, in laudando viro, qui maris monstra illa forma multiplici praedita veracissime descripsit, nihil est facilius quam vera dicere, nihil iucundius quam (ut Homeri verbis utar) *νημερτέα μυθήσασθαι*.

Duco ad vos AMBROSIUM ARNOLDUM WILLELMUM HUBRECHT.

(7) Instituto Lipsiensi physiologiae studiosi quantum ubique debeant, doctissimo cuique satis notum. Instituti illius praesidis olim adiutor egregius, postea Borussiae, nuper Helvetiae in capite physiologiam professus est; physiologiae *φαινόμενα* physicis praesertim rationibus explicare conatus est; adhibito

denique instrumentorum auxilio, quae ipse aut primus invenerat aut in melius mutaverat, multa accuratius investigavit, multa prius ignota patefecit, in regiones novas scientiae suae terminos feliciter propagavit. Ob imperii tanti fines tam late propagatos lauream nostram victori felici libenter decernimus.

Duco ad vos HUGONEM KRONECKER.

(8) In provincia Palatina physiologiae professor Heidelbergensis abhinc annos plus quam triginta corporis cellularum in protoplasmate disputandi materiem satis amplam invenit; abhinc annos plus quam viginti de forma "nervorum" in musculos desinentium multum conscripsit; abhinc annos decem coram Societate Regia Londinensi de ea physiologiae provincia disseruit, in qua vitae suae quasi tabernaculum posuerat. Qui totiens unumquodque duorum lustrorum spatium laboribus suis luculenter illustravit, quasi regulam vitae Horatianum illud videtur sumpsisse :—

"servetur ad imum
qualis ab incepto processerit, et sibi constet."

Ergo etiam in posterum intra decem annos speramus physiologiae e provincia chemica fore ut talium virorum victoriis laurus plurimae referantur.

Duco ad vos WILLELMUM KÜHNE.

(9) Galliae ex Collegio Parisiensi laetamur adesse hodie historiae naturalis professorem illustrem, qui, apparatu exquisito adhibito, physiologiae quaestiones physicarum rationum ope totiens explicavit. Idem non modo cordis palpitationem alternam, sanguinis cursum continuum, musculorum denique contractionem penitus exploravit, sed etiam animalium complurium motus varios lucis ipsius auxilio feliciter illustravit. Talium virorum dignitatem contemplata, Universitas nostra non sine superbia quadam etiam in hunc virum quadrare confitebitur verba illa comoediae Gallicae celeberrimae in extremo posita :— "dignus, dignus est intrare in nostro docto corpore."

Novem virorum insignium seriem, non Senatus tantum nostri praeconio dignatam, sed etiam collegarum suorum omnium plausu comprobatam, claudit hodie professor illustris, STEPHANUS IULIUS MAREY.

Prof. Kowalevsky, the distinguished Professor of Zoology in the Imperial University of St. Petersburg, was unfortunately prevented from being present to receive the honorary degree of Doctor in Science, which it had been proposed to confer on him. In introducing the nine recipients of honorary degrees who were present, the Public Orator adopted the reformed pronunciation of Latin; and his speeches were accordingly readily understood and appreciated by the great concourse of international visitors in the Senate House.

EXPERIMENTS WITH THE TELEPHONE.[1]

EARLY estimates of the minimum current of suitable frequency audible in the telephone having led to results difficult of reconciliation with the theory of the instrument, experiments were undertaken to clear up the question. The currents were induced in a coil of known construction, either by a revolving magnet of known magnetic moment, or by a magnetised tuning-fork vibrating through a measured arc. The connection with the telephone was completed through a resistance which was gradually increased until the residual current was but just easily audible. For a frequency of 512 the current was found to be 7×10^{-8} ampères (the details are given in *Phil. Mag.*, vol. xxxviii. p. 285, 1894). This is a much less degree of sensitiveness than was claimed by the earlier observers, but it is more in harmony with what might be expected upon theoretical grounds.

In order to illustrate before an audience these and other experiments requiring the use of a telephone, a combination of that instrument with a sensitive flame was introduced. The gas, at a pressure less than that of the ordinary supply, issues from a pin-hole burner (the diameter of the pin-hole may be 0·03") into a cavity from which air is excluded (see Fig. 1). Above the cavity and immediately over the burner, is mounted a brass tube, somewhat contracted at the top where ignition first occurs (*Camb. Proc.*, vol. iv. p. 17, 1880). In this arrangement the flame is in strictness only an indicator, the really sensitive organ being the jet of gas moving within the cavity and surrounded by a similar atmosphere. When the pressure is not too high, and the jet is protected from sound, the flame is rather tall and burns bluish. Under the influence of sound of suitable pitch the jet is dispersed. At first the flame falls, becoming for a moment almost invisible; afterwards it assumes a more smoky and luminous appearance, easily distinguishable from the unexcited flame.

When the sounds to be observed come through the air, they find access by a diaphragm of tissue paper with which the cavity is faced. This serves to admit vibration while sufficiently excluding air. To get the best results the gas pressure must be steady, and be carefully adjusted to the maximum (about 1 inch) at which the flame remains undisturbed. A hiss from the mouth then brings about the transformation, while a clap of the hands or the sudden crackling of a piece of paper often causes extinction, especially soon after the flame has been lighted.

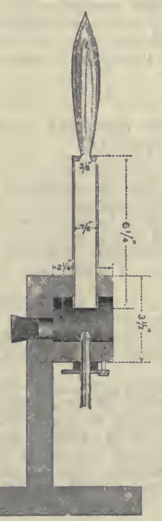

FIG. 1.

When the vibrations to be indicated are electrical, the telephone takes the place of the disc of tissue-paper, and it is advantageous to lead a short tube from the aperture of the telephone into closer proximity with the burner. The earlier trials of the combination were comparative failures, from a cause that could not at first be traced. As applied, for instance, to a Hughes' induction balance, the apparatus failed to indicate with certainty the introduction of a *shilling* into one of the cups, and the performance, such as it was, seemed to deteriorate after a few minutes' experimenting. At this stage an observation was made which ultimately afforded a clue to the anomalous behaviour. It was found that the telephone became dewed. At first it seemed incredible that this could come from the water of combustion, seeing that the lowest part of the flame was many inches higher. But desiccation of the gas on its way to the nozzle was no remedy, and it was soon afterwards observed that no dewing ensued if the flame were all the while under excitation, either from excess of pressure or from the action of sound. The dewing was thus connected with the *unexcited* condition. Eventually it appeared that the flame in this condition, though apparently filling up the aperture from which it issues, was nevertheless surrounded by a descending current of air carrying with it a part of the moisture of combustion. The deposition of dew upon the nozzle was thus presumably the source of the trouble, and a remedy was found in keeping the nozzle warm by means of a stout copper wire (not shown) conducting heat downwards from the hot tube above.

The existence of the downward current could be made evident to private observation in various ways, perhaps most easily by projecting little scraps of tinder into the flame, whereupon bright sparks were seen to pass rapidly downwards. In this form the experiment could not be shown to an audience, but the matter was illustrated with the aid of a very delicate ether manometer devised by Prof. Dewar. This was connected with the upper part of the brass tube by means of a small lateral perforation just below the root of the flame. The influence of sound and consequent passage of the flame from the unexcited to the excited condition was readily shown by the manometer, the pressure indicated being less in the former state of things.

The downward current is evidently closely associated with the change of appearance presented by the flame. In the excited state the gas issues at the large aperture above as from a reservoir at very low pressure. The unexcited flame rises higher, and must issue at a greater speed, carrying with it not only the material supplied from the nozzle, and constituting the original jet, but also some of the gaseous atmosphere in the cavity surrounding it. The downward draught thus appears necessary in order to equalise the total issue from the upper aperture in the two cases.

Although the flame falls behind the ear in delicacy, the combination is sufficiently sensitive to allow of the exhibition of a great variety of interesting experiments. In the lecture the introduction of a threepenny-piece into one of the cups of a

[1] A discourse delivered at the Royal Institution, on June 10, by the Right Hon. Lord Rayleigh, F.R.S.

Hughes' induction balance was made evident, the source of current being three Leclanché cells, and the interrupter being of the scraping contact type actuated by clockwork.

Among other experiments was shown one to prove that in certain cases the parts into which a rapidly alternating electric current is divided may be greater than the whole (see *Phil. Mag.*, vol. xxii. p. 496, 1886). The divided circuit was formed from the three wires with which, side by side, a large flat coil is wound. One branch is formed by two of these wires connected in series, the other (in parallel with the first), by the third wire. Steady currents would traverse all three wires in the same direction. But the rapidly periodic currents from the interrupter distribute themselves so as to make the self-induction, and consequently the magnetic field, a minimum; and this is effected by the assumption of opposite values in the two branches, the ratio of currents being as 2 : − 1. On the same scale the total or main current is + 1. It was shown by means of the telephone and flame that the current in one branch was about the same (arithmetically) as in the main, and that the current in the other branch was much greater.

THE STOCKHOLM MEETING OF THE IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute, held at Stockholm on August 26 and 27, under the presidency of Mr. E. P. Martin, of Dowlais, was a most successful one. An influential reception committee, including the Governor General of Stockholm and all the leading men in the iron industry, entertained the members with lavish hospitality. The King of Sweden invited the members to supper at his Palace, and attended the meeting in person.

The meetings were held at the House of Lords, a fine building erected in 1648, and were largely attended. Addresses of welcome were given, and the President announced that Prof. W. C. Roberts-Austen, C.B., F.R.S., had been unanimously chosen to succeed him as President.

No less than eleven papers were on the programme. The first paper read was by Mr. R. Åkerman, Director General of the Board of Trade, on the development of the Swedish iron industry. He traced the history of the industry from the earliest times, and showed the influence exerted by the chemists Scheele and Berzelius on metallurgy. The Swedish production last year comprised 538,197 tons of pig iron, 189,632 tons of wrought iron, 107,679 tons of Bessemer ingots, and 165,836 tons of open-hearth ingots.

Prof. G. Nordenström read a paper describing the characteristic features of Swedish iron ore mining. He began with an account of the geology of the country, and then discussed the geographical distribution of the iron ores, their mode of occurrence, composition, mining and production. The total production last year was 2,086,119 tons. Much of the paper was devoted to the use of magnetic instruments in exploring for iron ore, a subject previously treated by Mr. B. H. Brough in a paper read before the Institute in 1887.

Mr. C. P. Sandberg's paper on the danger of using too hard rails, contained the results of experience on the Swedish railways. He considered that it is preferable to adopt a heavier weight of rail of moderate hardness, rather than to try to remedy the deficiency in weight of rails originally used by now resorting to a dangerous hardness of rail of the same section.

Mr. A. Greiner, director of Cockerill's works at Seraing, communicated, as a supplement to the paper he read in May, the results of experiments by Mr. A. Witz with a simplex motor, using blast furnace gas. The results were highly satisfactory, showing that the working of the 200 horse-power engine is very economical and as regular as that of a steam engine. The dust in the gas is in no way injurious to its continuous operation.

Mr. H. Lundbohm, of the Geological Survey of Sweden, described the iron ore deposits of Kiirunavaara and Luossavaara, the largest deposits in Swedish Lapland. The ore occurs in bed-like masses in porphyry. It is very rich, and the author estimates that there is above the level of the lake at Kiirunavaara 215,000,000 tons, and at Luossavaara 18,000,000. The situation of the beds within the Arctic circle at 67° 50′ north lat. renders them inaccessible. A railway, now in course of construction, from the Gulf of Bothnia to Ofoten, will give access to these deposits and furnish a most important source of iron ore supply.

Mr. J. E. Stead supplemented the important paper on the crystalline structure of iron by presenting further facts bearing upon the brittleness produced in soft steel by annealing. The most important point established is that phosphorus must not exceed 0·08 per cent.

The paper on the micro-chemistry of cementation, read by Prof. J. O. Arnold, was of special interest as giving a detailed description of the effect of cementation on the brands of iron sent by Sweden to England.

Mr. G. R. Johnson, of Embreville, Tennessee, contributed a paper on the action of metalloids on cast iron. He insisted that foundrymen in buying iron should require analysis as well as fracture, for it is impossible to judge of the composition of an iron merely by looking at it.

Prof. W. C. Roberts-Austen discussed the action of the projectile and of the explosives on the tubes of steel guns, showing the interesting results obtained by an examination of the bores of corroded guns by the aid of micro-photography. An interesting discussion followed the reading of the paper, a noteworthy contribution being supplied by Mr. Nordenfeldt.

The two other papers on the list were taken as read. Baron H. Jüptner applied the data as to the thermal relations of iron carbon alloys contained in Prof. Roberts-Austen's fourth Report to the Alloys Research Committee of the Institution of Mechanical Engineers, to correcting the conclusions expressed in his paper on the solution theory of iron and steel read last May. And Prof. E. D. Campbell, of the University of Michigan, described some further experiments made by him on the diffusion of sulphides through steel.

The usual votes of thanks were given, and the meeting terminated.

An elaborate programme of excursions was arranged. Various works in Stockholm were visited. Before the meeting a limited number of members visited the remarkable iron mines of the Arctic Circle, and after the meeting there were two excursions occupying several days: one to the ironworks of Domnarfvel, Hofors, Sandviken, and the mines of Grängesberg, Falun, and Dannemora; and the other to the ironworks of Laxå, Degerfors, Bofors, Uddeholm and Storfors, and to the Persberg iron mine. All the arrangements were most satisfactory, and great credit is due to the Hon. Secretary of the Reception Committee, Mr. J. C. Kjellberg, and to Mr. Brough, the Secretary of the Institute.

THE OLD BEDS OF THE AMU-DARIA.

THE Russian Geographical Society has just issued a new volume which contains an important contribution to the much debated question as to the old beds of the Amu-daria. It is written by the mining engineer, A. M. Konshin, and contains a geological map showing the extension of the Pliocene and modern Caspian deposits, as well as of the Loess and the fluviatile deposits in the Transcaspian region, and a number of drawings of dunes and *barkhans* (of aeolic origin), and small plans of the Uzboi and the Ungus (supposed old beds of the Amu).[1]

When the Transcaspian region was first opened to scientific exploration it was generally believed that the ravine which runs from Lake Aral to the Caspian Sea, the Uzboi, as well as the Ungus and the Kelif Uzboi, represent old beds of the Amu, which, continually shifting its bed towards the right, ran successively at the foot of the Kopet dagh, then across the Karakum desert, and finally, after having taken to its present bed, sent a branch towards the Caspian Sea along what is now known as the Uzboi. This hypothesis has still a fervent adherent in Baron Kaulbars. A further exploration of this region, which was made in 1883, proved, however, that the Uzboi has not the characters of an old river bed, and that in Post-Pliocene times the Caspian Sea sent a broad gulf eastwards, into what is now the Karakum desert. The Ungus, which crosses this desert, is also not an old bed but an escarpment by which the Pliocene clays of the Karakum Plateau fall towards the lower-lying Post-Pliocene Karakum Sands. Consequently, two hypotheses are now in presence. One of them, supported by M. Konshin, is that a gulf of the Caspian stretched as far eastwards as the longitude of Merv, sending in its western part a branch northwards, along the Uzboi, as far as the

[1] "Contribution to the Question relative to the Old Course of the Amu-daria." 256 pp. with several maps and drawings. St. Petersburg, 1897. (*Memoirs of the Russian Geographical Society*, General Geography, vol. xxiii. part 1). Russian.

Sarykamysh lakes. When this gulf began to desiccate, the Amu began to flow northwards, in its present bed. The other hypothesis, developed with great skill by M. Obrucheff ("The Transcaspian Lowlands," 1890), is that the Karakum gulf existed and received the Amu with its tributaries, the Murghab and the Tejen; when the gulf began to desiccate the Amu continued to flow that way and entered the Caspian, and only later began to flow northwards, sending a branch along the Uzboi.

In his new volume M. Konshin discusses this hypothesis in detail, and gives his arguments in favour of his own views. His chief arguments are, first, that the Caspian shells, belonging to species now living in that sea (*Dreissena*, *Hydrobia*, *Neretina*, and *Lithogliphus*), are found in the southern parts of the Uzboi, uncovered by deposits of fluviatile origin, as also at the western entrance of the Karakum Gulf, where they are found at elevations of from 140 feet to (at least) 175 feet, and occasionally 280 feet, above the present level of the Caspian; and next, that the Karakum Sands bear no traces of fluviatile deposits or of the levelling action of water which would be apparent in case the Karakum Gulf had harboured a river after its desiccation. The hillocks, 150 feet to 250 feet high, which cover these sands, are marine dunes, and the elongated depressions filled with salt water (*shors*), which are considered as indicative of old river beds, have nowhere the regularity which old river beds would be possessed of. They are traces of a retreated sea.

It is evident that further exploration is wanted; but it must be acknowledged that the absence of river deposits in the Karakum Sands militates in favour of M. Konshin's views. P. K.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. R. B. OWENS, of the Nebraska University, has been appointed to the McDonald chair of Electrical Engineering in the McGill University, Montreal.

THE following appointments have been made in the School of Agriculture, Ghizeh, Egypt:—Senior Professor of Agriculture, Mr. H. J. Monson, lecturer on agriculture and horticulture at the Yorkshire College, Leeds; Junior Professor of Agriculture, Mr. Andrew Linton, B.Sc. (Hons.), Durham University.

THE 1898-99 programme of technological examinations conducted by the City and Guilds of London Institute has just been published by Messrs. Whittaker and Co. The contents comprise syllabuses of the seventy subjects in which examinations are held, and copies of the papers set at this year's examinations. At the end of the syllabus of each subject is a list of works of reference, which must prove of great service to both teachers and students.

THE doctorates conferred by universities in the United States in 1897 are classified in *Science*, with the view to comparing the tendency of the work of the students. It is pointed out that the American university is definitely a place for research, where both teachers and students are engaged in research or in learning the methods of research. The results of the work of the students is, therefore, in large measure summarised by the theses for the doctorate, and it is interesting to know what is the outcome of the past year's research. It appears from the classified list referred to that eighteen leading universities conferred the Ph.D. degree on 234 candidates. Of this total number, no less than 105 degrees were conferred for scientific theses. The Humanities came next with 91 degrees, while History and Economics numbered only 38 degrees.

THE reports of inspectors on schools and classes under the Department of Science and Art, contained in the forty-fifth annual report of the Department, show that the teaching of science in the Government schools is undergoing distinct improvement. In the schools of science inspection has entirely taken the place of examination, at any rate in the elementary course, and this, by relieving the teacher of the strain entailed by preparation for examination at a prescribed date, has tended to sounder and more satisfactory work. It is being gradually realised that a school of science should be characterised more by a systematic course of study than by the mere possession of laboratories and apparatus. In classes in physics and chemistry a decided improvement in the methods of teaching is reported. Apparatus is more freely used than formerly, the teaching is less mechanical, and increased attention is being given to practical work. There can be no doubt that the practical instruction in these and other science subjects adds enormously to the value of the theoretical lessons, and it is to be hoped that the number of schools arranging for such work will increase year by year.

THE coordination of the work of the class-room and laboratory was the subject of a paper read by Prof. Gaetono Lanza, Professor of Applied Mechanics, Massachusetts Institute of Technology, at the recent annual meeting of the American Society for the Promotion of Engineering Education. Prof. Lanza insisted that pure science and literature should not be neglected in an engineering education, and he pointed out that to impart to the student a thorough mastery of scientific principles far outweighs in importance anything else that can be done for him, and this is the chief function of an engineering course. The class-room work forms the basis of the course; and the laboratory work, to serve its purpose, must be based upon the class-room work which has preceded it, must be thoroughly co-ordinated with it, and must be made to depend upon it, to use it, and to serve as an aid to illustrate the principles involved. The functions of the engineering laboratory are partly to emphasise and illustrate the work of the class-room, partly to drill the students in performing carefully and accurately such experimental work as they are liable to be called upon to perform in the practice of their professions, and partly to teach them to carry on experimental investigation. In order to fulfil these purposes there should be an intimate relation between the class-room and the laboratory work, and the student should be made to work up the results of the tests in the light of what he has learned in the class-room. Prof. Lanza concluded by expressing the view that any organisation which does not tend to preserve the most intimate relation between the two, is not for the best interests of the student and should not exist.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, vol. iv. No. 10, July.—The structure of the hypoabelian groups, by Dr. L. E. Dickson, gives a marked simplification both in the general conceptions and in the detailed developments of the theory of the two hypoabelian groups of Jordan and of the author's generalisation ("the first hypoabelian group generalised," *Q. J. of Mathematics*, 1898), to the Galois field of order 2^n of the first group. It is important, for the generalisation, to give these groups an abstract definition independent of the theory of "exposants d'échange," by means of which Jordan derived them. The crucial point in the simplified treatment lies in the discovery of the explicit relations

$$\sum_{i,j}^{1\ldots m} a^{(i)} \delta^{(i)}_{j} = m, \quad \sum_{i,j}^{1\ldots m} a^{(i)}_{j} \delta^{(i)}_{j} + \alpha'_1 + \beta'_1 + \gamma'_1 + \delta'_1 = m,$$

satisfied by the substitutions of the simple sub-groups J and J_1, respectively, but ruling out the remaining substitutions of the total hypoabelian groups G and G_1. The paper was read in abstract at the Chicago meeting, April 9.—The following five papers were read at the meeting of the Society held on April 30 (for an account of five other papers read at the same meeting, see vol. lviii. No. 1500, p. 310).—On the Hamilton groups, by Dr. G. A. Miller. Dedekind's definition of such a group is that it is a non-Abelian group, all of whose sub-groups are self-conjugate. If the order of such a group is $p_1^{a_1} p_2^{a_2} p_3^{a_3} \ldots$ ($p_1, p_2, p_3 \ldots$ being prime numbers) it must be the direct product of its sub-groups of orders $p_1^{a_1}, p_2^{a_2}, p_3^{a_3}, \ldots$ since each of these sub-groups is self-conjugate, and no two of them can have any common operator except identity (*Math. Annal.*, vol. xxii. p. 97). Each of these sub-groups is either Abelian or Hamiltonian. Dr. Miller proceeds to show that one of the given prime numbers must be 2, and that every sub-group whose order is a power of any other prime number must be Abelian. The results are conveniently summarised at the end of the short paper.—Note on the infinitesimal projective transformation, by Prof. E. O. Lovett. The writer proposes to find the form of the most general infinitesimal projective transformation of ordinary space directly from its simplest characteristic geometric property. Geometrically, these transformations are those infinitesimal point transformations which transform a plane into a plane, *i.e.* which leave invariant the family of ∞^3 planes of ordinary space.—Prof. Lovett contributes a further note on infinitesimal transformations of concentric conics. He defines a family of curves to be invariant under the transformations of a continuous group of transformations when the family is invariant under the infinitesimal transformations which generate the group A family is invariant under an infinitesimal transformation when the differential equation of the family admits of the infinitesimal transformation. He states the criterion, and points out that the converse problem is an integration problem not capable of general solution.—A solution of the biquadratic by binomial resolvents, by Dr. G. P. Starkweather, claims to be a new solution in which the roots are given explicitly, and to be an interesting application of Galois' methods.—Mr. H. E. Hawkes, in "Limitations of Greek Arithmetic," discusses the number system of the Greeks, and shows how their arithmetical notions were limited by their geometrical symbolism. The argument is mainly based on Euclid's Elements.—There are some further notes: viz. note on special regular reticulations, by Prof. E. W. Davis. In his remarks on maxima and minima of functions of several variables. Prof. J. Pierpont points out a flaw in the treatment of this theory in the treatises of Todhunter, Williamson and Byerly, and calls attention to the results of Scheefers, Stolz and von Dantscher, which find a place in the Cours d'Analyse of M. C. Jordan.—On the intersections of plane curves, by F. S. Macaulay, discusses further some interesting points raised in Miss Scott's paper on Mr. Macaulay's "point groups in relation to curves" (of March number of the *Bulletin*).—In addition to four minor notices and reviews, and the notes, index, &c., there is a list of the papers read before the Society, with references to the journals in which they have been published.

American Journal of Science, August.—The origin and significance of spines, Part 2, by C. E. Beecher. Most organisms have certain parts which are more exposed to the forces of the environment than others, and such exposed parts, when acted upon by hereditary requirements, produce the various external organs and appendages. When such a hereditary predisposition is absent, the normal responsive action between growth and stimulus tends to produce a conical or spiniform growth. Other conditions favourable to the development of spines are restraint of environment, causing suppression of highly developed structures, and deficiency of growth force, causing degeneration of organs, such as leaves into spines representing the mid-rib, branches into spiniform twigs, legs or digits into spines.—The prehistoric fauna of Block Island as indicated by its ancient shell-heaps, by G. F. Eaton. Block Island is situated off the New England coast, to the east of Long Island. Three ancient shell-heaps were explored, which yielded valuable finds. Bones of the great auk were found in two of them, and in one, part of the skull of the grey seal. The human remains discovered show little variation from the type of the New England Indian. The remains of a child show distinct traces of a violent death, and the absence of the arms and a portion of the lower limbs points to the practice of cannibalism. Stone implements were also discovered, and some highly finished articles made of bone. The fauna generally is of a continental character, and indicates a former connection of the island with the mainland.—A registering solar radiometer and sunshine recorder, by G. S. Isham. Two barometer tubes are suspended by the arms of a balance. They contain mercury and saturated alcohol vapour. One of them is blackened and exposed to sunlight, which increases the pressure of the alcohol vapour and expels some mercury. The motion of the beam is recorded by a pen travelling across a divided scale moved by clockwork.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 22.—M. Wolf in the chair.—Observations of the planet 1898 DQ (Witt, 1898 August 14), made at the Paris Observatory, by M. Jean Mascart. The magnitude of the planet in question is about 10·5. Its apparent position was determined six times between August 18 and 20.—On the groups contained in motion of any kind, by M. G. Ricci.—Melting points of some substances under high pressures, by M. E. Mack. The apparatus used gave a range of pressure from 150 to 2140 atmospheres, and fourteen determinations of the melting-point of naphthalene were made at pressures between these two extremes. The results could be expressed with sufficient accuracy by the formula $t = 79{\cdot}8 + 0{\cdot}0373\,p - 0{\cdot}0000019\,p^2$, and the last term being very small, the increase in the melting-point is nearly proportional to the pressure. Measurements were also made with α-naphthylamine, diphenylamine, and paratoluidine, the results generally lying on a straight line, no indications being obtained of the maxima noticed by previous experimenters.—On the oxides of sodium, by M. de Forcrand. By heating sodium in a slow current of dry air, a greyish suboxide of sodium is formed, having the composition Na_3O. This, however, could not be obtained pure and unmixed with sodium. Further treatment with air gives Na_2O and Na_2O_2, but the former could not be obtained even approximately pure.—On the ammoniacal chlorides of lithium, by M. J. Bonnefoi. Pure dry LiCl, kept at a temperature above 85°, absorbs ammonia, giving $LiCl.NH_3$, the dissociation pressures of which were measured at four temperatures. The application of Clapeyron's formula to these measurements gave a value for the latent heat of dissociation in close agreement with that found experimentally. Between 60° and 85°, $LiCl2NH_3$ is formed; between 20° and 60°, $LiCl3NH_3$; and at 13°, $LiCl4NH_3$. In all cases the results given by Clapeyron's formula agreed well with the direct thermochemical data.—The estimation of tannin, by M. Leo Vignon. The tannin is absorbed from solution by silk, and the loss determined either by drying at 110°, or by titrating the solution with permanganate. Test analyses show a good agreement with those obtained by methods previously used (Sisley, Aimé Girard).—On the composition of phosphorescent sulphides of strontium, by M. J. R. Mourelo. The phosphorescent sulphide contains small proportions of strontium sulphate, sodium sulphide and chloride, and bismuth sulphide and oxide; and the presence of these impurities appears to be a necessary condition for a brilliant and lasting phosphorescence.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Zoological Results based on Material from New Britain, &c., collected during the Years 1895, 1896, and 1897, Part 1: Dr. A. Willey (Cambridge University Press).—City and Guilds of London Institute Programme of Technological Examinations, Session 1898–99 (Whittaker).—Geology for Beginners: W. W. Watts (Macmillan).—Plant Life: Prof. C. R. Barnes (N.Y., Holt).—Special Report on the Beet-Sugar Industry of the United States (Washington).

PAMPHLETS.—Deductive Series of Arithmetical Problems, Standards 3 to 7 (Reading, National Publishing Association, Ltd.).—Mines and Quarries: General Report and Statistics for 1897. Part 2. Labour (Eyre).

SERIALS.—Good Words, September (Isbister).—Sunday Magazine, September (Isbister).—English Illustrated Magazine, September (198 Strand).—Chambers's Journal, September (Chambers).—Longman's Magazine, September (Longmans).—Century Magazine, September (Macmillan).—Atti del Reale Istituto d'Incorraggiamento di Napoli, 4te serie, Vol. x. (Napoli).—Johns Hopkins University Studies, ser. xvi. Nos. 7, 8, 9 (Baltimore).—Natural Science, September (Dent).—Contemporary Review, September (Isbister).

CONTENTS.

THURSDAY, SEPTEMBER 8, 1898.

MODERN TAXIDERMY.

The Art of Taxidermy. By John Rowley. Pp. xi + 244; illustrated. (New York: Appleton and Co., 1898.)

THAT improvements in taxidermical methods are being carefully studied in the United States is evident not only from the publication of the present volume, but also from a paper recently communicated to the "Report of the U.S. National Museum" by Prof. R. W. Shufeldt, entitled "Taxidermical Methods in the Leyden Museum, Holland." Both these may be advantageously studied together; and the result of their perusal will scarcely fail to convince the reader that the art in question stands on a higher level, and is making more decided progress there than is the case in this country. One very striking feature in Mr. Rowley's little volume is the absence of all reserve in communicating so-called trade secrets, and in laying bare all his methods to public criticism. It is, as the author well states, by such frankness alone that the art of the taxidermist can be advanced; and it is a matter for congratulation that on the other side of the Atlantic, at any rate, the profession is being taken up by men of education and genius who are above petty trade jealousies. One difficulty in making a comparison between English and American methods is owing to the fact that to all but experts it is very difficult, in the absence of treatises like the present, to ascertain the precise details of the *modus operandi* in the former.

Perhaps the greatest interest in Mr. Rowley's volume centres round the chapters devoted to collecting specimens and the mounting of the skins of the larger mammals, since bird-stuffing, we venture to think, has already attained a comparatively high grade in this country. The remarks of our author in the fifth chapter indicate the importance of having collectors attached to a museum who shall themselves kill and flay the specimens whose skins are intended for exhibition. We are told, for instance, that the skins of small mammals prepared in the manner now becoming so general for study purposes are unsatisfactory for mounting, the hair sometimes coming off during the soaking process. In regard to larger mammals, the author may be allowed to speak for himself. "It is always better," he writes, "if possible, to decide upon the attitude the specimen is to assume when mounted before making the opening cuts, and to make them where they will show the least. The process by which the animal is to be mounted should also be considered."

Then again it is important that measurements and photographs or sketches of the specimen should be taken both before and after flaying, to be subsequently used in the construction of the "manikin" upon which the skin is finally to be mounted. In regard to the making of the manikin, both Mr. Rowley and Prof. Shufeldt agree that "it is simply impossible to get the correct form of a large mammal by taking casts in plaster of its lifeless flayed body." And the former recommends the gradual working up of the form of the animal upon a framework primarily constructed of a centre board to which are affixed the skull and limb-bones, or, when these are required for other purposes, casts of the same. Here again the necessity for a special collector is apparent, as in too many cases skins intended for mounting are sent home without the limb-bones; while even when these are obtained it is by no means certain that they, or replicas, will be used in the mounting. To follow the details of Mr. Rowley's method would obviously be out of place on the present occasion, but it may be mentioned that when the centre board has been cut into its proper shape, the general form of the animal is obtained by fine wire netting nailed along the top of the board and adjusted as nearly as may be to the general contour of the body and upper portions of the limbs, and tacked fast along the underside of the body-board. Upon the rude outline thus obtained the details of muscular anatomy are worked up in some soft material which can be applied where necessary. The employment of a bare clay or plaster manikin, however carefully modelled, is deprecated, as being likely to cause shrinkage owing to the abstraction of the last remnants of natural moisture from the skin by the clay or plaster. Whatever may be the case in the American institutions, we have great doubts whether this objection would have any weight in London, where the dry atmosphere maintained during winter in the Natural History Museum renders shrinkage one of the great difficulties to be contended against.

Another point on which the author lays great stress is the importance of shaving down the skins of "pachydermatous" mammals from the inside until they attain a degree of tenuity permitting of their being readily worked and moulded to the required form. As an instance of the extent to which he carries the reducing process, it may be mentioned that the skin of a rhinoceros weighing two hundred and seventy pounds when first removed from the body was shaved down until it weighed only twenty-seven pounds, inclusive of the hoofs.

With regard to reptiles and fish, Mr. Rowley recommends the making of coloured casts to replace mounted skins in museums in a large number of instances, especially among lizards and snakes. Wherever the pattern on a snake's skin is of an unusually complicated type it is, however, considered preferable to make a cast of the flayed body, upon which the prepared skin should be stretched, and the original coloration restored by careful painting. The few American coloured casts of lizards and snakes now exhibited in the Natural History Museum afford striking testimony as to the excellence of the first method.

That the appearance of Mr. Rowley's excellent little volume will give a fresh impetus to the study of the taxidermical art in this country must be the earnest wish of all interested in our museums as institutions for the display of the various forms of animals in the most life-like attitudes attainable. At the present day the matter is of even more urgent importance than might at first sight seem to be the case, since there is only too much reason to fear that many of the larger mammals recently set up in our museums will be the last of their kind obtainable for such a purpose. We should have welcomed a few observations on the best means of preventing fading in museum specimens, which is another crying evil, from so experienced a conservator as Mr. Rowley.

R. L.

KNUTH'S TEXT-BOOK OF FLORAL BIOLOGY.

Handbuch der Blütenbiologie unter zugrundelegung von Hermann Müller's werk: "Die Befruchtung der Blumen durch Insekten." Bearbeitet von Dr. Paul Knuth, i. Band, ii. Band, 1 Theil. Pp. xix + 400 and 697. (Leipzig: Wilhelm Engelmann, 1898.)

DR. KNUTH is to be congratulated on carrying out an excellent idea in a masterly manner. It is now twenty-five years since Hermann Müller's "Befruchtung der Blumen" appeared, and although the English translation of 1883 contains a good deal not to be found in the original book of 1873, yet it too is becoming antiquated. A book, therefore, like Knuth's "Handbuch," founded on Müller, and incorporating the mass of work accumulated in recent years, is very welcome. Dr. Knuth is well known as an active and successful worker in the domain of floral biology, and has therefore the chief requisite for success—a first-hand knowledge of his subject; he also makes it clear that he has gone thoroughly into the literature.

The book is to be in three volumes, of which vol. i. and the first part of vol. ii. are now published. It is summarised by its author as follows:—

I. Introduction and literature.
II. The Floral-Biology of European and Arctic plants.
  Part i. Ranunculaceæ to Compositæ.
  Part ii. Lobeliaceæ to Coniferæ.
III. The Floral-Biology of Extra-European Plants.

The first volume begins with the history of floral-biology, to which I shall return later. It then goes on to the different forms of reproduction occurring in flowering plants, *e.g. Xenogamy*, *Geitonogamy* and *Autogamy*, under which heading a useful list of self-fertilised and self-sterile plants is given. The author passes on to an excellent account of the biological classes into which flowers are grouped—such, for instance, as the Anemophilous and Entomophilous divisions. Among animal visitors the bird, and even the bat, are shown to be of importance: the powers of the snail in this line are respectfully discussed; while further evidence is demanded for the suggestion that the kangaroo fertilises *Dryandra*.

Next comes a good discussion of the elements that go to make up the floral machinery—protection of pollen—conspicuousness through odour or colour, nectar and nectar guides, protection against unbidden guests, &c. Then comes a fuller discussion of flowers in relation to insects, in which a well-known biological classification is adopted, flowers being grouped in an ascending series beginning with those nectarless kinds which are visited for the sake of their pollen, and then into various types of honey-supplying species, in which the protection of the nectar increases in complexity. Next, we have an account of the specialisation of flowers for certain groups of insects, and their classification as fly-flowers, butterfly-flowers, bee-flowers, &c. Lastly, a full account of the structure of insects in relation to flowers, a subject originated and brilliantly treated by H. Müller. The author has done wisely in giving a general account of floral-biology with so much fulness. The student who proposes to go on to vol. ii. comes to the study of special mechanisms far better prepared by Dr. Knuth's vol. i. than a reader who attacks for the first time H. Müller's "Fertilisation of Flowers."

A valuable feature in Dr. Knuth's book is the excellent account of the method which Hermann Müller introduced and used with such signal success—namely, the study of an exact record of the species of insects which visit each kind of flower. This, commonly known as the statistical method, gave astonishingly interesting results in Müller's hands, supplying as it did a solid basis of incontrovertible fact to his generalisation on the reciprocal interaction of insects and flowers, the evolution of the flower in general, and other interesting points. The statistical method has been largely taken up by the modern school of floral-biologists, and especially by MacLeod, Loew, Knuth and Kirchner on the continent, and by Willis, Burkill and Scott-Elliot in this country, with results which go to swell the lists of insect visitors given for each species in vol. ii. Space does not allow me to deal with the points of general interest which occur in this section; I may, however, call the reader's attention to the clear and useful account of MacLeod's method of treating the observed facts.

The growth of floral-biology is well illustrated by the admirable list of literature given by Dr. Knuth, and for which he deserves the thanks of all serious students. D'Arcy Thompson's list (1883) contains 814 entries, which seemed to contemporary readers a sufficiently striking proof of the growth of the subject, but it is a trifle to Knuth's literary index, in which are found 2871 entries. It should be mentioned, too, that in vol. ii. the literature is carefully given under each species. This part of the work is fully illustrated with Müller's excellent drawings, as well as figures from other sources, and a certain number of original illustrations. Dr. Knuth has introduced an improvement over H. Müller's arrangement by prefacing each natural order with a general sketch of the characteristic mechanisms; this seems a better arrangement than Müller's "retrospects," which were placed at the end.

Dr. Knuth has shown so much ability in the treatment of the part of the work already published that students may look forward to his completion, with equal success, of what will be the standard treatise on the subject. The only point in which I have any adverse criticism to offer is Dr. Knuth's treatment of the Knight-Darwin law. In common with some other modern writers on floral-biology, he takes what seems to me a mistaken view of the bearing of this law. The subject does not lend itself to treatment in a brief notice; I hope, however, to deal with it at length elsewhere.

FRANCIS DARWIN.

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.*]

Wasp and Bee Stings.

As we are now in the thick of the wasp season, it may interest some of the readers of NATURE to know that cocaine is a remedy for wasp or bee stings. It acts apparently not only as a temporary local anæsthetic, but seems also to have the power of destroying the poison of the sting. I happened to have some 1/6th grain cocaine tabloids for hypodermic injection when a lady was badly stung by a wasp a year or two ago. Such stings have a great effect on her, not only producing a very large and painful swelling, but making her feel more or less unwell for two or three days. One tabloid dissolved in a few drops of water, and applied with the finger at once, almost removed the pain; a second, applied an hour or two after, completed the cure. A few days later I found the cocaine equally effective in the case of a young girl who had been severely stung. Since then I have kept a small bottle of a strong solution of cocaine ready for use, and it has always proved effective. It should, of course, be applied as soon as possible, but only two days ago I found that it gave great relief seven or eight hours after the sting.

If any medical man should happen to read this, may I ask him to say whether it would be safe, in case a person were stung on the tongue, and no doctor could be secured at once, to give a hypodermic injection in the tongue of 1/6th grain cocaine, or whether it would be better to apply the tabloid or a solution externally to the place. J. F. D. DONNELLY.

September 4.

The "Jelly-fish" of Lake Urumiah.

SOME years ago there appeared in NATURE a letter from Mr. P. L. Sclater, drawing attention to the possibility of the occurrence of a species of medusa in the salt lake of Urmi in Persia.

During my present visit I have had several opportunities of examining the fauna of the lake, and have met with a great abundance of the organisms referred to by Mr. Curzon in his work on Persia (vol. i. p. 533) as "jelly-fish." Near land they are present in such countless swarms that they cannot escape the attention of the bather, and are consequently very well known to the inhabitants of the shores of the lake, who, moreover, deny the existence of any second kind of animal in its brine.

These organisms are Crustaceans belonging to the order Branchiopoda. Without books, I cannot refer them to their exact systematic position; but they seem to me to resemble the Artemia group of varieties of the Branchipus type, which are specially adapted for life in strong saline solutions.

The Urmi Branchiopods are of two sexes. The females grow to a length of about 13 millimetres, the males of about 10 millimetres; the former have a faint reddish, the latter a faint greenish tinge of colour. The males are, moreover, readily distinguished by the absence of egg sacs, and by the possession of enlarged anterior clasping appendages, by means of which they often hang on to the females and are towed about by them.

In very shallow water I have also found the larva of a fly in which the tracheæ open at the tip of a bifurcated process which is thrust up to the surface when the larva breathes. There is an abundance of an alga forming small dark green gelatinous masses floating freely in the lake, but up to the present these are the sole vestiges of life I have been able to detect in the salt water. R. T. GÜNTHER.

Urmi, Persia, July 20.

Science and Art Department Examinations.

FOR more than twenty years I have annually sent pupils in for some of these examinations, and, although at times unable to understand the reason for the adoption of some of the regulations, this is the first time that I have ever ventured to call attention to one or two points connected with the working of the Department. Recently, as is well known, the system of payment which has hitherto been adopted has been altered. It is claimed that this alteration is an improvement, because it is said to substitute payment by attendance for payment by results; but in reality it does nothing of the kind, for the examinational results are still one of the chief, if not *the* chief, factors in fixing the amount of grant. Also the amount of payment per attendance is so small that a most inadequate remuneration is given to the teacher. The result of this on the Science Classes throughout the country is, that while possibly only a comparatively slight alteration will be made in the total amount of money paid to large classes—such as the classes in large day schools—the amount paid to smaller classes, especially those held in the evening, where higher work is carried on, will be reduced to such an extent as to threaten the existence of many of them. For example, in a class known to me where work of the highest kind is carried on, and which work has been specially commended by the Inspector in two of his annual reports, the earnings this session will be reduced 75 per cent. If this is the outcome of the new policy, the sooner the Department reverts to the old plan the better for all concerned, and especially for the propagation of scientific knowledge. Of course all teachers are aware of the anomalies which occur in examinations, but the following is a somewhat remarkable instance:—A student sat for the examination in May last in the advanced stage of practical organic chemistry. He was required to answer two questions, and to analyse two substances (unknown), as well as to find the halogen element present in an organic solid, and to determine the melting point of this solid. The written questions were correctly answered, the analyses were correctly done, the halogen was correctly determined, and the melting point of the substance was less than 1 per cent. too low. The description of the practical work was also fairly well done; but this student is returned as having failed, notwithstanding that there are two classes of success, first and second class. It would be interesting to know, in the face of this, the standard the examiners require for a first class success. At the last May examinations the other chemistry results show many anomalies of a somewhat similar character. D.SC. (LOND.).

BOOKWORMS.[1]

THE naturalist frequently spends a good deal of time in abuse of his fellow man, considered in the light of a destructive agent; he points ruefully to the reduced faunas and floras of certain islands, to the Dodo, to the Moa, and to various creatures which have been extirpated by the direct or indirect influence of human occupation of the countries where they once flourished. But there is no action without compensation; and while man has sensibly impoverished the fauna and flora of the world in which he lives in some directions, he has unwillingly encouraged and promoted the welfare of many creatures belonging to humbler groups than those which he has thinned or entirely abolished. The average householder, as he takes his nightly rounds with a view to bolts and bars, is probably not aware that with luck and under favourable circumstances he might meet with nearly one hundred species of insects and other allied forms to whom he has not only furnished secure lodgings, but abundant food. Several species of clothes moth batten upon his Sunday coat; two species of cockroach may or do stalk boldly through his kitchen; and, in short, a host of creatures—some of them importations from abroad, destitute aliens in fact—thrive at the expense of the most formidable enemy of the brute creation. Our libraries afford pasturage to quite a number of small creatures, for the most part beetles, which have found in the dry leather and paper (and doubtless, too, on account of the infrequency with which books are apt to be consulted) a more suitable home than the woods which they presumably at one time inhabited. The Rev. J. F. X. O'Connor, whose interesting little book about bookworms is before us, was led to investigate these destructive creatures by discovering one in an old folio belonging to the library of Georgetown College.

Being a lover of books, it is not surprising to find that

[1] "Facts about Bookworms." By Rev. J. F. X. O'Connor, S.J. (London: Suckling and Co., 1898.)

the author's interest in his discovery was tempered by a reflection upon the enormous damage which the ancestors of his capture had inflicted in their time. He proceeds to remark—perhaps with more truth than freshness—that "books are precious things, for in them lies stored the wisdom of the centuries." But, although a man of letters rather than a man of science, Father O'Connor divides his booklet fairly—even rigidly—into two parts: one of these is devoted to the literary history of the bookworm, the other to its natural history and depredations. It is upon the latter half that we shall have most to say here.

The expression "*the* bookworm" is often used; but it is inaccurate, for some seven or eight species, perhaps more, actually do commit depredations in books. Besides, these creatures are not restricted in their diet to books. Dry food of no kind comes amiss, and one of the species which the author refers to, *Dermestes lardarius*, has received its specific name on account of the fact that it delights chiefly in bacon. *Anobium paniceum*, another beetle, is fond of books; but it feeds upon almost anything that comes in its way: the most singular food recorded as having been sought out by this exceedingly omnivorous insect is cayenne pepper.

Several other beetles and their larvæ fairly come under the designation of bookworms; and, indeed, it is only in this class of insects that we meet with species capable of producing those elaborately curved tunnels which often disfigure old books, and of which one or two samples are figured by Mr. O'Connor. When uninterrupted in their ravages, some of these beetles are able to progress through the interior of books for quite a long distance, eating their way before them like an earthworm boring through the soil. Messrs. Kirby and Spence, and also Mr. O'Connor, quote an instance of a bookworm which travelled through no less than twenty-seven folio volumes in so straight a tunnel that, by passing a string through the perfectly round hole that it had made, the entire set of volumes could be lifted at once.

To the popular mind the term "worm" implies anything of a smallish kind that scuttles, wriggles or crawls; and with this notion is blended an idea of voracity and omnivorousness. We may fairly therefore put down, as does Mr. O'Connor, the "silver-fish" among the category of bookworms. This creature, *Lepisma saccharina*, is of course not a beetle, but a representative of that archaic group of insects the Thysanura; it is quaintly described by Hooke in his "Micrographia" as "a small white Silver-shining Worm or Moth which I found much conversant among Books and Papers, and is supposed to be that which corrodes and eats holes through the leaves and covers. It appears to the naked eye a small glittering Pearl-coloured Moth, which upon the removing of Books and Papers in the Summer, is often observed very nimbly to scud, and pack away to some lurking cranny, where it may the better protect itself from any appearing dangers." Unlike the black-headed bookworm, *Ptinus fur* (which it has been suggested acquires its black head from its partiality to black letter books), the *Lepisma* lets printed matter severely alone, and carefully eats round it. The object of the *Lepisma* seems to be rather the paste than the paper or the binding. But it is not select in the matter of diet; and, among other foods, shares with the clothes moth a taste for garments and carpets. It has furnished Hooke with some physiological reflections which we quote from Mr. Butler's "Our Household Insects." "When I consider," observes the author of the "Micrographia," "what a heap of Sawdust or chips this little creature (which is one of the teeth of Time) conveys into its intrals, I cannot chuse but remember and admire the excellent contrivance of Nature in placing in animals such a Fire as is continually nourished and supply'd by the materials convey'd into the stomach, and fomented by the bellows of the lungs; and in so contriving the most admirable fabrick of Animals as to make the very spending and wasting of that fire to be instrumental to the procuring and collecting more materials to augment and cherish itself, which indeed seems to be the principal end of all the contrivances observable in bruit Animals."

A less obtrusive though hardly less tiresome foe to the book-lover is an insect which has been called the "Book-louse" (*Atropos divinatoria*). The term "louse," however, is unnecessarily offensive to the insect, for it is not parasitic and does not belong to the same group as that which contains the obscene *Pediculus*. It is a Neuropteron, allied therefore to the dragonflies. It may be reasonably placed under the heading of bookworms—although Mr. O'Connor has not placed it there—owing to its partiality for paste. The specific name of the insect is connected with the fact that it shares with the Death Watch (a beetle) the habit of producing an ominous ticking sound, carrying terror to the heart of the superstitious. It appears, however, that this is merely an amorous conversation with, or an act of adoration directed towards, the female insect, who is fascinated and overcome by this continued expression of feeling. This sound is caused by the insect knocking its head upon the ground, and it has been wondered, by those who under-estimate the power of love, how so small and tender an insect can create so loud a sound. Nevertheless it seems to be the fact that it does. The author, after dealing shortly with various kinds of bookworms (which are illustrated by not always very good figures), proceeds to the practical consideration of how to get rid of them. He is of opinion that (to speak somewhat hibernically) it is better to stop the mischief before it has commenced. Paste containing such deadly elements as corrosive sublimate is recommended for binding purposes; elsewhere we have seen the suggestion that pepper is a useful article to mingle with the paste. But this would be obviously a substance of no use wherewith to confront that particular kind of bookworm which relishes a diet of cayenne. The general panacea for insects of all kinds is camphor. But here again the bookworm is not to be so easily combated. Specimens of one kind have been found comfortably and confidingly nestling beneath pieces of camphor which it was hoped would put a speedy end to them. Possibly the best cure would be to put the books themselves to their legitimate uses, *i.e.* to read them; this would necessitate a constant shaking which would prevent the pest from obtaining a secure lodgment. But considering that the Royal Society of Science of Göttingen in the year 1744, and the Society of Bibliophiles of Mons in the year 1842, offered in vain a prize for the solution of these difficulties, it is not surprising to find that on the whole the bookworm has triumphed over both the bibliophile and the naturalist. In any case it has done us this service: it has furnished the material for a most interesting little book by Father O'Connor. F. E. B.

THE BRITISH ASSOCIATION.

SECTIONAL FORECAST.

THE destruction of the Colston Hall by fire, just when the preparations of the Local Committee for the Bristol meeting were complete, has given rise to serious difficulties. The best arrangements possible under the circumstances have been made. The People's Palace has been secured for the Presidential Address and for the Friday evening Discourse. For Monday evening the hall of the Young Men's Christian Association has been taken, the use of the People's Palace not being obtainable. Some inconvenience must inevitably arise; but the members will, it is hoped, make due allowance when they realise the difficult position in which the Local

Committee were suddenly placed within a week of the meeting.

In preparation for the Biological Exhibit at the Clifton Zoological Gardens, tanks, prepared at and stocked from the Marine Biological Association's Station at Plymouth, have been for some time in position, and the arrangements made for the continuous flow of water, under the skilful care of Mr. Allen, appear to be completely satisfactory. The Committee have had some disappointments; but it is hoped that, among other objects of interest, the crossed-breeds of cattle, Mr. Veitch's hybrid plants, Mr. E. J. Lowe's exhibit of ferns, Dr. Norton's illustrations of cuckoo eggs in the foster-parent nests, and Mr. Griffiths's entomological exhibit will, together with the Society's collection, which includes two recently born lions and a number of young pythons, form a centre of attraction.

The following will give some indication of the sectional prospects:—

In Section A (Mathematical and Physical Science) the President, Prof. Ayrton, delivers the address printed in this number of NATURE. Papers have already been received from Sir Geo. Stokes, Profs. Johnstone Stoney, Rijckerrorsel, Hele-Shaw, Oliver Lodge, MacGregor, and from Mr. E. H. Griffiths. A lengthy Report has been received from the Committee on Seismology. On Saturday the Section will meet as usual in two subdivisions, one taking papers dealing with Mathematics, and the other those dealing with Meteorology. On Monday a conjoint discussion with Section B will be opened by Prof. H. H. Turner, Captain Abney, and Prof. Thorpe on the results of the recent Solar Eclipse. There will be an international conference on Terrestrial Magnetism and Atmospheric Electricity, in connection with which Prof. Rücker will deliver a short address. Mr. Whittaker will report on the work in higher mathematics on which Cambridge graduates are engaged. Prof. A. P. Chattock reads a paper on "The velocity of the electricity in the electric wind," and a joint communication with Mr. S. R. Milner on "The thermal conductivity of water." Mr. F. B. Fawcett contributes a paper on "Standard high resistances," and Mr. T. W. Gifford one on "Lenses, not of glass."

In Section B (Chemistry) the subject of Prof. F. R. Japp's presidential address is "Stereochemistry and Vitalism." This address, which is an attempt to show that the results of modern stereochemical research preclude an explanation of the phenomena of life in terms of the mechanics of atoms, will be found in another part of the present number of NATURE. Prof. Ramsay and Dr. Morris Travers have promised a communication dealing with their recent researches on the constituents of the atmosphere; the title of their paper is "On the Extraction of the Companions of Argon and on Neon," and the spectra of the new gases will be shown at the soirée to be held at Clifton College. Prof. Sydney Young will contribute a paper on "Some researches on the thermal properties of gases and liquids," in which a summary of his important researches on the subject will be given; among points of more general interest will be a description of the methods employed by Dr. Young for the practical distillation of liquids, and their application to the separation of pure hydrocarbons from American petroleum. Dr. W. J. Russell will describe his interesting photographic investigations on "The action exerted by certain metals on a photographic plate," and will illustrate his paper by lantern slides. Dr. J. G. Parker will read a paper on "Recent advances in the tanning industry," which should be of considerable local interest, owing to the number of tanneries in Bristol and the neighbourhood. Amongst other papers promised are the following:—"On the cooling curves of fatty acids," by A. P. Laurie and E. H. Strange; "The analysis of soils in Derbyshire," by C. W. Luxmore; "An anomaly in the equivalent replacement of metals," by Prof. F. Clowes; three papers by Prof. W. R. E. Hodgkinson and Mr. A. H. Coote—"The action of ammonia gas upon guncotton," "Relations between chlorates and sulphates," "Compounds of SO_2 and amino-bases." Dr. R. S. Morrell and Mr. J. M. Crofts will contribute a paper on "The action of hydrogen peroxide on carbohydrates in presence of iron salts," and Prof. J. Wertheimer will read a paper on "The influence of examinations on the teaching of chemistry." The latter will be discussed together with the report of the Committee of the Section on "The teaching of natural science in elementary schools." Other reports of interest will be that of the Committee on "The action of light on dyed colours," and the results obtained by the Committee investigating the "Electrolytic methods of quantitative analysis"; the latter deals with the estimation of cobalt and nickel, contributed by Dr. Hugh Marshall, and with the estimation of zinc, contributed by Prof. Carlton Williams.

In Section C (Geology), Mr. W. H. Hudleston's presidential address will deal with certain points in the geology of the south-west of England. The papers promised also deal largely with the geology of southern Britain, and possess much local interest. Mr. A. Strahan summarises the recent work of the Survey in South Wales; Mr. Robert Etheridge contributes information on a subject of great public interest, the Kent coal-field in its relations with that of Belgium; Mr. E. B. Wethered will explain by means of lantern slides the action of microscopic organisms in building up the Carboniferous Limestones of Clifton; Mr. Bolton contributes a paper on Pleistocene mammals, based on the material collected by his predecessor the late Edward Wilson at Uphill. Prof. Lloyd Morgan gives some notes on local geology, illustrated by lantern slides. Prof. Hull will illustrate his well-known views on the Atlantic by an interesting series of new slides, and his paper ought to attract geographers also. The President of the Section promises a paper bearing on the same subject, and an interesting exchange of views may be expected. Prof. Blake's paper on "Aggregate deposits and their relation to zones" ought to promote lively discussion. Mr. Oldham will illustrate by means of slides the enormous extent and effects of the great Indian earthquake of 1897. Mr. Wheeler's paper on "The action of waves and tides on the movement of material on the sea-coast," concerns both geologists and engineers. Mr. Spencer contributes papers on mineralogical subjects. Prof. H. F. Osborn will speak on the early Lake-basins of the Rocky Mountains; and Prof. O. C. Marsh is expected to be present, and to speak on the preservation of type specimens. Among the Reports of Committees, two are the result of last year's visit to Canada, the first on the Canadian Pleistocene Flora and Fauna; the other on geological photographs. The collection of photographs of geological interest has been carried on for some years by a British Association Committee in Britain, who issue a report this year, and the second Canadian Report is from a similar Committee initiated in Toronto last year. The Irish Elk Committee describes a fairly perfect skeleton found in the Isle of Man; and the Coral Reef Committee will summarise the successful work commenced by Prof. Sollas, and continued by Edgeworth David.

In Section D (Zoology and Physiology) Prof. Weldon will, in his presidential address, urge the necessity of a statistical treatment of the problems of variation, inheritance, and selection. Mr. F. Galton will read an important paper on photographic records of pedigree stock in their bearing on heredity. Mr. Walter Garstang and Prof. McIntosh will contribute papers bearing on the fishery question. Dr. Willey will read a communication on the phylogeny of the vertebrate amnion; and Mr. Master-mann, on the origin of the vertebrate notochord and pharyngeal clefts. Miss Layard has promised papers on the development of the frog, and Dr. Mann on the structure of nerve-cells. Prof. Lloyd Morgan will probably speak on animal intelligence as an experimental study. There will be reports on the Canadian Biological Station, on bird migration, on the life-conditions of the oyster, and on the occupation of a table at the Naples Zoological Station.

In Section E (Geography) an unusual number of papers have been offered, and practically all of them will be illustrated by lantern slides, the more strictly scientific papers as well as those descriptive of little-known countries. Of the former class the presidential address, by Colonel G. E. Church, will deal with the origin of the surface features of southern South America; Mr. Ravenstein will present the report of a Committee on the climate of tropical Africa; Prof. Elisée Reclus will discuss some controverted features of his scheme for a great terrestrial globe; Mr. R. D. Oldham will give an account of the great earthquake in Assam; and Prof. Milne will describe recent seismological work in Italy. Oceanography will be represented by Dr. Natterer, who will summarise the results of the Austro-Hungarian deep-sea expeditions in the Eastern Mediterranean, Red Sea, and Sea of Marmora; and by Mr. H. N. Dickson, who will describe his recent researches on the salinity and temperature of the North Atlantic; while Dr. H. R. Mill will discuss the prospects of Antarctic exploration. Dr. J. W. Gregory will contribute a paper on the arrangement of continents and oceans on the earth's surface: and Mr. Vaughan-Cornish will deal with the geographical significance of waves in water, air and sand. Reports of recent expeditions will be given by Sir T. H. Holdich on Tirah, Mr. C. W. Andrews on Christmas Island, Mrs. Bishop on the Yang-tze-kiang, Mrs. Theodore Bent on the island of Sokotra, Mr. Barrett-Hamilton on Kamchatka, and Mr. Howarth on Mexico. It is uncertain if there will be any paper on African or Arctic exploration. Sir Benjamin Stone, M.P., will describe his work for the National Photographic Record; and Mr. G. G. Chisholm will discuss the timely subject of the economic resources of China.

In Section F (Economic Science and Statistics) the President, Dr. J. Bonar, will deal with "Old lights and new in economic study." There will be papers on "The sugar industry in Bristol" (Mr. G. E. Davies); on "Electrical enterprise and municipalities" (Mr. G. Pearson); on "Expenditure of middle class working women" (Miss C. Collet); on "Labour co partnership" (Mr. H. H. Vivian); on the "Bimetallic ratio" (Mr. L. L. Price); and on "Poor Law" (Mr. C. S. Loch).

In Section G (Mechanical Science) Sir John Wolfe-Barry will, in his presidential address, deal with the growth of British shipping and the recent and prospective demands for dock accommodation in Britain and in Bristol. He will also urge the necessity of experimental research. Among other papers we may note the following:—On the "Electric lighting system at Bristol" (H. F. Proctor); on the "Improvement of the waterway between the Bristol Channel and the Birmingham district" (Mr. E. D. Martin); on "Electric power and its application on the three-phase system to the Bristol Wagon Works" (Mr. W. Geipil); on the "Welsh methods of shipping coal" (Prof. J. Ryan); on "Some of the mechanical and economic features of the Coal question" (Mr. T. Forster Brown); on the "Conditions necessary for the successful treatment of sewage by bacteria" (Mr. T. Dibdin); and on "A new instrument for drawing envelopes, and its application to the teeth of wheels and for other purposes" (Prof. H. S. Hele-Shaw).

In Section H, the President, Mr. E. W. Brabrook, will take as his subject the unity of the anthropological sciences, and will suggest an ethnographical survey of the Empire. The papers promised are of varied interest, though, save for a paper by Prof. Lloyd Morgan on selection and segregation in the physical evolution of man, there is little on physical anthropology. Mrs. Bishop has promised an account of the Mantzu of Western-Sze-chuan, and Mr. Warington Smyth, notes on Siamese boats and music. For papers on folk-lore a larger proportion of time than usual has been reserved. Several communications will be made on American ethnology, including the final report of the Committee on the Western tribes of Canada, and Dr. Krauss's account of the Tarahumare people of Mexico. Sir Thomas Holdich will give a full account of the Afridis and Swatis of the frontier of India, which will naturally attract attention; while Mr. Crooke, the late director of the Ethnographical Survey of the North-west Provinces and Oudh, will speak on the characters and affinities of the Dravidian races of India. Miss Kingsley, M. le Comte Charles de Cardi, Mr. Fitzgerald Marriott, and Mr. C. H. Read, will contribute papers on various subjects relating to the native civilisations of West Africa. Prof. Flinders Petrie will give an account of recent discoveries in Egypt of the period of the first three dynasties, and M. Louis de Rougemont has promised a paper, which will probably be taken on Friday afternoon, on the tribes of North Australia, among whom he lived for many years. There will also be local papers. Mr. Arthur Bulleid will read one on the marsh village of Glastonbury, and Prof. Lloyd Morgan will illustrate by means of lantern slides the camps and megalithic remains near Bristol. The remarkable dry-walling of the Stoke Leigh camp, within a short walk, has been freed from débris and exposed to view.

In Section K, Prof. Bower's presidential address will deal with homology in plants and with the alternation of generations in green plants. Dr. Lang, of Glasgow, will open a discussion on alternation of generations, and will be followed by Prof. Klebs, of Basel. Mr. F. F. Blackman will lecture on the breathing mechanism of plants experimentally considered. Other papers promised include contributions on fungi, by Prof. Marshall Ward, Mr. Wager, and Mr. Biffen; on algæ, by Prof. Phillips and Mr. Lloyd Williams; on vascular cryptogams and gymnosperms (recent and fossil), by Dr. Scott and Messrs. Seward, Jones, and Pearson. A botanical excursion (probably to Cheddar Cliffs) also forms part of the programme.

As in previous years, we print in full the addresses of the president of the Association, and the presidents of Sections A and B. Other presidential addresses, and reports of the work of the Sections, will be published in subsequent numbers of Nature.

Inaugural Address by Sir William Crookes, F.R.S., V.P.C.S., President of the Association.

For the third time in its history the British Association meets in your City of Bristol. The first meeting was held under the presidency of the Marquis of Lansdowne in 1836, the second under the presidency of Sir John Hawkshaw in 1875. Formerly the President unrolled to the meeting a panorama of the year's progress in physical and biological sciences. To-day the President usually restricts himself to specialities connected with his own work, or deals with questions which for the time are uppermost. To be President of the British Association is undoubtedly a great honour. It is also a great opportunity and a great responsibility; for I know that, on the wings of the press, my words, be they worthy or not, will be carried to all points of the compass. I propose first to deal with the important question of the supply of bread to the inhabitants of these Islands, then to touch on subjects to which my life work has been more or less devoted. I shall not attempt any general survey of the sciences; these, so far as the progress in them demands attention, will be more fitly brought before you in the different Sections, either in the Addresses of the Presidents or in communications from Members.

Before proceeding with my address I wish to refer to the severe loss the British Association has sustained in the death of Lord Playfair. With Sir John Lubbock and Lord Rayleigh, Lord Playfair was one of the Permanent Trustees of our Association, and for many years he was present at our meetings. It would be difficult to overrate his loss to British science. Lord Playfair's well-matured and accurate judgment, his scientific knowledge, and his happy gift of clothing weighty thoughts in persuasive language, made his presence acceptable, whether in the council chamber, in departmental inquiries, or at light social gatherings, where by the singular laws of modern society, momentous announcements are sometimes first given to the world. Lord Playfair (then Sir Lyon Playfair) was President of the British Association at Aberdeen in 1885; his address on that occasion will long be remembered as a model of profound learning and luminous exposition.

And now I owe a sort of an apology to this brilliant audience. I must ask you to bear with me for ten minutes, for I am afraid what I now have to say will prove somewhat dull. I ought to propitiate you, for to tell the truth, I am bound to bore you with figures. Statistics are rarely attractive to a listening audience; but they are necessary evils, and those of this evening are unusually doleful. Nevertheless when we have proceeded a little way on our journey I hope you will see that the river of figures is not hopelessly dreary. The stream leads into an almost enexplored region, and to the right and left we see channels opening out, all worthy of exploration, and promising a rich reward to the statistic explorer who will trace them to their source—a harvest, as Huxley expresses it "immediately convertible into those things which the most sordidly practical of men will admit to have value, namely, money and life." My chief subject is of interest to the whole world—to every race—to every human being. It is of urgent importance to-day, and it is a life and death question for generations to come. I mean the question of food supply. Many of my statements you may think are of the alarmist order; certainly they are depressing, but they are founded on stubborn facts. They show that England and all civilised nations stand in deadly peril of not having enough to eat. As mouths multiply, food resources dwindle. Land is a limited quantity, and the land that will grow wheat is absolutely dependent on difficult and capricious natural phenomena. I am constrained to show that our wheat-producing soil is totally unequal to the strain put upon it. After wearying you with a survey of the universal dearth to be expected, I hope to point a way out of the colossal dilemma. It is the chemist who must come to the rescue of the threatened communities. It is through the laboratory that starvation may ultimately be turned into plenty.

The food supply of the kingdom is of peculiar interest to this meeting, considering that the grain trade has always been, and still is, an important feature in the imports of Bristol. The imports of grain to this city amount to about 25,000,000 bushels per annum—8,000,000 of which consist of wheat.

What are our home requirements in the way of wheat? The consumption of wheat per head of the population (unit consumption) is over 6 bushels per annum; and taking the population at 40,000,000, we require no less than 240,000,000 bushels of wheat, increasing annually by 2,000,000 bushels, to supply the increase of population. Of the total amount of wheat consumed in the United Kingdom we grow 25 and import 75 per cent.

So important is the question of wheat supply that it has attracted the attention of Parliament, and the question of national granaries has been mooted. It is certain that, in case of war with any of the great Powers, wheat would be contraband, as if it were cannon or powder, liable to capture even under a neutral flag. We must therefore accept the situation and treat wheat as munitions of war, and grow, accumulate, or store it as such. It has been shown that at the best our stock of wheat and flour amounts only to 64,000,000 bushels—fourteen weeks' supply—while last April our stock was equal to only 10,000,000 bushels, the smallest ever recorded by "Beerbohm" for the period of the season. Similarly, the stocks held in Europe, the United States, and Canada, called "the world's visible supply," amounted to only 54,000,000 bushels, or 10,000,000 less than last year's sum total, and nearly 82,000,000 less than that of 1893 or 1894 at the corresponding period. To arrest this impending danger, it has been proposed that an amount of 64,000,000 bushels of wheat should be purchased by the State and stored in national granaries, not to be opened, except to remedy deterioration of grain, or in view of national disaster rendering starvation imminent. This 64,000,000 bushels would add another fourteen weeks' life to the population; assuming that the ordinary stock had not been drawn on, the wheat in the country would only then be enough to feed the population for twenty-eight weeks.

I do not venture to speak authoritatively on national granaries. The subject has been discussed in the daily press, and the recently published Report from the Agricultural Committee on National Wheat Stores brings together all the arguments in favour of this important scheme, together with the difficulties to be faced if it be carried out with necessary completeness.

More hopeful, although difficult and costly, would be the alternative of growing most, if not all our own wheat supply here at home in the British Isles. The average yield over the United Kingdom last year was 29·07 bushels per acre, the average for the last eleven years being 29·46. For twelve months we need 240,000,000 bushels of wheat, requiring about 8,250,000 acres of good wheat-growing land, or nearly 13,000 square miles, increasing at the rate of 100 square miles per annum, to render us self-supporting as to bread food. This area is about one-fourth the size of England.

A total area of land in the United Kingdom equal to a plot 110 miles square, of quality and climate sufficient to grow wheat to the extent of 29 bushels per acre, does not seem a hopeless demand.[1] It is doubtful, however, if this amount of land could be kept under wheat, and the necessary expense of high farming faced, except under the imperious pressure of impending starvation, or the stimulus of a national subsidy or permanent high prices. Certainly these 13,000 square miles would not be available under ordinary economic conditions, for much, perhaps all, the land now under barley and oats would not be suitable for wheat. In any case, owing to our cold, damp climate and capricious weather, the wheat crop is hazardous, and for the present our annual deficit of 180,000,000 bushels must be imported. A permanently higher price for wheat is, I fear, a calamity that ere long must be faced. At enhanced prices, land now under wheat will be better farmed, and therefore will yield better, thus giving increased production without increased area.

The burning question of to-day is, What can the United Kingdom do to be reasonably safe from starvation in presence of two successive failures of the world's wheat harvest, or against a hostile combination of European nations? We eagerly spend millions to protect our coasts and commerce; and millions more on ships, explosives, guns, and men; but we omit to take necessary precautions to supply ourselves with the very first and supremely important munition of war—food.

To take up the question of food-supply in its scientific aspect, I must not confine myself exclusively to our own national requirements. The problem is not restricted to the British Isles—the bread-eaters of the whole world share the perilous prospect—and I do not think it out of place if on this occasion I ask you to take with me a wide, general survey of the wheat supply of the whole world.

Wheat is the most sustaining food grain of the great Caucasian race, which includes the peoples of Europe, United States, British America, the white inhabitants of South Africa, Australasia, parts of South America, and the white population of the European colonies. Of late years the individual consumption of wheat has almost universally increased. In Scandinavia it has risen 100 per cent. in twenty-five years; in Austro-Hungary, 80 per cent.; in France, 20 per cent.; while in Belgium it has increased 50 per cent. Only in Russia and Italy, and possibly Turkey, has the consumption of wheat per head declined.

In 1871 the bread-eaters of the world numbered 371,000,000. In 1881 the numbers rose to 416,000,000; in 1891, to 472,600,000, and at the present time they number 516,500,000. The augmentation of the world's bread-eating population in a geometrical ratio is evidenced by the fact that the yearly aggregates grow progressively larger. In the early seventies they rose 4,300,000 per annum, while in the eighties they increased by more than 6,000,000 per annum, necessitating annual additions to the bread supply nearly one-half greater than sufficed twenty-five years ago.

How much wheat will be required to supply all these hungry mouths with bread? At the present moment it is not possible

[1] The total area of the United Kingdom is 120,979 square miles; therefore the required land is about a tenth part of the total.

to get accurate estimates of this year's wheat crops of the world, but an adequate idea may be gained from the realised crops of some countries and the promise of others. To supply 516,500,000 bread-eaters, if each bread-eating unit is to have his usual ration, will require a total of 2,324,000,000 bushels for seed and food. What are our prospects of obtaining this amount?

According to the best authorities the total supplies from the 1897-98 harvest are 1,921,000,000 bushels. The requirement of the 516,500,000 bread-eaters for seed and food are 2,324,000,000 bushels; there is thus a deficit of 403,000,000 bushels, which has not been urgently apparent owing to a surplus of 300,000,000 bushels carried over from the last harvest. Respecting the prospects of the harvest year just beginning it must be borne in mind that there are no remainders to bring over from last harvest. We start with a deficit of 103,000,000 bushels and have 6,500,000 more mouths to feed. It follows, therefore, that one-sixth of the required bread will be lacking unless larger drafts than now seem possible can be made upon early produce from the next harvest.

The majority of the wheat crops between 1882 and 1896 were in excess of current needs, and thus considerable reserves of wheat were available for supplementing small deficits from the four deficient harvests. But bread-eaters have almost eaten up the reserves of wheat, and the 1897 harvest being under average, the conditions become serious. That scarcity and high prices have not prevailed in recent years is due to the fact that since 1889 we have had seven world crops of wheat and six of rye abundantly in excess of the average. These generous crops increased accumulations to such an extent as to obscure the fact that the harvests of 1895 and 1896 were each much below current requirements. Practically speaking, reserves are now exhausted, and bread-eaters must be fed from current harvests—accumulation under present conditions being almost impossible. This is obvious from the fact that a harvest equal to that of 1894 (the greatest crop on record, both in acre-yield and in the aggregate) would yield less than current needs.

It is clear we are confronted with a colossal problem that must tax the wits of the wisest. When the bread-eaters have exhausted all possible supplies from the 1897-98 harvest, there will be a deficit of 103,000,000 bushels of wheat, with no substitution possible unless Europeans can be induced to eat Indian corn or rye bread. Up to recent years the growth of wheat has kept pace with demands. As wheat-eaters increased, the acreage under wheat expanded. The world has become so familiarised with the orderly sequence of demand and supply, so accustomed to look upon the vast plains of other wheat-growing countries as inexhaustible granaries, that, in a light-hearted way, it is taken for granted that so many million additional acres can be added year after year to the wheat-growing area of the world. We forget that the wheat-growing area is of strictly limited extent, and that a few million acres regularly absorbed, soon mount to a formidable number.

The present position being so gloomy, let us consider future prospects. What are the capabilities as regards available area, economic conditions, and acreage yield of the wheat-growing countries from whence we now draw our supply?

For the last thirty years the United States have been the dominant factor in the foreign supply of wheat, exporting no less than 145,000,000 bushels. This shows how the bread-eating world has depended, and still depends, on the United States for the means of subsistence. The entire world's contributions to the food-bearing area have averaged but 4,000,000 acres yearly since 1869. It is scarcely possible that such an average, under existing conditions, can be doubled for the coming twenty-five years. Almost yearly, since 1885, additions to the wheat-growing area have diminished, while the requirements of the increasing population of the States have advanced, so that the needed American supplies have been drawn from the acreage hitherto used for exportation. Practically there remains no uncultivated prairie land in the United States suitable for wheat-growing. The virgin land has been rapidly absorbed, until at present there is no land left for wheat without reducing the area for maize, hay, and other necessary crops.

It is almost certain that within a generation the ever increasing population of the United States will consume all the wheat grown within its borders, and will be driven to import, and, like ourselves, will scramble for a lion's share of the wheat crop of the world. This being the outlook, exports of wheat from the United States are only of present interest, and will gradually diminish to a vanishing point. The inquiry may be restricted to such countries as probably will continue to feed bread-eaters who annually derive a considerable part of their wheat from extraneous sources.

But if the United States, which grow about one-fifth of the world's wheat, and contribute one-third of all wheat exportations, are even now dropping out of the race, and likely soon to enter the list of wheat-importing countries, what prospect is there that other wheat-growing countries will be able to fill the gap, and by enlarging their acreage under wheat, replace the supply which the States have so long contributed to the world's food? The withdrawal of 145 million bushels will cause a serious gap in the food supply of wheat importing countries, and unless this deficit can be met by increased supplies from other countries there will be a dearth for the rest of the world after the British Isles are sufficiently supplied.

Next to the United States Russia is the greatest wheat exporter, supplying nearly 95 million bushels.

Although Russia at present exports so lavishly, this excess is merely provisional and precarious. The Russian peasant population increases more rapidly than any other in Europe. The yield per acre over European Russia is meagre—not more than 8·6 bushels to the acre—while some authorities consider it as low as 4·6 bushels. The cost of production is low—lower even than on the virgin soils of the United States. The development of the fertile though somewhat overrated "black earth," which extends across the southern portion of the empire and beyond the Ural Mountains into Siberia, progresses rapidly. But, as we have indicated, the consumption of bread in Russia has been reduced to danger point. The peasants starve and fall victims to "hunger typhus," whilst the wheat growers export grain that ought to be consumed at home.

Considering Siberia as a wheat grower, climate is the first consideration. Summers are short—as they are in all regions with continental climates north of the 45th parallel—and the ripening of wheat requires a temperature averaging at least 65° Fahr. for fifty-five to sixty-five days. As all Siberia lies north of the summer isotherm of 65° it follows that such region is ill adapted to wheat culture unless some compensating climatic condition exists. As a fact, the conditions are exceptionally unfavourable in all but very limited districts in the two westernmost governments. The cultivable lands of Western Siberia adapted to grain-bearing neither equal in extent nor in potential productive powers those of Iowa, Minnesota, and Nebraska. There are limited tracts of fair productiveness in Central Siberia and in the valleys of the southern affluents of the Amoor, but these are only just capable of supporting a meagre population.

Prince Hilkoff, Russian Minister of Ways and Communications, declared in 1896 that "Siberia never had produced, and never would produce, wheat and rye enough to feed the Siberian population." And, a year later, Prince Kropotkin backed the statement as substantially correct.

Those who attended the meeting of the British Association last year in Canada must have been struck with the extent and marvellous capacity of the fertile plains of Manitoba and the North-west Provinces. Here were to be seen 1,290,000 acres of fine wheat-growing land yielding 18,261,950 bushels, one-fifth of which comes to hungry England. Expectations have been cherished that the Canadian North-west would easily supply the world with wheat, and exaggerated estimates are drawn as to the amount of surplus land on which wheat can be grown. Thus far performance has lagged behind promise, the wheat-bearing area of all Canada having increased less than 500,000 acres since 1884, while the exports have not increased in greater proportion. As the wheat area of Manitoba and the North-west has increased the wheat area of Ontario and the Eastern provinces has decreased, the added acres being little more than sufficient to meet the growing requirements of population. We have seen calculations showing that Canada contains 500,000,000 acres of profitable wheat land. The impossibility of such an estimate ever being fulfilled will be apparent when it is remembered that the whole area employed in both temperate zones for growing all the staple food crops is not more than 580,000,000 acres, and that in no country has more than 9 per cent. of the area been devoted to wheat culture.

The fertility of the North-west Provinces of the Dominion is due to an exceptional and curious circumstance. In winter the ground freezes to a considerable depth. Wheat is sown in the spring, generally April, when the frozen ground has been thawed to a depth of three inches. Under the hot sun of the short summer the grain sprouts with surprising rapidity, partly because the roots are supplied with water from the thawing depths. The summer is too short to thaw the ground thoroughly, and gate-posts or other dead wood extracted in autumn are found still frozen at their lower ends.

Australasia as a potential contributor to the world's supply of wheat affords another fertile field for speculation. Climatic conditions limit the Australian wheat area to a small portion of the southern littoral belt. Prof. Shelton considers there are still fifty million acres in Queensland suitable for wheat, but hitherto it has never had more than 150,000 acres under cultivation. Crops in former days were liable to rust, but since the Rust in Wheat conferences and the dissemination of instruction to farmers, rust no longer has any terrors. I am informed by the Queensland Department of Agriculture that of late years they practically have bred wheat vigorous enough to resist this plague. For the second season in succession the wheat crop last year was destroyed over large areas in Victoria; and in South Australia the harvest averaged not more than about $3\frac{2}{3}$ bushels per acre after meeting Colonial requirements for food and seed, leaving only 684,000 bushels for export. In most other districts the yield falls to such an extent as to cause Europeans to wonder why the pursuit of wheat-raising is continued

New Zealand has a moist climate resembling that of central and southern England, while South Australia is semi-arid, resembling Western Kansas. Only two countries in the world yield as much wheat per acre as New Zealand—these are Denmark and the United Kingdom. Notwithstanding the great yield of wheat, due to an equable climate, New Zealand finds fruit and dairy farming still more profitable. The climatic conditions favourable to wheat are also conducive to luxuriant growths of nutritious grasses. Thus the New Zealander ships his butter more than half-way round the world, and competes successfully with western Europe.

During the last twenty-seven years the Austro-Hungarian population has increased 21·8 per cent., as against an increase of 54·6 per cent. in the acreage of wheat. Notwithstanding this disparity in the rates of increase, exports have practically ceased by reason of an advance of nearly 80 per cent. in unit consumption. There can be little doubt that Austro-Hungary is about to enter the ranks of importing nations, although in Hungary a considerable area of wheat land remains to be brought under cultivation.

Roumania is an important wheat-growing country. In 1896 it produced 69,000,000 bushels, and exported 34,000,000 bushels. It has a considerable amount of surplus land which can be used for wheat, although for many years the wheat area is not likely to exceed home requirements.

France comes next to the United States as a producer of wheat; but for our purpose she counts but little, being dependent on supplies from abroad for an average quantity of 14 per cent. of her own production. There is practically no spare land in France that can be put under wheat in sufficient quantity to enable her to do more than provide for increase of population.

Germany is a gigantic importer of wheat, her imports rising 700 per cent. in the last twenty-five years, and now averaging 35,000,000 bushels. Other nations of Europe, also importers, do not require detailed mention, as under no conceivable conditions would they be able to do more than supply wheat for the increasing requirements of their local population, and, instead of replenishing, would probably diminish, the world's stores.

The prospective supply of wheat from Argentina and Uruguay has been greatly overrated. The agricultural area includes less than 100,000,000 acres of good, bad, and indifferent land, much of which is best adapted for pastoral purposes. There is no prospect of Argentina ever being able to devote more than 30,000,000 acres to wheat; the present wheat area is about 6,000,000 acres, an area that may be doubled in the next twelve years. But the whole arable region is subject to great climatic vicissitudes, and to frosts that ravage the fields south of the 37th parallel. Years of systematised energy are frustrated in a few days—perhaps hours—by a single cruelty of nature, such as a plague of locusts, a tropical rain, or a devastating hail storm. It will take years to bring the surplus lands of Argentina into cultivation, and the population is even now insufficient to supply labour at seed time and harvest.

During the next twelve years, Uruguay may add a million acres to the world's wheat fields, but social, political, and economic conditions seriously interfere with agricultural development.

At the present time South Africa is an importer of wheat, and the regions suitable to cereals do not exceed a few million acres. Great expectations have been formed as to the fertility of Mashonaland, the Shire Islands, and the Kikuyu plateau, and as to the adaptation of these regions to the growth of wheat. But wheat culture fails where the banana ripens, and the banana flourishes throughout Central Africa, except in limited areas of great elevation. In many parts of Africa insect pests render it impossible to store grain, and without grain-stores there can be little hope of large exports.

North Africa, formerly the granary of Rome, now exports less than 5,000,000 bushels of wheat annually, and these exports are on the decline, owing to increased home demands. With scientific irrigation, Egypt could supply three times her present amount of wheat, although no increase is likely unless the cotton fields of the Delta are diverted to grain growing. In Algeria and Tunis nearly all reclaimed lands are devoted to the production of wine, for which a brisk demand exists. Were this land devoted to the growth of wheat, an additional five million bushels might be obtained.

The enormous acreage devoted to wheat in India has been declining for some years, and in 1895 over 20,000,000 acres yielded 185,000,000 bushels. Seven-eighths of this harvest is required for native consumption, and only one-eighth on an average is available for export. The annual increase of population is more than 3,000,000, demanding an addition to the food-bearing lands of not less than 1,800,000 acres annually. In recent years the increase has been less than one-fourth of this amount.

In surveying the limitations and vicissitudes of wheat crops, I have endeavoured to keep free from exaggeration, and have avoided insistance on doubtful points. I have done my best to get trustworthy facts and figures, but from the nature of the case it is impossible to attain complete accuracy. Great caution is required in sifting the numerous varying current statements respecting the estimated areas and total produce of wheat throughout the world. The more closely official estimates are examined, the more defective are they found, and comparatively few figures are sufficiently well established to bear the deductions often drawn. In doubtful cases I have applied to the highest authorities in each country, and in the case of conflicting accounts have taken data the least favourable to sensational or panic-engendering statements. In a few instances of accurate statistics their value is impaired by age; but for 95 per cent. of my figures I quote good authorities, while for the remaining 5 per cent. I rely on the best commercial estimates derived from the appearance of the growing crops, the acreage under cultivation, and the yield last year. The maximum probable error would make no appreciable difference in my argument.

The facts and figures I have set before you are easily interpreted. Since 1871 unit consumption of wheat, including seed, has slowly increased in the United Kingdom to the present amount of 6 bushels per head per annum; while the rate of consumption for seed and food by the whole world of bread-eaters was 4·15 bushels per unit per annum for the eight years ending 1878, and at the present time is 4·5 bushels. Under present conditions of low acre yield, wheat cannot long retain its dominant position among the food-stuffs of the civilised world. The details of the impending catastrophe no one can predict, but its general direction is obvious enough. Should all the wheat-growing countries add to their area to the utmost capacity, on the most careful calculation the yield would give us only an addition of some 100,000,000 acres, supplying at the average world-yield of 12·7 bushels to the acre, 1,270,000,000 bushels, just enough to supply the increase of population among bread-eaters till the year 1931.

At the present time there exists a deficit in the wheat area of 31,000 square miles—a deficit masked by the fact that the ten world crops of wheat harvested in the ten years ending 1896 were more than 5 per cent. above the average of the previous twenty-six years.

When provision shall have been made, if possible, to feed 230,000,000 units likely to be added to the bread-eating population by 1931—by the complete occupancy of the arable areas of the temperate zone now partially occupied—where can be grown the additional 330,000,000 bushels of wheat required ten years later by a hungry world? What is to happen if the present rate of population be maintained, and if arable areas of sufficient extent cannot be adapted and made contributory to the subsistence of so great a host?

Are we to go hungry and to know the trial of scarcity? That is the poignant question. Thirty years is but a day in the life of a nation. Those present who may attend the meeting of the British Association thirty years hence will judge how far my forecasts are justified.

If bread fails—not only us, but all the bread-eaters of the world—what are we to do? We are born wheat-eaters. Other races, vastly superior to us in numbers, but differing widely in material and intellectual progress, are eaters of Indian corn, rice, millet, and other grains; but none of these grains have the food value, the concentrated health-sustaining power of wheat, and it is on this account that the accumulated experience of civilised mankind has set wheat apart as the fit and proper food for the development of muscle and brains.

It is said that when other wheat-exporting countries realise that the States can no longer keep pace with the demand, these countries will extend their area of cultivation, and struggle to keep up the supply *pari passu* with the falling off in other quarters. But will this comfortable and cherished doctrine bear the test of examination?

Cheap production of wheat depends on a variety of causes, varying greatly in different countries. Taking the cost of producing a given quantity of wheat in the United Kingdom at 100*s*., the cost for the same amount in the United States is 67*s*., in India 66*s*., and in Russia 54*s*. We require cheap labour, fertile soil, easy transportation to market, low taxation and rent, and no export or import duties. Labour will rise in price, and fertility diminish as the requisite manurial constituents in the virgin soil become exhausted. Facility of transportation to market will be aided by railways, but these are slow and costly to construct, and it will not pay to carry wheat by rail beyond a certain distance. These considerations show that the price of wheat tends to increase. On the other hand, the artificial impediments of taxation and customs duties tend to diminish as demand increases and prices rise.

I have said that starvation may be averted through the laboratory. Before we are in the grip of actual dearth the chemist will step in and postpone the day of famine to so distant a period that we, and our sons and grandsons, may legitimately live without undue solicitude for the future.

It is now recognised that all crops require what is called a "dominant" manure. Some need nitrogen, some potash, others phosphates. Wheat pre-eminently demands nitrogen, fixed in the form of ammonia or nitric acid. All other necessary constituents exist in the soil; but nitrogen is mainly of atmospheric origin, and is rendered "fixed" by a slow and precarious process which requires a combination of rare meteorological and geographical conditions to enable it to advance at a sufficiently rapid rate to become of commercial importance.

There are several sources of available nitrogen. The distillation of coal in the process of gas-making yields a certain amount of its nitrogen in the form of ammonia; and this product, as sulphate of ammonia, is a substance of considerable commercial value to gas companies. But the quantity produced is comparatively small; all Europe does not yield more than 400,000 annual tons, and, in view of the unlimited nitrogen required to substantially increase the world's wheat crop, this slight amount of coal ammonia is not of much significance. For a long time guano has been one of the most important sources of nitrogenous manures, but guano deposits are so near exhaustion that they may be dismissed from consideration.

Much has been said of late years, and many hopes raised by the discovery of Hellriegel and Wilfarth, that leguminous plants bear on their roots nodosities abounding in bacteria endowed with the property of fixing atmospheric nitrogen; and it is proposed that the necessary amount of nitrogen demanded by grain crops should be supplied to the soil by cropping it with clover and ploughing in the plant when its nitrogen assimilisation is complete. But it is questionable whether such a mode of procedure will lead to the lucrative stimulation of crops. It must be admitted that practice has long been ahead of science, and for ages farmers have valued and cultivated leguminous crops. The four-course rotation is turnips, barley, clover, wheat—a sequence popular more than two thousand years ago. On the continent, in certain localities, there has been some extension of microbe cultivation; at home we have not reached even the experimental stage. Our present knowledge leads to the conclusion that the much more frequent growth of clover on the same land, even with successful microbe-seeding and proper mineral supplies, would be attended with uncertainty and difficulties. The land soon becomes what is called "clover sick" and turns barren.

There is still another and invaluable source of fixed nitrogen. I mean the treasure locked up in the sewage and drainage of our towns. Individually the amount so lost is trifling, but multiply the loss by the number of inhabitants, and we have the startling fact that, in the United Kingdom, we are content to hurry down our drains and water-courses, into the sea, fixed nitrogen to the value of no less than 16,000,000*l*. per annum. This unspeakable waste continues, and no effective and universal method is yet contrived of converting sewage into corn. Of this barbaric waste of manurial constituents Liebig, nearly half a century ago, wrote in these prophetic words: "Nothing will more certainly consummate the ruin of England than a scarcity of fertilisers—it means a scarcity of food. It is impossible that such a sinful violation of the divine laws of nature should for ever remain unpunished; and the time will probably come for England sooner than for any other country, when, with all her wealth in gold, iron, and coal, she will be unable to buy one-thousandth part of the food which she has, during hundreds of years, thrown recklessly away."

The more widely this wasteful system is extended, recklessly returning to the sea what we have taken from the land, the more surely and quickly will the finite stocks of nitrogen locked up in the soils of the world become exhausted. Let us remember that the plant creates nothing; there is nothing in bread which is not absorbed from the soil, and unless the abstracted nitrogen is returned to the soil, its fertility must ultimately be exhausted. When we apply to the land nitrate of soda, sulphate of ammonia, or guano, we are drawing on the earth's capital, and our drafts will not perpetually be honoured. Already we see that a virgin soil cropped for several years loses its productive powers, and without artificial aid becomes infertile. Thus the strain to meet demands is increasingly great. Witness the yield of forty bushels of wheat per acre under favourable conditions, dwindling through exhaustion of soil to less than seven bushels of poor grain, and the urgency of husbanding the limited store of fixed nitrogen becomes apparent. The store of nitrogen in the atmosphere is practically unlimited, but it is fixed and rendered assimilable by plants only by cosmic processes of extreme slowness. The nitrogen which with a light heart we liberate in a battleship broadside, has taken millions of minute organisms patiently working for centuries to win from the atmosphere.

The only available compound containing sufficient fixed nitrogen to be used on a world-wide scale as a nitrogenous manure is nitrate of soda, or Chili saltpetre. This substance occurs native over a narrow band of the plain of Tamarugal, in the northern provinces of Chili between the Andes and the coast hills. In this rainless district for countless ages the continuous fixation of atmospheric nitrogen by the soil, its conversion into nitrate by the slow transformation of billions of nitrifying organisms, its combination with soda, and the crystallisation of the nitrate have been steadily proceeding, until the nitrate fields of Chili have become of vast commercial importance, and promise to be of inestimably greater value in the future. The growing exports of nitrate from Chili at present amount to about 1,200,000 tons.

The present acreage devoted to the world's growth of wheat is about 163,000,000 acres. At the average of 12·7 bushels per acre this gives 2,070,000,000 bushels. But thirty years hence the demand will be 3,260,000,000 bushels, and there will be difficulty in finding the necessary acreage on which to grow the additional amount required. By increasing the present yield per acre from 12·7 to 20 bushels we should with our present acreage secure a crop of the requisite amount. Now from 12·7 to 20 bushels per acre is a moderate increase of productiveness, and there is no doubt that a dressing with nitrate of soda will give this increase and more.

The action of nitrate of soda in improving the yield of wheat has been studied practically by Sir John Lawes and Sir Henry Gilbert on their experimental field at Rothamsted. This field was sown with wheat for thirteen consecutive years without manure, and yielded an average of 11·9 bushels to the acre. For the next thirteen years it was sown with wheat, and dressed with 5 cwt. of nitrate of soda per acre, other mineral constituents also being present. The average yield for these years was 36·4 bushels per acre—an increase of 24·5 bushels. In other words, 22·86 lbs. of nitrate of soda produce an increase of one bushel of wheat.

At this rate, to increase the world's crop of wheat by 7·3 bushels, about 1½ cwt. of nitrate of soda must annually be applied to each acre. The amount required to raise the world's crop on 163,000,000 acres from the present supply of 2,070,000,000 bushels to the required 3,260,000,000 bushels will be 12 million tons distributed in varying amounts over the wheat-growing countries of the world. The countries which produce more than the average of 12·7 bushels will require less, and those below the average will require more; but, broadly speaking, about 12,000,000 tons annually of nitrate of soda will be required, in addition to the 1¼ million tons already absorbed by the world.

It is difficult to get trustworthy estimates of the amount of nitrate surviving in the nitre beds. Common rumour declares the supply to be inexhaustible, but cautious local authorities state that at the present rate of export, of over one million tons per annum, the raw material "caliche," containing from 25 to 50 per cent. nitrate, will be exhausted in from twenty to thirty years.

Dr. Newton, who has spent years on the nitrate fields, tells me there is a lower class material, containing a small proportion of nitrate, which cannot at present be used, but which may ultimately be manufactured at a profit. Apart from a few of the more scientific manufacturers, no one is sanguine enough to think this debatable material will ever be worth working. If we assume a liberal estimate for nitrate obtained from the lower grade deposit, and say that it will equal in quantity that from the richer quality, the supply may last, possibly, fifty years, at the rate of a million tons a year; but at the rate required to augment the world's supply of wheat to the point demanded thirty years hence, it will not last more than four years.

I have passed in review all the wheat-growing countries of the world, with the exception of those whose united supplies are so small as to make little appreciable difference to the argument. The situation may be summed up briefly thus:—The world's demand for wheat—the leading bread-stuff—increases in a crescendo ratio year by year. Gradually all the wheat-bearing land on the globe is appropriated to wheat-growing, until we are within measurable distance of using the last available acre. We must then rely on nitrogenous manures to increase the fertility of the land under wheat, so as to raise the yield from the world's low average—12·7 bushels per acre—to a higher average. To do this efficiently and feed the bread-eaters for a few years will exhaust all the available store of nitrate of soda. For years past we have been spending fixed nitrogen at a culpably extravagant rate, heedless of the fact that it is fixed with extreme slowness and difficulty, while its liberation in the free state takes place always with rapidity and sometimes with explosive violence.

Some years ago Mr. Stanley Jevons uttered a note of warning as to the near exhaustion of our British coalfields. But the exhaustion of the world's stock of fixed nitrogen is a matter of far greater importance. It means not only a catastrophe little short of starvation for the wheat-eaters, but indirectly, scarcity for those who exist on inferior grains, together with a lower standard of living for meat-eaters, scarcity of mutton and beef, and even the extinction of gunpowder!

There is a gleam of light amid this darkness of despondency. In its free state nitrogen is one of the most abundant and pervading bodies on the face of the earth. Every square yard of the earth's surface has nitrogen gas pressing down on it to the extent of about seven tons—but this is in the *free* state, and wheat demands it *fixed*. To convey this idea in an object-lesson, I may tell you that, previous to its destruction by fire, Colston Hall, measuring 146 feet by 80 feet by 70 feet, contained 27 tons weight of nitrogen in its atmosphere; it also contained one-third of a ton of argon. In the free gaseous state this nitrogen is worthless; combined in the form of nitrate of soda it would be worth about 2000*l*.

For years past attempts have been made to effect the fixation of atmospheric nitrogen, and some of the processes have met with sufficient partial success to warrant experimentalists in pushing their trials still further; but I think I am right in saying that no process has yet been brought to the notice of scientific or commercial men which can be considered successful either as regards cost or yield of product. It is possible, by several methods, to fix a certain amount of atmospheric nitrogen; but to the best of my knowledge no process has hitherto converted more than a small amount, and this at a cost largely in excess of the present market value of fixed nitrogen.

The fixation of atmospheric nitrogen therefore is one of the great discoveries awaiting the ingenuity of chemists. It is certainly deeply important in its practical bearings on the future welfare and happiness of the civilised races of mankind. This unfulfilled problem, which so far has eluded the strenuous attempts of those who have tried to wrest the secret from nature, differs materially from other chemical discoveries which are in the air, so to speak, but are not yet matured. The fixation of nitrogen is vital to the progress of civilised humanity. Other discoveries minister to our increased intellectual comfort, luxury, or convenience; they serve to make life easier, to hasten the acquisition of wealth, or to save time, health, or worry. The fixation of nitrogen is a question of the not far distant future. Unless we can class it among certainties to come the great Caucasian race will cease to be foremost in the world, and will be squeezed out of existence by races to whom wheaten bread is not the staff of life.

Let me see if it is not possible even now to solve the momentous problem. As far back as 1892 I exhibited, at one of the soirées of the Royal Society, an experiment on "The Flame of Burning Nitrogen." I showed that nitrogen is a combustible gas, and the reason why when once ignited the flame does not spread through the atmosphere and deluge the world in a sea of nitric acid is that its igniting point is higher than the temperature of its flame—not, therefore, hot enough to set fire to the adjacent mixture. But by passing a strong induction current between terminals the air takes fire and continues to burn with a powerful flame, producing nitrous and nitric acids. This inconsiderable experiment may not unlikely lead to the development of a mighty industry destined to solve the great food problem. With the object of burning out nitrogen from air so as to leave argon behind, Lord Rayleigh fitted up apparatus for performing the operation on a larger scale, and succeeded in effecting the union of 29·4 grammes of mixed nitrogen and oxygen at an expenditure of one horse-power. Following these figures it would require one Board of Trade unit to form 74 grammes of nitrate of soda, and therefore 14,000 units to form one ton. To generate electricity in the ordinary way with steam engines and dynamos, it is now possible with a steady load night and day, and engines working at maximum efficiency, to produce current at a cost of one-third of a penny per Board of Trade unit. At this rate one ton of nitrate of soda would cost 26*l*. But electricity from coal and steam engines is too costly for large industrial purposes; at Niagara, where water power is used, electricity can be sold at a profit for one-seventeenth of a penny per Board of Trade unit. At this rate nitrate of soda would cost not more than 5*l*. per ton. But the limit of cost is not yet reached, and it must be remembered that the initial data are derived from small scale experiments, in which the object was not economy, but rather to demonstrate the practicability of the combustion method, and to utilise it for isolating argon. Even now electric nitrate at 5*l*. a ton compares favourably with Chili nitrate at 7*l*. 10*s*. a ton; and all experience shows that when the road has been pointed out by a small laboratory experiment, the industrial operations that may follow are always conducted at a cost considerably lower than could be anticipated from the laboratory figures.

Before we decide that electric nitrate is a commercial possibility, a final question must be mooted. We are dealing with wholesale figures, and must take care that we are not simply shifting difficulties a little further back without really diminishing them. We start with a shortage of wheat, and the natural remedy is to put more land under cultivation. As the land cannot be stretched, and there is so much of it and no more, the object is to render the available area more productive by a dressing with nitrate of soda. But nitrate of soda is limited in quantity, and will soon be exhausted. Human ingenuity can contend even with these apparently hopeless difficulties. Nitrate can be produced artificially by the combustion of the atmosphere. Here we come to finality in one direction; our stores are inexhaustible. But how about electricity? Can we generate enough energy to produce 12,000,000 tons of nitrate of soda annually? A preliminary calculation shows that there need be no fear on that score; Niagara alone is capable of supplying the required electric energy without much lessening its mighty flow.

The future can take care of itself. The artificial production of nitrate is clearly within view, and by its aid the land devoted to wheat can be brought up to the thirty bushels per acre standard. In days to come, when the demand may again overtake supply, we may safely leave our successors to grapple with the stupendous food problem.

And, in the next generation, instead of trusting mainly to food-stuffs which flourish in temperate climates, we probably shall trust more and more to the exuberant food-stuffs of the tropics, where, instead of one yearly sober harvest, jeopardised by any shrinkage of the scanty days of summer weather, or of the few steady inches of rainfall, nature annually supplies heat and water enough to ripen two or three successive crops of food-stuffs in extraordinary abundance. To mention one plant alone, Humboldt—from what precise statistics I know not—computed that, acre for acre, the food-productiveness of the banana is 133 times that of wheat; the unripe banana, before its starch is converted into sugar, is said to make excellent bread.

Considerations like these must in the end determine the range and avenues of commerce, perhaps the fate of continents. We must develop and guide nature's latent energies, we must utilise her inmost workshops, we must call into commercial existence Central Africa and Brazil to redress the balance of Odessa and Chicago.

Having kept you for the last half-hour rigorously chained to earth, disclosing dreary possibilities, it will be a relief to soar to the heights of pure science and to discuss a point or two touching its latest achievements and aspirations. The low temperature researches which bring such renown to Prof. Dewar and to his laboratory in the Royal Institution have been crowned during the present year by the conquest of one of nature's most defiant strongholds. On May 10 last Prof. Dewar wrote to me these simple but victorious words: "This evening I have succeeded in liquefying both hydrogen and helium. The second stage of low temperature work has begun." Static hydrogen boils at a temperature of 238° C. at ordinary pressure, and at 250° C. in a vacuum, thus enabling us to get within 23° C. of absolute zero. The density of liquid hydrogen is only one-fourteenth that of water, yet in spite of such a low density it collects well, drops easily, and has a well-defined meniscus. With proper isolation it will be as easy to manipulate liquid hydrogen as liquid air.

The investigation of the properties of bodies brought near the absolute zero of temperature is certain to give results of extraordinary importance. Already platinum resistance thermometers are becoming useless, as the temperature of boiling hydrogen is but a few degrees from the point where the resistance of platinum would be practically nothing, or the conductivity infinite.

Several years ago I pondered on the constitution of matter in what I ventured to call the fourth state. I endeavoured to probe the tormenting mystery of the atom. What *is* the atom? Is a single atom in space solid, liquid, or gaseous? Each of these states involves ideas which can only pertain to vast collections of atoms. Whether, like Newton, we try to visualise an atom as a hard, spherical body, or, with Boscovitch and Faraday, to regard it as a centre of force, or accept the vortex atom theory of Lord Kelvin, an isolated atom is an unknown entity difficult to conceive. The properties of matter—solid, liquid, gaseous—are due to molecules in a state of motion. Therefore, matter as we know it involves essentially a mode of motion; and the atom itself—intangible, invisible, and inconceivable—is its material basis, and may, indeed, be styled the only true *matter*. The space involved in the motions of atoms has no more pretension to be called matter than the sphere of influence of a body of riflemen—the sphere filled with flying leaden missiles—has to be called lead. Since what we call matter essentially involves a mode of motion, and since at the temperature of absolute zero all atomic motions would stop, it follows that matter as we know it would at that paralysing temperature probably entirely change its properties. Although a discussion of the ultimate absolute properties of matter is purely speculative, it can hardly be barren, considering that in our laboratories we are now within moderate distance of the absolute zero of temperature.

I have dwelt on the value and importance of nitrogen, but I must not omit to bring to your notice those little known and curiously related elements which during the past twelve months have been discovered and partly described by Prof. Ramsay and Dr. Travers. For many years my own work has been among what I may call the waste heaps of the mineral elements. Prof. Ramsay is dealing with vagrant atoms of an astral nature. During the course of the present year he has announced the existence of no fewer than three new gases—krypton, neon, and metargon. Whether these gases, chiefly known by their spectra, are true unalterable elements, or whether they are compounded of other known or unknown bodies, has yet to be proved. Fellow workers freely pay tribute to the painstaking zeal with which Prof. Ramsay has conducted a difficult research, and to the philosophic subtlety brought to bear on his investigations. But, like most discoverers, he has not escaped the flail of severe criticism.

There is still another claimant for celestial honours. Prof. Nasini tells us he has discovered, in some volcanic gases at Pozzuoli, that hypothetical element Coronium, supposed to cause the bright line 5316·9 in the spectrum of the sun's corona. Analogy points to its being lighter and more diffusible than hydrogen, and a study of its properties cannot fail to yield striking results. Still awaiting discovery by the fortunate spectroscopist are the unknown celestial elements Aurorium, with a characteristic line at 5570·7—and Nebulum, having two bright lines at 5007·05 and 4959·02.

The fundamental discovery by Hertz, of the electro-magnetic waves predicted more than thirty years ago by Clerk Maxwell, seems likely to develop in the direction of a practical application which excites keen interest—I mean the application to electric signalling across moderate distances without connecting wires. The feasibility of this method of signalling has been demonstrated by several experimenters at more than one meeting of the British Association, though most elaborately and with many optical refinements by Oliver Lodge at the Oxford meeting in 1894. But not until Signor Marconi induced the British Post Office and foreign Governments to try large-scale experiments did wireless signalling become generally and popularly known or practically developed as a special kind of telegraphy. Its feasibility depends on the discovery of a singularly sensitive detector for Hertz waves—a detector whose sensitiveness in some cases seems almost to compare with that of the eye itself. The fact noticed by Oliver Lodge in 1889, that an infinitesimal metallic gap subjected to an electric jerk became conducting, so as to complete an electric circuit, was rediscovered soon afterwards in a more tangible and definite form, and applied to the detection of Hertz waves by M. E. Branly. Oliver Lodge then continued the work, and produced the *vacuum filing-tube* coherers with automatic tapper-back, which are of acknowledged practical service. It is this varying continuity of contact under the influence of extremely feeble electric stimulus alternating with mechanical tremor, which, in combination with the mode of producing the waves revealed by Hertz, constitutes the essential and fundamental feature of "wireless telegraphy." There is a curious and widely spread misapprehension about coherers to the effect that to make a coherer work the wave must fall upon it. Oliver Lodge has disproved this fallacy. Let the wave fall on a suitable receiver, such as a metallic wire or, better still, on an arrangement of metal wings resembling a Hertz sender, and the waves set up oscillating currents which may be led by wires (enclosed in metal pipes) to the coherer. The coherer acts apparently by a species of end-impact of the oscillatory current, and does not need to be attacked in the flank by the waves themselves. This interesting method of signalling—already developing in Marconi's hands into a successful practical system which inevitably will be largely used in lighthouse and marine work—presents more analogy to optical signals by flash-light than to what is usually understood as electric telegraphy; notwithstanding the fact that an ordinary Morse instrument at one end responds to the movements of a key at the other, or, as arranged by Alexander Muirhead, a siphon recorder responds to an automatic transmitter at about the rate of slow cable telegraphy. But although no apparent optical apparatus is employed, it remains true that the impulse travels from sender to receiver by essentially the same process as that which enables a flash of magnesium powder to excite a distant eye.

The phenomenon discovered by Zeeman that a source of radiation is affected by a strong magnetic field in such a way that light of one refrangibility becomes divided usually into three components, two of which are displaced by diffraction analysis on either side of the mean position, and are oppositely polarised to the third or residual constituent, has been examined by many observers in all countries. The phenomenon has been subjected to photography with conspicuously successful results by Prof. T. Preston in Dublin, and by Prof. Michelson and Dr. Ames and others in America.

It appears that the different lines in the spectrum are differently affected, some of them being tripled with different grades of relative intensity, some doubled, some quadrupled, some sextupled, and some left unchanged. Even the two components of the D lines are not similarly influenced. Moreover, whereas the polarisation is usually such as to indicate that motions of a negative ion or electron constitute the source of light, a few lines are stated by the observers at Baltimore, who used what they call the "small" grating of five inches width ruled with 65,000 lines, to be polarised in the reverse way.

Further prosecution of these researches must lead to deeper insight into molecular processes and the mode in which they affect the ether; indeed already valuable theoretic views have been promulgated by H. A. Lorenz, J. Larmor, and G. F. Fitzgerald, on the lines of the radiation theory of Dr. Johnstone Stoney; and the connection of the new phenomena with the old magnetic rotation of Faraday is under discussion. It is interesting to note that Faraday and a number of more recent experimenters were led by theoretic considerations to look for some such effect: and though the inadequate means at their d isposal did not lead to success, nevertheless a first dim glimpse of the phenomenon was obtained by M. Fievez, of the Royal Observatory at Brussels, in 1885.

It would be improper to pass without at least brief mention the remarkable series of theoretic papers by Dr. J. Larmor, published by the Royal Society, on the relationship between ether and matter. By the time these researches become generally intelligible they may be found to constitute a considerable step towards the further mathematical analysis and interpretation of the physical universe on the lines initiated by Newton.

In the mechanical construction of Röntgen ray tubes I can record a few advances: the most successful being the adoption of Prof. Silvanus P. Thompson's suggestion of using for the anti-kathode a metal of high atomic weight. Osmium and iridium have been used with advantage, and osmium anti-kathode tubes are now a regular article of manufacture. As long ago as June 1896, X-ray tubes with metallic uranium anti-kathodes were made in my own laboratory, and were found to work better than those with platinum. The difficulty of procuring metallic uranium prevented these experiments from being continued. Thorium anti-kathodes have also been tried.

Röntgen has drawn fresh attention to a fact very early observed by English experimenters—that of the non-homogeneity of the rays and the dependence of their penetrating power on the degree of vacuum; rays generated in high vacua have more penetrative power than when the vacuum is less high. These facts are familiar to all who have exhausted focus tubes on their own pumps. Röntgen suggests a convenient phraseology; he calls a low vacuum tube, which does not emit the highly penetrating rays, a "soft" tube, and a tube in which the exhaustion has been pushed to an extreme degree, in which highly penetrating rays predominate, a "hard" tube. Using a "hard" tube he took a photograph of a double-barrelled rifle, and showed not only the leaden bullets within the steel barrels but even the wads and the charges.

Benoit has re-examined the alleged relation between density and opacity to the rays, and finds certain discrepancies. Thus, the opacity of equal thicknesses of palladium and platinum are nearly equal whilst their densities and atomic weights are very different, those of palladium being about half those of platinum.

At the last meeting of the British Association visitors saw—at the McGill University—Profs. Cox and Callendar's apparatus for measuring the velocity of Röntgen rays. They found it to be certainly greater than 200 kilometres per second. Majorana has made an independent determination, and finds the velocity to be 600 kilometres per second with an inferior limit certainly of not less than 150 kilometres per second. It may be remembered that J. J. Thomson has found for kathode rays a velocity of more than 10,000 kilometres per second, and it is extremely unlikely that the velocity of Röntgen rays will prove to be less.

Trowbridge has verified the fact, previously announced by Prof. S. P. Thompson, that fluor-spar, which by prolonged heating has lost its power of luminescing when re-heated, regains the power of thermo-luminescence when exposed to Röntgen rays. He finds that this restoration is also effected by exposure to the electric glow discharge, but not by exposure to ultra-violet light. The difference is suggestive.

As for the action of Röntgen rays on bacteria, often asserted and often denied, the latest statement by Dr. H. Rieder, of Munich, is to the effect that bacteria are killed by the discharge from "hard" tubes. Whether the observation will lead to results of pathologic importance remains to be seen. The circumstance that the normal retina of the eye is slightly sensitive to the rays is confirmed by Dorn and by Röntgen himself.

The essential wave-nature of the Röntgen rays appears to be confirmed by the fact ascertained by several of our great mathematical physicists, that light of excessively short wave-length would be but slightly absorbed by ordinary material media, and would not in the ordinary sense be refracted at all. In fact a theoretic basis for a comprehension of the Röntgen rays had been propounded before the rays were discovered. At the Liverpool meeting of the British Association, several speakers, headed by Sir George Stokes, expressed their conviction that the disturbed electric field caused by the sudden stoppage of the motion of an electrically charged atom yielded the true explanation of the phenomena extraneous to the Crookes high vacuum tubes—phenomena so excellently elaborated by Lenard and by Röntgen. More recently, Sir George Stokes has re-stated his "pulse" theory, and fortified it with arguments which have an important bearing on the whole theory of the refraction of light. He still holds to their essentially transverse nature, in spite of the absence of polarisation, an absence once more confirmed by the careful experiments of Dr. L. Graetz. The details of this theory are in process of elaboration by Prof. J. J. Thomson.

Meantime, while the general opinion of physicists seems to be settling towards a wave or ether theory for the Röntgen rays, an opposite drift is apparent with respect to the physical nature of the kathode rays; it becomes more and more clear that kathode rays consist of electrified atoms or ions in rapid progressive motion. My idea of a fourth state of matter, propounded in 1881 (*Phil. Trans.*, Part 2, 1881, pp. 433-4), and at first opposed at home and abroad, is now becoming accepted. It is supported by Prof. J. J. Thomson (*Phil. Mag.*, October 1897, p. 312): Dr. Larmor's theory (*Phil. Mag.*, December 1897, p. 506) likewise involves the idea of an ionic substratum of matter; the view is also confirmed by Zeeman's phenomenon. In Germany—where the term kathode ray was invented almost as a protest against the theory of molecular streams propounded by me at the Sheffield meeting of the British Association in 1879—additional proofs have been produced in favour of the doctrine that the essential fact in the phenomenon is electrified Radiant Matter.

The speed of these molecular streams has been approximately measured, chiefly by the aid of my own discovery nearly twenty years ago, that their path is curved in a magnetic field, and that they produce phosphorescence where they impinge on an obstacle. The two unknown quantities, the charge and the speed of each atom, are measurable from the amount of curvature and by means of one other independent experiment.

It cannot be said that a complete and conclusive theory of these rays has yet been formulated. It is generally accepted that collisions among particles, especially the violent collisions due to their impact on a massive target placed in their path, give rise to the interesting kind of extremely high frequency radiation discovered by Röntgen. It has, indeed, for some time been known that whereas a charged body in motion constitutes an electric current, the sudden stoppage, or any violent acceleration of such a body, must cause an alternating electric disturbance, which, though so rapidly decaying in intensity as to be practically "dead beat," yet must give rise to an ethereal wave or pulse travelling with the speed of light, but of a length comparable to the size of the body whose sudden change of motion caused the disturbance. The emission of a high-pitched musical sound from the jolting of a dustman's cart (with a spring bell hung on it) has been suggested as an illustration of the way in which the molecules of any solid not at absolute zero may possibly emit such rays.

If the target on to which the electrically-charged atoms impinge is so constituted that some of its minute parts can thereby be set into rhythmical vibration, the energy thus absorbed reappears in the form of light, and the body is said to phosphoresce. The efficient action of the phosphorescent target appears to depend as much on its physical and molecular as on its chemical constitution. The best known phosphori belong to certain well-defined classes, such as the sulphides of the alkaline-earthy metals, and some of the so-called rare earths; but the phosphorescent properties of each of these groups are profoundly modified by an admixture of foreign bodies—witness the effect on the lines in the phosphorescent spectrum of yttrium and samarium produced by traces of calcium or lead. The persistence of the samarium spectrum in presence of overwhelming quantities of other metals, is almost unexampled in spectroscopy: thus one part of samaria can easily be seen when mixed with three million parts of lime.

Without stating it as a general rule, it seems as if with a non-phosphorescing target the energy of molecular impact reappears as pulses so abrupt and irregular that, when resolved, they furnish a copious supply of waves of excessively short wave-length, in fact, the now well-known Röntgen rays. The phosphorescence so excited may last only a small fraction of a second, as with the constituents of yttria, where the duration of the different lines varies between the 0·003 and the 0·0009 second; or it may linger for hours, as in the case of some of the yttria earths, and especially with the earthy sulphides, where the glow lasts bright enough to be commercially useful. Excessively phosphorescent bodies can be excited by light waves, but most of them require the stimulus of electrical excitement.

It now appears that some bodies, even without special stimulation, are capable of giving out rays closely allied, if not in some cases identical, with those of Prof. Röntgen. Uranium and thorium compounds are of this character, and it would almost seem from the important researches of Dr. Russell that this ray-emitting power may be a general property of matter, for he has shown that nearly every substance is capable of affecting the photographic plate if exposed in darkness for sufficient time.

No other source for Röntgen rays but the Crookes tube has yet been discovered, but rays of kindred sorts are recognised. The Becquerel rays, emitted by uranium and its compounds, have now found their companions in rays—discovered almost simultaneously by Curie and Schmidt—emitted by thorium and its compounds. The thorium rays affect photographic plates through screens of paper or aluminium, and are absorbed by metals and other dense bodies. They ionise the air, making it an electrical conductor; and they can be refracted and probably reflected, at least diffusively. Unlike uranium rays, they are not polarised by transmission through tourmaline, therefore resembling in this respect the Röntgen rays.

Quite recently M. and Mdme. Curie have announced a discovery which, if confirmed, cannot fail to assist the investigation of this obscure branch of physics. They have brought to notice a new constituent of the uranium mineral pitchblende, which in a 400-fold degree possesses uranium's mysterious power of emitting a form of energy capable of impressing a photographic plate and of discharging electricity by rendering air a conductor. It also appears that the radiant activity of the new body, to which the discoverers have given the name of Polonium, needs neither the excitation of light nor the stimulus of electricity; like uranium, it draws its energy from some constantly regenerating and hitherto unsuspected store, exhaustless in amount.

It has long been to me a haunting problem how to reconcile this apparently boundless outpour of energy with accepted canons. But as Dr. Johnstone Stoney reminds me, the resources of molecular movements are far from exhausted. There are many stores of energy in nature that may be drawn on by properly constituted bodies without very obvious cause. Some time since I drew attention to the enormous amount of locked up energy in the ether; nearer our experimental grasp are the motions of the atoms and molecules, and it is not difficult mentally so to modify Maxwell's demons as to reduce them to the level of an inflexible law, and thus bring them within the ken of a philosopher in search of a new tool. It is possible to conceive a target capable of mechanically sifting from the molecules of the surrounding air the quick from the slow movers. This sifting of the swift moving molecules is effected in liquids whenever they evaporate, and in the case of the constituents of the atmosphere, wherever it contains constituents light enough to drift away molecule by molecule. In my mind's eye I see such a target as a piece of metal cooler than the surrounding air acquiring the energy that gradually raises its temperature from the outstanding effect of all its encounters with the molecules of the air about it; I see another target of such a structure that it throws off the slow moving molecules with little exchange of energy, but is so influenced by the quick moving missiles that it appropriates to itself some of their energy. Let uranium or polonium, bodies of densest atoms, have a structure that enables them to throw off the slow moving molecules of the atmosphere, while the quick moving molecules, smashing on to the surface, have their energy reduced and that of the target correspondingly increased. The energy thus gained seems to be employed partly in dissociating some of the molecules of the gas (or in inducing some other condition which has the effect of rendering the neighbouring air in some degree a conductor of electricity) and partly in originating an undulation through the ether, which, as it takes its rise in phenomena so disconnected as the impacts of the molecules of the air, must furnish a large contingent of light waves of short wave-length. The shortness in the case of these Becquerel rays appears to approach without attaining the extreme shortness of ordinary Röntgen rays. The reduction of the speed of the quick moving molecules would cool the layer of air to which they belong; but this cooling would rapidly be compensated by radiation and conduction from the surrounding atmosphere; under ordinary circumstances the difference of temperature would scarcely be perceptible, and the uranium would thus appear to perpetually emit rays of energy with no apparent means of restoration.

The total energy of both the translational and internal motions of the molecules locked up in quiescent air at ordinary pressure and temperature is about 140,000 foot-pounds in each cubic yard of air. Accordingly the quiet air within a room 12 feet high, 18 feet wide, and 22 feet long contains energy enough to propel a one-horse engine for more than twelve hours. The store drawn upon naturally by uranium and other heavy atoms only awaits the touch of the magic wand of science to enable the twentieth century to cast into the shade the marvels of the nineteenth.

Whilst placing before you the labours and achievements of my comrades in science I seize this chance of telling you of engrossing work of my own on the fractionation of yttria to which for the last eighteen years I have given ceaseless attention. In 1883, under the title of "Radiant Matter Spectroscopy," I described a new series of spectra produced by passing the phosphorescent glow of yttria, under molecular bombardment *in vacuo*, through a train of prisms. The visible spectra in time gave up their secrets, and were duly embalmed in the *Philosophical Transactions*. At the Birmingham meeting of the British Association in 1886 I brought the subject before the Chemical Section, of which I had the honour to be President. The results led to many speculations on the probable origin of all the elementary bodies—speculations that for the moment I must waive in favour of experimental facts.

There still remained for spectroscopic examination a long tempting stretch of unknown ultra-violet light, of which the exploration gave me no rest. But I will not now enter into details of the quest of unknown lines. Large quartz prisms, lenses, and condensers, specially sensitised photographic films capable of dealing with the necessary small amount of radiation given by feebly phosphorescing substances,[1] and above all tireless patience in collating and interpreting results, have all played their part. Although the research is incomplete, I am able to announce that among the groups of rare earths giving phosphorescent spectra in the visible region there are others giving well defined groups of bands which can only be recorded photographically. I have detected and mapped no less than six such groups extending to λ 3060.

Without enlarging on difficulties, I will give a brief outline of the investigation. Starting with a large quantity of a group of the rare earths in a state of considerable purity, a particular method of fractionation is applied, splitting the earths into a series of fractions differing but slightly from each other. Each of these fractions, phosphorescing *in vacuo*, is arranged in the spectrograph, and a record of its spectrum photographed upon a specially prepared sensitive film.

In this way, with different groups of rare earths, the several invisible bands were recorded—some moderately strong, others exceedingly faint. Selecting a portion giving a definite set of bands, new methods of fractionation were applied, constantly photographing and measuring the spectrum of each fraction.

[1] In this direction I am glad to acknowledge my indebtedness to Dr. Schuman, of Leipzig, for valuable suggestions and detail of his own apparatus, by means of which he has produced some unique records of metallic and gaseous spectra of lines of short wave-length.

Sometimes many weeks of hard experiment failed to produce any separation, and then a new method of splitting up was devised and applied. By unremitting work—the solvent of most difficulties—eventually it was possible to split up the series of bands into various groups. Then, taking a group which seemed to offer possibilities of reasonably quick result, one method after another of chemical attack was adopted, with the ultimate result of freeing the group from its accompanying fellows and increasing its intensity and detail.

As I have said, my researches are far from complete, but about one of the bodies I may speak definitely. High up in the ultra-violet, like a faint nebula in the distant heavens, a group of lines was detected, at first feeble and only remarkable on account of their isolation. On further purification these lines grew stronger. Their great refrangibility cut them off from other groups. Special processes were employed to isolate the earth, and using these lines as a test, and appealing at every step to the spectrograph, it was pleasant to see how each week the group stood out stronger and stronger, while the other lines of yttrium, samarium, ytterbium, &c., became fainter, and at last, practically vanishing, left the sought-for group strong and solitary. Finally, within the last few weeks, hopefulness has emerged into certainty, and I have absolute evidence that another member of the rare earth groups has been added to the list. Simultaneously with the chemical and spectrographic attack, atomic weight determinations were constantly performed.

As the group of lines which betrayed its existence stand alone, almost at the extreme end of the ultra-violet spectrum, I propose to name the newest of the elements Monium, from the Greek *μόνος*, alone. Although caught by the searching rays of the spectrum, Monium offers a direct contrast to the recently discovered gaseous elements, by having a strongly marked individuality; but although so young and wilful, it is willing to enter into any number of chemical alliances.

Until my material is in a greater state of purity I hesitate to commit myself to figures; but I may say that the wave-lengths of the principal lines are 3120 and 3117. Other fainter lines are at 3219, 3064, and 3060. The atomic weight of the element, based on the assumption of R_2O_3, is not far from 118—greater than that accepted for yttrium and less than that for lanthanum.

I ought almost to apologise for adding to the already too long list of elements of the rare earth class—the asteroids of the terrestrial family. But as the host of celestial asteroids, unimportant individually, become of high interest when once the idea is grasped that they may be incompletely coagulated remains of the original nebula, so do these elusive and insignificant rare elements rise to supreme importance when we regard them in the light of component parts of a dominant element, frozen in embryo, and arrested in the act of coalescing from the original protyle into one of the ordinary and law-abiding family for whom Newlands and Mendeleeff have prepared pigeon-holes. The new element has another claim to notice. Not only is it new in itself, but to discover it a new tool had to be forged for spectroscopic research.

Further details I will reserve for that tribunal before whom every aspirant for a place in the elemental hierarchy has to substantiate his claim.

These, then, are some of the subjects, weighty and far-reaching, on which my own attention has been chiefly concentrated. Upon one other interest I have not yet touched—to me the weightiest and the farthest reaching of all.

No incident in my scientific career is more widely known than the part I took many years ago in certain psychic researches. Thirty years have passed since I published an account of experiments tending to show that outside our scientific knowledge there exists a force exercised by intelligence differing from the ordinary intelligence common to mortals. This fact in my life is of course well understood by those who honoured me with the invitation to become your President. Perhaps among my audience some may feel curious as to whether I shall speak out or be silent. I elect to speak, although briefly. To enter at length on a still debatable subject would be unduly to insist on a topic which—as Wallace, Lodge, and Barrett have already shown—though not unfitted for discussion at these meetings, does not yet enlist the interest of the majority of my scientific brethren. To ignore the subject would be an act of cowardice—an act of cowardice I feel no temptation to commit.

To stop short in any research that bids fair to widen the gates of knowledge, to recoil from fear of difficulty or adverse criticism, is to bring reproach on science. There is nothing for the investigator to do but to go straight on, "to explore up and down, inch by inch, with the taper his reason"; to follow the light wherever it may lead, even should it at times resemble a will-o'-the-wisp. I have nothing to retract. I adhere to my already published statements. Indeed, I might add much thereto. I regret only a certain crudity in those early expositions which, no doubt justly, militated against their acceptance by the scientific world. My own knowledge at that time scarcely extended beyond the fact that certain phenomena new to science had assuredly occurred, and were attested by my own sober senses, and better still, by automatic record. I was like some two-dimensional being who might stand at the singular point of a Riemann's surface, and thus find himself in infinitesimal and inexplicable contact with a plane of existence not his own.

I think I see a little further now. I have glimpses of something like coherence among the strange elusive phenomena; of something like continuity between those unexplained forces and laws already known. This advance is largely due to the labours of another Association of which I have also this year the honour to be President—the Society for Psychical Research. And were I now introducing for the first time these inquiries to the world of science I should choose a starting-point different from that of old. It would be well to begin with *telepathy*; with the fundamental law, as I believe it to be, that thoughts and images may be transferred from one mind to another without the agency of the recognised organs of sense—that knowledge may enter the human mind without being communicated in any hitherto known or recognised ways.

Although the inquiry has elicited important facts with reference to the mind, it has not yet reached the scientific stage of certainty which would entitle it to be usefully brought before one of our Sections. I will therefore confine myself to pointing out the direction in which scientific investigation can legitimately advance. If telepathy take place we have two physical facts—the physical change in the brain of A, the suggester, and the analogous physical change in the brain of B, the recipient of the suggestion. Between these two physical events there must exist a train of physical causes. Whenever the connecting sequence of intermediate causes begins to be revealed, the inquiry will then come within the range of one of the Sections of the British Association. Such a sequence can only occur through an intervening medium. All the phenomena of the universe are presumably in some way continuous, and it is unscientific to call in the aid of mysterious agencies when with every fresh advance in knowledge it is shown that ether vibrations have powers and attributes abundantly equal to any demand—even to the transmission of thought. It is supposed by some physiologists that the essential cells of nerves do not actually touch, but are separated by a narrow gap which widens in sleep while it narrows almost to extinction during mental activity. This condition is so singularly like that of a Branly or Lodge coherer as to suggest a further analogy. The structure of brain and nerve being similar, it is conceivable there may be present masses of such nerve coherers in the brain whose special function it may be to receive impulses brought from without through the connecting sequence of ether waves of appropriate order of magnitude. Röntgen has familiarised us with an order of vibrations of extreme minuteness compared with the smallest waves with which we have hitherto been acquainted, and of dimensions comparable with the distances between the centres of the atoms of which the material universe is built up; and there is no reason to suppose that we have here reached the limit of frequency. It is known that the action of thought is accompanied by certain molecular movements in the brain, and here we have physical vibrations capable from their extreme minuteness of acting direct on individual molecules, while their rapidity approaches that of the internal and external movements of the atoms themselves.

Confirmation of telepathic phenomena is afforded by many converging experiments, and by many spontaneous occurrences only thus intelligible. The most varied proof, perhaps, is drawn from analysis of the sub-conscious workings of the mind, when these, whether by accident or design, are brought into conscious survey. Evidence of a region, below the threshold of consciousness, has been presented, since its first inception, in the *Pro-*

ceedings of the Society for Psychical Research; and its various aspects are being interpreted and welded into a comprehensive whole by the pertinacious genius of F. W. H. Myers. Concurrently, our knowledge of the facts in this obscure region has received valuable additions at the hands of labourers in other countries. To mention a few names out of many, the observations of Richet, Pierre Janet, and Binet (in France), of Breuer and Freud (in Austria), of William James (in America) have strikingly illustrated the extent to which patient experimentation can probe subliminal processes, and can thus learn the lessons of alternating personalities, and abnormal states. Whilst it is clear that our knowledge of subconscious mentation is still to be developed, we must beware of rashly assuming that all variations from the normal waking condition are necessarily morbid. The human race has reached no fixed or changeless ideal; in every direction there is evolution as well as disintegration. It would be hard to find instances of more rapid progress, moral and physical, than in certain important cases of cure by suggestion—again to cite a few names out of many—by Liébeault, Bernheim, the late Auguste Voisin, Bérillon (in France), Schrenck-Notzing (in Germany), Forel (in Switzerland), van Eeden (in Holland), Wetterstrand (in Sweden), Milne-Bramwell and Lloyd Tuckey (in England). This is not the place for details, but the *vis medicatrix* thus evoked, as it were, from the depths of the organism, is of good omen for the upward evolution of mankind.

A formidable range of phenomena must be scientifically sifted before we effectually grasp a faculty so strange, so bewildering, and for ages so inscrutable, as the direct action of mind on mind. This delicate task needs a rigorous employment of the method of exclusion—a constant setting aside of irrelevant phenomena that could be explained by known causes, including those far too familiar causes, conscious and unconscious fraud. The inquiry unites the difficulties inherent in all experimentation connected with *mind*, with tangled human temperaments and with observations dependent less on automatic record than on personal testimony. But difficulties are things to be overcome even in the elusory branch of research known as experimental psychology. It has been characteristic of the leaders among the group of inquirers constituting the Society for Psychical Research to combine critical and negative work with work leading to positive discovery. To the penetration and scrupulous fair-mindedness of Prof. Henry Sidgwick and of the late Edmund Gurney is largely due the establishment of canons of evidence in psychical research, which strengthen while they narrow the path of subsequent explorers. To the detective genius of Dr. Richard Hodgson we owe a convincing demonstration of the narrow limits of human continuous observation.

It has been said that "Nothing worth the proving can be proved, nor yet disproved." True though this may have been in the past, it is true no longer. The science of our century has forged weapons of observation and analysis by which the veriest tyro may profit. Science has trained and fashioned the average mind into habits of exactitude and disciplined perception, and in so doing has fortified itself for tasks higher, wider, and incomparably more wonderful than even the wisest among our ancestors imagined. Like the souls in Plato's myth that follow the chariot of Zeus, it has ascended to a point of vision far above the earth. It is henceforth open to science to transcend all we now think we know of matter, and to gain glimpses of a profounder scheme of Cosmic Law.

An eminent predecessor in this chair declared that "by an intellectual necessity he crossed the boundary of experimental evidence, and discerned in that matter which we, in our ignorance of its latent powers, and notwithstanding our professed reverence for its Creator, have hitherto covered with opprobrium, the potency and promise of all terrestrial life." I should prefer to reverse the apophthegm, and to say that in life I see the promise and potency of all forms of matter.

In old Egyptian days a well-known inscription was carved over the portal of the temple of Isis:—"I am whatever hath been, is, or ever will be; and my veil no man hath yet lifted." Not thus do modern seekers after truth confront nature—the word that stands for the baffling mysteries of the universe. Steadily, unflinchingly, we strive to pierce the inmost heart of nature, from what she is to reconstruct what she has been, and to prophesy what she yet shall be. Veil after veil we have lifted, and her face grows more beautiful, august, and wonderful with every barrier that is withdrawn.

SECTION A.

MATHEMATICS AND PHYSICS.

Opening Address by Prof. W. E. Ayrton, F.R.S., President of the Section.

A year ago Section A was charmed with a Presidential Address on the poetry of mathematics, and if, amongst those who entered the Physics lecture-theatre at Toronto on that occasion, there were any who had a preconceived notion that mathematics was a hard, dry, repellent type of study, they must, after hearing Prof. Forsyth's eloquent vindication of its charms, have departed convinced that mathematics resembled music in being a branch of the fine arts. Such an address, however, cannot but leave a feeling of regret amongst those of us who, engulfed in the whirl of the practical science of the day, sigh for the leisure and the quiet which are necessary for the worship of abstract mathematical truth, while the vain effort to follow in the footsteps of one gifted with such winning eloquence fills me with hopeless despair.

Section A this year is very fortunate in having its meetings associated with those of an "International Conference on Terrestrial Magnetism and Atmospheric Electricity," which is attended by the members of the "Permanent Committee for Terrestrial Magnetism and Atmospheric Electricity" of the "International Meteorological Conference." It has been arranged that this Permanent Committee, of which Prof. Rücker is the President, shall form part of the General Committee of Section A, and also shall act as the Committee of the International Conference, which will itself constitute a separate department of Section A. For the purpose, however, of preparing a Report to the International Meteorological Conference, and for similar business, this Permanent Committee will act independently of the British Association.

My first duty to-day, therefore, consists in expressing the honour and the very great pleasure which I feel in bidding you, members of the International Conference, most heartily welcome.

Among the various subjects which it is probable that the Conference may desire to discuss, there is one to which I will briefly refer, as I am able to do so in a triple capacity. The earth is an object of much importance, alike to the terrestrial magnetician, the telegraph electrician, and the tramway engineer; but while the first aims at observing its magnetism, and the second rejoices in the absence of the earth currents which interfere with the sending of messages, the third seems bent on converting our maps of lines of force into maps of lines of tramway.

It might, therefore, seem as if electric traction—undoubtedly a great boon to the people, and one that has already effected important social developments in America and on the continent of Europe—were destined in time to annihilate magnetic observatories near towns, and even to seriously interfere with existing telegraph and telephone systems. Already the principle of the survival of the fittest is quoted by some electrical engineers, who declare that if magnetic observatories are crippled through the introduction of electric tramways, then so much the worse for the observatories. And I fear that my professional brethren only look at me askance for allowing my devotion to the practical applications of electricity to be tainted with a keen interest in that excessively small, but none the less extremely wonderful, magnetic force which controls our compass needles.

But this interest emboldens me to ask again, Can the system of electric traction that has already destroyed the two most important magnetic observatories in the United States and British North America be the best and the fittest to survive? Again, do we take such care, and spend such vast sums, in tending the weak and nursing the sick because we are convinced that they are the fittest to survive? May it not perhaps be because we have an inherent doubt about the justness of the survival of the strongest, or because even the strongest of us feels compelled to modestly confess his inability to pick out the fittest, that modern civilisation encourages *not* the destruction but the preservation of what has obvious weakness, on the chance that it may have unseen strength?

When the electrical engineer feels himself full of pride at the greatness, the importance, and the power of his industry, and when he is inclined to think slightingly of the deflection of a little magnet compared with the whirl of his 1000 horse-power dynamo, let him go and visit a certain dark store-room near the entrance hall of the Royal Institution, and, while he looks at some little coils there, ponder on the blaze of light that has been shed over the whole world from the dimly-lighted cupboard in which those dusty coils now lie. Then he may realise that while the earth as a magnet has endured for all time, the earth as a tramway conductor may at no distant date be relegated to the class of temporary makeshifts, and that the raids of the feudal baron into the agricultural fields of his neighbours were not more barbarous than the alarms and excursions of the tramway engineer into the magnetic fields of his friends.

A very important consideration in connection with the rapid development of physical inquiry is the possibility of extending our power of assimilating current physical knowledge. For so wide have grown the limits of each branch of physics, that it has become necessary to resort to specialisation if we desire to widen further the region of the known. On the other hand, so interlinked are all sections of physics, that this increase of specialisation is liable to hinder rather than assist advance of the highest order.

An experimenter is, therefore, on the horns of a dilemma—on the one hand, if he desires to do much he must confine himself more or less to one line of physical research, while, on the other hand, to follow that line with full success requires a knowledge of the progress that is being made along all kindred lines. Already an investigator who is much engaged with research can hardly do more as regards scientific literature than read what he himself writes—soon he will not have time to do even that. Division of labour and co-operation have, therefore, become as important in scientific work as in other lines of human activity. Like bees, some must gather material from the flowers that are springing up in various fields of research, while others must hatch new ideas. But, unlike bees, all can be of the "worker" class, since the presence of drones is unnecessary in the scientific hive.

Englishmen have long been at a disadvantage in not possessing any ready means of ascertaining what lines of physical inquiry were being pursued in foreign countries—or, indeed, even in their own. And, so far from making it easier to obtain this information, our countrymen have, I fear, until quite recently, been guilty of increasing the difficulty. For every college, every technical school in Great Britain—and their number will soon rival that of our villages—seems to feel it incumbent on itself to start a scientific society. And in accordance with the self-reliant character of our nation, each of these societies must be maintained in absolute independence of every other society, and its proceedings must be published separately, and in an entirely distinct form from those of any similar body. To keep abreast, then, with physical advance in our own country is distinctly difficult, while the impossibility of maintaining even a casual acquaintance with foreign scientific literature lays us open to a charge of international rudeness.

There is, of course, the German *Beiblätter*, but the Anglo-Saxon race, which has spread itself over so vast a portion of the globe, is proverbially deficient in linguistic powers, and consequently, till quite recently, information that was accessible to our friends on the Continent was closed to many workers in Great Britain, America, and Australia.

Influenced by these considerations, the Physical Society of London, in 1895, embarked on the publication of abstracts from foreign papers on pure physics, and, as it was found that this enterprise was much appreciated, the question arose at the end of the following year, whether, instead of limiting the journals from which abstracts were made to those appearing in foreign countries, and the papers abstracted to those dealing only with pure physics, the abstracts might not with advantage be enlarged, so as to present a *résumé* of all that was published in all languages on physics and its applications.

The first application of physics which it was thought should be included was electrical engineering, and so negotiations were opened with the Institution of Electrical Engineers. After much deliberation on the part of the representatives of the two societies, it was finally decided to start a monthly joint publication, under the management of a committee of seven, two of whom should represent the Institution of Electrical Engineers, two the Physical Society, and three the two societies jointly. *Science Abstracts* was the name selected for the periodical, and the first number appeared in January of this year.

A section is devoted to general physics, and a separate section to each of its branches; similarly a section is devoted to general electrical engineering, and a separate section to each of its more important sub-divisions. The value of *Science Abstracts* is already recognised by the British Association as well as by the Institution of Civil Engineers, for those societies make a liberal contribution towards the expenses of publication, for which the Physical Society and the Institution of Electrical Engineers are responsible.

At no distant date it is thought that other bodies may co-operate with us, and we have hopes that finally the scheme may be supported by the scientific societies of many Anglo-Saxon countries. For our aim is to produce, in a single journal, a monthly record in English of the most important literature appearing in all languages on physics and its many applications. This is the programme—a far wider one, be it observed, than that of the *Beiblätter*—which we sanguinely hope our young infant *Science Abstracts* will grow to carry out.

The saving of time and trouble that will be effected by the publication of such a journal can hardly be over-estimated, and the relief experienced in turning to a single periodical for knowledge that could hitherto be obtained solely by going through innumerable scientific newspapers, in many different languages, can only be compared with the sensation of rousing from a distracting and entangled dream to the peaceful order of wakeful reality.

I therefore take this opportunity of urging on the members of the British Association the importance of the service which they can individually render to science by helping on an enterprise that has been started solely in its aid, and not for commercial purposes.

The greatness of the debt owed by industry to pure science is often impressed on us, and it is pointed out that the comparatively small encouragement given by our nation to the development of pure science is wholly incommensurate with the gratitude which it ought to feel for the commercial benefits science has enabled it to reach. This is undoubtedly true, and no one appreciates more fully than myself how much commerce is indebted to those whose researches have brought them—it may be fame—but certainly nothing else. The world, however, appears to regard as equitable the division of reward, which metes out tardy approbation to the discoverer for devising some new principle, a modicum of the world's goods to the inventor for showing how this principle can be applied, and a shower of wealth on the contractor for putting the principle into practice. At first sight, this appears like the irony of fate, but in fact the world thus only proves that it is human by prizing the acquisition of what it realises that it stands in need of, and by valuing the possession of what it is able to comprehend.

Now is there not a debt which those who pursue pure science are in their turn equally forgetful of—viz., the debt to the technical worker or to some technical operation for the inception of a new idea? For purely theoretical investigations are often born of technics, or, as Whewell puts it, "Art is the parent, not the progeny, of science; the realisation of principles in practice forms part of the prelude as well as of the sequel of theoretical discovery." I need not remind you that the whole science of floating bodies is said to have sprung from the solution by Archimedes of Hiero's doubt concerning the transmutation of metals in the manufacture of his crown. In that case, however, it was the transmutation of gold into silver, and not silver into gold, that troubled the philosopher.

Again, in the "History of the Royal Society at the End of the Eighteenth Century," Thomson says regarding Newton, "A desire to know whether there was anything in judicial astrology first put him upon studying mathematics. He discovered the emptiness of that study as soon as he erected a figure; for which purpose he made use of one or two problems in Euclid. . . . He did not then read the rest, looking upon it as a book containing only plain and obvious things."

The analytical investigation of the motion of one body round an attracting centre, when disturbed by the attraction of another, was attacked independently by Clairault, D'Alembert, and Euler, because the construction of lunar tables had such a practical importance, and because large money prizes were offered for their accurate determination.

The gambling table gave us the whole Theory of Probability, Bernoulli's and Euler's theorems, and the first demonstration of the binomial theorem, while a request made to Montmort to determine the advantage to the banker in the game of "pharaon" started him on the consideration of how counters could be thrown, and so led him to prove the multinomial and various other algebraical theorems. Lastly, may not the gambler take some credit to himself for the first suggestion of the method of least squares, and the first discussion of the integration of partial differential equations with finite differences contained in Laplace's famous "Théorie Analytique des Probabilités"?

The question asked Rankine by James R. Napier regarding the horse-power which would be necessary to propel, at a given rate, a vessel which Napier was about to build, resulted in the many theoretical investigations carried out by Rankine on water lines, skin-friction, stream lines, &c. For, as Prof. Tait has said, "Rankine, by his education as a practical engineer, was eminently qualified to recognise the problems of which the solution is required in practice; but the large scope of his mind would not allow him to be content with giving merely the solution of those particular cases which most frequently occur in engineering as we now know it. His method invariably is to state the problem in a very general form, find the solution, and apply this solution to special cases."

Helmholtz studied physiology because he desired to be a doctor, then physics because he found that he needed it for attacking physiological problems, and lastly mathematics as an aid to physical research. But I need not remind you that it is his splendid work in mathematics, physics, and physiology, and not his success in ministering to the sick, that has rendered his name immortal.

Did not Kepler ask: "How many would be able to make astronomy their business if men did not cherish the hope of reading the future in the skies?" And did he not warn those who objected to the degradation of mingling astrology with astronomy, to beware of "throwing away the child with the dirty water of its bath"? Even now, may we not consider all the astronomical research work done at the Royal Observatory, Greenwich, as a bye-product, since the Observatory is officially maintained merely for the purposes of navigation? And are there not many of us who feel assured that, since researches in pure physics and the elucidation of new physical facts must quite legitimately spring from routine standardising work, the most direct way—even now at the end of the nineteenth century of securing for the country a National Physical Laboratory is to speed forward a Government standardising institute?

Lastly, as you will find in Dr. Thorpe's fascinating "Life of Davy," it was the attempt to discover the medicinal effect of gases at the Pneumatic Institution in this city that opened up to Davy the charm of scientific research. And, indeed, the Royal Institution itself, the scientific home of Davy, Faraday, Tyndall, Rayleigh and Dewar, owes its origin to Romford's proposal "for forming in London by private subscription an establishment for feeding the poor and giving them useful employment . . . . connected with an institution for introducing and bringing forward into general use new inventions and improvements by which domestic comfort and economy may be promoted."

Coming now to physics proper, there is one branch which, although of deep interest, has hitherto been much neglected. We possess three senses which enable us to detect the presence of things at a distance—viz., seeing, hearing, and smelling. The first two are highly cultivated in man, and, probably for that reason, the laws of the propagation of the disturbances which affect the eyes and the ears have been the subject of much investigation, whereas, although to many animals the sense of smell is of far greater importance than those of seeing or hearing, and although, even in the human brain, a whole segment—a small one in modern man, it is true—is devoted to the olfactory fibres, the laws of the production and propagation of smell have received practically no attention from the physicists. For some time past it has, therefore, seemed to me to be of theoretical and practical importance to examine more fully into the physics of smell. Various other occupations have hitherto prevented my advancing much beyond the threshold of the subject, but, as it seems to me to open up what is practically a new field of inquiry for the physicist, I take this oportunity of putting on record some facts that have been already elucidated.

Various odoriferous substances have been employed in the experiments, and for several of these I am indebted to Mr. W. J. Pope. Although the physicist has been allowing the mechanical side of the subject to lie dormant, the chemist, I find, has been analysing flowers and other bodies used in the manufacture of scents, and then synthetically preparing the odoriferous constituents. In this way, Mr. Pope informs me, there has been added to the list of manufactured articles, during the past seven years or so, vanilin, heliotropin, artificial musk, irone and ionone, which give the perfume of the violet; citral, that of lemongrass; coumarin, that of hay, and various others; and specimens of several of these artificial scents, together with other strongly-smelling substances, he has kindly furnished me with.

If it be a proof of civilisation to retain but a remnant of a sense which is so keen in many types of dogs, then I may pride myself on having reached a very high state of civilisation. But with the present investigation in view, this pride has been of a very empty character, since I have been compelled to reject my own nose as quite lacking the sensitiveness that should characterise a philosophical measuring instrument. The ladies of my family, on the contrary, possess a nasal quickness which formerly seemed to me to be rather of the nature of a defect, since, at any rate in towns, there are so many more disagreeable odours than attractive ones. But on the present occasion their power of detecting slight smells, and the repugnance which they show in the case of so many of them, have stood me in good stead, and made it possible to put before you the following modest contribution to the subject.

There is a generally accepted idea that metals have smells, since if you take up a piece of metal at random, or a coin out of your pocket, a smell can generally be detected. But I find that, as commercial aluminium, brass, bronze, copper, German-silver, gold, iron, silver, phosphor-bronze, steel, tin and zinc are more and more carefully cleaned, they become more and more alike in emitting *no* smell, and, indeed, when they are *very clean* it seems impossible with the nose, even if it be a good one, to distinguish any one of these metals from the rest, or even to detect its presence. Brass, iron, and steel are the last to lose their characteristic odour with cleaning, and for some time I was not sure whether the last two could be rendered absolutely odourless, in consequence of the difficulty of placing them close to the nose without breathing on them, which, as explained later on, evolves the characteristic "copper" and "iron" smell. But experiment shows that, when very considerable care is taken both in the cleaning and the smelling, no odour can be detected even with iron or steel.

Contrary, then, to what is usually believed, metals appear to have no smell *per se*. Why, then, do several of them generally possess smells? The answer is simple; for I find that handling a piece of metal is one of the most efficient ways of causing it to acquire its characteristic smell, so that the mere fact of lifting up a piece of brass or iron to smell it may cause it to apparently acquire a metallic odour, even if it had none before. This experiment may be easily tried thus:—Clean a penny *very carefully* until all sense of odour is gone; then hold it in the hand for a few seconds, and it will smell—of copper, as we usually say. Leave it for a short time on a clean piece of paper, and it will be found that the metallic smell has entirely disappeared, or at any rate, is not as strong as the smell of the paper on which it rests. The smell produced by the contact of the hand with the bronze will be marked if the closed hand containing it be opened sufficiently for the nose to be inserted, and it can be still further increased by rubbing the coin between the fingers.

All the metals enumerated above, with the exception of gold and silver, can be made to produce a smell when thus treated, but the smells evolved by the various metals are quite different. Aluminium, tin, and zinc, I find, smell much the same when rubbed with the fingers, the odour, however, being quite different from that produced by brass, bronze, copper, German-silver, and phosphor-bronze, which all give the characteristic "copper" smell. Iron and steel give the strong "iron" smell, which, again, is quite different from that evolved by the other metals. In making these experiments it is important to carefully wash the hands after touching each metal to free them from the odour of that metal. It is also necessary to wait for a short time on each occasion after drying the hands, since it is not until they become again moist with perspiration that they are operative in bringing out the so-called smells of metals.

That the hands, when comparatively dry, do not bring out the smell of metals is in itself a disproof of the current idea that metals acquire a smell when slightly warmed. And this I have further tested by heating up specimens of all the above-mentioned metals to 120° Fahrenheit, in the sun, and finding that they acquire no smell when quite clean and untouched with the hands.

Again, dealing with the copper group, or with aluminium, *no* smell is produced by rubbing any one of them with dry table-salt, strong brine, or with wet salt, provided that a piece of linen is used as the rubber; but if the finger be substituted for the linen to rub on brine, a smell is observed with copper and German-silver, this smell, however, being rather like that of soda; and whether dry salt, brine, or wet salt be rubbed on aluminium, a smell is noticed if the finger be used as the rubber, this smell being very marked in the case of the brine or wet salt. Again, although even when linen soaked in brine, or having wet salt on it, is used to rub tin, iron, or steel, a faint smell is noticed, this is much increased when the finger is substituted for the piece of linen.

As a further illustration of the part played by the skin in causing metallic smells, it may be mentioned that the explanation of certain entirely contradictory results, which were obtained in the early part of the investigation, when linen soaked in strong brine was rubbed on aluminium, was ultimately traced to one layer of moist linen of the thickness of a pocket-handkerchief, allowing the finger to act through it, so that an odour was sometimes noticed on rubbing aluminium with the piece of linen soaked in brine. For it was found that when two or more layers of the same linen soaked in the same brine were employed to separate the finger from the aluminium during the rubbing, no smell could be detected.

From the preceding it seems that the smell in these cases is evolved partly by contact with the finger, partly by the action of the solution of salt, and partly by the rubbing of the solid particles of salt against the metals. That the friction of solid particles against metals is operative in evolving smells is also illustrated by the smell noticed when iron is filed, or when aluminium, iron, or steel is cleaned with glass-paper or emery-paper in the air. Indeed, the smell thus evolved by aluminium Mrs. Ayrton finds particularly offensive. A slight smell is also noticed if iron or steel be rubbed in the air with even a clean piece of dry linen, and each specimen of the copper group, with the exception of the phosphor-bronze, which was tried in this way, gave rise to a faint, rather agreeable smell. No indication of odour could, however, be thus produced with aluminium or zinc when both the metals and the linen rubber were quite clean. It should, however, be borne in mind that all these experiments, where very slight smells are noticed, and especially when the odour rapidly disappears on the cessation of the operation that produced it, are attended with a certain amount of doubt, for the linen rubber cannot be freed from the characteristic smell of "clean linen," no matter how carefully it may be washed.

Before, then, a metal can evolve a smell, chemical action must apparently take place, for rubbing the metal probably frees metallic particles, and facilitates the chemical action to which I shall refer. All chemical actions, however, in which metals take part do not produce smell; for example, no smell but that of soda, or of sugar, respectively, can be detected on rubbing any single one of the series of metals that I have enumerated with a lump of wet soda, or a lump of wet sugar, although chemical action certainly takes place. Again, no metallic smell is observable when dilute nitric acid is rubbed on copper, German-silver, phosphor-bronze, tin, or zinc, although the chemical action is very marked in the case of some of these metals. Weak vinegar or a weak solution of ammonia are also equally inoperative. On the other hand merely breathing on brass, copper, iron, steel, or zinc, which has been rendered practically odourless by cleaning, produces a very distinct smell, while a very thin film of water placed on iron or steel evolves a still stronger odour. Such a film, however, produces but little effect with any of the metals except these two, and if the whole series is lightly touched in succession with the tongue, the iron and steel smell as strongly as when breathed on, the German-silver more strongly than when breathed on, or covered with a water-film, and the other metals hardly at all.

Now, as regards the explanation of these metallic smells, which have hitherto been attributed to the metals themselves. This, I think, may be found in the odours produced when the metals are rubbed with linen soaked in dilute sulphuric acid. For here, apart from any contact of the metal with the skin, the aluminium, tin, and zinc are found to smell alike; the copper group also smell alike; and the iron and steel give rise to the characteristic "iron" smell, which, in this case, can be detected some feet away. Now, it is known that when hydrogen is evolved by the action of sulphuric acid on iron, the gas has a very unpleasant smell, and this, Dr. Tilden tells me, is due to the presence of hydrocarbons, and especially of paraffin. I have been, therefore, led to think that the smell of iron or steel when held in the hand is really due to the hydrocarbons to which this operation gives rise; and it is probable that no metallic particles, even in the form of vapour, reach the nose or even leave the metal. Hence, although smell may not, like sound, be propagated by vibration, it seems probable that particles of the metal with which we have been accustomed to associate the particular smell may no more come into contact with the olfactory nerves than a sounding musical instrument strikes against the drum of the ear.

And the same sort of result may occur when a metal is rubbed, for, although in that case particles may very likely be detached, it seems possible that the function of these metallic particles may be to act on the moisture of the air, and liberate hydrogen similarly contaminated; and that in this case also it is the impurities which produce the smell, and not the particles of the metal with which we have been accustomed to associate it.

This view I put forward tentatively, and to further elucidate the matter I am about to begin a series of smell tests in various gases, artificially dried, with metals as pure as can be obtained.

I next come to the diffusion of smell. From the experience we have of the considerable distance at which a good nose can detect a smell, and the quickness with which the opening of a bottle of scent, for example, can be detected at a distance, I imagined that tubes not less than 15 or 20 feet in length would be required for ascertaining, even roughly, the velocity at which a smell travels. But experiment soon showed, that when the space through which a smell had to pass was screened from draughts, it diffused with surprising slowness, and that feet could be replaced by inches in deciding on the lengths of the tubes to be used. These are made of glass, which is relatively easy to free from remanent smells.

When the room and tube had been freed from smell by strong currents of air blown through them, the tube was corked up at one end and taken outside to have another cork, to which was attached some odoriferous substance inserted at the other end. The tube was now brought back to the odourless room, and placed in a fixed horizontal or vertical position, and the unscented stopper was withdrawn. As a rule, immediately after the removal of the stopper, a smell was observed, which had been transmitted very quickly through the tube by the act of corking up the other end with the stopper carrying the odoriferous material. This first whiff, however, lasted only a very short time, and then a long period elapsed before any further smell could be detected at the free end of the tube, whether that end was left open or closed between times. Finally, however, after, for example, about eighteen minutes in the case of a three-foot horizontal tube, having a large cotton-wool sponge saturated with oil of limes attached to one cork, the smell became definite and recognisable.

It would, therefore, appear that the passage of smell is generally far more due to the actual motion of the air containing it than to the diffusion of the odoriferous substance through the air. And, as a striking illustration of this, the following is interesting:—After the stopper had been in contact with the odoriferous substance for some time, it, of course, acquired a smell itself, which gradually spread in the room in which the experiment was made. And although this smell was due simply to the exposed part of the stopper, while the air inside the tube was at one end in contact with a mass of the odoriferous subtance itself, the only place where the smell could *not* be detected during the course of the experiment was the space inside the open end of the glass tube. And, what seemed very surprising, it was found necessary, in several cases, to blow air through the room to clear out the smell which emanated from the *outside* of the stopper before the smell coming along the tube from the mass of odoriferous substance which was *inside* it at the other end could be detected. A further proof of the important part played by the motion of the air in diffusing smell was the fact that a strong smell at the free end of the tube could at any time be caused by merely loosening the stopper to which the scented sponge was attached; for sniffing at the free end then made a draught through the tube which brought the scent with it.

Further, although the glass tubes were coated outside with a thick layer of non-heat-conducting material, so as to check the formation of convection currents, due to difference in the inside and outside temperature, caused by handling, the rate of travel of a smell from a given odoriferous material was found to be much quicker when the tube was vertical than when it was horizontal. But this, I am inclined to think, may have been caused by a small convection current which still was produced in spite of these precautions.

For, as suggested by Dr. Ramsay several years ago, a substance must have a molecular weight at least fifteen times that of hydrogen to produce a sensation of smell at all, and, further, since camphor, with which many of my experiments have been made, has, when vaporised, a density about five times that of the air, it seems unlikely that scent vapour should diffuse much more quickly upwards through a vertical column of air than through a horizontal one. At the same time, not only are the tests with the glass tubes very striking, but the general impression which exists that smells rise, indeed the very fact that the nasal channels of animals open downwards, tends to show that, whether due to draughts or not, smells have really a tendency to ascend. And the following result obtained with glass tubes closed at one end with stoppers carrying respectively camphor, menthol, oil of limes, &c., and at the other end with corks, is instructive on this point. For, on uncorking such a tube after it had been closed for a long time and allowing the odour to stream out of it through the open air towards the experimenter's face, it was always found that the tube had to be brought much closer when the scent stream was poured downwards than when she was in a vertical position and it was allowed to ascend, although, when it was poured downwards, the experimenter brought her nose into as favourable a position as possible for receiving the smell, by lying down with her head thrown well back.

As an illustration of the inefficiency of diffusion alone to convey a smell you will find that if you hold your breath, without in any way closing your nose either externally or by contracting the nasal muscles, you will experience no smelling sensation even when the nose is held close to pepper, or a strong solution of ammonia, or even when camphor on a minute tube is introduced high up into the nostril. Mere diffusion from the lower nasal cavity into the upper cannot apparently take place with sufficient ease to produce the sense of smell, so that an actual stream of air through the upper portion of the nose seems necessary even when the nose is a very sensitive one. This stream, for substances placed outside the nose, is produced by breathing *in*, no smell being detected while breathing *out*. On the other hand, if a substance be placed inside the mouth its flavour is recognised when the air is forced outwards through the nostrils—that is, at each expiration. Hence we may experience alternately two totally different smells by placing one substance outside the nose and the other in the mouth, the one smell being noticed in inhaling and the other in exhaling. And the latter can be increased by smacking the lips, which, I think, has really for its object the forcing of more air through the nostrils at each expiration.

Experiments on the propagation of smells in a vacuum have also been commenced in my laboratory, and the results are no less surprising than those obtained with the propagation in air. A U tube, seven inches high, had the odoriferous substance placed inside it at the top of one limb, and a very good vacuum could be made by allowing mercury to flow out of the tube. Then the two limbs were separated by raising the mercury column, and air being admitted at the top of the other limb, without its coming into contact with the odoriferous substance, the nose was applied at the top of this limb.

When liquids like ammoniated lavender, smelling salts, solution of musk, and amyl acetate were employed, and various devices were used for introducing the liquid, and preventing its splashing when it boiled on exhausting the air, it was found that the time that it was necessary to leave the two limbs connected for a smell to be just observable was reduced from a few minutes or seconds when the tube was filled with air to less than half a second for a good vacuum; with solid camphor it was reduced from twenty minutes to one second, and when moist rose leaves were used, from fifty minutes to two seconds. But with solid particles of musk the time was not reduced below twenty minutes by taking away the air, while with dried lavender flowers and dried woodruff leaves no smell could be detected after the two limbs had been connected for many hours, and a good vacuum maintained. These experiments are, of course, somewhat complicated by variations in the amount of odorous surface exposed, but they seem to indicate that with these particular dried substances either the rate of evolution of the scent, or its rate of propagation, or both, are very slow even in a good vacuum.

I have also carried out some tests on the power of different substances to absorb various scents from the air. Lard, it is well known, is used to absorb the perfume from flowers in the commercial manufacture of scents, perhaps because it has little odour of its own, and because the scent can be easily distilled from it. But if lard, wool, linen, blotting-paper, silk, &c., be shut up for some hours in a box at equal distances from jasmine flowers, dried woodruff leaves, or from a solution of ammonia, I find that it is not the lard, but the blotting-paper, that smells most strongly when the articles are removed from the box. On the other hand, when solid natural musk is employed, it is the wool that alone acquires much smell, even after the box has been shut up for days.

Another noteworthy fact is the comparatively rapid rate at which grains of natural musk are found to lose their fragrance when exposed to the air. The popular statement, therefore, that a grain of musk will scent a room for years supplies but another example of the contrast between text book information and laboratory experience.

The power of a smell to cling to a substance seems to depend neither on the intensity of the smell nor on the ease with which it travels through a closed space. Musk has but a faint smell, but the recollection of the greeting of a rich Oriental survives many washings of the hands. The smell of rose leaves, again, is but faint, and it travels very slowly through air in a tube; and yet the experiments on its propagation in the glass vacuum apparatus were rendered extremely troublesome, by the difficulty experienced in removing the traces of the smell from the glass between the successive tests. Rubbing its surface was quite ineffectual, and even the mercury had to be occasionally shaken up with alcohol to free it from the remanent smell. In fact we found, as Moore put it:

> "You may break, you may shatter the vase if you will,
> But the scent of the roses will cling to it still."

This absorption of scents by glass, and the ease with which I found that jasmine flowers could be distinguished from woodruff leaves, even when each was enclosed in a series of three envelopes specially prepared from glazed paper, and when many precautions were taken to prevent an odour being given to any of the envelopes in the operation of closing, as well as to prevent its diffusion through the joints in the paper, led me to try whether an actual transpiration through glass could be detected with the nose. For this object a nnmber of extremely thin glass bulbs were blown from soda and from lead glass, so thin that they exhibited colours like a soap bubble, and felt, when gently touched, like very thin oiled silk, and after a little ammoniated lavender, amyl nitrite, ethyl, sulphide, mercaptan, solution of musk, oil of peppermint, and propylamine had been introduced into them respectively, they were hermetically sealed, and placed separately in glass stoppered bottles.

In some cases, on removing the stopper from a bottle after many hours, a faint odour could be detected, but so, generally, could a minute flaw after much searching; the crack, however, being so slight that it did not allow sufficient passage of the air to prevent the bulb subsequently breaking, presumably from changes of atmospheric pressure. And in those cases where a smell was detected without any flaw being found in the glass, the subsequent breaking of the bulb put an end to further testing. The question therefore remains unanswered.

In presenting this brief introduction to the physics of smell, I have aimed at indicating the vast territory that waits to be explored. That it will be found to contain mines of theoretical wealth there can be no doubt; while it is probable that a luxuriant growth of technical application would spring up later on. Already, for example, Mrs. Ayrton unintentionally picks out inferior glass by the repugnance she shows at drinking water out of certain cheap tumblers. To conclude, I may say that one of my fondest hopes is that an inquiry into the physics of smell may add another to the list of wide regions of knowledge opened up by the theoretical physicist in his search for answers to the questions of the technical man.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. F. R. JAPP, M.A., LL.D., F.R.S., PRESIDENT OF THE SECTION.

Stereochemistry and Vitalism.

OF the numerous weighty discoveries which science owes to the genius of Pasteur, none appeals more strongly to chemists than that with which he opened his career as an investigator—the establishing of the connection between optical activity and molecular asymmetry in organic compounds. The extraordinary subtlety of the modes of isomerism then for the first time disclosed; the novelty and refinement of the means employed in the separation of the isomerides; the felicitous geometrical hypothesis adopted to account for the facts—an hypothesis which subsequent investigation has served but to confirm; the perfect balance of inductive and deductive method; and lastly, the circumstance that in these researches Pasteur laid the foundation of the science of stereochemistry: these are characteristics any one of which would have sufficed to render the work eminently noteworthy, but which, taken together, stamp it as the capital achievement of organic chemistry.

Physiologists, on the other hand, are naturally more attracted by Pasteur's subsequent work, in which the biological element predominates; in fact, I doubt whether many of them have given much attention to the earlier work. And yet it ought to be of interest to physiologists, not merely because it is the root from which the later work springs, but because it furnishes, I am convinced, a reply to the most fundamental question that physiology can propose to itself—namely, whether the phenomena of life are wholly explicable in terms of chemistry and physics; in other words, whether they are reducible to problems of the kinetics of atoms, or whether, on the contrary, there are certain residual phenomena, inexplicable by such means, pointing to the existence of a directive force which enters upon the scene with life itself, and which, whilst in no way violating the laws of the kinetics of atoms—whilst, indeed, acting through these laws—determines the course of their operation within the living organism.

The latter view is known as Vitalism. At one time universally held, although in a cruder form than that just stated, it fell, later on, into disrepute; "vital force," the hypothetical and undefined cause of the special phenomena of life, was relegated to the category of occult qualities; and the problems of physiology were declared to be solely problems of chemistry and physics. Various causes contributed to this result. In the first place, the mere name "vital force" explains nothing; although, of course, one may make this admission without thereby conceding that chemistry and physics explain everything. Secondly, the older vitalists confounded force with energy; their "vital force" was a source of energy; so that their doctrines contradicted the law of the conservation of energy, and became untenable the moment that this law was established. I would point out, however, that the assumption of a purely directive "vital force," such as I have just referred to, using the word "force" in the sense which it bears in modern dynamics, does not *necessarily* involve this contradiction; for a force acting on a moving body at right angles to its path does no work, although it may continuously alter the direction in which the body moves. When, therefore, Prof. J. Burdon Sanderson writes: "The proof of the non-existence of a special 'vital force' lies in the demonstration of the adequacy of the known sources of energy in the organism to account for the actual day by day expenditure of heat and work," he does not consider this special case. The application of the foregoing principle of dynamics to the discussion of problems like the present is, I believe, due to the late Prof. Fleeming Jenkin. A third ground for abandoning the doctrine of a "vital force" was the discovery that numerous organic compounds for the production of which the living organism was supposed to be necessary, could be synthesised by laboratory methods from inorganic materials. It is the validity of some of the conclusions drawn from the latter fact that I wish especially to consider.

Recent years have, however, witnessed a significant revival of the doctrine of vitalism among the physiologists of the younger generation.

It is not my intention to offer any opinion on the various arguments which physiologists of the neo-vitalistic school have put forward in support of their views; these arguments and the facts on which they are based lie entirely outside my province. I shall confine myself to a single class of chemical facts rendered accessible by Pasteur's researches on optically active compounds, and, considering these facts in the light of our present views regarding the constitution of organic compounds, I shall endeavour to show that living matter is constantly performing a certain geometrical feat which dead matter, unless indeed it happens to belong to a particular class of products of the living organism and to be thus ultimately referable to living matter, is incapable—not even conceivably capable—of performing. My argument, being based on geometrical and dynamical considerations, will have the advantage, over the physiological arguments, of immeasurably greater simplicity; so that, at all events, any fallacy into which I may unwittingly fall will be the more readily detected.

In order to make clear the bearing of the results of stereochemical research on this physiological problem, it will be necessary to give a brief sketch of the stereochemistry of optically active organic compounds, as founded by Pasteur and as further developed by later investigators.

Substances are said to be optically active when they produce rotation of the plane of polarisation of a ray of polarised light which passes through them. The rotation may be either to the right or to the left, according to the nature of the substance; in the former case the substance is said to be dextro-rotatory; in the latter, lævo-rotatory. The effect is as if the ray had been forced through a twisted medium—a medium with a right-handed or a left-handed twist—and had itself received a twist in the process; and the amount of the rotation will depend upon the degree of "twist" in the medium (that is, on the rotatory power of substance) and upon the thickness of the stratum of substance through which the ray passes, just as the angle through which a bullet turns in passing from the breech to the muzzle of a rifle will depend upon the degree of twist in the rifling and the length of the barrel. If the bullet had passed through the barrel in the opposite direction, the rotation would still have been in the same sense; since a right-handed (or left-handed) twist or helix remains the same from whichever end it is viewed, in whichever direction it is traversed. This also applies to optically active substances; if the polarised ray passes through the substance in the opposite direction, the rotation still occurs in the same sense as before. This characteristic sharply distinguishes the rotation due to optically active substances from that produced by the magnetic field, the latter rotation being reversed on reversing the direction of the polarised ray.

Optically active substances may be divided into two classes. Some, like quartz, sodium chlorate, and benzil, produce rotation only when in the crystallised state; the dissolved (or fused) substances are inactive. Others, like oil of turpentine, camphor, and sugar, are optically active when in the liquid state or in solution. In the former case the molecules of the substance have no twisted structure, but they unite to form crystals having such a structure. As Pasteur expressed it, we may build up a spiral staircase—an asymmetric figure—from symmetric bricks; when the staircase is again resolved into its component bricks, the asymmetry disappears. (I will explain presently the precise significance of the terms symmetry and asymmetry as used in this connection.) In the case of compounds which are optically active in the liquid state, the twisted structure must be predicated of the molecules themselves; that is, there must be a twisted arrangement of the atoms which form these molecules.

The earliest known experimental facts regarding the rotation of the plane of polarisation by various substances, solid and liquid, were discovered by Arago and by Biot.

After this preliminary statement as to what is understood by optical activity, we may consider Pasteur's special contributions to the solution of the problems involved.

Pasteur tells us, in the well-known "Lectures on the Molecular Asymmetry of Natural Organic Products," which he delivered in 1860, before the Chemical Society of Paris, that his earliest independent scientific work dealt with the subject of crystallography, to which he had turned his attention from a conviction that it would prove useful to him in the study of chemistry. In order to perfect himself in crystallographical methods, he resolved to repeat all the measurements contained in a memoir by De la Provostaye on the crystalline forms of tartaric acid, racemic acid, and their salts. These two sets of compounds have the same composition, except that they frequently differ in the number of molecules of water of crystallisation which they contain; but whereas tartaric acid and the tartrates are dextro-rotatory, racemic acid and the racemates are optically inactive. It was probably this circumstance that decided Pasteur in his choice of a subject, for it appears that, even as a student, he had been attracted by the problem of optical activity. In the course of the repetition, however he detected a fact which had escaped the notice of his predecessor in the work, accurate observer as the latter was—namely, the presence, in the tartrates, of right-handed hemihedral faces, which are absent in the racemates. Hemihedral faces are such as occur in only half their possible number; and in the case of non-superposable hemihedry, to which class that of the tartrates belongs, there are always two opposite hemihedral forms possible: a right-handed or dextro-form, and a left-handed or lævo-form. Which is right, and which is left, is a matter of convention; but they are opposite forms, and differ from one another exactly as the right hand of the human body differs from the left: that is, they resemble one another in every respect, except that they are non-superposable—the one cannot be made to coincide in space with the other, just as a right hand will not fit into a left-hand glove. The one form is identical with the mirror image of the other: thus the mirror image of a right hand is a left hand. Such opposite hemihedral crystalline forms are termed *enantiomorphs*; they have the same faces and the same angles, but differ in the fact that all positions in the one are reversed in the other for one dimension of space, and left unchanged for the other two dimensions; this being the geometrical transformation which an object appears to undergo when reflected in a plane mirror. Enantiomorphism is possible only in the case of asymmetric solid figures; these alone give non-superposable mirror images. Any object which gives a mirror image identical with the object itself—a superposable mirror image—must have at least one plane of symmetry.

The hemihedry of the tartrates discovered by Pasteur is in every case in the same sense—that termed right-handed—provided that the crystals are oriented according to two of the axes which have nearly the same ratio in all the tartrates.

Pasteur was inclined to connect the molecular dextro-rotatory power of the tartrates with this right-handed hemihedry; since in the racemates both the hemihedry and the rotatory power were absent. A similar connection, which, however, held good only for the crystalline condition, had, as he points out, been already observed in the case of quartz, the crystals of which occasionally exhibit small asymmetric (tetrahedral) faces, situated in some specimens to the right and in others to the left; the former specimens being dextro-, the latter, lævo-rotatory. The possibility of this connection was first suggested by Sir John Herschel.

Pasteur's views were confirmed by an unexpected discovery which he made shortly after. Mitscherlich had stated, in 1844, in a communication to Biot, which the latter laid before the French Academy of Sciences, that sodium ammonium tartrate and sodium ammonium racemate were identical, not merely in chemical composition, but in crystalline form, in specific gravity, and in every other property, chemical and physical, except that the solution of the former salt was dextro-rotatory, that of the latter inactive. And to make his statement still more definite, he added: "The nature and the number of the atoms, their arrangement, and their distances from one another, are the same in both compounds."

At the time this passage appeared, Pasteur was a student in the École Normale. He tells us how it puzzled him, as being in contradiction to the views universally held by physicists and chemists that the properties, chemical and physical, of substances depended on the nature, number, and arrangement of their constituent atoms. He now returned to the subject, imagining that the explanation would be found in the fact that Mitscherlich had overlooked the hemihedral faces in the tartrate, and that the racemate would not be hemihedral. He therefore prepared and examined the two double salts. He found that the tartrate was, like all the other tartrates which he had investigated, hemihedral; but, to his surprise, the solution of the racemate also deposited hemihedral crystals. A closer examination, however, disclosed the fact that, whereas in the tartrate all the hemihedral faces were situated to the right, in the crystals, from the solution of the racemate they were situated sometimes to the right, and sometimes to the left. Mindful of his view regarding the connection between the sense of the hemihedry and that of the optical activity, he carefully picked out and separated the dextro-and lævo-hemihedral crystals, made a solution of each kind separately, and observed it in the polarimeter. To his surprise and delight, the solution of the right-handed crystals was dextro-rotatory; that of the left-handed, lævo-rotatory. The right handed crystals were identical with those of the ordinary (dextro-) tartrate; the others, which were their mirror image, or enantiomorph, were derived from the hitherto unknown lævo-tartaric acids. From the dextro- and lævo-salts, thus separated, he prepared the free dextro- and lævo-tartaric acids. And having thus obtained from racemic acid its two component acids—dextro- and lævo-tartaric acids—it was an easy matter to recompose racemic acid. He found that, on mixing equal weights of the two opposite acids, each previously dissolved in a little water, the solution almost solidified, depositing a mass of crystals of racemic acid.

These two tartaric acids have the same properties, chemical and physical, except where their opposite asymmetry comes into play. They crystallise in the same forms, with the same faces and angles; but the hemihedral facets, which in the one are situated to the right, are, in the other, situated to the left. Their specific gravities and solubilities are the same; but the solution of the one is dextro-rotatory; of the other, lævo-rotatory. The salts which they form with inorganic bases also agree in every respect, except as regards their opposite asymmetry and opposite rotatory power. They are enantiomorphous.

Pasteur, discussing the question of the molecular constitution of these acids, anticipates in a remarkable manner the views at present held by chemists. "We know, on the one hand," he says, "that the molecular structures of the two tartaric acids are asymmetric, and on the other, that they are rigorously the same, with the sole difference of showing asymmetry in opposite senses. Are the atoms of the right acid grouped on the spirals of a right-handed helix, or placed at the solid angles of an irregular tetrahedron, or disposed according to some particular asymmetric grouping or other? We cannot answer these questions. But it cannot be a subject of doubt that there exists an arrangement of the atoms in an asymmetric order having a non-superposable image. It is not less certain that the atoms of the left acid realise precisely the asymmetric grouping which is the inverse of this."

The idea of the irregular tetrahedron is, it may be explained, derived from the hemihedral facets. Imagine these to develop in the case of dextro-tartaric acid until the other faces of the crystal disappear, and there results an irregular tetrahedron. Repeat the process with a crystal of lævo-tartaric acid, and the enantiomorphous tetrahedron—the mirror-image of the former—is obtained. We shall see later that the idea, on the one hand, of two asymmetric tetrahedra, and, on the other, that of two opposite helices, given as alternatives by Pasteur to explain the grouping of the atoms within the molecules of dextro- and lævo-tartaric acids, are in reality identical.

The precision of Pasteur's views as to the asymmetry of these acids enabled him to discover two further methods of separating them. Thus he points out that although these acids will possess equal affinity for any given symmetric base, such as potash, or ammonia, or aniline, yet their affinities will not be equal if the base, like quinine or strychnine, is itself asymmetric; because here the special one-sided asymmetry of the base will modify its mode of combination with the two enantiomorphous acids. The solubility is different in the case of the dextro- and lævo-tartrates of the same asymmetric base; the crystalline form, the specific gravity, the number of molecules of water of crystallisation, may be all different. Potassium dextro- and lævo-tartrates are mirror-images of one another; quinine dextro- and lævo-tartrates are not. Pasteur employed in his experiments the asymmetric base cinchonicine, which he converted into its acid racemate, and allowed the solution to crystallise. The first crystallisations consisted of pure lævo-tartrate of cinchonicine, whilst the more soluble dextro-tartrate remained in the mother liquor, from which it finally crystallised in forms totally distinct from those of the lævo-tartrate.

Pasteur's third method is of physiological interest, and is, moreover, the stepping-stone to his later work on ferments. As we shall see presently, he regarded the formation of asymmetric organic compounds as the special prerogative of the living organism. Most of the substances of which the animal and vegetable tissues are built up—the proteids, cellulose—are asymmetric organic compounds, displaying optical activity. Pasteur had shown that two compounds of inverse asymmetry behaved differently towards a third asymmetric compound. How would they behave towards the asymmetric living organism?

It had frequently been noticed that impure calcium tartrate, when mixed with organic matters, as is the case when it is obtained in the process of preparing tartaric acid from argol, readily underwent fermentation. Pasteur examined the action of the ferment (apparently a *Penicillium*) on ammonium tartrate—a substance which had the advantage over calcium tartrate of being soluble—and finding that the fermentation here followed a normal course, ending with the destruction of the tartrate, repeated the experiment with ammonium racemate, examining the solution from time to time with the polarimeter. The fermentation proceeded, apparently, as before; but the solution, originally optically inactive, became lævo-rotatory, the activity gradually increasing in amount until a maximum was reached. At this point the fermentation ceased. The whole of the dextro-tartrate had disappeared, and from the solution the lævo-tartrate was obtained in a state of purity. The asymmetric living organism had selected for its nutriment that particular asymmetric form of tartaric acid which suited its needs—the form, doubtless, which in some way fitted its own asymmetry—and had left the opposite form either wholly or, for the most part, untouched. The asymmetric micro-organism, therefore, exhibits a power which no symmetric chemical substance, such as our ordinary oxidising agents, and no symmetric form of energy, such as heat, can ever possess: it distinguishes between enantiomorphs. If we oxidise racemic acid with nitric acid, for example, both the emantiomorphous constituents are attacked in exactly the same degree. If we heat racemic acid, whatever happens to its right-handed constituent happens equally to its left-handed constituent: the temperature of decomposition of both is the same. Asymmetric agents can alone display selective action in dealing with enantiomorphs.

By the action of heat Pasteur converted ordinary tartaric acid into racemic acid, in which process a portion of the right acid is converted into the left, an equilibrium being established; and lævo-tartaric acid may be converted into racemic acid in the same way, the inverse change taking place. At the same time, a new tartaric acid is formed in both cases: mesotartaric acid, or true inactive tartaric acid, which resembles racemic acid in having no action on the plane of polarisation, but differs from it in not being separable into two acids of opposite activity. According to our present views, it contains two equal and opposite asymmetric groups *within* its molecule. Racemic acid is thus inactive by *inter*-molecular compensation; mesotartaric acid, by *intra*-molecular compensation.

Pasteur, generalising somewhat hastily from the few cases which he had studied, came to the conclusion that all organic compounds capable of exhibiting optical activity might exist in the foregoing four forms—dextro, lævo, racemoid, and meso. As regards the dextro and lævo forms this is correct; as regards the racemoid form it is generally correct; but the meso form, as we now know, is a very special case, implying that the molecule contains two structurally identical complexes of opposite asymmetry.

Were I following the exact historical order, I should introduce here Pasteur's view that compounds exhibiting optical activity have never been obtained without the intervention of life—a view which it is the object of the present address to consider. The later developments of stereochemistry, however, throw so much light on this question, and enable us to discuss it with such precision, that we shall turn our attention to these first. Before so doing, however, we may note that, in spite of the immense growth in the material of stereochemistry, and in spite of the development of the theoretical views of stereochemists, hardly any experimental method of fundamental importance for the separation and transformation of optically active compounds has been added to those described in Pasteur's classical researches, although it is almost forty years since these came to a close. Perhaps Walden's remarkable discovery of a method for the transformation of certain enantiomorphs into their optical opposites without previous racemisation, is the only one entitled to be so classed.

Pasteur was in advance of his time, and his theory of molecular asymmetry was a seed that lay for many years in the ground without germinating.

In 1858, just about the period when Pasteur was concluding his researches in the foregoing field, Kekulé published his celebrated theoretical paper, "On the Constitution and Metamorphoses of Chemical Compounds, and on the Chemical Nature of Carbon," in which he showed that, by assuming that the carbon atom had four units of affinity, the constitution of organic compounds could be satisfactorily explained. This was the starting-point of the theory of chemical structure, and from that time to the present day organic chemists have been engaged, with enormous expenditure of labour, in determining the constitution or molecular structure of the carbon compounds on the lines of Kekulé's theory.

In order that Pasteur's ideas should bear fruit it was only necessary that his purely general statements with regard to molecular asymmetry should be specialised, so as to include the recognised constitution of organic compounds. It was from this union of Pasteur's theory with that of Kekulé that modern stereochemistry sprang. The necessary step was taken, independently and almost simultaneously, by Van 't Hoff and Le Bel, in 1874. I will briefly state their conclusions, so far as these bear on the subject of optical activity.

If we examine the structural formulæ of a number of thoroughly investigated optically active organic compounds, we shall find that the molecule of each contains at least one carbon atom of which the four affinities are satisfied by four different atoms or groups—an asymmetric carbon atom, as it is termed.

The four affinities, or directed attractive powers, of the carbon atom are not to be conceived of as lying in one plane. The simplest assumption that we can make with regard to their distribution in space is that the direction of each makes equal angles with the directions of the three others. We may express this differently by saying that the four atoms or groups attached to the carbon atom are situated at the solid angles of a tetrahedron, in the centre of which the carbon atom itself is placed. If the four atoms or groups are all identical they will be equally attracted by the carbon atom; consequently they will be equidistant from it, and the tetrahedron will be regular. If they are all different the force with which each is attracted will be different; they will arrange themselves at different distances from the carbon atom; and the tetrahedron will be irregular: it will have no plane of symmetry. Any compound of the formula $CHX'Y'Z'$ can therefore exist in two enantiomorphs, applying this term to the molecules themselves—in two non-superposable forms, each of which is the mirror image of the other: thus—

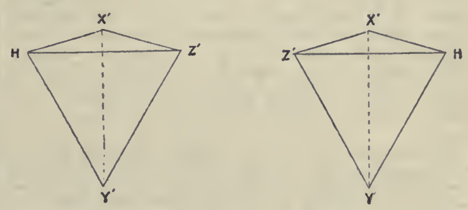

FIG. 1. FIG. 2.

(In these figures no attempt has been made to represent the tetrahedra as irregular; the opposite asymmetry is indicated merely by the opposite order of the four attached atoms or groups. In reality, however, they would be irregular. The carbon atom itself is not shown.)

If we consider any particular set of three atoms or groups—for example H, Z', and Y'—looking towards that face of the tetrahedron about which they are arranged, any order, thus HZ'Y', which is clockwise in one figure, will be counter-clockwise in the other. In like manner, a continuous curve, passing through the four atoms or groups in any given sequence, will form a right-handed helix in the one case and a left-handed helix in the other. We thus find that the foregoing assumptions—the very simplest that could be made—regarding the distribution of the four affinities of carbon and the different degree with which four different atoms or groups will be attracted by the carbon atom to which they are attached, lead to the asymmetric structures postulated by Pasteur to account for optical activity—namely, enantiomorphous irregular tetrahedra, and right- and left-handed helices.

That a spiral arrangement, right- or left-handed, will produce rotation of the plane of polarisation in its own sense, may be shown by various experiments: thus in Reusch's optically active piles of plates of mica, produced by crossing successive plates of biaxal mica at an angle of 60° to one another; or in the twisted jute fibres recently described by Prof. Bose, which, according to the direction of the twist previously imparted to them, rotate the plane of polarisation of electric waves either to the right or to the left.

If two of the four atoms or groups attached to carbon are identical there is no asymmetry, and no optical activity. Thus, in a compound of the formula $CH_2X'Y'$, which we may represent by our tetrahedral scheme as shown in Fig. 3, the two hydrogen atoms are equidistant from the carbon atom; the system has a plane of symmetry passing through X′ Y′ and the carbon atom, and has therefore a superposable mirror image.

If the molecule contains only one asymmetric carbon atom, the latter may be either positive or negative, so that the substance may exist in two forms of opposite optical activity; in addition to which we may have the racemoid combination of

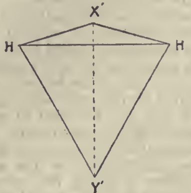

FIG. 3.

the two, which will be inactive but separable. Mandelic acid, $C_6H_5.CH(OH).COOH$,[1] is a case in point: it is known in these three forms.

If, as in the case of tartaric acid, $\begin{array}{l} CH(OH).COOH \\ | \\ CH(OH).COOH \end{array}$, the molecule contains two asymmetric carbon atoms, and at the same time consists of two structurally identical halves, then these two atoms may be either both positive or both negative, reinforcing each other's effect in either case; or one may be positive and the other negative, when, owing to the structural identity of the two halves of the molecule, the effect of the one will exactly compensate that of the other, and the compound will be inactive, but not separable. Furthermore, there may be the racemic combination of the bi-dextro-form with the bi-lævo-form: a combination inactive, but separable. We have thus the explanation of the four forms observed by Pasteur.

In fact all the complex cases of isomerism that have been met with among compounds of this class—compounds structurally identical, but figuratively distinct, as it is termed—may be satisfactorily explained, and their possible number accurately predicted, by means of the theory of the asymmetric carbon atom.

I must apologise to the organic chemists among my audience for inflicting on them this very elementary exposition of what to them is a well-known theory. But outside the circle of organic chemists the theory is, I fear, far from well known. Thus, an eminent physicist, in his "Theory of Light," referring to the rotation of the plane of polarisation by liquid or dissolved substances, says: "I am not aware that any explanation of it has ever been suggested." And in the *Proceedings* of the Royal Society for the present year, another eminent physicist, after quoting with approval this purely personal confession, goes on to suggest the possibility of the molecules having a twisted structure, and points out that a right-handed twist "would appear right-handed when looked at from either end," apparently unaware that such conceptions have been commonplaces of stereochemistry for the past quarter of a century at least.

This brief sketch of the theory was therefore necessary in order that we may now effectively discuss Pasteur's views on the relation between optical activity and life.

Whenever we prepare artificially, starting either with the elements or with symmetric compounds, any organic compound which, when it occurs as a natural product of the living organism, is optically active, the primary product of our laboratory reactions, however closely it may in other respects resemble the natural product, differs from it in being optically inactive. Pasteur was greatly impressed by this fact. In the lectures delivered in 1860 he says: "Artificial products have no molecular asymmetry; and I could not point out the existence of any more profound distinction between the products formed under the influence of life, and all others." And again, he refers to "the molecular asymmetry of natural organic products" as "the great characteristic which establishes perhaps the only well-marked line of demarcation that can at present be drawn between the chemistry of dead matter and the chemistry of living matter." He would not admit that even racemoid forms, optically inactive by intermolecular compensation, might be artificially prepared; thus, to the suggestion that the malic acid which he had obtained from Dessaignes's artificial aspartic acid might possibly be the racemoid form (as we now know that it is), he replied: "That is improbable, for then not only should we have made an active body from an inactive one, but we should have made two—a right and a left."

The view that racemoids could not be prepared artifically did not long remain tenable In 1860, the year in which the foregoing lectures were delivered, Perkin and Duppa, and, independently, Kekulé, obtained from dibromsuccinic acid a form of tartaric acid, which Pasteur recognised as racemic acid. But the succinic acid employed had been prepared from amber, a substance of vegetable origin; and there was still the possibility that herein lay the source of the opitical activity of the two constituents of the artificial racemic acid. This objection, which was raised by Pasteur himself, fell to the ground when, in 1873, Jungfleisch prepared racemic acid from Maxwell Simpson's synthetic succinic acid, and separated it into its right and left constituents by means of the sodium ammonium salt.

"Thus falls the barrier," wrote Schützenberger, "which M. Pasteur had placed between natural and artificial products. This example shows us how reserved we must be in attempting to draw distinctions between the chemical reactions of the living organism and those of the laboratory."

To these words, which, although written a quarter of a century ago, may fairly be taken as representing the prevailing belief of chemists at the present day, Pasteur replied as follows:

"Contrary to M. Schützenberger's belief, this barrier still exists. . . . To transform *one inactive compound into another inactive compound* which has the power of resolving itself simultaneously into a right-handed compound and its opposite (*son symétrique*), is in no way comparable with the possibility of transforming *an inactive compound into a single active compound.* This is what no one has ever done; it is, on the other hand, what living nature is doing unceasingly before our eyes."

On this and subsequent occasions Pasteur did little more than reiterate opinions which he had previously expressed. As he himself stated, he was then occupied with other problems which absorbed his entire time and energies. The result has been that the opinions have suffered neglect and even misrepresentation. Thus Ostwald, in his *Allgemeine Chemie*, translating, or rather paraphrasing, the foregoing passage, omits the word "single"—which is the key to Pasteur's meaning—and then condemns the statement as illogical.

Pasteur's point is, that whereas living nature can make a *single* optically active compound, those laboratory reactions, to which we resort in synthesising such compounds, always produce, simultaneously, at least *two*, of equal and opposite optical activity; the result being intermolecular compensation and consequent optical inactivity, Not necessarily implied in Pasteur's statement, but entirely in harmony with it, is the fact that we can sometimes produce artificially a single compound containing within its molecule two equal and opposite asymmetric groups, and therefore inactive by *intra*-molecular compensation; thus in the oxidation of maleic acid to mesotartaric acid.

Let us consider the cause of this limitation of our synthetic reactions. Why cannot we produce, by laboratory processes, involving the play of symmetric forces and the interaction of symmetric atoms and molecules, *single* optically active compounds? To answer that question, let us turn our attention to the mechanism of the change in which a symmetric carbon atom becomes asymmetric.

A simple case of such a change, typical of all similar changes, is the transformation of a compound, $CH_2X'Y'$, by substitution, into $CHX'Y'Z'$. If we follow this process by means of our tetrahedral model, we see at once why, in our ordinary laboratory reactions, both enantiomorphs must be generated in equal quantity. The molecule of the compound, $CH_2X'Y'$, of which the tetrahedral representation is given in Fig. 3, has, as we have already seen, a plane of symmetry passing through X′Y′ and the carbon atom; and from this plane of symmetry the two hydrogen atoms are equidistant on opposite sides. Any purely mechanical, symmetric force, therefore—any force, for example, such as comes into play in the motions of the symmetric molecules of a gas or a liquid—which affects one of these hydrogen atoms in

[1] The asymmetric carbon atom is represented by an italic *C*.

one molecule of the compound $CH_2X'Y'$, has an equal chance of affecting the other hydrogen atom in another molecule. If the right-hand hydrogen atom in Fig 3 is replaced by the radicle Z', we obtain the enantiomorph represented in Fig. 1; if the left-hand hydrogen atom, that represented in Fig. 2. The chances in favour of these two events being equal, the ratio,

$$\frac{\text{Number of occurrences of event I.}}{\text{Number of occurrences of event II.}}$$

will, if we are dealing with an infinitely great number of molecules, approximate to unity. We therefore obtain a mixture, optically inactive by inter-molecular compensation.

All cases of the conversion of symmetric into asymmetric compounds may be referred to the same category, no matter whether the chemical process is one of substitution or of addition, or whether the resulting molecule contains one or more asymmetric carbon atoms. Thus, in the reduction of a ketone of the formula X'.CO.Y' to a secondary alcohol of the formula X'.*C*H(OH).Y'; in the transformation of an aldehyde by the addition of hydrocyanic acid into a nitrile of an α-hydroxy-acid; in the oxidation of fumaric acid to racemic acid—cases typifying the various additive processes in which asymmetric groupings are produced—there is one condition common to all: in the symmetric compound, with which we start, there are, in every case, two identical points of attack, equidistant from the plane of symmetry of the molecule, and the result is that the two possible events happen in equal number, so that the mixture of enantiomorphs obtained is optically inactive by compensation. We are, of course, in many cases able afterwards to separate these enantiomorphs by the methods devised by Pasteur, and thus obtain the single optically active compounds; but we cannot produce them singly as long as we have at our disposal only the symmetric forces which we command in the laboratory.

Precisely the same state of things prevails when symmetric molecules unite, under the influence of symmetric forces, to build up an asymmetric crystalline structure. When, for example, sodium chlorate crystallises from its aqueous solution, the number of right-handed crystals is, on the average, as was shown by Kipping and Pope, equal to the number of left-handed crystals. The same fact was proved by Landolt by observing the optical inactivity of the mixture of microscopic right and left crystals obtained by adding alcohol to a concentrated aqueous solution of sodium chlorate. The two possible asymmetric events occur in equal number.

Non-living, symmetric forces, therefore, acting on symmetric atoms or molecules, cannot produce asymmetry, since the simultaneous production of two opposite asymmetric halves is equivalent to the production of a symmetric whole, whether the two asymmetric halves be actually united in the same molecule, as in the case of mesotartaric acid, or whether they exist as separate molecules, as in the left and right constituents of racemic acid. In every case, the symmetry of the whole is proved by its optical inactivity.

The result is entirely different, however, when we allow symmetric forces to act under the influence of already existing asymmetric, non-racemoid compounds.

Thus if we start with an optically active compound—a compound containing one or more asymmetric carbon atoms and non-racemoid—and, by appropriate chemical reactions, render asymmetric some carbon atom in the compound which was not previously so, then it does not follow that the two forms represented by the two possible arrangements of this new asymmetric carbon atom will be produced in equal quantity. The compound with which we start has no plane of symmetry; and, although there are still the two possible points of attack, one will be more exposed than the other; in fact, one mode of attack may so predominate that apparently only one asymmetric compound is formed, the other compound, if formed at all, escaping detection by the smallnnss of its amount. A case in point is the conversion of *d*-mannose by combination with hydrocyanic acid into the nitrile of *d*-mannoheptonic acid, studied by Emil Fischer, in which only one nitrile is formed, although there are two ways in which the hydrocyanic acid may attach itself to the aldehyde group of the mannose. On the other hand, the same general reaction, in the union of hydrocyanic acid with ordinary aldehyde $CH_3.CHO$—a symmetric compound—yields the right and left forms of lacto-nitrile $CH_3.\mathit{C}H(OH).CN$ in equal quantity, the two asymmetric events occurring in equal number, and the resulting mixture of compounds being inactive. It is the difference between guidance and no guidance: the asymmetric group present in the mannose guides into a particular path the symmetric forces which bring about the addition of the hydrocyanic acid; in the case of the symmetric aldehyde the result is left to pure chance. The latter action is like that of tossing a perfectly balanced coin; in the former the coin is heavily weighted on one side. The saying, "*les dés de la Nature sont pipés*," is certainly true of living nature and its products.

This guiding action displayed by asymmetric compounds may even impart a bias to the crystallisation of those molecularly symmetric substances already referred to, which crystallise in enantiomorphous forms. Thus Kipping and Pope have recently made the interesting observation that the crystals of sodium chlorate which are deposited from an aqueous solution containing 200 grams of *d*-glucose to the litre consist, on an average, of about 32 per cent. of right-handed to 68 per cent. of left-handed crystals, the asymmetric carbohydrate, by its mere presence, favouring the formation of the one asymmetric form of the inorganic salt at the expense of the other.

These observations possibly afford a clue to the mode of action of the living organism in producing single enantiomorphs. This production of single asymmetric forms may be a result of the asymmetric character of the chemical compounds of which the tissues of plants and animals are built up. The optically active products of the organism—the carbohydrates, the terpenes, tartaric acid, asparagine, quinine, the serum of the blood, and countless others—have been formed in an asymmetric environment, and their asymmetry is an induced phenomenon. They have been cast, as it were, in an asymmetric mould. According to this view they are a result of the selective production of one of the two possible enantiomorphous forms. The same would hold good with regard to the organised tissues themselves, developed from inherited asymmetric beginnings in the ovum or the seed, or obtained by fission. The perplexing question of the *absolute origin* of these asymmetric compounds I will discuss later.

Another view has been put forward by Émil Fischer. In his lecture on "Syntheses in the Sugar Group," delivered before the German Chemical Society in 1890, he says:

"Starting with formaldehyde, chemical synthesis leads, in the first instance, to the optically inactive acrose. In contradistinction to this only the active sugars of the *d*-mannitol series have hitherto been found in plants.

"Are these the only products of assimilation [of carbon dioxide and water]? Is the preparation of optically active substances a prerogative of the living organism; is a special cause, a kind of vital force, at work here? I do not think so, and incline rather to the view that it is only the imperfection of our knowledge which imports into this process the appearance of the miraculous.

"No fact hitherto known speaks against the view that the plant, like chemical synthesis, first prepares the inactive sugars; that it then resolves them into their active constituents, using the members of the *d*-mannitol series in building up starch, cellulose, inulin, &c., whilst the optical isomerides serve for other purposes at present unknown to us."

There are, therefore, two opposite processes which would account for the presence of optically active compounds among the substances generated in the living organism, and which we may briefly describe as *selective production* and *selective consumption*. An instance of artificial selective production is the formation of only one nitrile of *d*-mannoheptonic acid already cited. Selective consumption, dissociated, however, from the previous production of the racemoid form, may be illustrated by the fermentation of dextro-tartaric acid in the action, studied by Pasteur and already referred to, of a mould on racemic acid, the lævo-tartaric acid remaining untouched, and by numerous similar fermentations since discovered. Selective consumption is not restricted to living ferments; various cases are known of enzymes, or soluble ferments, which can effect the hydrolysis of one glucoside, but not of its enantiomorph. As Emil Fischer, who studied this phenomenon, says: "Enzyme and glucoside must fit each other like key and lock, in order that the one may exercise a chemical action on the other." And a similar selective action, embracing the much more complex phenomenon of alcoholic fermentation, is displayed by E. Buchner's soluble zymase obtained from yeast cells.

It is true, moreover, that the organism sometimes produces both enantiomorphs. Thus the lactic ferment converts carbohydrates into racemoid lactic acid; ordinary, or lævo-rotatory, asparagine is accompanied in plants, as Piutti showed, by a small quantity of its optical isomeride; and there are other cases.

These facts might be taken as evidence in favour of Fischer's view that selective consumption is the cause of the phenomenon we are discussing. But I do not think that, in the present state of our knowledge, we can decide between the two views. For that matter both may be correct, each may explain particular cases. What I wish to point out is that Fischer's statement that the "miraculous" character of the phenomenon is eliminated by his assumption appears open to question. It is just as much, or as little, miraculous after as before. The production of a single asymmetric form, and the destruction of one of two opposite asymmetric forms, are problems of precisely the same order of difficulty, and there are only two ways in which either of them has ever been solved: firstly, by the direct action of living matter, and, secondly, by the use of previously existing asymmetric non-racemoid compounds, which are, in the last resort, due to the action of life. Directly, or indirectly, then, life intervenes.

Doubtless this will appear a very extraordinary statement in view of Jungfleisch's synthesis of racemic acid and its resolution into dextro- and lævo-tartaric acids by the crystallisation of the sodium ammonium salts. The process does not take place in a living organism; nor is the aid of life invoked in the shape of a micro-organism as in Pasteur's third method of separation. No asymmetric base of vegetable origin is employed as in Pasteur's second method, so that the indirect action of life through its products is also excluded; sodium and ammonium are symmetric inorganic radicles, and no substance of one-sided asymmetry is introduced from beginning to end. The process is one of ordinary crystallisation; the two forms are deposited side by side, the operator afterwards picking out the right and left crystals and separating them. The reason why the two tartrates crystallise out and not the racemate, is that at the ordinary temperature of the air at which the crystallisation is conducted they are less soluble than the racemate. At a higher temperature, on the other hand, these solubilities are reversed and the racemate is deposited. The conditions are precisely those which govern the formation or non-formation of ordinary double salts.

Consequently the overwhelming majority of chemists hold that the foregoing synthesis and separation of optically active compounds have been effected without the intervention of life, either directly or indirectly. Every manual of stereochemistry emphasises this point.

I have already hinted that I hold a contrary opinion. I have held it for some time, but have not ventured to give public expression to it, except in lecturing to my students. I was deterred chiefly by the impression that I stood alone in my belief. I find, however, that this was a mistaken impression. In a lecture on "Pasteur as the Founder of Stereochemistry," which Prof. Crum Brown delivered before the Franco-Scottish Society in July 1897, and which is published in the *Revue française d'Édimbourg*, he says, referring to the separation of enantiomorphs by crystallisation:—

"The question has often occurred to me: Do we here get rid of the action of a living organism? Is not the observation and deliberate choice by which a human being picks out the two kinds of crystals and places each in a vessel by itself the specific act of a living organism of a kind not altogether dissimilar to the selection made by *Penicillium glaucum?* But I do not insist on this, although I think it is not unworthy of consideration."

It is this question, so precisely posed by Prof. Crum Brown, that I would discuss in detail. I think we shall find that the answer to it will be in the sense which he indicates. The action of life, which has been excluded during the previous stages of the process, is introduced the moment the operator begins to pick out the two enantiomorphs.

It will doubtless be objected that, if this is the case, there can be no such thing as a synthesis of a naturally occurring organic compound without the intervention of life, inasmuch as the synthetic process is always carried out by a living operator.

Here, however, we must draw an important distinction. In the great majority of the operations which we carry out in our laboratories—such as solution, fusion, vaporisation, oxidation, reduction and the like—we bring to bear upon matter symmetric forces only—forces of the same order as those involved in the chance motions of the molecules of a liquid or a gas. All such processes, therefore, might conceivably take place under purely chance conditions, without the aid of an operator at all. But there is another class of operations, to which Pasteur first drew attention: those into which one-sided asymmetry enters, and which deal either with the production of a single enantiomorph, or with the destruction (or change) of one enantiomorph in a mixture of both, or with the separation of two enantiomorphs from one another. We have already seen that such processes are possible only under one-sided asymmetric influences, which may take the form either of the presence of an already existing enantiomorph, or of the action of a living organism, or of the free choice of an intelligent operator. They cannot conceivably occur through the chance play of symmetric forces.

We must, therefore, in classifying the actions of the intelligent operator, distinguish between those actions in which his services might conceivably be dispensed with altogether, and those in which his intelligence is the essential factor. To the former class belongs the carrying out of symmetric chemical reactions; to the latter, the separation of enantiomorphs.

Take the synthesis of formic acid—a symmetric compound—by the absorption of carbon monoxide by heated caustic alkali. Given a forest fire and such naturally occurring materials as limestone, sodium carbonate, and water, it would not be difficult to imagine a set of conditions under which a chance synthesis of sodium formate from inorganic materials might occur. I do not assert that the conditions would be particularly probable; still, they would not be inconceivable. But the chance synthesis of the simplest optically active compound from inorganic materials is absolutely inconceivable. So also is the separation of two crystallised enantiomorphs under purely symmetric conditions.

The picking out of the two enantimorphs is, moreover, to be distinguished from the process of similarly separating the crystals of two different non-enantiomorphous substances, although this distinction is commonly ignored by classing both processes together as *mechanical*, in opposition to *chemical* separations. In the case of the non-enantiomorphs there may be differences of solubility, of specific gravity and the like; so that other means of separation, involving only the play of symmetric forces, may be resorted to. Such a process may justly be regarded as "mechanical." But the two crystallised enantiomorphs, as we have seen, have the same solubility—at least in symmetric solvents; the same specific gravity; behave, in fact, in an identical manner towards all symmetric forces; so that no separation by such means is feasible. It requires the living operator, whose intellect embraces the conception of opposite forms of asymmetry, to separate them. Such a process cannot, by any stretch of language, be termed "mechanical." Conscious selection here produces the same result as the unconscious selection exercised by the micro-organism, the enzyme, or the previously existing asymmetric compound.

I need not point out that if the operator chooses to bring about the separation by an asymmetric solvent, or some other asymmetric means, he is still making use of his conception of asymmetry. He merely effects his end indirectly instead of directly. But in either case he exercises a guiding power which is akin, in its results, to that of the living organism, and is entirely beyond the reach of the symmetric forces of inorganic nature.

In like manner, it is not of the least consequence, for the purposes of the present argument, whether the micro-organism, with which we have compared the operator, acts directly in fermenting one of two enantiomorphs, or whether it acts indirectly by first preparing an asymmetric enzyme which displays this selective action. The contention, therefore, of E. Fischer, Buchner, and others, that the discovery of enzymes and zymases "has transferred the phenomena of fermentation from biological to purely chemical territory," is true only as regards the immediate process, and leaves intact the *vitalistic origin* of these phenomena.

We thus arrive at the conclusion that the production of single asymmetric compounds, or their isolation from the mixture of their enantiomorphs, is, as Pasteur firmly held, the perogative of life. Only the living organism with its asymmetric tissues, or the asymmetric products of the living organism, or the living intelligence with its conception of asymmetry, can produce this result. Only asymmetry can beget asymmetry.

Is the failure to synthesise single asymmetric compounds without the intervention, either direct or indirect, of life, due to a permanent inability, or merely to a temporary disability which the progress of science may remove? Pasteur took the latter view, and suggested that the formation of chemical compounds in the magnetic field, or under the influence of circularly polarised light, would furnish a means of solving the problem; and Van 't Hoff also thinks the latter method feasible. As regards magnetism, Pasteur's suggestion was undoubtedly based on a misconception; the magnetic field has not an asymmetric structure; it is merely polar, since the rotation which it produces in the plane of polarisation of a ray of light changes sign with the direction of the field. As regards circularly polarised light, I must confess to having doubts as to whether it can be regarded as an asymmetric phenomenon: the motion of the ether about the axis of the ray is circular, not spiral; and it is only by considering the difference of phase from point to point along the ray that the idea of a spiral can be evolved from it. In fact, are there such things as forces asymmetric in themselves? Is the geometrical conception of asymmetry applicable to dynamical phenomena at all, except in so far as these deal with asymmetric material structures, such as quartz crystals, or organic molecules containing asymmetric carbon atoms? But this is a question which I would submit to the judgment of mathematical physicists.

One thing is certain—namely, that all attempts to form optically active compounds under the influence of magnetism or circularly polarised light have hitherto signally failed. These forces do not distinguish between the two equally exposed points of attack which present themselves in the final stage of the transformation of a symmetric into an asymmetric carbon atom.

But even if such an asymmetric force could be discovered—a force which would enable us to synthesise a single enantiomorph—the process would not be free from the intervention of life. Such a force would necessarily be capable of acting in two opposite asymmetric senses; left to itself it would act impartially in either sense, producing, in the end, both enantiomorphs in equal amount. Only the free choice of the living operator could direct it consistently into one of its two possible channels.

I will briefly recapitulate the conclusions at which we have arrived. Non-living symmetrical matter—the matter of which the inorganic world is composed—interacting under the influence of symmetric forces to form asymmetric compounds, always yields either pairs of enantiomorphous molecules (racemoid form), or pairs of enantiomorphous groups united within the molecule (meso-form), the result being, in either case, mutual compensation and consequent optical inactivity. The same will hold good of symmetric matter interacting under the influence of asymmetric forces (supposing that such forces exist) provided that the latter are left to produce their effect under conditions of pure chance.

If these conclusions are correct, as I believe they are, then the *absolute origin* of the compounds of one-sided asymmetry to be found in the living world is a mystery as profound as the absolute origin of life itself. The two phenomena are intimately connected for, as we have seen, these symmetric compounds make their appearance with life, and are inseparable from it.

How, for example, could lævo-rotatory protein (or whatever the first asymmetric compound may have been) be spontaneously generated in a world of symmetric matter and of forces which are either symmetric or, if asymmetric, are asymmetric in two opposite senses? What mechanism could account for such selective production? Or if, on the other hand, we suppose that dextro- and lævo-protein were simultaneously formed, what conditions of environment existing in such a world could account for the survival of the one form and the disappearance of the other? Natural selection leaves us in the lurch here; for selective consumption is, under these conditions, as inconceivable as selective production.

No fortuitous concourse of atoms, even with all eternity for them to clash and combine in, could compass this feat of the formation of the first optically active organic compound. Coincidence is excluded, and every purely mechanical explanation of the phenomenon must necessarily fail.

I see no escape from the conclusion that, at the moment when life first arose, a directive force came into play—a force of precisely the same character as that which enables the intelligent operator, by the exercise of his Will, to select one crystallised enantiomorph and reject its asymmetric opposite.

I would emphasise the fact that the operation of a directive force of this nature does not involve a violation of the law of the conservation of energy. Enantiomorphs have the same heat of formation; the heat of transformation of one form into the other is *nil*. Whether, therefore, one enantiomorph alone is formed, or its optical opposite alone, or a mixture of both, the energy required per unit weight of substance is the same. There will be no dishonoured drafts on the unalterable fund of energy.

The interest of the phenomena of molecular asymmetry from the point of view of the biologist lies in the fact that they reduce to its simplest issues the question of the possibility or impossibility of living matter originating from dead matter by a purely mechanical process. They reduce it to a question of solid geometry and elementary dynamics; and therefore if the attempted mechanical explanation leads to a *reductio ad absurdum*, this ought to be of a correspondingly simple and convincing character. Let us see how far this is the case.

Life is a phenomenon of bewildering complexity. But in discussing the problem of the origin of life, this complexity cuts two ways. Whilst, on the one hand, it is appealed to by one set of disputants as an argument against the mechanical theory, on the other it affords shelter for the most unproved statements of their opponents. I will take a concrete instance from the writings of an upholder of the mechanical theory of the origin of life, the late Prof. W. K. Clifford. He says:

"Those persons who believe that living matter, such as protein, arises out of non-living matter in the sea, suppose that it is formed like all other chemical compounds. That is to say, it originates in a coincidence, and is preserved by natural selection. . . . The coincidence involved in the formation of a molecule so complex as to be called *living*, must be, so far as we can make out, a very elaborate coincidence. But how often does it happen in a cubic mile of sea-water? Perhaps once a week; perhaps once in many centuries; perhaps, also, many million times a day. From this living molecule to a speck of protoplasm visible in the microscope is a very far cry; involving, it may be, a thousand years or so of evolution."

It was easy for Clifford to write thus concerning life itself, for it was difficult for any one to contradict him. But had he been asked whether any mechanical (symmetric) coincidence would suffice to convert an infinitely great number of molecules of the type shown in Fig. 3 into that shown in (say) Fig. 1, to the exclusion of that shown in Fig. 2; or whether, given a mixture, in equal proportions, of molecules of the types shown in Figs. 1 and 2, any mechanical (symmetric) conditions of environment would bring about the destruction of one kind and the survival of the other, I think his exact mathematical and dynamical knowledge would have prevented him from giving an affirmative answer. But short of this affirmative answer, his other statements, it seems to me, fall to the ground.

I am convinced that the tenacity with which Pasteur fought against the doctrine of spontaneous generation was not unconnected with his belief that chemical compounds of one-sided asymmetry could not arise save under the influence of life.

Should any one object that the doctrine of the asymmetric carbon atom is a somewhat hypothetical foundation on which to build such a superstructure of argument as the foregoing, I would point out that the argument is in reality independent of this doctrine. All that I have said regarding the *molecular* asymmetry of naturally occurring optically active organic compounds, and all the geometrical considerations based thereon, hold good equally of the hemihedral *crystalline* forms of these compounds, about which there is no hypothesis at all. The production of a compound crystallising in one hemihedral form to the exclusion of the opposite hemihedral form, as in the case of the tartaric acid of the grape, is a phenomenon inexplicable on the assumption that merely mechanical, symmetric forces are at work. Nor is this conclusion invalidated even if we ultimately have to admit that the connection between molecular and crystalline asymmetry is not an invariable one—a point about which there is some dispute.

At the close of the lectures from which I have so frequently quoted, Pasteur, with full confidence in the importance of his work, but without any trace of personal vanity, says:—

"It is the theory of molecular asymmetry that we have just established—one of the most exalted chapters of science. It was completely unforeseen, and opens to physiology new horizons, distant but sure."

I must leave physiologists to judge how far they have availed themselves of the new outlook which Pasteur opened up to them. But if I have in any way cleared the view towards one of these horizons, I shall feel that I have not occupied this chair in vain.

Some of my hearers, however, may think that, instead of rendering the subject clearer, I have brought it perilously near to the obscure region of metaphysics; and certainly, if to argue the insufficiency of the mechanical explanation of a phenomenon is to be metaphysical, I must plead guilty to the charge. I will, therefore, appeal to a judgment—metaphysical, it is true, but to be found in a very exact treatise on physical science—namely, Newton's "Principia." It has a marked bearing on the subject in hand:—

"*A cæca necessitate metaphysica, quæ utique eadem est semper et ubique, nulla oritur rerum variatio.*"

I will merely add this is certainly true of the particular *rerum variatio* in which optically active organic compounds originate.

NOTES.

THE funeral of Dr. John Hopkinson and his three children, whose sad deaths on the Dent Veisivi were recorded in last week's NATURE, took place on Friday last at Territet. The coffins were covered with flowers, and many of the wreaths had been sent from England. After a service in the English church the coffins were carried to the cemetery, where they were interred.—At a special meeting of the Council of the Institution of Electrical Engineers, held on August 31, the following resolution was passed unanimously:—"That the Council of the Institution of Electrical Engineers do hereby place on record this expression of their sincere sorrow and deep regret for the great and irreparable loss sustained by the Institution through the untimely and calamitous death of Dr. John Hopkinson, F.R.S., past President of the Institution of Electrical Engineers, Major commanding the Corps of Electrical Engineers, Royal Engineers (Volunteers), and Professor of Electrical Engineering in King's College, London." It was further decided that, subject to it being consonant with the wishes of the family, the members of the Council should attend the funeral as representatives of the Institution. Owing to the sudden alteration in the arrangements for the interment, however, it was impossible for them to carry out their intention; but Prof. Ewing, member of Council, who was in Switzerland at the time, was accessible by telegraph, and was therefore able officially to represent the Institution and, in its name, to lay a wreath of flowers upon the grave of his former colleague.

THE American Association for the Advancement of Science appear to have had a very successful meeting at Boston. Following the usual custom the retiring president, Prof. Wolcott Gibbs, delivered an address, taking for his subject the constitution of the complex-inorganic acids and their salts, which class of compounds was selected by him because it is well adapted to throw light upon the structure and modes of combination of molecules. We regret that on account of the large amount of space which will be devoted during the next few weeks to the proceedings of the British Association, room cannot be found to print Prof. Gibbs's address in full, but a summary of it will be given in a subsequent number, together with a general account of the meeting at which it was delivered.

THE Secretary of State for the Colonies has appointed Dr. Daniel Morris, C.M.G., Assistant Director of the Royal Gardens at Kew, to be Commissioner of the new Imperial Agricultural Department for the West Indies.

WE are requested to state that all communications regarding the full Report of the International Congress of Zoology should be addressed to Adam Sedgwick, Esq., Trinity College, Cambridge.

PROF. VIRCHOW has formally accepted the invitation to the banquet to be given in his honour on October 5, in the Whitehall Room of the Hôtel Métropole. The number of stewards who have signified their intention to be present at the dinner is now 180. Gentlemen who wish to be present should communicate without delay with Mr. Andrew Clark, 71 Harley Street, London, W.

MR. C. E. STROMEYER, writing from Whitby, says that on Friday evening, September 2, from 7.45, to 8.15 an aurora was visible there, with the centre of the rays apparently resting on the horizon about N. 25° E. The rays revolved from west to east at the rate of about 20° in ten minutes. The sky was rather cloudy, but numerous stars could be seen. Twilight was still noticeable in the west, and the full moon was occasionally shining brightly; otherwise, Mr. Stromeyer thinks, the phenomena would doubtless have been very conspicuous. In connection with this observation, it is interesting to call attention to the announcement in this week's Astronomical Column that a fine sun-spot has been visible during the past few days.

MR. ARTHUR JENKIN sends from Redruth some very interesting observations on the motion of falling spray. He points out that if the spray resulting from the breaking of sea-waves on rocks is observed, it will be noticed that after the spray has reached its greatest elevation it exists in the form of drops. Shortly after the downward motion has begun a sudden change takes place, the drops being seen to burst and falling in a state of fine division. Mr. Jenkin adds: "I have repeatedly observed this; and the kind of twinkle which takes place at the moment of change, and the marked difference in appearance, render the phenomenon very noticeable. I have further observed that just before the spray-drop breaks up it momentarily assumes a shape similar to a vortex ring." These observations require an unusual endowment of quick eyesight and power of attention. Mr. Jenkin endeavours to account for the appearance by an explanation based upon difference of velocity between the mass of water and the component particles, due to change of direction of motion.

As already announced, the seventieth Congress of German Naturalists and Physicians will open at Düsseldorf on Monday, September 19, under the presidency of Prof. Mooren. We learn from the *British Medical Journal* that Prof. F. Klein, of Göttingen, will give an address on University and Technical High Schools, and Prof. Tillmanns, of Leipzig, an address on a Hundred Years of Surgery. The Sections will commence their business on Tuesday, September 20, at 9 a.m., and will sit again in the afternoon. In the evening there will be a gala performance of Wagner's *Die Walkure* in the town theatre. On Wednesday the Medical Sections will meet together under the presidency of Prof. His, of Leipzig, when a discussion will take place on the results of recent investigations into the physiology and pathology of the circulatory organs. In the evening there will be a banquet, which will be attended by ladies as well as by members of the Congress. On Thursday the Sections will meet morning and afternoon, and in the evening there will be a ball. The second general meeting will take place on Friday morning, when addresses will be given by Prof. Martius, of Rostock, on the causes of beginnings of disease, by Prof. van 't Hoff, of Berlin, on the increasing importance of inorganic chemistry; and by Dr. Martin Mendelssohn, of Berlin, on the importance of sick nursing to scientific therapeutics. In the evening the city of Düsseldorf will give a farewell entertainment, and Saturday will be spent in excursions. During the meeting there will be four exhibitions: (1) a historical exhibition, (2) an exhibition of scientific medical, hygienic, chemical, and pharmaceutical inventions, (3) an exhibition of photography in relation to science, and (4) a collection of physical and chemical teaching appliances for use in intermediate schools.

THE Ottawa correspondent of the *Times* announces that some Indians who have just arrived at Dauphin from the far north report meeting Esquimaux, who told them of the appearance among them of strange men who descended from the clouds on the shores of Hudson Bay. It is hoped that the report has reference to Herr Andrée's safety.

Two sets of Röntgen ray apparatus are reported to have been provided for the Sudan Expeditionary Force. One of these, which has been taken up the Nile by Major Battersby, will be established at Abadieh. Considerable difficulty and the greatest care had to be exercised to get the apparatus to the hospital in good order. Major Battersby has the assistance of Sergeant-Major Bruce, Royal Army Medical Corps, who is skilled in the manipulation of the necessary apparatus. This will be the main depôt for Röntgen ray work, but Lieut. Huddlestone, R.A.M.C., has taken a small outfit with 6-inch coil to the front.

THE second International Sea Fisheries Congress, organised by the French Society for the Promotion of Technical Instruction in Matters relating to Sea Fisheries, opened at Dieppe on September 2, and it appears, from a report in the *Times*, to have dealt with questions which will help forward the movement for international discussion of the numerous important problems and difficulties which beset the fishing industry. The first congress promoted by the Society was held two years ago at Sables-d'Olonne, on the west coast of France. At this second meeting one of the most important achievements of the congress will be the nomination of an international, instead of a purely French, committee for the organisation of future congresses. The total muster of members attending the present congress at Dieppe exceeds 300, and this number includes representatives, actually present, from the following countries: — France, Sweden, Norway, Great Britain, Belgium, Austria, Italy, the United States, Japan, and Venezuela. The congress opened on Friday, under the presidency of M. E. Perrier, professor of zoology at the Paris Museum of Natural History, and member of the Consultative Committee on Fisheries. After the president's address the congress divided into four sections for the discussion of special topics, viz.: (1) scientific researches, under the presidency of M. Mathias Duval, director of the fishery school at Boulogne; (2) fishery apparatus, preparation and transport, under the presidency of M. Delamare-Debouteville; (3) technical education, under the presidency of M. Jacques Le Seigneur, Commissioner of Marine at Granville; and (4) fishery regulations, under the presidency of M. Roché, Inspector-General of Fisheries. More than forty communications dealing with these subjects were submitted to the congress.

THE scientific work of Lord Rayleigh is the subject of an interesting article contributed by Prof. Oliver Lodge to the *National Review*. Every active worker in the realm of science is familiar with most of Lord Rayleigh's researches, but Prof. Lodge's popular account of the various directions in which these investigations have advanced natural knowledge will nevertheless be read with interest by scientific as well as general readers. "Every subject and branch of a subject that he has taken up," writes Prof. Lodge, "has been left by him in an improved and clarified state, with every kind of avoidable fog or excuse for such fog cleared away from it. Add to this philosophic insight, consummate mathematical power, great versatility of thought, and extraordinary experimental skill, and we have summed up briefly the scientific equipment of Lord Rayleigh." The discovery of argon brought Lord Rayleigh's name prominently before the reading public two or three years ago, but the accurate and laborious investigations which indicated the existence of this gas in atmospheric air had commanded the attention and esteem of men of science long before the gas was actually isolated. This research was only one of a long series distinguished alike by extreme accuracy, clear insight, precision of thought, and ingenious design. Prof. Lodge mentions that Lord Rayleigh's work refers to chemical physics, capillarity and viscosity, theory of gases, flow of liquids, photography, optics, colour vision, wave theory, electric and magnetic problems, electrical measurements, general energy theorems, and other mathematical papers on elasticity and the like, hydrodynamics, and sound. A few of the results which have gained for Lord Rayleigh the admiration and gratitude of physicists are described; and though the notes are necessarily brief, they will serve to give readers not in the stream of scientific thought an idea of the depth and value of his work.

A NOTEWORTHY feature in Dr. Le Neve Foster's general report and statistics for the year 1897 (Part ii.), relating to mines and quarries in the United Kingdom, is a number of instructive diagrams showing graphically the facts tabulated and described in the report. The part of the volume just published as a Parliamentary Blue-book, deals more particularly with the subject of accidents in mines and quarries. During 1897 there were 1015 separate fatal accidents in and about all the mines and quarries, more than 20 feet deep, in the United Kingdom, involving the loss of 1102 lives, showing, on comparison with the previous year, an increase of 11 in the number of accidents and a decrease of 86 in the number of lives lost. It is satisfactory to notice the statement that the decrease in the death-rates mentioned in the two previous reports continues, and that the death-rates for last year are the lowest hitherto recorded. So far as explosions of fire damp or coal dust are concerned the year 1897 is described as an "annus mirabilis," for the deaths by accidents from explosions formed a smaller proportion of the total number of fatalities than in any previously recorded year, the exact proportion being only 1·9 per cent. An examination of the causes of these accidents brings into view two striking facts—first, that most of them were due to open flame, either of naked lights, of matches, or of safety lamps illegally opened; and, second, that not a single fatal ignition of gas or coal dust can with certainty be ascribed to the flame of an explosive in shot-firing. Falls of ground, on the other hand, were responsible for 490, or one-half of the deaths.

IT will be remembered that about a year ago Prof. F. R. Fraser, F.R.S., published the results of some researches which showed that the bile of several animals possesses antidotal properties against serpents' venom and against the toxins of such diseases as diphtheria and tetanus, and that the bile of venomous, or more correctly of nocuous, serpents is specially powerful as an antidote against the venom of serpents. The experiments have been extended, and the new results are stated by Prof. Fraser in the *British Medical Journal*. The most important conclusions are that the bile of nocuous or venomous serpents is the most powerful antidote to venom, and is closely followed in efficiency by the bile of innocuous serpents, while the bile of animals having no venom-producing glands —as man and the ox, pig, and rabbit—while definitely antidotal, is less so than the bile of innocuous serpents, and much less so than the bile of nocuous or venomous serpents. It is remarkable that the bile of one species of venomous serpent may actually be a more powerful antidote against the venom of another species than is the bile produced by this species, and that there is no direct correspondence between the toxic activity of the venom produced by a serpent and the antidotal power of the bile of that serpent. Extending these experiments to the toxins of disease, Prof. Fraser found that the bile of the venomous serpents examined had more antidotal power against the toxins of disease than the bile of the majority of non-venomous animals. It is noteworthy that among the non-venomous animals, the rabbit produced a bile definitely superior to the others in antidotal quality against not only toxins but also venoms.

THE Michigan State Agricultural College has just issued a bulletin embodying an elaborate series of experiments on the use of tuberculin. As a diagnostic agent, expert opinion appears to be practically unanimous that tuberculin is of the greatest value, and such favourable testimony regarding its efficacy as that of Prof. Grange, of the Michigan College, who states he has used it in upwards of a thousand instances during two years, and did not meet with a single case which impeached the trustworthiness of the test, is only one out of many similar statements. Tuberculin is now, in fact, an article of commerce, and its production on a business scale is conducted all over the world. The Pasteur Vaccine Company of Chicago, for example, elaborate tuberculin, and send out detailed instructions for its application. But despite the increasing favour with which it is regarded, a great deal yet remains to be done in perfecting its production, so as to ensure greater uniformity in its reaction, whilst careful scientific records of its influence on animals treated with it are much wanted. It is to help in supplying such data that Mr. Marshall, assistant bacteriologist of the Michigan College, has taken up the subject, and now publishes the results of very careful observations on "the relation of the tuberculin test to normal temperatures."

SOME time ago Dr. Franz Kerntler published a paper on the fundamental laws of electrodynamics, of which we gave a short notice in NATURE. In it the author attempted to discriminate between the various laws of force between two current-elements, all of which laws were in conformity with the accepted theory of action between closed circuits as laid down by Maxwell and others. Dr. Kerntler is continuing his difficult investigation by examining into the possibility of an experimental discrimination between the different laws of force, and we have received a copy of his further paper on the subject, published by the Pester Lloyd Gesellschaft of Budapest.

SOME diversity of opinion has existed among physiologists as to the physiological signification of eating salt; according to Bunge, the use of sodium chloride with food is to counteract the effects of the potassium salts predominating especially in vegetable diet, while other physiologists regard salt purely in the nature of a condiment with no special action. M. Léon Fredericq, writing in the *Bulletin de l'Académie Royale de Belgique*, describes his observations on certain salts used by the natives of the Congo State. These salts are produced by the incineration of aquatic plants, and are placed on the market in the form of cakes produced by evaporation of the solution formed by dissolving the residue. An analysis shows them to consist almost entirely of chloride and sulphate of potassium, the former largely preponderating, and the presence of sodium being only detectable by the spectroscope. The fact that salts of potassium are thus used for cooking purposes seems to negative the views of Bunge, and to support the opinion, previously advanced by Lapicque, that the use of salt is primarily to improve the flavour of food.

MESSRS. F. KING AND SONS, Halifax, are publishing a second edition of Mr. H. Ling Roth's valuable monograph on "The Aborigines of Tasmania." The first edition, published in 1890, consisted of 200 copies, issued to subscribers only. In the preparation of the second edition, Mr. Ling Roth has been assisted by Mr. James Backhouse Walker, of Hobart, Tasmania.

THE American Entomological Society has just published, in pamphlet form, a biographical notice of the late Dr. George H. Horn, by Mr. Philip P. Calvert, and a list of his entomological papers (1860–1896), with an index to the genera and species of Coleoptera described and named, by Mr. Samuel Henshaw. The biography is a very good one, and will be read with interest by entomologists.

A LIST of Röntgen apparatus just issued by Messrs. Isenthal, Potzler, and Co., contains descriptions of several novel pieces of apparatus. The smallest coil described in the list gives a six-inch spark in air; while the largest gives a spark having a minimum length of 40 inches. The catalogue is a striking testimony to the advances which have been made in Röntgen photography during the last two years or so, and it should be seen by medical men and others who contemplate obtaining an outfit for work with Röntgen rays.—Another new catalogue to which attention may profitably be called is Mr. R. Kanthack's catalogue of optical instruments. The high order of the instruments described in the catalogue is vouched for by the fact that the microscopes are exclusively of Messrs. Zeiss and Leitz's manufacture, while the prisms, lenses, mirrors, and astronomical instruments bear the name of Steinheil, Mr. Kanthack being sole agent for the productions of this celebrated firm of Munich opticians.

A "Review and Bibliography of the Metallic Carbides," by Mr. J. A. Mathews, has been published as No. 1090 of the Smithsonian Miscellaneous Collections, upon the recommendation of the Committee on Indexing Chemical Literature, appointed by the American Association for the Advancement of Science. On account of the renewed attention given to this class of bodies during the last five years, Mr. Mathews's review of the work accomplished up to the end of 1897 will be of considerable interest; and, in conjunction with the bibliographical references, will be of value to the chemical student and investigator. The general plan adopted is to give a concise account of the methods of preparation, and physical and chemical properties of the carbides now known, considering them in alphabetical order. Following each descriptive portion are the references to the literature bearing upon the substances to which it refers. The result is a very handy bibliographical dictionary of metallic carbides, and chemists will thank Mr. Mathews for preparing it, and the Smithsonian Institution for making it available.

THE additions to the Zoological Society's Gardens during the past week include a Humboldt's Lagothrix (*Lagothrix humboldti*) from the Upper Amazon, presented by Mr. E. H. L. Ewen; a Ruppell's Colobus (*Colobus guereza*) from Nigeria, presented by Mr. H. S. Kelly; a Hoolock Gibbon (*Hylobates hoolock*, ♀) from Assam, presented by Mr. Lionel Inglis; a Duke of Bedford's Deer (*Cervus xanthopygius*) from Mantchuria, presented by H.G. the Duke of Bedford; a Brazilian Hang-nest (*Icterus jamaica*), a White-throated Finch (*Spermophila albogularis*) from Brazil, presented by Mr. Percy M. Calder; five Rufous Tinamous (*Rhynchotus rufescens*) from Brazil, presented by Mr. Ernest Gibson; two Augural Buzzards (*Buteoauguralis*), three Goliath Beetles (*Goliathus druryi*) from West Africa, presented by Dr. Chalmers; a Lazuline Finch (*Guiraca parellina*) from Central America, presented by Mr. John B. Toone; an Iceland Falcon (*Hierofalco islandus*) from Iceland, presented by Mr. C. R. Anderson; two Great Kangaroos (*Macropus giganteus*, ♂ ♀) two Great Wallaroos (*Macropus robustus*), eleven Brush Turkeys (*Talegalla lathami*), twelve Roseate Cockatoos (*Cacatua roseicapilla*), six Greater Sulphur-crested Cockatoos (*Cacatua galerita*) from Australia, a Red-bellied Wallaby (*Macropus billardieri*), two Bennett's Wallabys *Macropus bennetti*), a Dormouse Phalanger (*Dromicia nana*) from Tasmania, two Brush-tailed Kangaroos (*Petrogale penicillata*), five Silky Bower Birds (*Ptilonorhynchus violaceus*) from New South Wales, a Brown-necked Parrot (*Pæocephalus fusicollis*) from West Africa, two Pretre's Amazons (*Chrysotis prætrii*), a Red-vented Parrot (*Pionus menstruus*) from South America, deposited.

OUR ASTRONOMICAL COLUMN.

A Large Sun-spot.—On Saturday last a very fine spot was visible near the sun's eastern limb, having evidently been brought into view by the sun's rotation. Its full magnitude was revealed a few days later, when the foreshortening was reduced. Changes in the umbra and bright bridges crossing it were detected in the course of a few hours. The spot will be well worth watching during the remaining period of its visibility, especially as many years may perhaps elapse before observers are favoured with another spot of similar size.

The Atmosphere of D.M. + 30° 3639.—Prof. Keeler announces, in the *Astrophysical Journal* for August, that he has fully confirmed Prof. Campbell's discovery of a hydrogen envelope around the Wolf-Rayet star D.M. + 30° 3639 (Nature, vol. xlix. p. 210). The observation was made with the spectroscope attached to the 36-inch refractor of the Lick Observatory, and it was found that the $H\beta$ line appeared as a circular fairly well-defined disc when the slit was opened wide, the cylindrical lens being of course removed, and the focus correctly adjusted on the slit plate for light of that wave-length. No such appearance was noticed in the case of the line at 4652, which has almost the same brightness as $H\beta$, thus proving that the disc was not due to irradiation. Further proof that the appearance was not an illusion was afforded by the visibility of the H line when the star itself was thrown off the slit, as in the observation of the solar chromosphere. Prof. Keeler believes that this hydrogen envelope could be observed visually with a large reflector without the aid of a spectroscope, a piece of blue glass, perhaps, being required. With a refractor the disc would be confused with the circles of chromatic aberration.

The Exterior Nebulosities of the Pleiades.—In connection with the recent discussion concerning the real existence of certain nebulous patches depicted on photographs of the Pleiades taken with a portrait lens, Prof. Barnard has forwarded to the editors of the *Observatory* a copy of a photograph of the same region taken by Dr. H. C. Wilson. This picture was obtained with a 6-inch Brashear portrait lens, the exposure being eleven hours. The coincidence in position of the patches on two perfectly independent photographs is considered strong evidence of their actual existence. The whole group of stars in the Pleiades would thus appear to be involved in scattered nebulosity, with the brightest portions in the neighbourhood of some of the brighter stars.

Luminosity of Gases in Vacuum Tubes.—Bolometric measurements made by K. Ångström have indicated that the radiation of a gas rendered luminous by electricity is proportional to the current strength, within the wide limits of his experiments. This relation was equally true for the total and luminous radiation, and it might be expected that the same law would hold good for the luminosity of the separate spectral lines. In the *Physical Review* for July, E. S. Ferry details the results of a photometric study of the changes produced in the spectra of pure gases when subjected to various conditions of current and pressure. An accumulator of twelve hundred elements was employed to render luminous the gas in the discharge tube, experience having shown that the use of a Ruhmkorff coil produces composite spectral lines whose luminosity is influenced by the partial discharges which follow each principal discharge of the secondary coil. The line spectrum of hydrogen and the band spectrum of nitrogen were investigated, and the following conclusion sarrived at: (1) With gas pressure from 0·25 mm. to 4·00 mm. of mercury, and current strengths from 1 milliampère to 6 milliampères, the luminosity of the separate spectral lines of gases at a given pressure is directly proportional to the current strength. (2) With constant current, the luminosity of a spectral line of a gas increases as the pressure decreases, at first slowly and then more rapidly. The curve showing the relation between the pressure of the gas and the luminosity of a spectral line is regular, but is different for different lines.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

On the initiative of the Business Committee of the Glasgow University General Council, a movement has been set on foot to place a stained glass window in the Bute Hall of the University as a special tribute by past and present students of the University of Glasgow to the memory of the late Prof. Caird. It is estimated that the undertaking will require about 1000*l*., and the maximum subscription is 1*l*. 1*s*. As there are many former students of the University whom it is obviously impossible to communicate with from any lists at present available, the co-operation of all interested in making the movement known among students of older date is invited. The Secretaries are Mr. John G. Kerr, Convener of the Business Committee of the University General Council, and the Rev. Arthur Stanley Middleton, President of the Students' Representative Council. Mr. Archibald Craig, 156 St. Vincent Street, Glasgow, is Treasurer.

Readers of prospectuses of educational institutions and polytechnics may have noticed that of late years there has been a tendency to convert the teachers into professors. The nature of the institution in which the instructors can rightly use the latter title is apparently a matter of opinion, and it is becoming worth while to define the duties and position of a professor. Miss Catherine Dodd describes in the *National Review* how she asked 105 primary school children, between the ages of ten and fourteen, to give this definition, among others. Here are some of the attempts:—"A man who has passed a high examination." "A very clever man." "One who can do his work easily." "A man skilled in sense." That a professor has a certain social standing is evident from the definitions which describe him as "a man who is well off," and "a man who lives in a nice house." Among the vague definitions are the following:—"A person who professes to do something." "A man who says he can do anything." But the children's general idea is that a professor teaches music, dancing, or languages, or performs conjuring tricks. Thus, "A professor teaches all kinds of instruments." "He is a gentleman that generally plays at balls," and "a man who knows clever tricks." To correctly define a professor would probably prove a difficulty to many children of older growth.

In April of the present year the New York State Legislature passed an Act authorising the trustees of Cornell University "to create and establish a department in said University to be known as, and called, the New York State College of Forestry, for the purpose of education and instruction in the principles and practices of scientific forestry." In the same Act, provision was also made to establish a Demonstration Forest of not more than 30,000 acres in the Adirondacks, to be purchased out of the funds set aside for the Forest Preserve Board, and to become the property of Cornell University for the term of thirty years, and to be used for demonstrations of practical forestry. The sum of 10,000 dollars has been granted for the organisation and maintenance of the College and Demonstration Forest. A copy of the prospectus of this new institution, the director of which is Prof. B. E. Fernow, has just been received, and it shows that the College will furnish systematic instruction in the science and art of forestry. Scientific forestry has not hitherto received much attention in the United States, so the new College should prove of assistance not only to New York State, but to the whole country, by increasing and extending the knowledge of rational methods of forest management. As the College is in connection with Cornell University, the educational facilities for the studies leading to the degree of Bachelor of the Science of Forestry are of the best; while the large College Forest in the Adirondacks furnishes opportunities for studying practically methods of silviculture and forest administration. Each student as a part of his last year's work will be required to write a thesis, selected with the advice of the director, giving the results of a personal investigation upon some forestry subject. The opportunities for study and investigation in all branches of the natural sciences underlying forestry and in the various departments of Cornell University are ample, while the connection of the demonstration area with the College of Forestry will furnish additional advantage for original work, research and experimentation, in advancing the science and art of forestry. Some time must elapse before the College Forest is in the best shape for demonstrative purposes, but starting under such high auspices, there is every promise that the institution will prove a success.

Introductory addresses will be given at many of the metropolitan and provincial medical schools, at the opening of the winter session early in October. At St. George's Hospital (says the *Times*) the session will begin on October 1, with an introductory address by Mr. G. R. Turner, surgeon to the hospital. At Charing Cross Hospital the session will commence on October 3, when Prof. Virchow will deliver the second Huxley lecture—"Recent Advances in Science and their Bearing on Medicine and Surgery"—at the St. Martin's Town Hall, Charing Cross. The chair will be taken by Lord Lister. At Guy's Hospital the session will begin on October 3. The first meeting of the Physical Society will be held on that day in the new physiological theatre at 8 p.m., when Sir Samuel Wilks will preside and a paper will be read by Mr. W. H. Crosse. At St. Mary's Hospital the session will be opened with an introductory address by Dr. Caley. At the Middlesex Hospital Dr. Arthur F. Voelcker will deliver an introductory address. At St. Thomas's Hospital the session will commence on October 3, when the prizes will be distributed at 3 p.m. by the Bishop of Rochester. At University College an introductory lecture will be given by Mr. Sidney Spokes, dental surgeon to the hospital. The London School of Medicine for Women will open with an introductory address by Dr. J. W. Carr, senior assistant physician to the Royal Free Hospital. The winter session at Mason College, Birmingham, will commence on October 1, when Prof. Michael Foster will deliver an address. At Yorkshire College, Leeds, the session will open with an address by Dr. C. J. Cullingworth, president of the Obstetrical Society. The University College of South Wales and Monmouthshire, Cardiff, will open on October 3, and Dr. Robert Saundby will deliver an address on October 7. The session at University College, Liverpool, will commence on October 1. The opening ceremony in connection with the new laboratories of physiology and pathology will take place on October 8, when Lord Lister will declare the laboratories open. At University College, Sheffield, Dr. Dyson, vice-president of the College, will deliver the introductory lecture.

SOCIETIES AND ACADEMIES.

DUBLIN.

Royal Dublin Society, June 22.—Prof. D. J. Cunningham, F.R.S., in the chair.—Dr. E. A. Letts and Mr. R. F. Blake communicated a paper on the carbonic anhydride of the atmosphere. The first part was read dealing with (1) a brief historical account of the subject, with a discussion of the methods which have been employed in the determinations; (2) a description of the authors' modification of Pettenkofer's process, whereby results of great accuracy were obtained with mixtures of known volumes of purified air and carbonic anhydride; (3) an account of the authors' experiments (qualitative and quantitative) on the action of weak baryta water on glass; and (4) on the disturbing effect produced by soluble silicates on the delicacy of the phenol colour reaction with alkalis.—A paper was next read by Mr. E. St. John Lyburn, of Pretoria, consisting of notes on the minerals and mining in the Transvaal and Swaziland.—This was followed by a paper by Mr. A. Vaughan Jennings and Mr. H. Hanna on *Corallorhiza innata*, R.Br., and its mycorhiza. The coralloid rhizome is shown to be covered with numerous papillæ whereon tufts of hairs arise. The latter enter very closely into relationship with the fungal hyphæ growing in the soil, forming a mycorhiza. Owing to changes taking place in the hairs, bundles of hyphæ pass down in the inside of the hairs through the outer layers of cells into the cortex, in the outer layers of which they form a coiled mycelium, and in the deeper layers they undergo a process of degeneration, and are absorbed by the protoplasm of the cells. The evidence indicates that the host plant acts carnivorously towards the hyphæ. The hyphæ constituting the *mycorhiza* in this case were traced to one of the higher fungi, *Clitocybe infundibuliformis*.

PARIS.

Academy of Sciences, August 29.—M. Wolf in the chair.—On the measures to be taken for securing uniformity in the methods and control of the instruments employed in physiology, by M. Marey. After discussing the difficulties that have arisen owing to the defective nature of some of the recording instruments in common use, the resolutions adopted at the recent meeting of the International Congress of Physiology at Cambridge are quoted, proposing an international committee. The object of the committee will be to study the means of instituting comparisons between the various types of self-recording instruments, and to introduce some uniformity into the methods employed in physiology.—Observations of the planet DQ Witt, made at the Observatory of Toulouse, with the 25 cm. Brunner equatorial, by M. F. Rossard.—Observations of some shooting stars which appeared during the nights of August 9, 10, 12, 13, 14, 16 and 18, by Mlle. D. Klumpke.—Modification of the internal pressures exerted in closed, empty receivers and submitted to the influence of electric currents, by M. G. Séguy. Experimental evidence is given showing that the pressure inside a vacuum tube is neither uniform nor constant, so long as it is traversed by a current of electricity.—The modifications undergone by the organs of the body during seventy-two hours on the bicycle, studied by phonendoscopy, by MM. A. Bianchi and Félix Regnault. From the variations in the size and shape of lungs and stomach, some therapeutical applications are suggested. The effects of prolonged bicycling exercise are most severely felt by the lungs and heart.

NEW SOUTH WALES.

Royal Society, July 6.—Mr. G. H. Knibbs, President, in the chair.—On the stringy-bark trees of New South Wales, especially in regard to their essential oils, by R. T. Baker and Henry G. Smith. Part i. This paper is the authors' third contribution to a knowledge of the essential oils of the genus Eucalyptus. Some notes on the classification of the species of this genus by other authors are given, and the species now investigated are arranged according to their chemical, economic, and botanical affinities. It was shown that the essential oil of the red stringybark, *E. macrorhyncha*, besides containing a large percentage of eudesmol (the stearoptene of eucalyptus oil) gives an oil of excellent quality containing over fifty per cent. of eucalyptol, and answering all the requirements of the British Pharmacopœia with the exception of that of specific gravity.—On current observations on the Canadian-Australian route, by Captain Campbell Hepworth, R.M.S. *Aorangi*. This paper showed by observations of ocean current made during sixty-four passages between Australia and British Columbia in the liners *Aorangi*, *Warrimoo*, and *Miowera*, the general set and strengths of the currents which are experienced, according to the season of the year, by vessels making the passage between these two colonies. The paper was illustrated by twelve charts, one for each month of the year, on which was delineated each current observation recorded, amounting to several thousand observations.

BOOKS AND PAMPHLETS RECEIVED.

BOOKS.—Medical Diseases of Infancy and Childhood: Dr. D. Williams (Cassell).—Catalog der Handbibliothek des K. Zoologischen und Anthropologisch-Ethnographischen Museums in Dresden (Berlin, Friedländer).—Schantung und seine eingangspforte Kiantschon: F. F. von Richthofen (Berlin, Reimer).

PAMPHLETS.—Colony of Natal. Report of the Government Astronomer for the Year 1897 (Pietermaritzburg, Davis).—Arithmetic, Scheme B, Standards 1, 2, 3 (Reading, N.P.S.A., Ltd.).

CONTENTS.

THURSDAY, SEPTEMBER 15, 1898.

ORCHIDS OF THE SIKKIM HIMALAYA.

Annals of the Royal Botanic Garden, Calcutta. Vol. viii. *The Orchids of the Sikkim Himalaya.* By Sir George King and Robert Pantling. Part I. Letterpress; II. Plates of the Malaxideæ; III. Plates of the Epidendreæ and Vandeæ; IV. Plates of the Listereæ, Goodyereæ, Ophrydeæ, and Cypripediæ. Pp. iv + 11 + 342 4to. (Calcutta: Printed at the Bengal Secretarial Press, 1898.)

THE publication of vol. viii. of the "Annals of the Royal Botanic Garden, Calcutta," makes a valuable contribution to our knowledge of the orchids indigenous to the Eastern Himalaya. It bears the title of "The Orchids of the Sikkim Himalaya," and its authors are Sir George King, K.C.I.E., F.R.S., the distinguished Director of the Royal Botanic Garden, Calcutta, and Mr. George Pantling, Deputy Superintendent of the Government Cinchona Plantation, Sikkim. The many obligations under which the former has placed botanists are well known, but the name of Mr. Pantling is new to orchidology. To the value of his services Sir George King bears emphatic testimony, and he will doubtless make himself a name in Indian botany. The circumstances under which this work have been produced are interesting. Mr. Pantling's position in Sikkim gave him opportunities of which he has taken full advantage. He sent a small party of trained native (Lepcha) collectors into the ranges between the valley of the "Great Rungeet" river and the higher snows during the hot and rainy seasons of several successive years.

"These men were provided with a few swift coolies, by whom living plants of every species collected were quickly conveyed to Mr. Pantling, who, while the plants were still fresh, made drawings of them. . . . These Lepcha collectors, as the following pages show, discovered a considerable number of species formerly unknown."

As an additional precaution the native collectors were provided with a stock of *Formaldehyd*, in a weak solution of which "excellent medium" inflorescences of every species collected were preserved. Three hundred copies of the book have been printed; in half of them the lithographs are lightly printed, and the flowers and analyses coloured; in the other half, the lithographs are darkly shaded and uncoloured.

"The drawings have all been put on stone by natives of Bengal educated at the Government School of Art in Calcutta. And the colouring has, under very careful supervision on Mr. Pantling's part, been done by the sons of Nepaulese coolies employed on the Government Cinchona Plantations—boys who had never, until Mr. Pantling took them in hand, been accustomed to use any implement more delicate than a hoe. Mr. Pantling's perseverance and skill in drilling these boys into accurate colourists has been a standing marvel to everybody who has seen them at work."

In the "Introduction" Sir George King discusses two questions, upon one of which he finds himself at variance with the highest authorities, as well as with his collaborator, Mr. Pantling. Messrs. Darwin, Bentham and Hooker, Bolus, Rolfe, Pfitzer and Krantzlin, following Robert Brown and Lindley, consider that the stamen is single in the genera Orchis, Habenaria, Herminium, Diplomeris, and Satyrium, belonging to the Ophrydeæ. Sir George has satisfied himself that in the Sikkim Ophrydeæ this is not so, and that these have two anthers, one cell of each being fertile, the other infertile.

The other question is one of classification, as to which Sir George and Mr. Pantling are in agreement. They would (*a*) restore Lindley's tribe Malaxideæ, which has recently been merged in Epidendreæ; (*b*) re-include in the Vandeæ a few specified genera which have lately been added to the Epidendreæ; and (*c*) break up Neottiæ into two tribes, Listereæ and Goodyereæ. It is further stated in the introduction that—

"Our study of the Sikkim species convinces us that the fertilisation of orchids by insect agency is by no means so universal as is sometimes supposed."

This is corroborated by the occasional self-fertilisation of cultivated plants, among them one specially mentioned by our authors, *Dendrobium crepidatum.* In regard to orchid classification numerous changes have of recent years recommended themselves to botanists, who have, for example, transferred to Miltonia from Odontoglossum the large-lipped section of plants to which *M. vexillaria*, *Roezlii*, *phalænopsis*, *Warscewiczii*, &c., belong.

The letterpress of vol. viii. of the "Annals" extends to 342 large quarto pages, the plates number 448, and there are indices both to text and plates. A full and clear botanical description of every plant figured is given in English, with its habitat, height above the sea, season of flowering, general characteristics, and distribution elsewhere than in the Sikkim Himalaya. In the coloured copies, coloured flowers and other parts of every species described are given, accompanied by botanical details, coloured and enlarged.

In looking through this work, any one acquainted with cultivated orchids can hardly fail to be struck with the large number of interesting plants it contains which are not to be met with in cultivation, even in the most extensive collections—and also with the not inconsiderable number for the first time described and figured therein. If the labours of the authors suffice to bring home to collectors of orchids the fact that many of the small-flowered genera are as beautiful and interesting as the large, they would produce good fruit. Of the genus Cirrhopetalum alone there are numerous species than which it would be difficult to find any orchid with more beautiful, fantastic and striking flowers, *e.g. C. Medusæ*, *C. picturatum*, *C. ornatissimum*, *C. Cumingi*, *C. O'Brienianum*, *C. Mastersianum*, and others. In referring to this genus it may be noted that the remarkable Cirrhopetalum, represented in pl. 133, is not *C. ornatissimum*, which has a whorled umbel and not a solitary flower, and has been figured in the *Botanical Magazine*, t. 7229, and elsewhere, its near Burmese ally, *C. Collettii*, having been figured, t. 7198, in the same work. The species figured in pl. 133 was recently sent to Kew, but was not identified. If it has not been authoritatively named, it might well be dedicated to Sir George King, and bear his name.

Of the genus Dendrobium thirty-six species are figured, and of these some twenty-four are, or have been, in cultivation. Among them is *D. nobile*, which, being beautiful and of easy growth, is universally cultivated. It was introduced from China about sixty years ago, and has been figured many times.

Mr. Pantling's Nepaulese lads have done so well that it is hardly gracious to find fault with them. But the figures of the more showy Dendrobia illustrate a defect which detracts somewhat from the artistic value of some of the plates. The defect referred to is a want of brilliancy of colour—the tints are too sober. This may be due to the colour wash being too thin, having regard to the lithographic drawing it has to cover.

Plate 285 represents the small local form of *Vauda teres*. This plant, one of the most beautiful of the Orchideæ, produces, as found in cultivation, flowers fully twice the size. *V. teres* crossed with its near Malayan ally, *V. Hookeri*, has produced *V.* "*Agnes Joachim*," which carries a 12 to 16-flowered raceme.

Plate 445 represents, growing on a stone, a very striking orchid, *Diplomeris hirsuta*, which, besides its remarkable mode of growth and beautiful flower, is of great botanical interest, as in it "is indicated with comparative clearness a theory of the structure of the flower of the Ophrydeæ," explained in the Introduction.

Sir George King is so eminent a botanist and so high an authority on the Orchideæ that his conclusions will doubtless meet with general acceptance. Yet it is somewhat difficult to accept the view that *Dendrobium Jenkinsi*, Wallich, pl. 85, is not a good species. Under cultivation it differs widely from *D. aggregatum* in bulb, mode of growth, and inflorescence. The sub-genus Pleione is merged in Cœlogyne, but the Pleiones seem sufficiently distinct in bulb and leaf habit, and flower, fully to justify the retention of the sub-genus. Again, it would appear to be intended to merge *Thunia* in *Phaius*, from which it differs in having no pseudo-bulbs, but leafy stems with a terminal inflorescence. *Phaius albus*, pl. 153, seems to be *Thunia Marshalliana*, Rchb. f., which, when gathered on oaks in the Kangra valley at an elevation of 4000 to 5000 feet, flowered profusely in a verandah at Dharmsala.

It should be mentioned that this volume is dedicated to our great botanist, Sir Joseph Hooker. It forms a valuable contribution to the botany of the natural order it deals with, and reflects great credit on the care, skill, energy and enterprise of its authors. Moreover, the careful notes at the end of each botanical description are a useful help to the cultivator.

OUR BOOK SHELF.

Essai sur la Théorie des Machines electriques à Influence. By V. Schaffers. Pp. 139. (Paris: Gauthier-Villars et Fils. Brussels: Polleunis and Ceuterick, 1898.)

THIS is an important monograph on the history and theory of the influence electrical machine. It is now a good deal more than a century since Wilke invented the electrophorus; the apparatus was improved by Volta, and in 1786 the principle was utilised by Bennet in the "doubler." There confusion begins: machines are rediscovered, re-improved, re-named; and men of science of all nationalities make claims for the rights of priority. The author maintains his opinions unbiassed through all these historical predicaments, and deals equally fairly with Holtz, Voss, and Wimshurst. The theory of the two generic types of influence machines is dealt with at considerable length, and some account is given of the "water-dropping" apparatus, and its application to cloud formation. This part of the subject might with advantage be extended to include the beautiful experiments of Lord Rayleigh on the electrification of liquid jets.

An Introductory Course of Practical Magnetism and Electricity. By J. Reginald Ashworth, B.Sc. (Vict.). Pp. xii + 84. (London: Whittaker and Co., 1898).

IF testimony were needed of the increasing recognition of experimental work in physics as a valuable factor in education, it would be found in the large number of text-books recently published for the use of students in physical laboratories. The present manual comprises a series of practical exercises, by the performance of which the young student will add to his stock of real knowledge, and qualify himself to carry on more difficult experiments when he advances to the higher stages of his subject. The book is intended for use in the laboratory, the course in it being supplementary to the theoretical teaching of the class-room and class-book. The experiments cover the subjects of the elementary stage of magnetism and electricity of the Science and Art Department; they are concisely described, and can be successfully done with simple and inexpensive apparatus. These characteristics are sufficient to commend the volume to the attention of teachers in technical and other schools.

Photography Annual: a Compendium of Photographic Information, with a Record of Progress in Photography for the past Year. Henry Sturmey, editor. Pp. cxlvi + 722. (London: Iliffe, Sons, and Sturmey, Ltd., 1898.)

TO the photographer, be he professional or amateur, who desires to keep in touch with the progress of the science and art of photography, and to know what novelties there are in the market, this volume is almost indispensable. It contains tables of reference and other useful information for photographers; a list of photographic societies; selected articles upon practical subjects by experienced photographers; a record of progress in the various branches of the science and practice of photography during the year 1897 (including photographic chemistry), photographic optics, astronomical photography, photographic mechanical printing, and other applications of photography (including Röntgen photography). Each of these articles is a very valuable summary of scientific work published last year upon subjects related to photography, and results obtained by the aid of photography. In addition to these serviceable abstracts, the volume contains notes on novelties in photographic apparatus and materials, optical lanterns and related appliances, and several excellent specimens of process work as illustrations.

Botanisches Bilderbuch für Jung und Alt. By Franz Bley. Part ii. With explanatory text by H. Berdrow. Pp. viii + 192. 24 Plates. (Berlin: Gustav Schmidt (formerly Robert Oppenheim), 1898.)

THE first part of this work, containing coloured pictures of plants obtainable in Germany during the opening half of the year, has already been noticed in these columns; the present part contains 216 pictures upon 24 plates arranged in the order of the months in which the plants appear, from June to September. The pictures are in most cases well coloured, and, in conjunction with the explanatory notes referring to them, will assist and encourage the study of outdoor botany.

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.*]

Flow of Water Shown by Colour Bands.

I SHALL be obliged if you will publish, as soon as possible, the enclosed correspondence under the heading given above.

OSBORNE REYNOLDS.

28 Marine Terrace, Criccieth, N.W.

COPY.

September 2, 1898.

DEAR OSBORNE REYNOLDS.—I do not know whether you are going to the British Association at Bristol. In any case you may like to have the enclosed.

I am just re-reading the Royal Institution discourse you were kind enough to send me some time ago, and from several things I see in it, I am sure you would like to see Prof. Stokes' proof, especially in view of the doubt you had at one time as to the distance at which viscosity would dominate the flow.

I enclose a photograph which will give you an idea of the sort of effects obtained with glycerine.

Yours truly,

Prof. Osborne Reynolds, F.R.S. H. S. HELE-SHAW.

DEAR PROF. HELE-SHAW,—I have to thank you for your letter of the second inst., and the copy of Sir George Gabriel Stokes' paper " On the viscous flow between parallel surfaces."

I think it was in June 1896 that you asked me to show you the appliances and experiments, which I have introduced during the last twenty-five years, for studying and demonstrating the manners of motion of water by the method of colour bands, which I introduced in 1875, in order that you might have similar demonstrations introduced at University College, to which request I had great pleasure in responding as far as your time would allow. I was glad when I heard shortly afterwards from you that you had already begun experimenting, and I had great pleasure in furnishing you with copies and references to all my publications bearing on the subject, as well as any verbal information I could give you in several interviews. When, however, you sent me a copy of a paper you proposed to read, and subsequently read, before the Institution of Naval Architects, being deeply engaged in other work, I felt it necessary to put it aside, and this I did with less reluctance as I felt that any criticism suggested by experience would tend to discourage rather than to encourage you in your work, which reason I gave shortly afterwards on your pressing me for an opinion, and in this opinion I remained until this last summer, when the widely published and striking photographs were brought before me in so many ways as to force my attention in spite of my reluctance.

I then apprehended for the first time the method you had employed as described in your first paper, and the conclusion you had formed from results you had obtained by this method; which conclusion, I see from your last letter, you still maintain, namely, that with water in sinuous motion and air bubbles as indices of the manner of motion, the light bands adjacent to the surfaces of the solids, which show absence of bubbles adjacent to the solid, prove that the, once air charged, water has not been carried by sinuous motion sufficiently near to the solid surface to displace the initially adjacent water; and hence prove that the sinuous motion does not extend up to the solid surface.

With this conclusion I am entirely unable to agree for reasons which are as follows:—

(1) The photographs show that the air-clear bands adjacent to the solid surfaces are in a sense permanent; that is to say, these bands do not get thinner and ultimately vanish as the experiment is continued even when the solid surface is discontinuous fore and aft, and that the light bands on the sides of the object are thicker at the bows than at the stern, which facts cannot be explained by the maintenance of initial water, for when water meets the bow of a solid, over the surface of which it flows, no matter how slow and steady the current, the water initially at any point near the surface will be drifted back parallel to the surface with a velocity, if the motion is not sinuous, diminishing to nothing at the surface. As, then, at the bow, there is no water which has been initially adjacent to the surface available to replace that which is swept back, the bow first becomes cleared of initial water. Then as the supply of initially adjacent water swept back from the bow to replace that swept back further along diminishes, the thickness of the initial layer becomes taper from nothing at the bow to the original thickness at the stern, and then, if the experiment continues steadily, thins down till it becomes indefinitely thin.

This is an experimental result which I have demonstrated many times since first doing so before Section A at the Glasgow meeting, 1876. All that is necessary is to surround a solid object in a tank of clean water with coloured water, so that the surface of the solid is coated with a sufficiently thin coat of coloured water of the same density as the clear water, and thus keeping the solid fixed, causes the water to flow uniformly through the tank, when, if the velocity is below the critical velocity, the gradual waste of the colour, commencing at the bows, will at once be apparent, at rates proportional to the velocity of flow, which may be such it takes seconds or many minutes for the colour to disappear from the surface.

In this experiment, if the velocity of flow be above the critical velocity so that the motion is sinuous, the manner of removal of the colour is very different, and the rate of removal indefinitely enhanced, so that it seems as though it had been removed with a rough brush. It is thus seen that the maintenance of a layer of any finite thickness on the surface of a discontinuous solid over which water is flowing is contrary to well-established experience, and hence cannot account for the clear bows observed in the photographs of the experiments with air.

While the manner of the removal of the colour from the surface when the motion is sinuous proves that the sinuous motion does extend up to the solid surface.

(2) The use of air bubbles for the purpose of indicating the lines of fluid motion is setting aside the most elementary precautions. Unless the indicating body, whether solid or liquid, is of the same density as the fluid, the motion of which has to be examined, although it will drift with the fluid, will besides this motion of drift have a proper motion of its own through the fluid, which may be simply that resulting from gravitation, as in the case of a fluid in steady uniform motion, but which, in the case of a fluid of more irregular motion, will also result from the varying pressure in the fluid owing to its varying motion. This varying motion impressed on the body by the drift of the fluid causing it to move towards the higher pressure if denser than the fluid, and if lighter towards the lower pressure. Now, air bubbles form about the lightest bodies possible, and are thus those best calculated, by their motion through the fluid across the lines of motion, to seek out and indicate the positions at which the pressure in the fluid are least. In this way they have performed a very useful part in the study of fluid motion. It was from the observation of the behaviour of air bubbles in the wake of a vane moving obliquely through water that I was enabled to study the action of the screws of steamships, and to determine the cause of their racing. A most emphatic part they have played is that of indicating the line of minimum pressure in a vortex or vortex ring in water—a part which was, I feel sure, emphasised in the demonstration I gave at the College.

It is thus seen, that while air bubbles are the most misleading bodies that can be possibly chosen to indicate the lines of motion in a fluid in sinuous motion, they are the very best to indicate the lines and surfaces of mininum pressure, and by their absence to indicate the positions in which pressure is greatest. Whence it naturally follows that when the bubbles introduced in a sinuous stream of fluid shun any specific positions in the fluid, whatever may be the cause, the pressure in those parts are greater than the pressures in the immediately surrounding parts.

Thus the conclusion to be drawn from the general existence of light-bands adjacent to the solid surface over which the fluid is flowing, as shown in the photographs, in sinuous motion would, if there were no other proof of it, be that they afford evidence that the pressure of water at the solid boundaries of water in sinuous motion is a maximum, and diminishes rapidly with the distance from the surface. As it is, however, it must stand as an interesting verification of a well-established deduction from the laws of motion. For although probably but little known, the existence of this maximum pressure at the boundaries of fluid in sinuous motion, is one of the most direct conclusions from the laws of motion, as I have shown in my paper on the dynamical theory of a viscous fluid (*Phil. Trans. R.S.*, 1895, p. 142).

We have only to consider a narrow band of fluid adjacent to the surface which may be considered flat; the mean motion is in the direction of the surface, and the fluid is in mean equilibrium in direction perpendicular to the surface.

Taking u for the mean flow, and w for the relative motion perpendicular to the surface.

Then, by the laws of motion, we have, ρ being the density if z is distance from the surface, $\frac{d}{dz}(p + \rho w^2) = 0$.

Now w^2 is the square of the normal component of sinuous motion, which rapidly increases from zero at the surface, hence the fall of pressure from the surface is measured by the rate of increase of ρw^2.

With this interpretation the facts shown by the light bands adjacent to the solid, afford not only a very interesting verification, but also an instructive addition to the methods of demonstrating the actions in fluid.

With respect to the photographs with the air, as indicating the character of sinuous flow; these, I think, are entirely confused by the motion of the air through the water, and are far inferior to what has been obtained with colour bands of equal density.

The more recent of your experiments (made after my method of colour bands) are in many respects similar to those which I exhibited with the lantern first at the Royal Institution in a Friday evening lecture "On the two manners of motion of water" in 1884, and which I have since elaborated for demonstration in the College. They are strictly conformable to the theory of the motion of viscous fluids as given in the papers on the Theory of Lubrication (*Phil. Trans. R.S.*, 1886, part i.), and on the Theory of Viscous Fluids, already referred to. But although I had applied the theory to the flow of fluids between parallel surfaces very close together, I had not studied the flow between such surfaces round obstructions, and it was with much interest that I saw the beautiful photographs of the stream lines, realising as I did at once that the velocities must have been so small compared with the critical velocities that the inertia was of no account, so that the pressure would vary only along the lines of flow, while since the surfaces were parallel, p being pressure, u and v mean component velocities, $\frac{dp}{dx} = -cu$, $\frac{dp}{dy} = -cv$, and hence p became the potential function of the mean flow which, therefore, corresponded (geographically but not dynamically) to the ideal flow of a perfect fluid. (The same explanation of this coincidence is given in the copy of Sir George Stokes' paper). The coincidence is theoretically interesting. But as the domination of the effects of inertia by viscosity in the experiments is only obtained by reducing the mean velocity far below the critical value, the results cannot imply any such domination beyond that which breaks down when the critical value is reached, and therefore cannot imply any finite layer of fluid not subjected in some degree to sinuous motion. Yours truly, OSBORNE REYNOLDS.

Prof. Hele Shaw.

September 4.

Magnetic Storm.

IN view more especially of the present sitting of the International Conference on Terrestrial Magnetism at Bristol, it is of interest to note the occurrence of a fairly sharp magnetic storm on the afternoon and evening of Friday, September 9. It was associated presumably with the aurora simultaneously seen in England.

On the night of September 2 and morning of September 3 there was a very appreciable though much smaller disturbance; but subsequent to that the magnetic curves were quiet, especially so on the 6th, 7th, and morning of the 8th. The principal disturbance commenced somewhat gradually about noon on the 9th; but one of its most striking features, as recorded at Kew Observatory, was an exceptionally rapid fall occurring simultaneously, at 3.5 p.m., in the horizontal and vertical forces and in the westerly declination. The fall was so rapid as to be shown somewhat indistinctly on the photographic traces; but it amounted to at least 15′ in the declination, and ·0023 C.G.S. units in the horizontal force. The recovery from this fall was also rapid.

The declination needle between 5.15 p.m. and 8.8 p.m. receded 54′ to the east, then turned, and in the course of the next 32 minutes moved 59′ to the west.

The horizontal force attained its extreme maximum and minimum at 2.42 p.m. and 8.30 p.m. respectively, the range amounting to ·0050 C.G.S. units (or about 1/37 of the whole component). Between 7.30 and 8.30 p.m. this element fell ·0036 C.G.S. units. The vertical force reached its maximum about 6 p.m. and its minimum *about* 8.30; but as the trace unfortunately got off the sheet near the minimum, one can only say that the range of vertical force exceeded ·0036 C.G.S. units.

The curves had become fairly quiet by midnight of the 9th; but there was a recrudescence of the disturbance between 8 a.m. and midnight of the 10th, and subsequent smaller movements occurred on the 11th. CHARLES CHREE.

Kew Observatory, September 12.

Lilienfeld's Synthesis.

THE interesting article in your issue of August 18, signed by Dr. Sidney Williamson, ably summarises the position of affairs as regards the various attempts that have been made towards the synthesis of proteids. There is one point, however, which may possibly require modification. Dr. Williamson states "Such colour tests as Millon's, nitric acid, &c., have no real value; the colour developed *may* be due to the proteid molecule as a whole, but more probably to some decomposition product, and, as already mentioned, some colloids which bear no relation to actual proteids give reactions considered characteristic of these substances."

Having devoted considerable attention to the colour reactions of proteids and their derivates, I may state that there is every probability that all the colour reactions are due to disintegration of the proteid molecule during the reaction. Full details of this work will be found in a paper I published in the *Journal of Physiology* in 1894. There are ten more or less trustworthy colour reactions given by proteids, and I am unaware of any colloid that is not related to a proteid which will give more than two of these reactions, and there is at present no known colloidal substance which will produce the intravascular coagulation of the blood, except the substances synthesised by Grimaux and myself, and nucleo-proteids derived from the animal organism.

Although some of the substances I have synthesised give all the colour reactions of proteids, I do not think they are proteids; indeed, they are probably far from it, and until an absolutely trustworthy test for a proteid is discovered, and the molecular constitution of albumen is known, it is premature to assert that any synthesised substance is a proteid. To show the fallacy of relying solely on colour reactions, I may mention that a mixture of tyrosine, indol, and biuret will give all the colour tests considered diagnostic of proteids. There is little doubt that Lilienfeld's substance is an addition to those already made by Schützenberger, Grimaux, and myself, but for the reasons above stated I do not think there is any trustworthy evidence that it is actually pepton.

Sandridge, Eltham, Kent. JOHN W. PICKERING.

Larvæ in Antelope Horns.

I AM much interested in the article upon horn-feeding larvæ which appears in the last number of NATURE, just received by me (June 9).

It may interest your readers to have additional assurance that the *living* horns are attacked and infested with the larvæ in question, for cocoons and pupæ have been extracted from such horns within an hour or two of the killing of the animal owning them. This I am able to state on the unimpeachable authority of an officer who made the observation.

I myself have removed the cocoons and empty pupa cases, half extended from the orifice of the burrow in the horn; but the horns so affected had been dead for some weeks; and I have not, so far, had the opportunity of examining freshly killed specimens, nor of seeing the living larvæ.

I enclose a few of the empty cocoons and pupa cases, extracted by me from the diseased horns—for a disease it must be considered—from the antelope's point of view!

Lagos, July 22. HENRY STRACHAN.

THIS letter is of unusual interest, as it now clears up a point which has been long in doubt. In my article to NATURE which appeared on June 9 last, I gave a short account of the habits of horn-feeding larvæ, and since that time, having obtained additional notes, I beg to submit the following remarks. I have carefully examined the cocoons sent by Mr. Strachan, and unhesitatingly pronounce them to be formed by the larvæ of the *Tinea vastella*, Zell. = *gigantella*, Stn. = *lucidella*, Wkr., which is practically distributed over the whole of Africa and in various districts of India; the larvæ were believed to feed only on the horn of dead animals; it had been asserted to feed on that of living animals, but as the authority for this latter statement was based on the evidence of one eye-witness and by hearsay on the part of others, it was generally discredited, and by some held to be absurd.

"Dr. Fitzgibbon, as long ago as 1856, brought home from Gambia two pairs of horns, one pair belonging to *Kolus ellipsiprymnus*, the other to *Oreas canna*, which he had purchased from some natives in the market at Macarthy's Island, being struck with their appearance, as they were perforated by grubs enclosed in cases which projected abundantly from the surface of the horns, although they were taken from freshly killed animals, the blood not having thoroughly dried up on them when brought to market. The larvæ, evidently those of the *Tineidæ*, were found with the head outwards, indicating probably that they had arrived at their full growth, and had then turned round preparatory to final transformation." The point of this proves that the horns were infested while the animal was yet living which bore them. I have been unable to find any corroboration of this in working through the literature dealing with the subject.

I find that in 1867, at a meeting of the Ent. Soc. of London, "Mr. Stainton had to record a new habitat for the larva of a Tinea; Mr. Swanzy had shown him the larva case of a Tinea, which was taken from the horn of a Kooloo from Natal, and there would be little doubt that the larva must have been burrowing in the horn of a living animal." "Mr. Swanzy added that, since Mr. Stainton's visit, he had found a living larva in the horn."

"Prof. Zeller, in 1873, received from Herr Rogenhofer, of Vienna, one male and two females, with two larvæ and one pupa of a moth, the caterpillar of which *lives* in the horns of buffaloes at the Cape, the specimens agreeing exactly with *Scardia vastella*, Zell." In Prof. Zeller's opinion the larvæ fed on the dead horn, and he was in doubt as to the truth of its feeding on that of the living animal.

At a meeting of the Ent. Soc. of London, in 1878, Mr. Stainton exhibited specimens of "new horn-feeding Tinea (*Tinea orientalis*) reared from horns from Singapore, allied to the species from South Africa, of which the larvæ was *asserted* to feed in the horns of living buffaloes and antelopes, and which had been described by Zeller under the name of Vastella, and subsequently by himself under the name of Gigantella"; both names referring to the extraordinary size of the insect in the genus Tinea.

"Mr. Simmons, of Poplar, who found them in his greenhouse, was quite at a loss to account for their appearance, till Mr. Stainton suggested they were horn feeders, when he remembered a piece of horn placed on a shelf and forgotten, but which when examined showed evident traces of having been eaten, and from which pupa-skins had been obtained."

We have, therefore, the strong evidence of Dr. Fitzgibbon that the larvæ feed on the living horn, and as the fibre of the horn undergoes little or no change at death, there is no reason why the moth should not deposit its eggs while the living animal is at rest, nor why the larvæ should not penetrate the horn; notwithstanding, Lieut.-Colonel the Hon. Wenman Coke and Mr. Roland Trimen were confident that the larvæ did not feed on the living horn, giving as their reason, that having shot over many parts of Africa, had this been the case it could not have escaped their observation. Many naturalists and sportsmen have backed this opinion on the same grounds; it is, therefore, very gratifying that Mr. Strachan's letter places all doubts on one side, and our thanks are due to him for clearing up a matter which has been under judgment for nearly half a century.

W. H. McCORQUODALE.

THE FUTURE OF VACCINATION.

IN certain quarters the impression seems to have gained ground that those who are antagonistic to systematic vaccination have, as the result of recent proceedings in Parliament, received fresh encouragement to persevere in their resistance. No doubt "anti-vaccinators" have claimed, and will continue to claim, that in the abolition of the compulsory clause they have justification for the course they have pursued. It is just possible that even some of those who believe in the good effects of vaccination as a protective measure against small-pox may be persuaded to take the same view, and it behoves all who have studied the question carefully to state the position as it presents itself to them.

In the first place, it must be evident that there is no room in the discussion of this subject for the introduction of political-party considerations. No doubt attempts will be made, and, unfortunately, have been made, by those who should know better, to drag this question through party mire. Neither party can free itself from this reproach, and the result is that the Vaccination Bill has not received the unbiassed consideration through which alone it could be rendered thoroughly practical, workable, and successful. The spirit of the Bill and the intention of its framers are excellent; its drafting, as is now seen, is exceedingly faulty.

It was one of the great merits of the report of the majority of the Royal Commissioners on Vaccination, that it was eminently judicial, both in tone and in substance. With the evidence before them they came to the conclusion that as to the prophylactic or protective value of vaccination against small-pox there could not be the slightest doubt. At the same time, they pointed out that under certain conditions, and in an infinitesimally small proportion of cases, there was a danger, although in most cases an easily preventible danger, of evil results accruing from the operation. In these circumstances, they did not close their eyes to the fact that there must always be a certain small section of people who would put the claims of individual feeling before the public welfare, not avowedly, of course, but rather on the very ground of the public welfare; and they indicated that in any future legislation it would be well, under certain stringent conditions, to allow this small minority to have its way, so far, at any rate, as its own children are concerned.

There can be little doubt that the Anti-Vaccination League is now kept alive by those who have from time to time been arraigned for not having their children vaccinated according to the law, and that, posing as martyrs, they have enlisted the sympathies of others who have no objection at all to vaccination as vaccination, but only as *compulsory* vaccination. The Commissioners at once saw the desirability of removing such a power from the hands of the anti-vaccinators, and suggested a most rational way of doing so. Make the man who wishes to become a martyr take some trouble, they say, and you quench some of his ardour; better still, do away with the possibility of his becoming a martyr, and you remove the sympathy and admiration on which so many of them have subsisted, whilst you allow the man who has genuine conscientious objections to vaccination to place his personal desires against the general welfare, but only at some considerable personal inconvenience. In this way the false would, in time, be weeded from the true, martyrs would disappear, and the anti-vaccination crusade would die of inanition. It must be acknowledged that, theoretically, compulsory vaccination affords the best possible protection yet known against small-pox epidemics, but in recent years the law has been administered in so lax a fashion, especially in certain towns and districts, that whole communities have been left unprotected, and the Gloucester and similar outbreaks have been the result. As this is the case, is it not better to devote attention to seeing that there is efficient and safe vaccination in those quarters in which science is not met and foiled by prejudice, and, where prejudice exists, to use every educational means to remove it or render it as harmless as possible? Medical men who know the ravages that small-pox wrought towards the end of the last and in the earlier part of the present century, and who have knowledge of the protective value of vaccination, can scarcely put themselves in the position of the man who hears only the anti-vaccinator's story, and who is moved to the action he takes in regard to his own children by ignorant sentiment, and not by actual information. Practically *compulsory* vaccination has failed, because, as soon as the danger against which it was to protect was temporarily lost sight of, it was no longer enforced. Medical men were not oblivious of the danger of the recurrence of small-pox in unvaccinated communities, but they have not been able to convince their patients of the existence of the danger. Under these conditions, what can be done to counteract what has come to be a most dangerous agitation, the danger and importance of which, unless proper steps are taken, will go on increasing with every year that we are removed from the small-pox period, until we are again confronted with an unvaccinated population and a general epidemic of small-pox such as has not been experienced in the time of the oldest amongst us?

One step has already been taken: the man with conscientious objections (and it must be remembered that such men do exist, otherwise there would be no funds forthcoming for the payment of those by whom the agitation is principally kept alive) is allowed to enter his protest, and to prevent the child entrusted to his care from receiving protection against a disease which may disfigure and maim it for life.

The next step is to take every precaution (and to make punishable every lack of known precaution) that the lymph used shall be of the best, and the operation carried out under the most favourable conditions possible. In these days of surgical cleanliness, medical men do not require to be specially trained in respect to these two points.

Lord Lister, in his speech before the House of Lords, insisted strongly on the necessity of revaccination, on the ground that in the course of a few years the protective effect of vaccination gradually becomes weakened. This fact certainly came out very prominently before the Royal Commission, and, as may be gathered from the final report of the Commissioners, bulked largely in their minds when they made their recommendations for the guidance of future legislation. In the event of any serious attempt to continue the anti-vaccination movement, revaccination must form an important factor in the prevention of the spread of small-pox in epidemic form. When there is any outbreak of small-pox, those who have not already submitted themselves for revaccination, especially those who are in any way brought into contact with the disease, hasten to have themselves revaccinated, with, as is pointed out by the Report of the Commission, the very best results, as proved by the statistics relating to doctors, nurses, and others attending directly on small-pox patients. So, also, when there is the possibility of an outbreak of small-pox in epidemic form amongst those whom parents and guardians have left susceptible to the attack of this disease, revaccination should constitute an additional line of defence even for those already vaccinated in infancy. Under such conditions the vaccinated community may regard with equanimity the possibility of infection by small-pox, so far as they themselves are concerned, though they will still have to bear the brunt of pecuniary calls made for the stamping out of the disease in the unvaccinated or imperfectly vaccinated section of the population. The Vaccination Bill has been spoken of as "a great experiment." We do not hesitate to state that, under the above conditions, it will be one of the most convincing experiments ever performed, *especially if a record, to which reference may afterwards be made, be kept of every conscientious objector.* With vaccination and revaccination *efficiently carried out* in the bulk of the population, *and registration of the unvaccinated residuum*, this latter will no longer be a source of danger except to itself.

One thing more remains to be done to meet the anti-vaccinators with their own weapons. This matter, as Dr. Bond has pointed out, has been left too much in the hands of the medical man, who, as a rule, has little time and less money to devote to the carrying on of any propaganda in favour of vaccination. The bulk of the agitation against vaccination is carried on by laymen, many of whom display ingenuity and perseverance worthy of a better cause. These laymen, as for example in the Houses of Parliament, are convinced—often by mere hearsay—that they are thoroughly in the right, and the only way to deal with them successfully is to bring every scrap of evidence under their notice tellingly, and in authoritative form. This, for the present, can only be done by other laymen who have made a careful study of the question. In time bitter experience will convince some, but isolated cases, unless carefully made known, are of little value for the conviction of those not specially concerned. The Jenner Society has a great work before it in educating the public by making known everything that is to be said in favour of vaccination, and by recording the personal experience of those who have been attacked by small-pox. As an example of the effect of an outbreak of small-pox on the opinions of an anti-vaccinator, the following may be taken as being fairly typical. Mr. H——, a well-to-do and intelligent "Clerk of Works" on a large developing estate in Kent, was a strong anti-vaccinator. When the time came for him to have his first-born son vaccinated the law was evaded. A few years later, during an outbreak of small-pox, a tramp, suffering from the disease in an early stage, came to H.'s door to beg, and the child, sent to give him a piece of bread and butter, contracted small-pox, and, as the father and mother say, suffered most horribly. It was thought that the sight of both eyes would be lost, and the boy was terribly disfigured. So impressed was the father with the severity of the attack as compared with those in children who had been vaccinated, that he has had his other children vaccinated, and says that he would now gladly walk twenty miles and give ten shillings to help to persuade any father who has "conscientious objections" to vaccination to change his views on the subject. There are few such cases nowadays, but such a record is only the echo of what at one time was frequent enough, and unless the public takes up this matter in earnest, will be in the future. Doctors who understand what vaccination has already done will continue their efforts to protect the community, and will certainly see that this is done in their own families; but it rests with the wealthy and intelligent layman to do what he can to counteract the influence of anti-vaccination statements, spoken and printed, on the minds of the public.

Vaccination is a prophylactic measure, not a curative. Its beneficial effects can, therefore, not be seen except through statistics and in the modification of the type of the disease in those attacked. Moreover its effects can, even in these cases, now only be rarely seen, as owing to its action small-pox but seldom makes its appearance. Let it be remembered, however, that when anti-diphtherial serum was first introduced in this country there was a tremendous outcry against its use. "The brute force of facts" has silenced objectors for the present. With a death-rate reduced to two-thirds, or even one-half of what it was only three or four years ago, and with the type of disease completely altered (only, however, in those cases in which antitoxin is given), even the most obstinate objector is constrained to keep silence; but there can be little doubt that should diphtheria be almost eliminated from our midst, a prospect by no means beyond the reach of possibility, there would in time rise up a generation of doubters and objectors who would assail the anti-diphtherial serum treatment as stoutly and as blindly as do the anti-vaccination party of to-day and as did the anti-serum party of yesterday.

It may be said that sensible people do not listen to the rubbish talked by those who take part in this agitation. Unfortunately this is not the case. As in every other relation of life, the old saying holds good, "Throw enough mud and some of it is sure to stick," and such as does stick can only be got rid of by thorough washing and efficient whitewashing. It is to this part of the work that we now wish to call the attention of all thoughtful men; and we can not help thinking that their work will be all the easier from the fact that the "compulsory" clause has been eliminated from a "Bill" that has already proved somewhat weak as an "Act," but which would have been still weaker as a legislative measure had not the amendment proposed in the House of Commons been ultimately carried in the House of Lords.

THE BRITISH ASSOCIATION.

THE meeting which has just been brought to a conclusion in Bristol may fairly be regarded as a highly successful one. The weather, though at first somewhat oppressive, has been on the whole eminently favourable for garden parties, conversazioni, and excursions. The destruction of the Colston Hall by fire raised difficulties at the last moment, but the emergency arrangements of the local committee amply met the requirements of the case. Although the seating accommodation of the People's Palace is far inferior to that of the Colston Hall, its acoustic properties are greatly superior. A brilliant audience met to hear Sir William Crookes's presidential address, and the members and associates attended in large numbers to listen to the discourses of Prof. Sollas and Mr. Jackson. Prof. Sollas's lecture on Funafuti was clear, lucid, and well illustrated, while Mr. Herbert Jackson's discourse on Phosphorescence, with his admirable experiments, is universally regarded as a brilliant success. The conversazione at Clifton College was well arranged and highly appreciated; the exhibits including a demonstration of the spectra of rare atmospheric elements by Prof. Ramsay and of wireless telegraphy, attracting large numbers, and the tastefully-lighted Close forming a pleasant promenade in the open air. The garden parties and the Saturday excursions have also gone off well. The Mayor of Bath took special trouble to make the excursion to Bath a pleasant one, and invited many members to visit the city and environs, the new excavations of the Roman Baths being especially visited and explained. Members who look forward to the meeting as a pleasant opportunity for social converse with their scientific *confrères* and with people of standing in the locality, have every reason to be well satisfied with the arrangements which have been made in Bristol. The old city has well maintained its tradition of hospitality. Sir William Crookes, speaking on Saturday at the banquet given by the Chamber of Commerce to distinguished visitors and guests, said that he had attended many meetings of the British Association, but could remember no occasion when the welcome accorded was more hospitable and enthusiastic, or the arrangements more carefully planned. In fact, it was agreed by all the members that the local arrangements have been a model of what such arrangements should be. The local hon. secretaries, Mr. Arthur Lee, J.P., and Dr. Bertram Rogers, have been indefatigable in their exertions, and have given nights as well as days to the work, hence everything has progressed with perfect smoothness.

The visit of four men-of-war has served to give an added interest to the meeting in its social aspect. This was a new feature, and was much appreciated both by the visitors and the local members. The ships' companies were not forgotten in the local arrangements, several entertainments being arranged for them. The officers of the Association provided for a lecture to be given to them upon a suitable topic, but it had to be cancelled, as the commander was unable, on account of his early departure, to grant leave to the 350 officers and men for whom arrangements had been made.

The very successful smoking symposium and concert given by the Scientific Societies of Bristol in the beautiful hall of the Merchant Venturers' Society's Technical College, assuredly gave no evidence of dulness. An excellent and humorous programme, capital speeches by the High Sheriff (Mr. Richardson Cross, the well-known oculist), Dr. Ryan (Professor of Engineering in University College, Bristol) and the president of the meeting, and the customary appurtenances of such a gathering, put all who were present in excellent humour.

We have alluded specially to the social aspects of the meeting. But they in truth form a not unimportant part of the work of the British Association. It is pleasant even to serious students of science to meet in the flesh those who have been hitherto met only on the printed page, and to find them after all eminently human; while words of kindly encouragement from older to younger workers are stimulating to renewed effort. Good work has been done in the Sections; but of this we hope to furnish an outline later on. The conference on terrestrial magnetism and atmospheric electricity, under the presidency of Prof. Rücker, was extremely well attended. Delegates from Germany, France, Holland, Italy, etc., were present, and most important conclusions were arrived at.

Everyone agrees that the local representatives of science have done all they could to stimulate interest in the neighbourhood of Bristol and the scientific work which is there being prosecuted, and it is, we hope, not invidious to make special mention of the work done by the Masters of Clifton College and the Professors at the Bristol University College to make the meeting successful. The local secretaries and their staff have spared no efforts to render the general arrangements efficient in themselves and intelligible to the members. The numbers in attendance approach 2500. The applications for tickets for the longer excursions on Thursday have been so numerous as to render their allotment a matter of difficulty; and the final four days' excursion to Devonshire will probably be taken by the limiting number of 100 visitors.

As to the work of the General Committee, the report of the Council of the Association was read by Prof. Schäfer at the meeting of the Committee on September 7, and among the matters of scientific interest referred to in it are the following:—

The Council have elected the following men of science who have attended meetings of the Association to be corresponding members:—Prof. C. Barus, Brown University; M. C. de Candolle, Geneva; Dr. G. W. Hill, West Nyack, N.Y.; Prof. Oskar Montelius, Stockholm; Prof. E. W. Morley, Cleveland, Ohio; Prof. C. Richet, Paris; Prof. W. B. Scott, Princeton, N.J. The Council were invited to nominate one or two members to give evidence before the Committee appointed by the Government to report on the desirability of establishing a National Physical Laboratory, and at their request Prof. G. Carey Foster, F.R.S., and Prof. W. E. Ayrton, F.R.S. gave evidence before this Committee. A report has been presented to Parliament, and the Council trust that the deliberations of the Committee will result in the establishment of a National Laboratory.

In regard to the resolutions referred to them for consideration and action, if desirable, the Council report as follows:—(1) That the Council appointed a committee to consider the desirability of approaching the Government with a view to the establishment in Britain of experimental agricultural stations similar in character to those which are producing such satisfactory results in Canada. The committee having reported that much is already being done in this direction by County Councils and

Agricultural Societies, advised that the co-operation of these bodies should first be invited. The committee was re-appointed for this purpose, and sent in a report, the principal recommendation of which was adopted by the Council, and is as follows:—"Your committee recommend that the Board of Agriculture be informed that, in the opinion of the British Association, there is an urgent need for the co-ordination of existing institutions for agricultural research, and that the Association hopes that steps may be taken towards this end, including the strengthening of the scientific work of the Board of Agriculture and the provision of the means for dealing adequately with scientific questions which may come before it." At the request of the Council this report was brought by the President to the notice of the President of the Board of Agriculture, from whom the following reply, dated July 26, was received:—"I have laid before the Board of Agriculture your letter of the 18th inst., and I am desired to express to the Council of the British Association for the Advancement of Science the thanks of the Board for the attention which the Council have been so good as to give to the important subject of agricultural research. The Board will not fail to bear in mind the views set out in the resolution communicated to them in the letter above referred to."

(2) That a committee was appointed to report to the Council whether, and, if so, in what form, it is desirable to bring before the Canadian Government the necessity for a hydrographic survey of Canada, and that the following formed the committee:—Prof. A. Johnson (chairman and secretary), Lord Kelvin, Prof. G. H. Darwin, Admiral Sir W. J. L. Wharton, Prof. Bovey, and Prof. Macgregor. The committee reported to the Council, and it was decided, in conformity with the recommendation contained in the report, that the following resolution should be sent to the Canadian Government:—"The Council of the British Association have learnt with regret that the Government of the Dominion of Canada is contemplating the discontinuance of their tidal survey of Canadian waters. Whilst the work already carried out is primarily connected with hydrography and navigation, they consider that science will incur a great loss if the work of the survey is discontinued. They would, therefore, urge on the Government the desirability of continuing the tidal survey as heretofore." The President transmitted the resolution to the Governor-General, who forwarded it to the Government of the Dominion of Canada for their favourable consideration. In reply, the Council were informed that "in view of the limited appropriation made by Parliament, it has been deemed advisable to defer the prosecution of the survey for the present and to confine the work to the maintenance and operations of the tidal gauges already established, and the preparation of tide tables."

(3) That a committee was appointed by the Council to consider the following resolution:—"That, in view of the facts (*a*) that a committee of astronomers appointed by the Royal Society of London, in consequence of a communication from the Royal Society of Canada, has recently considered the matter, and has arrived at the conclusion that no change can now be introduced in the *Nautical Almanac* for 1901, and (*b*) that few English astronomers are attending the Toronto meeting of the Association: the committees of sections A and E are not in a position to arrive at any definite conclusion with respect to the unification of time; but they think it desirable to call the attention of the Council to the subject, in which the interests of mariners are deeply involved, with the view of taking such action in the matter as may seem to them to be desirable." Several members of this committee had also served on the committee of the Royal Society, and after careful consideration of the whole question the committee saw no good reason for dissenting from the conclusion which had been recently adopted by the Royal Society and reported in the following terms:—"The committee report that as there is a diversity of opinion amongst astronomers and sailors as to the desirability of the adoption of civil reckoning for astronomical purposes, and as it is impossible to carry out such a change in the *Nautical Almanac* for the year 1901, they do not recommend that the Council of the British Association should at present take any steps in support of the suggested change of reckoning." The President has transmitted this report to the Royal Society of Canada.

In their report last year at Toronto, the Council informed the General Committee that the establishment of a Bureau for Ethnology was under the consideration of the trustees of the British Museum. In the course of their reply, dated December 15, 1897, the trustees state "that they are quite of opinion that such a bureau might be administered in connection with the Ethnographical Section of their collections, with advantage both to the objects in view of the Association and to the enlargement of the British Museum collections. They are, therefore, willing to accept in principle the proposal of the British Association, and they would be ready to take the necessary steps for carrying it into effect as soon as certain rearrangements affecting space, &c., which are now taking place within the museum, shall have been finished, as it is expected, in the course of the coming year."

In accordance with the regulations, the retiring members of the Council are: Prof. Edgeworth, Mr. Victor Horsley, Mr. G. J. Symons, Prof. W. Ramsay. The Council recommended the re-election of the other ordinary members of the Council, with the addition of the gentlemen whose names are distinguished by an asterisk in the following list:—Mr. C. Vernon Boys, F.R.S., Captain E. W. Creak, R.N., F.R.S., Mr. F. Darwin, F.R.S., the Hon. Sir C. W. Fremantle, K.C.B., *Dr. W. H. Gaskell, F.R.S., Prof. W. D. Halliburton, F.R.S., Prof. L. F. Vernon Harcourt, Prof. W. A. Herdman, F.R.S., *Dr. J. Scott Keltie, *Major P. A. MacMahon, F.R.S., Mr. J. E. Marr, F.R.S., Prof. R. Meldola, F.R.S., Prof. E. B. Poulton, F.R.S., Mr. W. H. Preece, C.B., F.R.S., *Mr. L. L. Price, Prof. J. Emerson Reynolds, F.R.S., Mr. W. N. Shaw, F.R.S., Mr. J. J. H. Teall, F.R.S., Mr. W. T. Thiselton-Dyer, C.M.G., F.R.S., Prof. S. P. Thompson, F.R.S., *Prof. J. M. Thomson, F.R.S., *Prof. W. A. Tilden, F.R.S., Prof. E. B. Tylor, F.R.S., Prof. W. C. Unwin, F.R.S., Sir W. H. White, K.C.B., F.R.S.

As to the financial position of the Association, the statement presented by Prof. Rücker showed that the receipts for the past year were 4623*l.* 18*s.* 2*d.*, and that there was a balance of 1703*l.* 3*s.* 8*d.* in the treasurer's hands.

At a meeting of the General Committee held on Monday, it was decided to accept the invitation of the municipal authorities at Bradford to meet there in the year 1900. Dr. Michael Foster was elected President for the meeting at Dover next year. The following Vice-Presidents were also elected:—The Archbishop of Canterbury, the Marquis of Salisbury, the Mayor of Dover, Lord Herschell, the General Commanding the South-Eastern District, Mr. Akers-Douglas, M.P., the Dean of Canterbury, Sir Norman Lockyer, and Prof. G. H. Darwin. Prof. Rücker was appointed a trustee, in succession to the late Lord Playfair. Profs. Schäfer and Roberts-Austen were re-elected general secretaries, and Mr. Griffith assistant general secretary. Prof. G. Carey Foster was elected to succeed Prof. Rücker as general treasurer.

At the meetings of the Committee of Recommendations, the following sums of money were voted for scientific purposes:—

Synopsis of grants of money appropriated to scientific purposes by the General Committee at the Bristol meeting, August 1898. The names of the members entitled to call on the General Treasurer for the respective grants are prefixed.

Mathematics.

	£
*Rayleigh, Lord—Electrical Standards (and £75 in hand)	225
*Judd, Prof. J. W.—Seismological Observations... ...	75
*Rücker, Prof. A. W.—"Science Abstracts"	100
Kelvin, Lord—Heat of Combination of Metals... ...	20
Fitzgerald, Prof. G. F.—Radiation in a Magnetic Field	50

Chemistry.

*Thorpe, Dr. T. E.—Action of Light upon Dyed Colours	10
Hartley, Prof. W. N.—Relation between Absorption Spectra and Constitution of Organic Substances ...	50
Ramsay, Prof. W.—Chemical and Bacterial Examination of Water and Sewage	10

Geology.

*Hull, Prof. E.—Erratic Blocks	15
*Geikie, Prof. J.—Photographs of Geological Interest ...	10
*Marr, Mr. J. E.—Life Zones in British Carboniferous Rocks	10
Dawkins, Prof. W. Boyd.—Remains of Irish Elk in the Isle of Man	15
*Dawson, Sir J. W.—Pleistocene Fauna and Flora in Canada	30
Hicks, Dr. H.—Records of Drift Section at Moel Tryfan	5
Hicks, Dr. H.—Ty Newydd Caves	40
Lloyd-Morgan, Prof. C.—Ossiferous Caves at Uphill ...	30

Zoology.

*Herdman, Prof. W. A.—Table at the Zoological Station, Naples	100
*Bourne, Mr. G. C.—Table at the Biological Laboratory, Plymouth	20
*Woodward, Dr. H.—Index Generum et Specierum Animalium...	100
*Newton, Prof. A.—Migration of Birds	15
Hoyle, Mr. W. E.—Apparatus for keeping Aquatic Organisms under definite Physical Conditions... ...	15
Lankester, Prof. E. R.—Plankton and Physical Conditions of the English Channel during 1899	100

Geography.

Keltie, Dr. J. Scott.—Exploration of Socotra	35

Economic Science and Statistics.

*Sidgwick, Prof. H.—State Monopolies in other Countries (Balance in hand)	
*Price, Mr. L. L.—Future Dealings in Raw Produce ...	5

Anthropology.

*Munro, Dr. R.—Lake Village at Glastonbury	50
*Brabrook, Mr. E. W.—Ethnographical Survey	25
*Evans, Mr. A. J.—Silchester Excavation	10
*Penhallow, Prof. D. P.—Ethnological Survey of Canada (and unexpended balance in hand)	35
Tylor, Prof. E. B.—New Edition of "Anthropological Notes and Queries"	40
Garson, Dr. J. G.—Age of Stone Circles	20

Physiology.

*Schäfer, Prof. E. A.—Physiological Effects of Peptone...	30
Waller, Dr. A.—Electrical Changes accompanying Discharge of Respiratory Centres	20
Gotch, Prof. F.—Influence of Drugs upon the Vascular Nervous System	10
Schäfer, Prof. E. A.—Histological Changes in Nerve Cells	20
Schäfer, Prof. E. A.—Micro-Chemistry of Cells ...	40

* Re-appointed.

	£
Schäfer, Prof. E. A.—Histology of Suprarenal Capsules	20
Gotch, Prof. F.—Comparative Histology of Cerebral Cortex	10

Botany.

*Farmer, Prof. J. B.—Fertilisation in Phæophyceæ ...	20
Darwin, Mr. F. Assimilation in Plants	20
*Stebbing, Rev. T. R. R.—Zoological and Botanical Publication...	5

Corresponding Societies.

*Meldola, Prof. R.—Preparation of Report...	25
	£1485

* Re-appointed.

INTERNATIONAL CONFERENCE ON TERRESTRIAL MAGNETISM AND ATMOSPHERIC ELECTRICITY.

OPENING ADDRESS BY PROF. A. W. RÜCKER, M.A., D.SC., SEC. R.S., PRESIDENT OF THE CONFERENCE.

THE President of the Section of Mathematics and Physics has already expressed the pleasure with which British physicists welcome the distinguished band of visitors who have assembled to take part in the International Conference on Terrestrial Magnetism. None join in that welcome with more cordiality than those who are especially interested in the science with which the Conference will be occupied. To us it is a source both of gratification and pride that the International Committee, to whose action this meeting is due, should have allowed us to play the part of hosts to the eminent men from many lands who have responded to their call. Some, whom we would gladly have seen here, but who have been prevented from attending by various causes, have nevertheless shown the interest which they take in our proceedings by sending written communications. Thus our meeting is as fully representative as we could have hoped.

It may be interesting to those who are unaware of the fact if I remind the Conference that this is not the first occasion on which students of terrestrial magnetism have taken counsel together during a meeting of the British Association.

Fifty-four years ago the then President of the Association, the Very Rev. George Peacock, Dean of Ely, stated in his address that the period was drawing to an end for which a series of magnetic observatories had been established by international co-operation. "Six observatories," he stated (*Brit. Assoc. Rep.*, 1844, p. xliv.), "were established, under the zealous direction of M. Kupffer, in different parts of the vast empire of Russia, the only country, let me add, which has established a permanent physical observatory. The American Government instituted three others, at Boston, Philadelphia, and Washington; two were established by the East India Company, at Simla and Singapore; from every part of Europe, and even from Algiers, offers of co-operation were made." The observations thus provided for were to be carried out for three years only, but as nearly the whole of that time was spent in preparation, the period was doubled. When the term thus fixed drew to an end, the question arose as to whether it was desirable to extend it further, and M. Kupffer (Director-General of the Russian System of Magnetic and Meterological Observations) addressed a letter to Colonel (afterwards Sir Edward) Sabine, suggesting the propriety of summoning a Magnetic Congress to be held at the next meeting of the British Association.

In accordance with that suggestion the Congress was held during the meeting of the Association at Cambridge in 1845. The number of distinguished foreigners who attended in person was considerable in spite of the difficulties of travel fifty years ago. Amongst those who were present was M. Kupffer, Dr. Erman, of Berlin, the celebrated circumnavigator and meteorologist, Baron von Senftenberg, the founder of the Astronomical and Meterological Observatory of Senftenberg in Bohemia; M. Kreil, the director of the Imperial Observatory at Prague; Dr. von Boguslawski, the director of the Royal Prussian Observatory at Breslau; Herr Dove, professor of physics in the University of Berlin; and Baron von Waltershausen, a gentleman who had taken part in the magnetic observations of Gauss and Weber at Göttingen, and had executed a magnetic survey of portions of Italy and Sicily. In addition to these a number of well-known British men of science were invited to be present, amongst whom I need only mention the Marquis of Northampton (President of the Royal Society), Sabine, Sir John Herschel, Lloyd, Airy, Brown, and Sir James Ross, then recently returned from his celebrated expedition to the Antarctic seas. Letters were also received from Wilhelm Weber, Gauss, Loomis, Lamont, Quetelet, Von Humboldt, and others.

The principal question which this conference had to decide was whether "the combined system of British and foreign co-operation for the investigation of magnetic and meteorological phenomena, which [had then] been five years in progress, must be broken up" (*Brit. Assoc. Rep.*, 1845, p. 69). I will not trouble you with a recapitulation of the recommendations of the Congress, some of which have been carried out, while others have not yet been realised; but one resolution will, I am sure, so exactly express your own sentiments that I venture to quote it, viz.: "That the cordial co-operation which has hitherto prevailed between the British and foreign magnetic and meteorological observatories having produced the most important results, and being considered by us as absolutely essential to the success of the great system of combined observation which has been undertaken, it is earnestly recommended that the same spirit of co-operation should continue to prevail." Whatever changes half a century may have wrought in the problems which press upon magneticians, and in the difficulties which confront them, there can be no doubt that they are still of the same spirit as that in which this resolution was framed.

It is true that we sometimes meet with the objection that international conferences of all kinds are now too numerous, and that their decisions from their very number and complexity cease to attract attention or to command respect. Admitting that this objection is not without weight, it may be answered by two remarks. The closer union between scientific workers in different countries which these meetings encourage, the strengthening of the ties of intellectual sympathy by those of personal friendship are in themselves good. It is surely a hopeful omen that science, as she reaches her maturity, forgets or ignores the political and geographical boundaries which sometimes seemed so important in her youth, and that workers for the common good are more and more learning that it is good to work in common.

But there are special and cogent reasons why the science of Terrestrial Magnetism should be cosmopolitan. The advance of some sciences is most easily achieved by the methods of guerilla warfare. In a hundred different laboratories widely separated workers plan independent attacks on nature. In different universities and colleges little groups are devising stratagems and arranging ambuscades in the hope of wresting from our great opponent some of the treasures which she yields only to the violent who take them by force. But for those who would unravel the causes of the mysterious movements of the compass needle concerted action is essential. They cannot, indeed, dispense with individual initiative, or with the leadership of genius, but I think that all would agree that there is urgent need for more perfect organisation, for an authority which can decide not only what to do, but what to leave undone.

The advance of the science of Terrestrial Magnetism must depend upon the establishment, the maintenance, and the utilisation of the records of observatories. The bulk of the material to be dealt with must in any case be vast, and every needless addition to it, every obstacle in the way of its being readily comprehended and easily used, is a drawback which proper organisation should prevent.

Thus it is wasteful to devote to the multiplication of observatories, in regions of which we know much, energy and funds which would be invaluable if applied to districts of which we know little or nothing. I take some credit to myself in that within the last few months I have assisted in checking well-intended but mistaken proposals to add to the number of the magnetic observatories which we already possess in this country.

Again, it is desirable that the records of the observations should be so published as to be ready for application to the problems the solution of which they are intended to subserve, and that the individual worker should not be harassed by petty differences in the methods of presentment, which often entail on him labour too enormous to be faced. On this point something has already been done by international co-operation, and we may hope that this meeting will do much to complete the task.

Lastly, there are many investigations which are now undertaken independently at irregular intervals which would be far more useful if planned in common. Thus there has of late been a great outburst of energy in Europe devoted to magnetic surveys more detailed than have ever before been accomplished. Is it too much to hope that when the time comes for these to be repeated they may be carried out simultaneously, and reduced by the same methods, so that we may have a magnetic map of Europe in which no uncertainty as to the accuracy of details is introduced by the necessity for correcting for the secular change over long intervals of time?

Taking it, then, for granted that international co-operation is desirable for purposes such as these, I come next to the question of the nature of the machinery by which it shall be secured. And here I may at once state that the arrangements under which we are meeting to-day are in some respects abnormal, and that plans for the future will have to be formally or informally considered before we part. Meanwhile, it is desirable that I should state precisely the circumstances which have brought us together.

The last meeting of the International Meteorological Conference was held in Paris in September 1896. It was attended by several men of science specially interested in Terrestrial Magnetism, and, perhaps on this account, a new departure was taken by the International Committee, in the appointment of a "Permanent Committee for Magnetism and Atmospheric Electricity," to which certain specific questions were referred. Eight gentlemen were nominated as members of this Committee, with power to add to their number. We in turn co-opted eight other magneticians, taking care that as far as possible all countries in which Terrestrial Magnetism is specially studied should be represented. About the same time, and, as I believe, in ignorance of the establishment of this Committee, a suggestion for the assembling of an International Conference on Terrestrial Magnetism was made in the journal of that name by Prof. Arthur Schuster. It appeared to me and to Prof. Schuster himself that it would be a great pity if this suggestion resulted in the establishment of a rival organisation, and I at once submitted to the Committee the question whether, in their opinion, it was desirable that we ourselves should take the responsibility of summoning an international meeting, with the view of obtaining a wide discussion of the points submitted to us by the Meteorological Conference. This suggestion was approved, and as the British Association was willing to allow us to organise the Conference as a branch of Section A (Mathematics and Physics), to undertake the expense of sending out the necessary notices, to print our papers in its Report, and to extend to foreign members of the Conference all the privileges of foreign members of the Association, it was also determined that so hospitable an invitation should be accepted with the gratitude it deserved. But although the main result has been achieved, and a representative gathering of magneticians has assembled in Bristol, it cannot be denied that our relations to the various bodies with which we are connected are somewhat complicated, and that our constitution is devoid both of simplicity and symmetry. I take it that these facts are signs of health and vigour rather than symptoms of decay. Terrestrial Magnetism has been attracting far more attention of late years than in the not very distant past. The necessity for meeting, for common action, for common publication has been forced upon us. We have cared more for meeting than for the terms on which we were to meet, more for acting together than for drawing up an elaborate deed of partnership, more for the promotion of science than for a flawless paper constitution. Thus, and in my opinion most wisely, we have sought to attain our ends, not by starting a brand new International Association, but by making use of machinery which is already in existence, which has stood the test of time, and is, as I believe, capable of being put to new uses in meeting our wants and supplying our deficiencies.

I confess, however, that in this arrangement we have been compelled to pay scant attention to the simplicity and even to the logical consistency of our schemes. We are an International Conference on special subjects—Terrestrial Magnetism and Atmospheric Electricity—summoned by a Committee owing its authority and bound to report to another International Conference of wider scope, which regards our sciences as branches of Meteorology.

On the other hand, this Committee is for the moment a part of the Committee of the Section of Mathematics and Physics of the British Association, though it retains its right of separate meeting, more especially for the discussion of its report to the International Meteorological Conference. It is evident that here there is plenty of opportunity for collision between rival authorities, for confusion between conflicting jurisdictions; but to all questions as to the precise limits of authority and jurisdiction it is sufficient to reply in the most general terms. The whole of the arrangements are temporary, to meet an immediate pressing need. The work of the Conference will be conducted like that of a Department of the British Association. The members of the International Committee will act as the Committee of the Department, but some of their work will be done on the General Committee of Section A, of which other magneticians will also be members. Should it be necessary, they will hold some separate meetings, and some such meetings will certainly be necessary to discuss their report to the International Meteorological Conference. These general regulations will probably suffice for all practical purposes. If cases occur which they do not cover, we must deal with them as they arise.

With regard to the future, I do not propose to lay before you any detailed scheme, but in discussing the matter among ourselves, the following principles should, in my opinion, be adhered to. The International Meteorological Conference has held a number of successful meetings. I believe that I am correct in saying that the right to attend that Conference was at first confined to those who were officially connected with Meteorological and Magnetic observatories, but that of late invitations have been more widely distributed. If the authorities of that Conference see their way to inviting in future most or all of those who are known to be specially interested in Terrestrial Magnetism, I do not see why the Magnetic Conference, which would then be constituted once in five years, should not meet all our requirements. If, however, additional meetings are necessary, I would urge that they should be held in turn in different countries, and, if possible, in connection with existing societies which play elsewhere the part taken by the British Association in this country.

That a permanent committee should be established is essential, and the mode of appointing this body must no doubt be considered, but I hope that in the course of the next few days the committee may be able to discuss the whole question, and that when the next meeting of the Meteorological Conference takes place we may be able to lay before the Committee suggestions which may lead to the foundation of an International Magnetic Association on a stable and permanent basis.

Another matter of great importance is the maintenance of an international journal devoted to Terrestrial Magnetism. This we now possess, thanks to the energy of Dr. Bauer, and I feel sure that all present will agree that such a means of intercommunication is invaluable. I believe, however, that the enterprise is threatened with financial dangers, and I desire to take this opportunity of urging all those who are interested in its success to do what they can to support it by increasing the circulation. There is every reason for making more use of a common journal. The records of the observatories are necessarily so bulky, that any one who desires to obtain the facts as to the magnetic state of the earth at any given time must collect or consult a large library of quarto volumes, in some of which the magnetic facts are mingled with data interesting chiefly to the meteorologist or astronomer. It is no doubt essential that an account of all the work done at each observatory should be published in a collected form, and that full details of the magnetic observations should be given; but for many, nay, for most, purposes, those who use the records will require only final results; the means of the various elements for the year, for each month, or for any other period which may hereafter be adopted, and the mean diurnal variation, are in general wanted, rather than the hourly values. If these means could be published together, once a year, an enormous boon would be conferred upon magneticians. For special purposes the theorist will have to test his views by reference to the results published in their fullest detail; but it would be no slight gain if the more salient facts could be compared by being placed side by side in the same journal. One advantage such a system would unquestionably possess. It would impress upon the authorities of the observatories the necessity for adhering to a common form of publication.

Some small beginnings have already been made. The Kew Observatory Committee now publish in the *Proceedings* of the Royal Society the annual means of the elements recorded by all the observatories which send their publications to Kew. By comparing two of these tables, the secular change can at once be determined. But the system is capable of extension, not merely to the normal values of the elements, but to disturbances. By common agreement, Greenwich and Parc St. Maur publish in each year the records of the same magnetic storms. If this agreement could be extended, and if the facts thus selected were brought into juxtaposition, we might hope for a fuller and more instructive analysis than is at present usual.

Turning from questions of organisation, the primary business of our conference will be to discuss four questions submitted to our Committee by the International Meteorological Conference.

The first two of these refer to the methods for calculating and publishing the monthly means of the magnetic elements which should, in our opinion, be adopted. I will not anticipate the discussion which will take place on these points, except to say that it will be necessary to bear in mind not only what is desirable, but also what is practicable in view of the resources at the disposal of the directors of the various magnetic observatories.

Another question deals with the relative merits of long and short magnets, and on this point we shall have the advantage of hearing a report on the subject by M. Mascart.

Lastly, there is a very important proposal for the establishment of temporary magnetic observatories at certain specified places. General Rykatcheff and Prof. von Bezold present an excellent report on this subject, and I will only remind you that whereas the accuracy of the mathematical expression of the magnetic state of the earth's surface depends entirely on the number and position of the spots at which the magnetic elements are accurately known, the establishment of temporary observatories will be a costly undertaking, for the carrying out of which all the resources at the disposal of international science will have to be employed.

Another point of considerable practical importance will also be brought before us. The rapid extension of electrical railways and tramways is a serious menace to magnetic observatories. From all parts of the world we hear of observatories ruined or threatened by the invasion of the electrical engineer. Toronto and Washington have already succumbed; Potsdam, Parc St. Maur, Greenwich, and Kew are besieged, and the issue largely depends upon whether these great national observatories can or cannot make good their defence.

It seems to be a law of nature, ruling alike the human race and the humblest microbe, that the products of an organism are fatal to itself. The pessimist might infer that we are in presence of another instance of the universality of the application of this law, and that pure science is threatened by the very success of its practical applications. The smoke of our cities blots the stars from the vision of the astronomer, who, like the anchorites of old, flies from the world to mountains and desert places. It is only in the small hours of the morning when

"Save pale recluse, for knowledge seeking,
All mortal things to sleep are given,"

that the physicist can escape from the tremors of the traffic of a great town.

Civilisation as it spreads by aid of the means that science has placed at its disposal is destroying records, and obliterating boundaries by the study of which the anthropologist and the biologist might have read far back into the history of our race. And now in turn the science of Terrestrial Magnetism, which, on the one hand, is forging another link to connect the sun and earth, and, on the other, is penetrating within the surface of the globe to depths beyond the ken of the geologist, is threatened by the artificial earth currents of the electric railway.

That the crisis is serious there can be no doubt, but I will only anticipate the fuller discussion which will take place by stating that magneticians, in common with the rest of the world, recognise the great benefit which electric traction confers upon the community at large. We are not so foolish as to desire to embark on a crusade against a great industrial improvement of which science may well be proud; on the other hand, we must hold fast to the position that provision for the conveniences which are immediately appreciated by the public should be made with as little damage as possible to those studies which are not less for the ultimate benefit of the race.

Had science, when the use of coal was introduced, been sufficiently advanced to devise means for smokeless combustion, an evil, which now in more senses than one darkens the lives of the inhabitants of our great towns, might have been prevented from attaining its present gigantic proportions.

We are now at the beginning of another industrial epoch, which may indeed, if power is transmitted from a distance on a large scale, brighten our skies, but which threatens to saturate the earth beneath us with electric currents. That these may interfere with the general comfort is evident from the injury which has been done to underground pipes at Washington and elsewhere. The construction of a powerful electric railway in the immediate neighbourhood of the laboratories of a college would interfere with its efficiency, and make it impossible to perform experiments of certain types. In such a case, however, something could be done by arranging the experiments to suit the conditions under which they would have to be performed. But in the case of a magnetic observatory no such protective measures are possible. The very object of the observatory is to measure the earth's field, and if that field is artificially altered, no modification of the methods of measurement, however ingenious, can overcome this fundamental defect. I am glad to take this opportunity of acknowledging that both the danger to pure science and the necessity for obviating it have been acknowledged by those who are chiefly interested in the technical applications of science; and in particular that one of the principal technical journals, the *Electrician*, has supported the view that industry can and ought to respect the necessities of research.

If, however, there be any who are inclined to ask whether the careful study of Terrestrial Magnetism has led or is leading to any definite results, or whether we are not merely adding to the lumber of the world by piling up observations from which no deductions are drawn, we may answer that, though the fundamental secret of Terrestrial Magnetism is still undiscovered, the science is progressing. In the presence of several of the most active workers I will not enter into a detailed discussion of the tasks to which they are devoting themselves; I will only ask that the doubter should compare a good summary of the state of the science of Terrestrial Magnetism written fifteen or twenty years ago, such as that contained in the article by Balfour Stewart in the "Encyclopædia Britannica," with what would be written on the same subject to-day. Additions would have to be made to the descriptions of the instruments employed, to the discussion of the theory of the diurnal and secular change, while such questions as the reality of earth-air currents, and the tracing of loci of local disturbance have only been dealt with effectively in very recent times. When, too, we compare the older models of the magnetic state of the earth with that devised by Mr. Henry Wilde we cannot but admit not only that a great advance has been made in forming a simple diagram of the magnetic state of the earth, but that it is possible that the model contains a very pregnant hint as to the physical construction of the earth as a magnetic body.

The fact that Mr. Wilde has imitated the declination and dip with remarkable accuracy all over the surface of the earth by means of a simple arrangement of electrical currents, and by coating the oceans with thin sheet iron, has not attracted the attention it deserves. Whether the physical cause thus suggested be due to the greater depth to which the underground isothermals penetrate below oceans, the bottoms of which are always cold, or whether the geological nature of the rocks is different below the great depressions and elevations of the earth's surface, respectively may be open to question, but I am persuaded that the matter should be more fully investigated.

In conclusion, let me once more revert to the points on which I dwelt at the beginning of this brief address. We meet with the confidence of men who know that their science is progressing, but with the mingled hopes and fears of those who still have to deal with the great unsolved problem of the causes of Terrestrial Magnetism and of its manifold fluctuations. This solution will be most easily attained if we are not merely content to collect facts, but if we so arrange that they shall be easily dealt with. To observe is our first duty, to organise our second, and if these be fulfilled we may hope that a theory of terrestrial magnetism will in the future crown the efforts not merely of him on whom the first glimpse of the truth may flash, but of the international co-operation which has, by way of preparation, made "the crooked straight and the rough places plain."

SECTION C.

GEOLOGY.

Opening Address by W. H. Hudleston, M.A., F.R.S., President of the Section.

Introductory.—About this time last year British geologists were scattered over no inconsiderable portion of the northern hemisphere, partly in consequence of the International Geological Congress at St. Petersburg, and partly owing to the meeting of the British Association at Toronto. From the shores of the Pacific at Vancouver, on the one hand, to the highlands of Armenia on the other, there were parties engaged in the investigation of some of the grandest physical features of the earth's surface.

The geologists in Canada were especially favoured in the matter of excursions. Everything on the American continent is so big that a considerable amount of locomotion is required to enable visitors to realise the more prominent facts. If there is no great variety of formation in Canada, yet the Alpha and Omega of the geological scale are there most fully represented, from the great Laurentian complex at the base to the amazing evidences of glacial action, in a country where it is possible to travel for a whole day without once quitting a glaciated surface. But Russia presented equal attractions, and in Finland almost identical conditions were observed, viz. glacial deposits on Archæan rocks. The great central plain of Russia, too, with its ample Mesozoic deposits often abounding in fossils, offered attractions which to some may have been stronger than the mineral riches of the Urals, or the striking scenery of the Caucasus.

It seems almost incredible, even in this age of extraordinary locomotion, that scenes so wide apart were visited by British geologists last autumn. This year we are more domestic in our arrangements, and Section C finds its tent pitched once more on the classic banks of the Bristol Avon, and in that part of England which has no small claim to be regarded as the cradle of English geology. But we may go a step further. For if the strata observed by William Smith during the six years' cutting of the Somersetshire coal-canal imprinted their lessons on his receptive mind, it is also equally true that Devonshire, Cornwall, and West Somerset first attracted the attention of the "Ordnance Geological Survey." And thus it comes to pass that the region which lies between the Bristol Channel and the English Channel claims the respect of geologists in all parts of the world, not only as the birthplace of stratigraphical palæontology, but also as the original home of systematic geological survey.

The city of Bristol lies on the confines of this region, where it shades off north-westwards into the Palæozoics of Wales, and north-eastwards into the Mesozoics of the Midland counties. There are probably few districts which display an equal amount of variety within a limited circumference. The development of the various formations was excellently portrayed by Dr. Wright, when he occupied this chair twenty-three years ago—so well, indeed, that his address might serve as text-book on the geology of the district. In the following year (1876) there appeared the Survey Memoir on the Geology of East Somerset and the Bristol Coal-fields, by Mr. H. B. Woodward, who has since contributed important memoirs on the Jurassic rocks of Britain, which are so largely developed in Somerset and the adjacent counties. Since that date many papers also have appeared in various journals, and some of these, as might be expected, give new and perhaps more accurate interpretations of phenomena previously described. In addition to this, portions of the south-west of England have been geologically re-surveyed, and in some cases new maps have been published.

I would call especial attention to the Survey map on the scale of four miles to the inch, known as the "Index-map," which has recently been issued. Sheet 11 includes this particular district; but if a portion of sheet 2 is tacked on to its southern border, we obtain a block of country about 120 miles square, which has not its equal for variety of geological formation in any part of the world within the same space. If Europe is to be regarded as presenting a geological epitome of our globe, and if Great Britain is an epitome of Europe, then, without doubt, this particular block of the south-west, which has Bath for its more exact centre, with a radius (say) of fifty miles, may be said to contain almost everything to be found on the geological scale, except the very oldest and the very youngest rocks; while east of the Severn and south of the Bristol Channel true Boulder clay is rare or absent.

It may be convenient to consider a few points which have arisen of late years in connection with the geology of portions of the district now under consideration.

Palæozoic.—If we omit the Silurian inlier at Tortworth, the geological history of the country, more immediately round Bristol, may be said to commence with the Old Red Sandstone, whose relations with the Devonian towards the south-west, have always presented some difficulty. And this difficulty is accentuated by doubts as to the true Devonian sequence in West Somerset and North Devon. Ever since the days of Jukes that region has been fruitful in what I must continue to regard as heresy until the objectors have really established the points for which they are contending. The uncertainty is to be regretted, since it is through these beds of West Somerset that the system is to be made to fit in with the several members of the Old Red Sandstone.

There is a mystery underlying the great alluvial flats of Bridgewater which affects more than one formation; so much so, that one cannot avoid asking why there should be Old Red Sandstone in the Mendips and Devonian in the Quantocks. The line which separates the Old Red Sandstone of South Wales and the Mendips from the West Somerset type of Devonian lies here concealed. I have already suggested (*Trans. Devonsh. Assoc.*, vol. xxi., 1889, p. 45) that, if we regard the Old Red Sandstone of South Wales as an inshore deposit over an area which was deluged with fresh water off the land, we can believe that further out to sea, in a southwesterly direction, the conditions were favourable for the development of a moderate amount of marine mollusca. This view not only does away with the necessity for a barrier, but it also, in a general sense, suggests a kind of gradation between the Old Red and Devonian deposits. Mr. Ussher, whose practical acquaintance with this region dates from a long period, stated a few years ago that, "As far as Great Britain is concerned, the true connections of the Old Red Sandstone beds with their marine Devonian equivalents have yet to be carefully worked out on the ground."[1] I am not aware that further progress has been made in this direction.

The Carboniferous Limestone of the Bristol area has attracted the attention of so many distinguished geologists that its palæontology and general features are tolerably familiar. Of late years we owe some interesting petrographic details to Mr. Wethered. The varying thickness of the Carboniferous Limestone and also of the Millstone Grit in this part of England is noteworthy. If we follow the Carboniferous Limestone in a south-westerly direction, across the mysterious Bridgewater flats, a change is already noted in the case of the Cannington Park limestone, which was the subject of so much discussion in former years. Referring to this, Mr. Handel Cossham (*Proc. Cottes. Club*, vol. viii, 1881-2, p. 20 *et seq.*) was so sanguine as to believe that its identification with the Carboniferous Limestone would have the effect of extending the Bristol coal-field thirteen miles south of the Mendips. However this may be, all further traces of Carboniferous rocks fail at this point. After crossing the vale of Taunton, when next we meet with them in the Bampton district, the Culm-measure type, with its peculiar basal limestones, is already in full force.

In the new "Index-map" the Culm-measures are placed at the base of the Carboniferous series—below the Carboniferous Limestone. It is no part of my purpose to attempt any precise correlation, but I would point out the somewhat singular circumstance that the change to Culm rock occurs only a few miles to the south-west of the line where, in the previous system, we have already seen that the Old Red Sandstone changes into the Devonian. This curious coincidence may be wholly accidental, or it may be the result of some physical feature now concealed by overlying formations.

Since 1895 a new light has been thrown on the Lower Culm-measures by the discovery of a well-marked horizon of Radiolarian rocks. One result of the important paper of Messrs. Hinde and Fox has been to alter materially our views as to the physical conditions accompanying the deposition of a portion of the Culm-measures. The palæontology leads the authors to conclude (*Quart. Journ. Geol. Soc.* vol. li., 1895, p. 662) that "the Lower *Posidonomya*- and Waddon Barton Beds are the representatives and equivalents of the Carboniferous Limestone in other portions of the British Isles; not, however, in the at present generally understood sense that they are a shallow-water facies of the presumed deeper-water Carboniferous Limestones, but altogether the reverse, that they are the deep-water representatives of the shallower-formed calcareous deposits to the north of them. . . . The picture that we [Messrs. Hinde and Fox] can now draw of this period is that while the massive deposits of the Carboniferous Limestone—formed of the skeletons of calcareous organisms—were in the process of growth in the seas to the north [*i.e.* in the Mendip area and elsewhere] there existed to the south-west a deeper ocean in which silicious organisms predominated and formed these silicious Radiolarian rocks."

This is probably a correct view of the case, but one cannot help wondering that the ocean currents and other causes did not effect a greater amount of commingling of the elements than seems to have taken place. As a practical result, this discovery of a Radiolarian horizon in the Culm-measures has been of service in enabling surveyors to discriminate between Devonian and Carboniferous in the very obscure area on the other side of Dartmoor. This, I ventured to predict, would be the case when the paper was read before the Geological Society.

The principal features of the Bristol coal-field are too well known to call for many remarks. It would seem that the Pennant rock was formerly regarded as Millstone Grit, until Mr. Handel Cossham, in 1864, pointed out the mistake. Mr. Wethered gave a good description of the Pennant in his paper on the Fossil Flora of the Bristol coal-field (*Proc. Cottes. Club*, vol. vii, 1878, p. 73). It might seem almost unnecessary to refer to the existence of such a well-known formation as the Pennant, but for the fact that in a recent scheme of the Carboniferous sequence in Somersetshire the Pennant rock was wholly omitted.

The interest now shifts from the almost continuous deposition of the later Palæozoics, in one great geosynclinal depression, to an entirely different class of phenomena. Nowhere, perhaps, are the effects of the post-Carboniferous interval better exhibited than in those parts of the south-west of England where Tertiary denudation has removed the Mesozoic deposits. Here we perceive some of the effects of the great foliations which terminated the Palæozoic epoch in this part of the world. The immense amount of marine denudation which characterises this stage is particularly obvious in the anticlinals, which were the first to suffer, as they came under the planing action of the sea.

Attention may be drawn to a peculiarity which has no doubt been observed by many persons who have studied a map of the Bristol and Somerset coal-field. It will be seen that the strike of the Coal-measures is widely different on either side of a line which may be drawn through Mangotsfield to a point north of Bristol. The beds north of this line have for the most part a meridional strike, nearly parallel with the present Cotteswold escarpment; south of this line the strike is mainly east and west, though much curved in the neighbourhood of Radstock and the flanks of the Mendips. Of course this is only part of an extensive change in the direction of flexure, much of which is still hidden under Mesozoic rocks. Mr. Ussher, in the paper previously quoted, tells us that the line of change of strike may be traced in the general mass of the Palæozoic rocks, from near Brecon in South Wales to the neighbourhood of Frome. This means that within the Bristol district two distinct systems of flexure must have impinged on each other in post-Carboniferous times. Have we not here, then, another instance of extraordinary change within the limits of our area? This time it is not a mere change in the nature of a deposit, like that of the Old Red Sandstone into the Devonian, or of the Carboniferous Limestone into the Culm-rock, but a change in the direction of the elevatory forces, which had made its mark on the structure of our island even at that early date.

At this point I ought to quit the Palæozoics; but there is just one subject of interest which claims a momentary attention, viz. the probability of finding workable coal east of the proved Somersetshire field. I avoid the question of coal south of the Mendips as being too speculative, on account of the chances of deterioration of the coal-measures in that direction. But in view of the forthcoming meeting of the British Association at Dover, the question of finding coal to the eastward of Bath becomes a specially interesting subject for discussion. It is also a matter of some consequence whether the hidden basin or basins belong to the meridional or to the east and west system of flexures.

[1] Prospects of obtaining coal by boring south of the Mendips, *Proc. Som. Nat. Soc.*, vol. xxxvi. (1891) pt. 2, p. 104.

The latter is most likely to be the case.[1] The vale of Pewsey has been mentioned as a suitable locality for boring along the line of the recognised axis.

But prospectors should bear in mind the warning of Ramsay, that the basins containing coal are but few in comparison with the number of basins throughout the palæozoic rocks. No doubt the line indicated is more favourably situated for coal-exploration than the eastern counties; where, for instance, the Coal Boring and Development Company has lately gone into liquidation. The unsuitability of East Anglia as a field for coal-prospecting was insisted on in my second anniversary address to the Geological Society (*Quart. Journ. Geol. Soc.* vol. i., 1894, p. 70), and the results seem to have been very much what might have been expected. If coal is to be found beneath the Secondary rocks, the line of search should be carried through the counties of Kent, Surrey, Berkshire, and Wiltshire, though the three latter counties have hitherto been content to leave their underground riches unexplored. The Kent Coal Exploration Company is doing some good work with a reasonable chance of success; though if they wish to find coal sufficiently near the surface they had better adhere as much as possible to the line of the North Downs, since operations on the Sussex side are only too likely to be within the influence of the Kimmeridgian gulf, which was proved to exist at Battle (Netherfield). Mr. Etheridge, I hope, will have something to tell us as to the progress of the Kent Collieries Corporation, who now carry on the work at Dover.

Secondary or Mesozoic Rocks.—Commencing a totally different subject, I must now direct attention to the "red beds" and associated breccias so characteristic of eastern Devonshire. These rest in complete discordance on the flanks of the palæozoic highlands, and must be regarded as forming the base of the Secondary rocks of that district.

By the Geological Survey this series has hitherto been mapped as Trias, but in the new "Index-map" they are coloured as Permian. There is no Palæontological evidence which would connect them with the fossiliferous Permians, usually regarded as of Palæozoic age, but it has been evident for some time past that opinion was inclining to revert to the views of Murchison and the older geologists, more especially as to the position of the breccias so largely charged with volcanic rocks. The subject was dealt with by Sir A. Geikie in his address to the Geological Society, where he speaks of some of these rocks as presenting the closest resemblance to those of the Permian basins of Ayrshire and Nithsdale (*Quart. Journ. Geol. Soc.*, vol. xlviii., 1892, p. 161).

One difficulty which presented itself to the Devonshire geologists in accepting the Permian age of the "red beds" was, that the whole of the lower Secondary rocks appeared as an indivisible sequence, proved by its fossils to be of Keuper age at one end, and therefore inferentially of Keuper age at the other. Dr. Irving, however, considered that at the base of the Budleigh Salterton pebble-bed there is a physical break of as much significance as that between the Permian and Trias of the Midlands. In the marls which underlie this pebble-bed he recognised a strong resemblance to the Permian marls of Warwickshire and Nottinghamshire; and Prof. Hull, who had been studying the sections east of Exmouth about the same time, ultimately acceded to this view.[2] Its acceptance by the Survey thus throws all the Exmouth beds into the Permian; and that formation, according to the new reading, has an outcrop of some thirty-five miles from the shores of the English Channel to within three miles of Bridgewater Bay. The fertility of these red clays, loams, and marls has long been recognised by agriculturists, and it is not improbable that the abundance of contemporaneous volcanic material may in some measure have contributed to this result.

In conformity with the new mapping, the Budleigh Salterton pebble-bed and its equivalents to the northwards are accepted as of Bunter age, and thus constitute the base of the Trias in the south-west. Like most pebble-beds, they are irregularly developed between the Permians and a strip of reddish sandstone (coloured as Keuper), which runs up from the mouth of the Otter to within a short distance of Bridgewater Bay. The materials of the pebble-beds are not of local origin, like so much of the breccia at the base of the Permian. The general resemblance, both as regards scenery and composition, to the Bunter conglomerate of Cannock Chase has been pointed out by Prof. Bonney, who seems prepared to endorse the recognition of the Budleigh Salterton pebble-bed as a Bunter conglomerate. He was not impressed by any marked unconformity with the underlying series. To some extent we may accept this view, since whatever may be the age of the Devonshire breccias and "red beds," they, in common with the Trias, must have been deposited under fairly similar physical conditions in a sort of Permo-Triassic lake basin.

The bulk of the Trias, including the Dolomitic Conglomerate of the Bristol district, is still regarded as of Keuper age, though it is now admitted, as insisted on by Mr. Sanders years ago, that the Dolomitic Conglomerate does not necessarily occupy the base of the Keuper, but is mainly a deposit of hill-talus, which has been incorporated with the finer deposits of the old Triassic lake as the several palæozoic islands gradually became submerged. The great blocks which fell from the old cliffs were formerly regarded as proofs of glacial agency, and there are persons who still believe, more especially with respect to the Permian breccias, that such rocks are indicative of a glacial origin.

In the "Index-map" the Dolomitic Conglomerate and the Red Marl are thus included under the same symbol and colour. But this is also made to include the Rhætic—an arrangement which is hardly in accordance with the facts observed in the Bristol area. On a small-scale map so narrow an outcrop as that of the Rhætic could hardly be shown; yet its affinities are probably with the Lower Lias rather than with the Trias. The late Edward Wilson, whose recent death we all deplore, in his paper on the Rhætic rocks at Totterdown (*Quart. Journ. Geol. Soc.*, vol. xlvii., 1891. p. 545), showed most clearly that the "Tea-green Marls," which had previously been associated with the Rhætic, represent an upwards extension of the Red Marls of the Trias, in which the iron had suffered reduction; though there are indications of a change of conditions having set in before the deposition of the Rhætics. The black Rhætic shales which succeed usually have a sharp and well-defined base in a bone-bed with quartz pebbles, &c., indicating a sudden change of physical conditions, though perhaps no marked unconformity. In the South Wales district the Rhætic limestones are said to be largely of organic origin, and, in addition to a Rhætic fauna, to abound in the lamellibranchs so plentiful in the lowest Lias limestones (*Ann. Rep. Geol. Survey* for 1896, p. 67).

The late Charles Moore always deplored the comparative poverty of the Trias in fossils. In his last communication to the Geological Society (*Quart. Journ. Geol. Soc.*, vol. xxxvii., 1881, p. 67), he set himself to describe certain abnormal deposits about Bristol, and to institute a comparison with the region of the Mendips. He then suggested, on the faith of a sketch by Mr. Sanders, that the famous Durdham Down deposit, already inaccessible, might have been a fissure-deposit in the Carboniferous Limestone like those at Holwell. He also stated that at one time he had been inclined to regard the reptilian deposit on Durdham Down as of Rhætic age; but the discovery of teeth of *Thecodontosaurus*, identical with those of Bristol, in a Keuper Marl deposit near Taunton, induced him to refer the Durdham Down deposit to the middle of the Upper Keuper. He had arrived at the conclusion that the same genera of vertebrata are found in the Keuper and Rhætic beds, though the species, with few exceptions, are quite distinct.

But it is with the Lias that the name of Charles Moore is most intimately associated. Time does not permit me to do more than allude to the wonderful collections of Rhætic and Liassic fossils made by him from the fissure-veins of the Carboniferous Limestone, or of the treasures which are stored in the Bath Museum. There never was a more enthusiastic palæontologist, and nothing pleased him better than to exhibit the fossilised stomach of an *Ichthyosaurus*, stained by the ink bag of the cuttle-fish, on which it had been feeding, or some similar palæontological curiosity. Every one here knows how deeply the West of England is indebted to Charles Moore for his unceasing researches, and I have been thus particular in alluding to them because it was under his auspices that I first became acquainted with the geology of this part of the country thirty years ago.

Amongst more recent work in the Rhætic and Lias, I might

[1] The boring at Burford, where coal was found at a depth of 1100 feet, below a surface of Bathonian beds, at a point thirty-five miles E.N.E. of the extreme end of the Bristol Coal-field at Wickwar, is not included in this category; since it must belong to the meridional system, and is altogether outside the prolongation of the axis of Artois.

[2] (*Cf.* Irving, *Quart. Journ. Geol. Soc.*, vols. xliv., 1888, p. 149, xlviii., 1892, p. 68, and xlix., 1893, p. 79; and Hull, *op. cit.* vol. xlviii., 1892, 60).

mention papers by Mr. H. B. Woodward and Mr. Beeby Thompson, each in explanation of the arborescent figures in the Cotham Marble. The latter revives an old idea with modifications, and his theory certainly seems plausible. Mr. H. B. Woodward's Memoir of 1893 does full justice to the Lias of this district, and much original matter is introduced.

It is, however, in the Inferior Oolite that the most important interpretations have to be recorded since the days when Dr. Wright and Prof. J. Buckman endeavoured to correlate the development of the series in the Cotteswolds with that in Dorset. To this subject I alluded at considerable length in my address to the Geological Society in 1893, pointing out how much we owed in recent years to the late Mr. Witchell and to Mr. S. S. Buckman. In the following year appeared Mr. H. B. Woodward's Memoir on the Lower Oolitic Rocks of England ("Jurassic Rocks of Britain," vol. iv.), wherein he did full justice to the work of previous observers. Meantime Mr. Buckman has not been idle, and his paper on the Bajocian of the Sherborne district (*Quart. Journ. Geol. Soc.*, vol. xlix., 1893, p. 479) marks the commencement of a new era, where the importance of minute chronological subdivisions, based upon the prevailing ammonites, is insisted on with much emphasis. This system he considers to be almost as true for the Inferior Oolite as for the Lias.

There can be no doubt that its application has enabled Mr. Buckman to effect satisfactory correlations between the very different deposits of the Cotteswolds and those of Dorset and Somerset. In subsequent papers also he brings out an important physical feature, viz. the amount of contemporaneous denudation which has affected deposits of Inferior Oolite age in this country. This serves in part to explain the absence of well-known beds in certain areas. For instance, in the Cotteswolds contemporaneous erosion has, prior to the deposition of the Upper *Trigonia*-grit, cut right through the intervening beds, so as to produce in the neighbourhood of Birdlip a shelving trough 6 miles wide and about 30 feet deep. Thus the extensively recognised overlap of the *Parkinsoni*-zone is accentuated in many places.

We have a further instance of good work in the case of Dundry Hill. An inspection of the 1-inch Survey map would lead one to suppose that the Inferior Oolite there rests directly on the Lower Lias. Recently, owing to the investigations of Messrs. Buckman and Wilson,[1] this apparent anomaly has been removed, whilst beds of Middle and Upper Lias age, and even Midford Sands have been recognised. In this way the authors claim to have reduced the thickness assigned to the Inferior Oolite on Dundry Hill by about 100 feet. In the paper above quoted the vicissitudes and faunal history of the Inferior Oolite from the *opalinus*-zone to the *Parkinsoni*-zone inclusive are shown with much detail; whilst the position of the chief fossil-bed in time and place has been well established. The general resemblance of the Dundry fossils to those of Oborne, which I could not fail to notice in working out the Gasteropoda of the Inferior Oolite, now admits of explanation. Although the quondam *Humphriesianus*-zone is richly represented, yet the particular *Humphriesianum*-hemera is held to be absent at Dundry. But if there is a *Sowerbyi*-bed anywhere it should serve to connect these two localities, where, according to Mr. Buckman's phraseology, the principal zoological phenomenon is the acme and paracme of Sonninínæ.

Mr. Buckman, as we have seen, is no longer satisfied with the old-fashioned threefold division of the Inferior Oolite, and his time-table includes at least a dozen hemeræ, with prospect of increase. Granting that it would have been difficult to solve the Dundry problem without a detailed knowledge of ammonite horizons, there arises the question as to the utility of such minute subdivisions for the purposes of general classification. Mr. Buckman has earned the right to put forwards, if he pleases, the several stratigraphical rearrangements in which from time to time he indulges. The Inferior Oolite has been his especial playground, and, as the kaleidoscope revolves, this formation is perpetually made to assume different proportions, even to the verge of extinction. But this practice is not without its disadvantages; whilst the invention of new names tends to clog the memory, and the novel use of old ones is apt to produce confusion.

We have not quite finished with Dundry yet, since that classic hill serves to illustrate in Mesozoic times a peculiarity of which I have already pointed out two notable instances in this district, where an abrupt and seemingly unaccountable difference is observed in beds which are approximately synchronous. The problem to be solved is this—why does the fossiliferous portion of the Inferior Oolite on Dundry Hill resemble that of the neighbourhood of Sherborne, both in lithology and fossils, rather than that of the Cotteswolds, only a few miles distant?

Nine years ago Mr. Buckman offered an ingenious solution of this difficulty (*Proc. Cottes. Club*, vol. ix., 1890, p. 374), though his recent investigations at Dundry, and especially his appreciation of the effects of contemporaneous erosion, may have caused him to alter his views. Like most people who wish to account for strong local differences, he placed a barrier of Palæozoic rocks between Dundry and the southern prolongation of the Cotteswold escarpment. At that time it was not fully realised that the Inferior Oolite in the Bath district is, for the most part, limited to the *Parkinsoni*-zone, so that the comparison was really being made between beds of different age as well as different physical conditions. The question resolves itself into one of local details, which are not suited for a general address. Still, I think it may be taken for granted that, notwithstanding the east-and-west barrier of the Mendip range, which acted effectually previously to the *Parkinsoni*-overlap, there was in some way a communication by sea between Dundry and Dorsetshire, more especially during the *Sowerbyi*-stage, and this most probably was effected round the western flank of the Mendips. Thus, without acceding to the necessity for a barrier facing the southern Cotteswolds, we may readily believe that much of the Inferior Oolite of Dundry Hill is to be regarded as an outlying deposit of the Anglo-Norman basin. If this be so, it is difficult to avoid the conclusion that the low-lying area of the Bridgewater flats was, during part of the Inferior Oolite period, occupied by a sea which was continuous from Sherborne to Dundry, and that, although the barrier of the Mendips was interposed, communication was effected round the west flank of that chain. This would make a portion of the Bristol Channel a very ancient feature.

We must now take a wide leap in time, passing over all the rest of the Jurassics, and just glancing at the Upper Cretaceous system, which reposes on the planed-down surface of the older Secondary rocks. The remarkable double uncomformity is nowhere better shown than in the south-west of England. Some of the movements of the older Secondary rocks, prior to the great revolution which brought the waters of the Cretaceous sea over this region, have been successfully localised by Mr. Strahan, more especially in the south of Dorset.

Owing to Tertiary denudation the Chalk in this immediate district has been removed, and we have no means of judging the relations of the Cretaceous deposits to the Palæozoic rocks of Wales. If we may judge by results recently recorded from Devonshire (*cf.* Jukes-Browne and Hill, *Quart. Journ. Geol. Soc.* vol. lii., 1897, p. 99), the Lower Chalk especially undergoes important changes as it is traced westwards, and generally speaking terrigenous deposits seem more abundant in this direction. At the same time the more truly oceanic deposits, such as the Upper Chalk, appear to be thinning. As regards the possible depths of the Cretaceous sea at certain periods, we are supplied with some interesting material in Mr. Wood's two papers on the Chalk Rock (*Quart. Journ. Geol. Soc.*, vol. lii., 1897, p. 68, and vol. liii., 1898, p. 377), which has been found especially rich in Gasteropoda at Cuckhamsley, near Wantage.

Tertiary, Pleistocene, and Recent.—Although the Tertiaries of the Hampshire basin are within the "Index-map" which we have been considering, they may be regarded as beyond our sphere. Some of the gravels of Dorsetshire, which have gone under the name of plateau gravels, are held by Mr. Clement Reid to be of Bagshot age. Many of the higher hill gravels most likely date back to the Pliocene, and even further, and represent a curious succession of changes, brought about by meteoric agencies, where the valley-flat of one period, with its accumulated shingle, becomes the plateau of another period—an endless succession of revolutions further complicated by the Pleistocene Cold Period, which corresponds to the great Ice Age of the north.

In the more immediate neighbourhood of Bristol, since some date in Middle Tertiary time, the process of earth-sculpture, besides laying bare a considerable amount of Palæozoic rock,

[1] *Quart. Journ. Geol. Soc.*, vol. iii., 1897, p. 669. *Cf.* also *Proc. Brist. Nat. Soc.*, vol. viii., 1897, pt. ii. p. 188.

has produced both the Jurassic and Cretaceous escarpments as well as the numerous gorges which add so much to the interest of the scenery. These phenomena have been well described by Prof. Sollas (*Proc. Geol. Assoc.*, vol. vi., 1881, p. 375), when he directed an excursion of the Geologists' Association in 1880. Should any student wish to know the origin of the gorge of the Avon at Clifton, for instance, he will find in the Report an excellent explanation of the apparent anomaly of a river which has been at the trouble of sawing a passage through the hard limestone, when it might have taken what now seems a much easier route to the sea by way of Nailsea.

The origin and date of the Severn valley is a still bigger question, and this was broached by Ramsay, some five-and-twenty years ago, in a suggestive paper on the River Courses of England and Wales (*Quart. Jour. Geol. Soc.*, vol. xxviii., 1872, p. 148). He there postulates a westerly dip of the chalk surface, which determined the flow of the streams in a westerly direction towards the long gap which was being formed in Miocene times, near the junction of the Mesozoic with the Palæozoic rocks. The still more important streams from the Welsh highlands had no doubt done much towards initiating that gap; and by the end of the Miocene period, if one may venture to assign a date, the valley of the Severn, which is one of the oldest in England, had already begun to take form, though many of the valleys of Wales are probably much older.

We may now be supposed to have arrived at a period when the physical features of this immediate district did not differ very materially from what they are at present. The great Ice Age was in full force throughout Northern Europe, and, according to views which meet with increasing favour, the German Ocean and the Irish Sea were filled with immense glaciers. What was taking place at that time in the estuary of the Severn?

This is a case which requires the exercise of the scientific imagination, of course under due control. There is probably nothing more extraordinary in the history of modern investigation than the extent to which geologists of an earlier date permitted themselves to be led away by the fascinating theories of Croll. The astronomical explanation of that "will o' the wisp," the cause of the great Ice Age, is at present greatly discredited, and we begin to estimate at their true value those elaborate calculations which were made to account for events which in all probability never occurred. Extravagance begets extravagance, and the unreasonable speculations of men like Belt and Croll have caused some of our more recent students to suffer from "the nightmare."

Nevertheless Croll, when he confined his views to the action of ice, showed himself a master of the subject, and his suggestions are often worthy of attention, even when we are not convinced. Writing in the *Geological Magazine* in 1871, he points out that the ice always seeks the path of least resistance; and he refers to the probability that an outlet to the ice of the North Sea would be found along the natural hollow formed by the valleys of the Trent, the Warwickshire Avon, and the Severn. Ice moving in this direction, he says, would no doubt pass down into the Bristol Channel and thence into the Atlantic. Again (*op. cit.* Dec. 2, vol. i., 1874, p. 257), referring to the great Scandinavian glacier, he says, "it is hardly possible to escape the conclusion that a portion of it at least passed across the south of England, entering the Atlantic in the direction of the Bristol Channel." These views were not based on any local knowledge, but merely on general considerations. The problem as to whether there are any traces of the passage of such a body of ice in the basin of the lower Severn must be worked out by local investigators. Irrespective, too, of the hypothetical passage of a lobe of the North Sea glacier, we are confronted by a much more genuine question, namely, what was the possible termination towards the south of the great body of ice with which our more advanced glacialists have filled the Cheshire plain?

A recent president of the Cotteswold Field Club, of whom, unfortunately, we must now speak as the late Mr. Lucy, took a lively interest in the Pleistocene geology of the district, and his papers in the *Proceedings* of the Cotteswold Field Club have always attracted attention. His map of the distribution of the gravels of the Severn, Avon, and Evenlode, and their extension over the Cotteswold hills, prepared in conjunction with Mr. Etheridge, is a valuable contribution to the history of the subject (*Proc. Cottes. Nat. Club*, vol. v. pt. ii., 1869, p. 71). Again he wrote on the extension of the Northern Drift and Boulder-clay over the Cotteswold Range (*op. cit.* vol. vii. pt. i., 1878, p. 50), and on this occasion described the interesting section in the drifts presented by the Mickleton tunnel. In his previous paper, Mr. Lucy had carried the drifts with northern erratics to a height of 750 feet, but he now claimed that "the *whole* Cotteswold Range had ceased to be dry land at the time the Clays and Northern Drifts passed over it." We perceive from this passage that Mr. Lucy was a "submerger," and in this respect differed from Croll, who most probably would have attributed the phenomena to the action of his great ice-lobe traversing the south of England.

The question which more immediately concerns us relates to the value of the evidence which would require either a glacier or a "great submergence" to account for these things. The alleged phenomena are in many cases capable of other interpretations. We have the authority of Mr. Etheridge that little or no true Boulder-clay occurs in the Cotteswold area (*Proc. Cottes. Nat. Club*, vol. xi., 1893, p. 83). On the other hand, the distribution of much of the erratic gravel is probably due to agencies of earth-sculpture long anterior to the great Ice Age. There remains one special piece of evidence adduced by Mr. Lucy in favour of his contention, and this he considered of so much importance that it formed the principal part of the subject of his annual address to the Field Club on quitting the chair in 1893 (*Proc. Cottes. Nat. Club*, vol. *cit.*, p. 1).

He there referred more especially to the discovery *in* the Inferior Oolite, on Cleeve Cloud, of quartzose sand and of a boulder of a similar character to some described in his previous papers. The sand and the boulder, he says, belong to the period of the great submergence. Similar sand also appears in several places on the hillside. He had previously recorded boulders of Carboniferous Limestone, Millstone Grit, &c., in the northern Cotteswolds, but not at so great an elevation. He further proceeds to account for the absence of striæ, and of the fact that the Cotteswold rocks are not *moutonnée*, on the supposition that the soft oolites would not retain striation, but would be crushed by pressure. Consequently he claims the top of Cleeve Cloud as a fine example of "glacial denudation," whatever that may mean. The boulder from Cleeve Cloud is now in the Gloucester Museum, and might well become a bone of contention between the submerger and the glacialist as to how it got into its elevated position of over 1000 feet. Fortunately there is a third explanation, which, if it be correct, shows how dangerous it is to build theories, as well as houses, upon sand. Other distinguished members of the Cotteswold Club are of opinion that the whitish sands on Cleeve Common belong to the "Harford Sands," which constitute an integral part of the Inferior Oolite itself. There may be some difference of opinion as to the concretionary nature of the boulders, though these may well be nothing more than the "doggers," or "pot-lids," so characteristic of calcareous sandstones. Mr. Winwood believes that "the so-called foreign boulder" in the Gloucester Museum evidently came from the "Harford Sands."

So far, therefore, the evidences of glacial action in the Cotteswolds do not rest on a very sure foundation. Yet the Severn valley separates that range from an area on the west, where there are clear evidences of local glaciation, as described in the "Annual Report of the Geological Survey for 1896." Portions of this material find their way into the river bed and elsewhere as Drift which has most probably been rearranged—hence the so-called Boulder-clay and Drift in the bed of the Severn. Once more, then, in the cycle of geological time we perceive that our district lies on the confines of two distinct sets of phenomena. West of the Severn and north of the Bristol Channel the evidences of considerable local glaciation are obvious, whilst this can hardly be said of the Cotteswolds, the Mendips, or the Quantocks.

To the more recent geological history of our district it will be sufficient to allude in the briefest terms, when I remind you of the paper by Mr. Strahan on the deposits at Barry Dock, and the still later one by Mr. Codrington on the submerged rock valleys in South Wales, Devon, and Cornwall. Here we have important testimony to certain moderate changes of level which have taken place, and a picture is presented to us of the Bristol Channel as a low-lying land surface, with streams meandering through it. Thus a depression of something like 60 feet appears to be the most recent change which the geologist has to record in the estuary of the Severn.

THE TRIENNIAL INTERNATIONAL CONGRESS OF PHYSIOLOGISTS.

FOURTH MEETING.

THE fourth Triennial International Congress of Physiologists, held at Cambridge on August 23–27, was the largest assembly of the kind that has yet met. The third congress (Bern, 1895) defined the qualification for membership as "open to (1) professors and lecturers on physiology and their official assistants; (2) to members of the American Physiological Society; the Physiological Society, England; Société de Biologie, Paris; Physiologische Gesellschaft, Berlin; Physiologisches Club, Vienna; (3) to ladies and gentlemen proposed by their National Committee, and accepted by the International Congress Committee." This rule was strictly observed for the present congress, and the number of members attending was two hundred and twenty-six. The press were not officially admitted to the meetings. The different nationalities represented were as follows:—Austria-Hungary and Germany, 33 members; Belgium, 9; Denmark and Sweden, 3; Egypt, 2; France, 29; Holland, 3; India, 2; Italy, 9; Japan, 4; Roumania, 2; Russia, 7; Switzerland, 9; United States, 16; Great Britain and Canada, 98.

A larger number of communications were received than on any previous occasion, and it became difficult to transact the business in the allotted time. The rule awarding preference to communications illustrated by experiment was adhered to, and the meetings were as free from mere verbal or pictorial exposition as on any previous occasion.

The official work of the congress commenced on the morning of August 23 at 10 o'clock, with a few pithy words of welcome and direction from the President, Prof. Michael Foster, Sec. R. S.

Prof. E. J. Marey (Paris) urged the necessity of creating an international committee for the unification and the control of physiological instruments employed for graphic methods. The following were appointed to serve: E. J. Marey, Paris; M. Foster, Cambridge; H. Kronecker, Bern; K. Hüerthle, Breslau; V. Frey, Zürich; E. Weiss, Paris; H. Bowditch, Boston.

Prof. Mosso (Turin) made a communication regarding mountain sickness. Mountain sickness, in his opinion, does not depend on diminution of the tension of the atmospheric oxygen, but on diminution of the carbon dioxide of the arterial blood.

Prof. A. Kossel (Marburg) communicated an important paper upon albumens. Starting from the probability that a protamine-like group of atoms is contained in the proteid molecule, and that from it by decomposition the hexon-bases arginin $C_6H_{14}N_4O_2$, histidin $C_6H_9N_3O_2$, lysin $C_6H_{14}N_2O_2$ arise, he with Dr. Kutscher had sought for arginin and histidin in various proteids and quantitatively determined them. They had found the hexon-bases obtainable from all the proteid substances they had as yet examined, also from elastin. The amounts obtainable from the various bodies were very different; the largest proportion was obtainable from histon, the smallest from elastin; an intermediate proportion was yielded by casein and egg albumen.

Dr. J. Demoor (Brussels) gave an interesting demonstration and account of his researches upon the association centres and the cerebral localisation of the dog. He then proceeded to describe the changes found by Prof. Heger and himself in the form of the neurons of the cortex cerebri under various conditions of rest and excitation. In animals decapitated in sleep produced by ether, chloroform, morphia, &c., the cell-body of the neuron is retracted, the dendrites are moniliform, and the distribution of the spine-like appendages is irregular and in some places they are wanting. The altered neurons recover their normal aspect after elimination of the modifying agent.

Dr. J. Demoor then gave a statement of his views of the signification of the moniliform condition of the cortical neuron. He drew attention to the similarity between this condition of the brain-cells and that of the pseudopodia of certain of the protozoa. He concludes that the nerve-cell is plastic, and that the moniliform condition of its processes is a condition of contraction.

Dr. H. Wright (Montreal) contributed the account of recent observations on the effects produced on the microscopical appearance of the nerve-cell by the action of ether and of chloroform.

Prof. H. Hamburger (Utrecht) gave an account of his continued work on the influence of solutions of inorganic salts on the volume of animal cells. He finds that white blood-corpuscles and spermatozoa increase in volume when placed in hypisotonic, and shrink when set in hyperisotonic solutions. The volumetric proportion of the two component parts of the cell, its framework and the intracellular fluid, can be accurately ascertained.

Prof. Kronecker (Bern) communicated for himself and Mlle. Schilina the results of a comparison instituted between Ludwig's kymograph and Hüerthle's tonograph.

Prof. Kronecker, for himself and Mlle. Devine, reported the results of further investigation of the respiration of the heart of the tortoise. Blood free from or very poor in oxygen (saturated with H or CO) serves to nourish the perfused tortoise heart just as well, to judge by the pulse-volume, as does arterial blood. Blood saturated with CO_2 quickly reduces the performance of the heart.

Prof. Bowditch (Harvard, Boston, U.S.A.) demonstrated an ingenious apparatus for elucidating the movements of the human eye-ball. Even on the small scale on which the mechanism exhibited had been executed he succeeded in making clear his demonstration to the whole audience in the large theatre.

Dr. L. Asher (Bern) gave a communication, illustrated by experiment, on the theory of lymph production. He defended the thesis that lymph is a product of the work of the organs, no mere filtrate from the blood, and no mere secretion from the cells of the walls of the blood-vessels. The specific activity of the salivary glands, of the thyroid, and of the digestive organs, each and all occasion increased formation of lymph.

By Dr. W. M. Bayliss (London) a demonstration was given to show the non-antagonism of visceral and cutaneous vascular reflexes.

A canula in the carotid artery of a curarised rabbit is connected to an ordinary mercurial manometer, and also, by means of a side-tube, to a wide glass tube dipping under mercury contained in a tall cylinder; the depth at which the end of the tube is situated under the mercury is adjusted so that blood just begins to escape. The leg is enclosed in a plethysmograph, and its alteration of volume traced by means of a piston recorder. If now the central end of the anterior crural, or other sensory nerve, is excited, the arterial blood pressure is prevented from rising by the escape which takes place from the tube under mercury, so that there is no opposing force to be overcome by the vessels of the leg in constricting, and accordingly the volume of the leg is seen to *diminish*. In asphyxia a similar constriction occurs.

Mr. W. M. Fletcher (Cambridge) showed the apparatus and methods employed by him in his investigation on the CO_2 discharge of excised tissues.

The titrations are performed in closed absorption chambers, and the necessary stirring and expulsion of the solutions are effected without contamination by atmospheric air. A reduplication of the apparatus allows an absorption of CO_2 to proceed in one part while estimation of that previously absorbed is conducted in the other, so that a given discharge of CO_2 may be kept under continuous observation.

The method has been used in following the survival respiration of excised tissues—mainly the leg muscles of the frog, the tortoise heart and some non-muscular tissues; and it has been found very suitable for the study of the respiration of insects.

Dr. Leonard Hill (London) brought forward interesting new experiments in pursuance of his well-known investigation of the influence of gravity of the circulation of the blood.

An eel or grass-snake is affixed to a board in the extended position, and the heart exposed. On turning either animal into the vertical position (tail downwards) the heart, after a few beats, becomes emptied of blood. On pressing the body from the tail upwards the heart immediately fills to repletion. On ceasing to compress the body the heart once more as completely empties. So soon as the animal is placed head downwards the heart engorges. This engorgement is limited by the inextensile pericardium, which in the eel is extremely strong. If a snake or eel be sunk vertically and tail downwards in a vessel of water the heart does not empty. The hydrostatic pressure of the column of water exerted on the surface of the body tends to counterbalance the hydrostatic pressure of the column of blood within the body. A chloralised tame rabbit is placed in the vertical position with the feet downwards.

Record of the aortic pressure is at the same time taken. After ten minutes or so the pressure begins to steadily fall, the respiratory pump, at first more active, gradually ceases, the animal passes into syncope, the heart is almost empty and death imminent. Compression of the abdomen will at this point immediately restore the circulation and remove the condition of syncope. The same end can equally well be attained if the body of the animal be sunk in a bath of water. In the wild rabbit, cat, dog, monkey and man, the power to resist the influence of gravity on the circulation is very perfect. The hutch rabbit is likewise restored by a bath, and in this fact it is possible to find a simple explanation of the beneficial influence of baths on the bodies of debilitated men. The hydrostatic pressure of the water not only acts on the blood vessels, but also causes the abdominal organs to float upwards. Thereby the diaphragm is raised, and the tension on the vena cava inferior relieved, that is to say, so soon as the dragging weight of the abdominal organs be removed.

Prof. Townsend Porter (Harvard, Boston, U.S.A.) communicated two important papers on the mammalian heart, entitled "The nutrition of the heart through the vessels of Thebesius," and "The beat of the isolated mammalian ventricle fed on blood-serum alone." His method was demonstrated and consists in the revivifying of the excised and washed out dog's heart by simply allowing a stream of defibrinated dog's blood to flow through it from the coronary artery.

A heart fed simply through the veins of Thebesius and the coronary veins will maintain strong, rhythmic contractions for many hours if supplied with oxygen at high tension. The absence of corpuscles was readily borne by the heart. Continued rhythmic contractions were obtained with the serum alone, so soon as the oxygen tension rose to about two atmospheres. It follows that the mammalian heart fed through the vessels of Thebesius and the coronary veins with blood-serum alone will maintain rhythmical contractions for hours when surrounded by oxygen at high tension. Isolated pieces of the ventricle beat if fed with serum through a branch of the coronary artery.

These experiments permit the conclusion that even isolated portions of the mammalian ventricle supplied through their nutrient arteries with a small quantity of serum at very low pressure will maintain rhythmical, long-continued, forceful contractions when surrounded by oxygen at high tension.

The influence of salts upon the electromobility of medullated nerve was the subject of a communication, illustrated by experiments and by lantern galvanograms, by Prof. A. D. Waller, F.R.S. (London). The method of investigation was that previously employed by the author.

Excised frog's sciatic laid across unipolar electrodes in moist chamber. Electrical response to electrical excitation at regular intervals photographically recorded before and after modification of the nerve by various salts dissolved in normal saline.

In the action upon nerve of a salt BA, the predominant moiety is B (the basic or electropositive element), *e.g.* any potassium salt is more effective than any sodium salt.

The acidic or electronegative element A is of subordinate action, *e.g.* KI > KBr.

	Strength of solution		Effect upon electrical response.
	°/o	M.	
NaBr	1·030	*m*/10	No effect.
KBr	1·190	*m*/10	Abolition in 30 mins.
KCl	0·744	*m*/10	Abolition in 30 mins.
NaF	0·840	*m*/5	No effect.
KF	1·160	*m*/5	Abolition in 8 mins.

Is the action upon nerve of a salt $\overset{+}{B}\ \overset{-}{A}$, or of an acid $\overset{+}{H}\ \overset{-}{A}$, or of an alkali $\overset{+}{B}\ \overset{-}{OH}$, that of dissociated ions?

Do *e.g.* HNO_3 act upon nerve by virtue of its electropositive H, and KOH by virtue of its electronegative OH?

Certainly not exclusively. Because *e.g.* the action of the highly dissociated *n*/10HNO_3 is not greater than that of the slightly dissociated CH_3, COOH, and the action of KOH is considerably greater than that of NaOH at equality of dilution and of dissociation. The action of the highly dissociated chlorides, bromides, &c., is not greater than that of the slightly dissociated acetates.

Data.

	Strength of solution			Effect upon electrical response.
	°/o	M.	N.	
H_2SO_4	0·490	*m*/20	*n*/10	Abolition in 7 mins.
HNO_3	0·630	*m*/10	*n*/10	Abolition in 15 mins.
CH_3, COOH	0·600	*m*/10	*n*/10	Abolition in 15 mins.
H_3PO_4	0·653	*m*/15	*n*/5	Abolition in 25 mins.
CH_3, CHOH, COOH	0·450	*m*/20	*n*/20	Abolition in 15 mins.
NaOH	0·200	*m*/20	*n*/20	Diminution.
KOH	0·140	*m*/40	*n*/40	Abolition in 8 mins.

Prof. E. Wertheimer (Lille) demonstrated observations, made with M. Lepage, that the influence of the accelerator nerves on the heart is much less, in the dog, during expiration than during inspiration.

Prof. Grützner (Tübingen) demonstrated (1) a tambour by means of which the slightest alteration in the pitch of a sung note can be visually demonstrated before an auditorium; (2) a method of analysis of a compound note by means of interference established by stopped tubes of different lengths; (3) his graphic record of induction currents upon paper.

Dr. J. N. Langley, F.R.S. (Cambridge), demonstrated his discovery of the possibility of obtaining an experimental union between the nerve-fibres of the vagus nerve and the sympathetic nerve-cells of the superior cervical ganglia. The vagus and sympathetic nerves were ligatured with horse-hair. On August 23 sixty-four days had elapsed since the end of the vagus was joined to the sympathetic nerve. The vagus nerve was then cut near the skull, and its peripheral end stimulated. Regeneration had taken place; the stimulation of the vagus caused opening of the eye, retraction of the nictitating membrane, dilation of the pupil, contraction of the vessels of the ear, and more or less of the other effects ordinarily produced by stimulating the cervical sympathetic. The injection of 20 milligrams of nicotin temporarily prevented the vagus from producing any of these effects, but did not prevent stimulation of the superior cervical ganglion from producing them. This result shows in the clearest manner that the specific effect of the excitation depends upon the specific character of the peripheral ending, not on the character of the central conducting paths.

Prof. Heymans (Ghent), gave experiments upon physiological and artificial disintoxication. The simple nitrils are within the organism decomposed and eliminated in the form of sulphocyanide. This physiological disintoxication, acting under the intervention of sulphuretted organic bodies, is much increased by the administration of certain compounds of sulphur such as the hyposulphites, &c. These sulphur compounds prevent or remove the poisonous effects of a dose of the nitrils many times that sufficient to kill.

Prof. Sherrington, F.R.S. (Liverpool), demonstrated his discovery of inhibition of the tonus of a skeletal muscle by the excitation, either electrical or mechanical, of the antagonist muscle. The phenomena has bearing upon spinal coordination for volitional and other kinds of movement. The experiment shown dealt with the antagonistic flexors and extensors of the knee-joint. The stretching of a muscle produced by the contraction of its antagonist may excite (mechanically) the sensorial organs in the muscle that is under extension; in this way a reflex of pure muscular initiation may be started. The experiment proved that electrical excitation of the central end of an exclusively muscular nerve produces inhibition of its antagonist. (1) The central end of the severed hamstring nerve was faradised. This nerve contains sensory nerve-fibres from the flexor muscles of the knee. The effect of these on the extensor muscles of the knee was seen (α) in elongation of those muscles, (β) in temporary diminution of the knee-jerk. (2) The exposed flexor muscles detached from the knee, and therefore incapable of mechanically affecting the position of the joint, were then stretched or kneaded. This produced reflex elongation of the extensor muscles of the knee and a temporary diminution of the knee-jerk. It may therefore be that reciprocal innervation, which Prof. Sherrington has pointed out to be a common form of coordination of antagonistic muscles, is secured by a simple reflex mechanism, important in its execution being the tendency for a muscle to produce its own inhibition reflexly by mechanical stimulation of the sensory apparatus in its antagonist.

Prof. O. Frank (Munich) demonstrated methods of recording the action of the cardiac muscle both isotomically and isometrically.

Prof. Gotch, F.R.S., and Mr. G. J. Burch (Oxford) showed photographs of the electrical response of nerve to excitation. The results obtained have been: Biphasic effects indicated by a rapid displacement in one direction which is followed by one in the other. Examples of these are (1) effect in uninjured fresh nerve with both contacts upon the surface, (2) effect in excised nerve kept for twenty-four hours in 0·6 per cent. NaCl. Monophasic effects indicated by a rapid displacement returning very slowly and exhibiting a second effect of similar direction but of slow development, the negative after-effect obtained when the functional capacity of the tissue under the distal contact is so lowered that it is incapable of undergoing the change which produces the excitatory electrical response. Biphasic effects with prolonged second phase when the functional capacity of the tissue is low; the records show an initial small displacement followed by a prolonged one of opposite sign, *i.e.* a positive after-effect. The nerve when excited by a rapid series of stimuli gives a series of independent spikes; the injured nerve gives a series of displacements which are superimposed; the after-effect not having subsided when the second response occurs.

Prof. A. B. Macallum (Toronto) brought forward and illustrated by demonstration his method for detection and localisation of phosphorus in animal and vegetal cells, &c. The use of pyrogallol for this purpose is not free from objection, and a reagent was sought which would definitely distinguish between the molybdate and phospho-molybdate of ammonla. This reagent was found in phenylhydrazin hydrochloride in a 1–4 per cent. aqueous solution which gives a dark-green reaction with the phospo-molybdate compound, but none with molybdate of ammonia in the presence of nitric acid. The nitric-molybdate reagent is allowed to act for some hours at a slightly elevated temperature on the sections of tissue, which are then transferred to the solution of phenyl-hydrazin hydrochloride. To prevent the confusion which might result from the presence of lecithin, the latter must be extracted with hot alcohol, frequently renewed, for five hours, and the presence and amount of inorganic phosphates are indicated by the early appearance of the reaction and its extent.

The method has resulted in demonstrating the presence of "masked" phosphorus in the chromatin of all animal and vegetable cells, in nucleoli, in the anisotropic substance in muscle fibre, in the prozymogen and zymogen of pancreatic cells, in the colloid material of the thyroid, in the outer limbs of the rods and cones, in pyrenoids of the Protophyta, &c. It also shows that in non-nucleated organisms like the Cyanophyceæ and *Saccharomyces* the phosphorus-holding substance, or nucleo-proteid, although sometimes in the form of granules or spherules which have been taken for nuclei, is frequently dissolved in the cytoplasm.

Prof. Boruttau (Göttingen) communicated a paper upon recent advances in electro-physiology. After speaking of the methods of investigating the course in time of the action-current of nerve, and especially of the use of combining photographic records with rheotom experiments, he discussed the biphasic and monophasic action-currents of frog's nerve, their modifications in electrotonus, their alteration and abolition under ether narcosis and in cold, their increase by CO_2, the alterations effected in the electrotonic state by ether and by CO_2, and the phenomena of the curare preparation.

Prof. J. B. Sanderson (Oxford) communicated a paper on the duration of the monophasic variation of the sartorius muscle of the frog.

Dr. Theodore Beer (Vienna) brought forward an important communication, richly illustrated by experiment, upon the accommodation of the eye in various species of the animal kingdom. In order to adapt an eye to a range of objects at different distances, *two* plans are employed. In the first the curvature of the refracting surface is made adjustable; in the second the distance of the refracting surfaces from the receptive screen is adjustable. The adjustment of the curvature is exclusively of increase of the curvature, affording thus an active accommodation for near vision. This exists in mammals, birds, lizards, crocodiles, tortoises, and in a few snakes. Throughout the above-named forms the means by which the adjustable increase of curvature is obtained is by the active contraction of a muscle slackening the suspensory apparatus that under the resting condition of the muscle keeps to some degree flattened the anterior surface of the lens.

In cephalopods and the bony fishes the eye is when at rest in focus for objects near at hand. In these forms the adjustment is for distant objects, and is brought about by the retreat of the lens towards the retina. In amphibia and snakes—or rather in such of them as possess any visual accommodation—there exists an active accommodation for near vision executed by an advance of the lens from the retina. In the bony fishes a special muscle (*Retractor lentis*, Beer) drags the lens backwards towards the retina. In the cephalopods, amphibia and snakes, alterations in intraocular pressure, brought about by contraction of circularly-arranged muscle-fibres, play an important part. Among mammals, reptiles, amphibians, and fish there are certain species that have no power of visual accommodation; these are for the most part nocturnal species and forms with narrow, even slit-like pupils (great sensitivity to light). Some of the tortoise-tribe, which dive under water, not only counterbalance the loss of the corneal refracting surface thus occasioned, but even under water accommodate for near vision.

Prof. Halliburton, F.R.S., and Dr. F. W. Mott, F.R.S. (London) demonstrated the influence of cholin, neurine, and some allied substances upon the arterial blood-pressure. In certain diseases of the central nervous system the cerebrospinal fluid becomes laden with toxic substances of this class, and it is in prosecution in that direction that the researches of Profs. Halliburton and Mott are especially suggestive.

Prof. E. Weymouth Reid, F.R.S., and Dr. J. S. Macdonald (Dundee) demonstrated experiments illustrative of their study of the electromotive changes in the phrenic nerve.

Electromotive changes in the phrenic nerve can be demonstrated to accompany the groups of nervous impulses periodically generated in the respiratory centre. By the cut end and a point about a centimetre central thereto, the nerves are suspended on "cable" non-polarisable electrodes, free of the tissues of the neck, and are led off to the galvanometer (without compensation) or capillary electrometer. A single nerve, or, taking symmetrical points on the two sides, both "in parallel" (galvanometer) or "in series" (electrometer) may be used for experiment. The characteristic effects have been seen as long as two hours after putting the nerves in circuit. Intermittent electrical discharges (negative variations of the demarcation current) are observed and can be abolished by ligature of the nerve with moist thread above the proximal electrode. If the animal is curarised and artificial respiration set up, it is found that the magnitude of the discharge is directly affected by the supply of air, so that with over-supply there is cessation of discharge, with under-supply or stoppage of pump, asphyxial increase.

Prof. Sherrington, F.R.S. (Liverpool), with Dr. Hering (Prague), gave a convincing demonstration in the monkey (*Macacus*) of inhibition of the contraction of voluntary muscle evoked by electrical excitation of certain points of the *cortex cerebri*. This inhibition, producing relaxation of volitional muscles, was shown to occur regularly in the evocation of co-ordinated movements from the cerebral cortex. The relaxation of a muscle is not obtained by excitation of the same point of cortex as that whence its contraction is elicitable, but is obtainable from the same point of cortex as that whence contraction of its antagonist can be obtained. A distance of more than a centimetre sometimes separates the points whence contraction and relaxation of one and the same muscle can respectively be obtained. Besides this reciprocal innervation of the true antagonists, evidence was demonstrated of a more complex relationship between different muscle groups; relaxation of some muscles and contraction of others was shown to exist in cases where the physiological connection between the two different activities is not obvious or easily intelligible.

Dr. Maurice Nicloux (Paris) showed that if carbonic oxide is made to pass over iodine anhydride maintained at a temperature of 100°–150°, the carbonic oxide is oxidised, and passes off in the form of carbonic anhydride at the same time that the iodine is set free in corresponding quantity. This reaction occurs whatever be the dilution of CO in the air, even if the dilution be 50,000. Search for traces of CO becomes, therefore, simple, rapid and exact. There is, therefore, a certain amount of CO normally in the blood. The average quantity seems to be 1·4 cc. per litre of blood. M. Desgrez has shown that chloroform in contact with an aqueous solution of potassium produces some carbonic oxide. The general reaction of the blood and tissue fluids being alkaline, Nicloux and Desgrez have inquired whether this decomposition does actually occur in the organism. Experiment has shown that it does.

Prof. Marey (Paris) showed a new series of studies in chronophotography.

A conjoint communication was made by Prof. Waller, F.R.S., and Miss Sowton (London), on the action upon isolated nerve of muscarine, chlorine and neurine, commenced at the instance of Prof. Halliburton. Comparative experiments were made with the hydrochlorides of these two bodies. Occasion was taken to bring into the comparison the effect of muscarine, which in previous experiments at a strength of 1 per cent. had showed itself to be of doubtful action upon nerve. Choline as compared with neurine is inert in relation to nerve. 4 per cent. solution of choline produces no effect, whereas the electromobility of nerve is abolished by neurine at 4 per cent., at 2 per cent., at 1 per cent., and markedly diminished at 0·5 per cent. As regards the substance of cerebro-spinal fluid, if the issue be narrowed to an alternative between choline and neurine, there can be no doubt that neurine is absent, and therefore choline present. The muscarine used was less active upon nerve than neurine. As regards an action upon isolated nerve, the order of efficacy of the samples used was: (1) neurine, (2) muscarine, (3) choline.

Miss S. C. Sowton (London) gave an interesting report of a large series of galvanometric records of the decline of the current of injury in medullated nerve, and of the changes in its response to periodic stimulation. The work had been prosecuted chiefly in Prof. Waller's laboratory, and had for its object the study, by means of prolonged photographic records, of:—

(*a*) The progressive modifications of electromotivity described by Engelmann, viz. decline of current of injury with lapse of time, and its restoration by a fresh transverse section.

(*b*) The progressive modification of electromobility described by Waller, viz. decline of negative variation and appearance of a positive variation.

The curve of diminishing electromotivity falls convex to the abscissa. Time being taken in arithmetical progression, the residual electromotivity is in geometrical progression, with a ratio = $\frac{4}{5}$ per 1 hour. The negative variation progressively diminishes during the first 2 or 3 hours, and gives place to a progressively increasing positive variation.

Dr. Bayliss and Dr. E. Starling (London) showed an influence of blood-supply on peristaltic movement. The cutting off of blood-supply from the intestine reduces the peristaltic movements after a variable interval. The intestinal inhibition due to the splanchnic may be only secondary to vascular constriction.

Dr. H. Ito (Bern) reported a research into the place of the heat-production evoked by cortical excitation.

Physical absorption of isotonic and anisotonic salt solutions was the subject of a communication by Prof. S. P. Budgett (St. Louis, U.S.A.). A dilute solution of egg-albumen placed inside the shell membrane of the hen's egg, and separated by it from a strong solution of sodium chloride, increased in volume at the expense of the latter. An explanation of this phenomenon may be of interest with regard to the intestinal absorption of hypertonic salt solutions. The membrane offers so little resistance to the dialysis of sodium chloride, that the osmotic pressure due to the latter is for the most part transmitted through, rather than exerted against, the membrane, and consequently can interfere but little with the absorption of its solvent. Added to these circumstances is the osmotic pressure exerted by the albumen on the inner side of the membrane; this force and the greater resistance presented by the membrane to the exit of water, together overbalance the lesser resistance offered by the membrane to the entrance of water, and the slight resistance to the dialysis of sodium chloride. The solution of egg albumen may be replaced by serum, by milk, by a solution of dextrin, or gum arabic, or by an even somewhat hypotonic solution of a crystalloid such as ammonium sulphate, which dialyses less readily than sodium chloride through the egg-shell membrane.

Dr. F. S. Lee (New York) gave a communication on the fatigue of muscle. He had studied the process of fatigue in the frog, the turtle, and the cat. The increase in the duration of relaxation that occurs in the frog is not found in the case of the two other species. The one essential factor in the phenomenon of fatigue is the diminution of the lifting power of the muscle. Of the two supposed causes of muscle fatigue, viz. decrease of contractile substance, and accumulation of fatigue-products with poisoning of the muscle thereby, the former plays no part in the phenomenon; the latter is the sole cause. Fatigue is a safeguard against exhaustion. Attempts to demonstrate histological differences between resting and fatigued muscle had yielded him only negative results.

Prof. W. H. Thompson (Belfast) reported observations on the diureric effects of small quantities of normal saline solution. Sodium chloride solution (·6 per cent. ·6 per cent. and ·9 per cent.) 2–4 c.c. per kilo was injected into the external saphenous vein. The quantity of urine was greatly increased, far beyond the amount injected. The urea and total nitrogen was increased when measured hour by hour, though the urine was more dilute. At first this might be thought due to absorption of water into blood-vessels causing a dilute blood. This cannot, however, be the explanation, since sp. gr. of blood in many cases is higher than normal during period of greatest diuresis. It is also not due to excretion of surplus NaCl—for in many cases this is diminished, though urine is increased, *i.e.* the two phenomena do not run parallel.

Dr. Brunton Blaikie (Edinburgh), with Prof. Gottlieb's cooperation (at Heidelberg), had examined the muscle of dogs which had been bled to death, the bleeding being of a very thorough nature. The estimation of urea was conducted according to von Schroeder's method, and *urea in crystalline form was conclusively demonstrated in all cases.*

Prof. Hagemann (Bonn-Poppelsdorf) gave an account of his researches on the actual nutritional value of the feed of the horse. Each weighed-out "feed" can be divided into *a* per cent. which is absorbed, and $100 - a$ per cent. which reappears in the fæces. The portion *a* per cent. is often regarded as digested, that is, completely usable by the organism for its nutrition. Such a view is only partly justified. From it there has to be substracted that digestion-work consumed in absorbing it, and also that part which is broken up by fermentation processes in the intestine.

Drs. F. G. Hopkins and W. B. Hope (London) dealt with the questions of the nucleo-proteids as dietetic precursors of uric acid. They confirmed Mares that after a meal the increase of uric acid in the urine is immediate and has a duration shorter than that of the increase of urea. They called attention to the difficulty of reconciling this fact with an origin from nucleins which are unaffected by the earlier (gastric) period of digestion. In testing this matter it was found that taking filtered pepsin-hydrochloric acid extracts of the thymus gland as test meals produces a large increase of uric acid, though the extracts could be shown to contain no more than traces of nuclein; whereas the administration of pure nuclein prepared from the gland gave (in the authors' experiments) no increase at all. The ascription of all uric acid production in the mammal to the breakdown of nucleins is over hasty.

Dr. Martin Hahn (Munich) gave a communication on the chemical and immunising properties of plasmines. By plasmines the author denotes the substances contained in animal cells. He pointed out that it is now possible to express from yeast-cells a cell-free juice or plasmine which ferments sugar. This yeast plasmine contains also a proteolytic enzyme. The injection of the plasmines of cholera and typhoid bacilli in the guinea-pig establishes a specific immunity against intraperitoneal infection with cholera or typhoid. The same immunity can be obtained by injecting an alcoholic precipitate of the plasmine, or a precipitate thrown down from the plasmine by acidifying with acetic acid.

Prof. Livon (Marseilles) communicated observations on the action of extract of the pituitary body upon the function of the vagus nerve, illustrated by a number of kymograms. The inhibitory action of the vagus on the heart he found to be distinctly weakened temporarily after the injection of doses of pituitary extract.

Dr. Medwedew (Odessa) reported his studies concerning the oxidation of salicyl aldehyde in tissue-extracts. The oxidising principle contained in the extracts seems to be one or several peroxidised substances that can give up their oxygen in a molecular form.

Drs. Bedart and Mabille (Lille) read a paper on the action of arsenic upon the intoxication produced by ingestion of the thyroid body. The acceleration and irregularity of heart-beat produced in the dog by feeding with thyroid gland are removed by treatment with arsenic.

Dr. de Saint-Martin (Paris) made a communication on the absorbent power of the blood for oxygen and for carbonic oxide. Setting out from the statement of Claude Bernard that carbonic oxide displaces the oxygen from the blood volume for volume, he makes use of the following method of analysing the oxygen content of the blood. In a glass bulb are placed the blood to be examined, pure CO_2, and a saturated aqueous solution of sodium fluoride. These are well shaken, and then transferred to the gas-pump and extracted. The difference between the volume of carbonic oxide found and that introduced into the bulb gives the exact measure of the absorbing power of the blood. The addition of the sodium fluoride (Arthus, 1892) stops all consumption of oxygen, and is helped towards that end by the agitation of the blood with CO. The latter produces complete displacement of the oxygen, and thus ensures total extraction of the oxygen by the pump. Finally the carbonic oxide fixed by the hæmoglobin can be removed by adding to the residue an equal volume of saturated solution of tartaric acid. This method avoids the error due to the decomposition of the oxyhæmoglobin remaining incomplete, and to the consumption of a certain amount of oxygen by the blood itself during manipulation. By his new method De Saint-Martin arrives at the result; the power of hæmoglobin to absorb CO is very variable, altering even from day to day in the same individual. To estimate the respiratory power of the blood, it is necessary therefore not merely to determine the quantity of hæmoglobin in it, but to determine the absorbing power of the hæmoglobin. It follows, further, that according to De Saint-Martin estimations of the amount of hæmoglobin in blood based upon its absorbing power are quite untrustworthy.

Dr. C. Phisalix (Paris) demonstrated the existence of an oxydase in the skin of certain batrachians. The skin of the frog is macerated in saline, and the juice thus obtained is placed in three tubes. The first is heated to boiling, the second is sealed in vacuo, the third is left open to the air. The first and second preserve their original tint, the third turns brown, the brown colour commencing at and spreading from the surface of the fluid. At the end of five days the whole fluid is a deep brown. The fresh juice turns tincture of guiacum blue.

Prof. Moussu (Alfort) communicated a paper upon the functions of the thyroid and parathyroid bodies. Extract of parathyroid has no alleviative effect upon the symptoms of thyroid cachexia.

Prof. E. Schäfer, F.R.S (London), gave an interesting paper on the alleged sensory functions of the motor cortex cerebri. The conclusion drawn by Munk is that "Schiff was right in affirming that the parietal lobe is the tactile sphere as the temporal is the auditory and the occipital the visual sphere." Munk's view of the question has been adopted in this country by Mott, who states that his experiments "support Munk's conclusions that in the 'motor area' the sensation of touch and of pressure of the corresponding extremities is perceived." The chief method employed by Mott for testing tactile sensibility was the application of a steel spring clip to the skin (Schiff's clip test). This method is completely illusory. Schäfer found that an animal which will apparently disregard the constant pressure of even a strong clip on the skin of a paralysed limb, will, nevertheless, instantly take notice of a light touch, or of a light stroking with a straw upon the same limb. Experiments, thirty in number, have been made. The result has been to show that the assertions above quoted are entirely erroneous: that, in fact, complete voluntary motor paralysis of a part may be produced by a cortical lesion without perceptible loss of tactile sensibility. It cannot, therefore, be the case that the motor paralysis which is produced by a lesion of the Rolandic area is due to a sensory disturbance. And it also follows that tactile sensibility is not localised in the same part of the cortex from which voluntary motor impulses directly emanate. Hemianæsthesia sometimes results from an extensive lesion of the motor cortex; this is, however, not local but general, and is due to the vascular and mechanical disturbance produced upon the whole side of the brain by the establishment of the lesion. That this is the case is shown by the fact that it is generally accompanied by hemiopia. Five experiments were made in the following manner. Having exposed the upper Rolandic region in a monkey, the leg-area in the gyrus marginalis is completely severed by a cut passing as nearly as could be determined as far down as the calloso-marginal sulcus, and at any rate deep enough to sever all the fibres passing from the cortex to the centrum ovale. In no case did this lesion produce anything more than quite a temporary sensory disturbance, not to be detected after a day or two; and even this was exceptional. The opposite leg was always completely paralysed, and gave no sign of voluntary motion, although after a time "associated movements" returned. The animal would at once look round if the foot were touched ever so lightly with a straw, although it would usually not remove a clip. After a variable period a second operation was performed upon the same region. In this the cut was extended more deeply, so as to sever as much as possible of the gyrus fornicatus; which was in some cases removed, in others left *in situ*, but with its coronal fibres cut. *In every case no perceptible effect was produced* by this second operation. The amount of actual severance of the fibres of the gyrus fornicatus varied, but in two it was considerable; and since in none of these cases could any anæsthetic effect of such severance be detected, it must be admitted that the result militates against the view that the gyrus fornicatus is the centre for tactile sensibillty. The result is also fatal to the view which has been taken of the experiments on the gyrus fornicatus by H. Munk, and accepted by Mott, that the anæsthesia found was due to injury of the adjacent motor region. For in the experiments here described, the adjacent motor region was not only injured, but actually removed, without the production of any anæsthesia, although the lower limb was completely paralysed.

Dr. G. Mann (Oxford) gave a paper on higher and lower centres in the mammalian cerebrum.

Prof. A. Vitzou (Bucarest) reported recovery of sight in monkeys after total ablation of the occipital lobes. The blindness produced by the operation was only temporary, although at first complete. The chief evidence that the animals see is their power to avoid obstacles. The removal of the angular gyri renders the blindness longer persistent.

Drs. Moore and Reynolds (London) have examined the rate of transmission of nerve-impulses through the spinal ganglia. They find no appreciable delay caused by the interposed nerve-cell.

Prof. Verworn (Jena) addressed the meeting on the subject of so-called hypnosis in animals. Tonic contraction of muscles was, he maintained, the most characteristic symptom of the condition.

Dr. Wybauw (Brussels) found that continued perfusion of the heart with normal saline destroyed the inhibitory effect of the vagus.

Prof. Boyce and Dr. Warrington (Liverpool) gave an illustrated summary of the physiological structure of the brain of the fowl. Certain tracts degenerate from the pallium into underlying parts, namely, into the thalamencephalon and mesencephalon. The anterior commissure degenerates severely after removal of one hemisphere. Fibres arise from the thalamic nuclei and form a commissure comparable with Gudderi's commissure. From the mesencephalon an ascending tract was traced to near the junction of optic thalamus with corp. striatum, and descending tracts into the ventral and lateral columns of the spinal cord. In the cord itself ascending tracts can be distinguished traceable into cerebellum and into the upper part of the cord, and descending in the ventral and lateral regions of the cord. Ferrier's results on excitation of the surface of hemisphere were confirmed.

Prof. v. Frey (Zürich) communicated the results of his work on the adequate stimulation of touch nerves. The intensity of the just noticeable stimulus depends upon the size of tactual surface; the pressure that has to be applied per unit of surface is greater the larger the continuous area of surface simultaneously tested. It is not the pressure *per se* which determines the stimulation, but the difference of pressure obtaining from point to point within the skin.

Profs. Langlois and Richet (Paris) gave an account of observations upon the resistance of diving animals to asphyxia. A hen dies after one minute's immersion, but a duck does not suffer from an immersion of even fifteen minutes. A duck with occluded trachea shows asphyxia in four minutes if left in the air; if plunged in water at 20° C. it shows asphyxia only after a quarter of an hour. After paralysis of the vagus by atropine, plunging does not delay the asphyxia. The plunging in water appears to reflexly restrain the respiratory combustions.

Prof. Lanlainé (Toulouse) brought forward experiments which show that in all cases and under all conditions the heat produced by an animal is equal to the heat calculated from the oxygen consumed by the animal in the time of the experiment.

Dr. R. Magnus (Heidelberg) reported an investigation upon the reaction of the pupil of the isolated eel's eye under various homogeneous lights. A Rowland's grating spectrum was used. The two isolated eye-balls from the same eel, the pupils of which under similar conditions are of similar size, were exposed for twenty minutes, and then photographed by a flash-light. The curve of the intensity of reaction agrees with the absorption curve of the eel's rod-purple. This argues against an effect being produced upon the contractile tissue of iris mediately through its yellow-brown pigment.

Prof. Delezenne (Montpellier) answered the question whether the congestion of the limbs and skin produced in asphyxia is due to the active dilatation of the blood-vessels of those parts or mechanical dilatation by the blood driven out of the viscera by the asphyxial contraction of the visceral blood-vessels. The femoral vessels of a limb severed, with the exception of its nerves, from the rest of the animal are connected with the circulation of a second animal. Asphyxia, excitation of sensory nerves, &c., still produce under those circumstances increase in the volume of the limb and rise of its temperature.

Dr. O. Grünbaum (Cambridge), showed experiments demonstrating the impermeability of the salivary glands to molecules above a certain weight.

Prof. Bédart (Lille) read a paper on production oı mammary secretion by cutaneous Franklinisation.

Dr. D. Noël Paton (Edinburgh) contributed a communication upon the distribution of nitrogen and of sulphur in the urine of the dog. In the course of an investigation on the influence of diphtheria toxin on metabolism it was found that the increase in ammonia nitrogen observed in febrile conditions in the human subject is absent. It was further found that the increase in the excretion of nitrogen was out of proportion to the increase in the excretion of SO_3 of sulphates. It was then proved that the neutral sulphur of the urine is increased, and that thus the total sulphur excretion is proportionate to the excretion of nitrogen. This absence of increase in the sulphuric acid production seems to explain the absence of increase in the formation of ammonia in the dog.

Dr. J. S. Haldane, F.R.S. (Oxford), showed his method of liberating and estimating the amount of oxygen in the blood by means of potassium ferricyanide.

Dr. Arthur Biedl (Privat-docent, Vienna) demonstrated that the blocking of the thoracic duct, or the removal of the lymph from it by a cannula, produces a glycosuria, even in fasting animals. This glycosuria can be set aside by the injection of lymph serum into the veins. Pancreatic diabetes is increased, not removed, by ligating the thoracic duct.

Prof. Denys (Louvain) brought forward experiments towards distinguishing distinct species among the leucocytes of mammals. Myelocytes ground up in serum warmed to 60° communicate to the serum an extraordinary bactericidal power. Lymphocytes, on the other hand, yield no bactericidal substance.

Prof. Graham Lusk (Newhaven, U.S.A.) pointed out that administration of phlorhizin to starving dogs produces elimination of the systemic sugars through the urine, and thereafter dextrose appears in the urine in the constant average ratio as regards nitrogen of 3·75 : 1. This removal of sugar is accompanied by a rise in proteid metalbolism as high even as 560 per cent. Such a rise has only been noted in phosphorus poisoning. The question arises, is not the high proteid metabolism due in both cases to the same cause—the non-burning of the carbohydrates? In the case of diabetes the sugar is removed, in the other perhaps converted into fat. If this be true, and if phosphorus be given in phlorhizin diabetes, then perhaps the urinary sugar might decrease in quantity, because the proteid sugar is being converted into fat. Experiment shows that this diminution does not take place.

Prof. G. Burch (Oxford) gave a communication on temporary colour-blindness produced by exposing the eye to sunlight in the focus of a burning glass, behind a transparent screen. After fatigue by red light, the spectrum appears green, blue, and violet, the green beginning in the part that usually appears orange. After green light, the spectrum consists of red, blue, and violet, the red meeting the blue near the *b* lines. After blue light, the spectrum consists of red, green, and violet, the green meeting the violet between the F and G lines. After violet light between H and K the spectrum consists of red, green, and blue only, the blue ending midway between G and H. After orange light from D the spectrum consists of two colours only, viz. blue and violet, the blue beginning at the *b* lines. After indigo light, the spectrum consists of two colours only, namely red and green, the green ending a little beyond F. After purple light, or after indigo light followed by red light, the spectrum consists of green only, from about D to F. After indigo light followed by green light, the spectrum consists of red only, and is visible from A to about the *b* lines.

Dr. René du Bois-Reymond (Berlin) communicated for Prof. N. Zuntz an account of the construction and performances of a new ergometer. of which a working model was exhibited.

Prof. A. B. Macallum (Toronto) communicated for Dr. F. H. Scott (Toronto) some points in the micro-chemistry of nerve-cells. The Nissl granules are found to contain "organic" phosphorus as well as "masked" iron; they, therefore, probably consist in part at least of something which, like nuclear chromatin, is an iron-holding nucleo-proteid.

Communications were also brought forward by Prof. Allen, Dr. Atwater, Dr. Cohnheim, Prof. Floresco, Dr. Johansson, Miss Huie, Dr. S. Fränkel, Dr. Barnard, Prof. Bohr, Dr. Lauder Brunton, and others.

On Thursday, August 25, the honorary degree of D.Sc. was conferred upon Prof. Bowditch (Harvard), Prof. Golgi (Pavia), Prof. Kronecker (Bern), Prof. Kühne (Heidelberg), and Prof. Marey (Paris). The speeches delivered by the Public Orator in the Senate House on the occasion have already appeared in NATURE (p. 428).

Among the members of the congress not actually contributing communications were the following:—Prof. Fredericq (Liège), Dr. L. Querton (Brussels), Dr. J. H. Cameron (Toronto), Prof. Gordon (Toronto), Profs. Sandwith and Wilson (Cairo), Prof. Dastre (Paris), Prof. Doyon (Lyon), Prof. Dubois (Lyon), Prof. Jolyet (Bordeaux), Prof. Lambert (Nancy), Prof. Lortet (Lyon), Prof. Morat (Lyon), Dr. L. Olivier (Paris), Prof. Weiss (Paris), Prof. Edinger (Frankfort), Prof. Garten (Leipzig), Prof. Jaffé (Königsberg), Prof. Kühne (Heidelberg), Dr. K. Mays (Heidelberg), Prof. Hans Meyer (Marburg), Dr. V. Uexküll (Heidelberg), Dr. Anderson (Cambridge), Dr. Brodie (London), Dr. Edkins (London), Dr. Elliot Smith (Cambridge), Dr. Ewart (London), Prof. Gamgee, F.R.S. (Lausanne), Dr. Garrod (London), Dr. Gaskell, F.R.S. (Cambridge), Miss Greenwood (Cambridge), Dr. Head (London), Dr. Leonard Hill (London), Dr. W. Hunter (London), Prof. Kanthack (Cambridge), Prof. Leech (Manchester), Dr. Pembrey (London), Prof. Ringer. F.R.S. (London), Dr. Shore (Cambridge), Prof. Stirling (Man, chester), Prof. Stockman (Glasgow), Prof. Einthoven (Leyden)- Prof. Stokvis (Amsterdam), Dr. Hankin (Agra), Prof. Purse, (Dublin), Dr. Treves (Turin), Prof. Amaya (Tokio), Profr Mislawski (Kasan), Prof. Wedenskii (St. Petersburg), Prof. Oehrwall (Upsala), Prof. Kocher (Bern), Prof. Prévos. (Geneva), Prof. Metzner (Basle), Prof. Sahli (Bern), Drt Billings (New York), Prof. Lombard (Ann Arbor, Michigan). Dr. E. Dupuy (Paris), Prof. H. C. Wood (Philadelphia), Prof. Wilson (Cairo), Prof. Fano (Florence), Prof. Peters (Toronto), and Prof. Golgi (Pavia).

NOTES.

THE recent meeting of the American Association at Boston was one of the largest and most successful in the history of the Association, the attendance numbering nearly one thousand members, representing almost every State in the Union. More than four hundred papers were read and discussed in the various sections, and a large proportion of them were of a very high order. The address of the retiring president, upon some points in theoretical chemistry, was referred to in last week's NATURE. Prof. Putnam, the new president, also delivered an address, and the following addresses were given by the sectional presidents:—Section A (Mathematics and Astronomy), development of astronomical photography, Prof. E. E. Barnard. Section B (Physics), on the perception of light and colour, Prof. F. P. Whitman. Section C (Chemistry), the electric current in organic chemistry, Prof. Smith. Section E (Geology and Geography), glacial geology in America, Prof. H. L. Fairchild. Section F (Zoology), a half-century of evolution with special reference to the effects of geological changes on animal life, Prof. A. S. Packard. Section G (Botany), the conception of species as affected by recent investigations on fungi, Prof. W. G. Farlow. Section H (Anthropology), the advance of psychology, Prof. Cattell. Section I (Economic Science and Statistics), the historic method in economics, Mr. Archibald Blue. The following officers were elected for the ensuing year:—President: Mr. Edward Orton, President of

Ohio State University. General Secretary: Prof. F. Bedell. Secretary of the Council: Mr. Charles Baskerville. Treasurer: Prof. R. S. Woodward. Vice-Presidents: Section A, Prof. Alexander MacFarlane; Section B, Prof. Elihu Thomson; Section C, Prof. F. P. Venable; Section D, Prof. Storm Bull; Section E, Mr. J. F. Whiteaves; Section F, Prof. Simon H. Gage; Section G, Prof. Charles R. Barnes; Section H, Mr. Thomas Wilson; Section I, Mr. Marcus Benjamin. Next year's meeting will be held at Columbus, Ohio.

THE tenth Congress of Russian Naturalists and Physicians was opened at Kieff on September 3, with an attendance of nearly 1500 members, under the presidency of Prof. N. A. Bunge. The presidents of the different sections were the following professors: Mathematics, V. P. Ermakoff; sub-sections of Mechanics, G. K. Susloff; Astronomy, M. T. H. Khandrikoff; Physics, N. N. Schiller; sub-section of Aeronautics, N. E. Zhukovsky; Chemistry, N. A. Bunge; Mineralogy and Geology, K. M. Feofilaktoff; Botany, O. K. Baranetsky; Zoology, N. V. Bobretsky; Anatomy, Physiology, and Medical Science, M. A. Tikhomiroff; Geography and Anthropology, V. B. Antonovich; Agriculture, S. M. Bogdanoff; and Hygiene, V. D. Orloff. Two papers were read at the first general meeting: one by Prof. Bugaeff, on the philosophical purports of mathematics; and the other by Prof. Mendeléeff, on the oscillations of the balance.

PROF. KOCH, accompanied by several assistants, has gone to Italy for the purpose of continuing his researches on malaria. The Italian university laboratories have been placed at his disposal by the Government, which will do everything to facilitate his work. On leaving Italy he will proceed to Greece. This first journey will be of a preliminary character, and will be finished within three months. Afterwards he will visit the fever districts in East Africa, India, and New Guinea, and will be absent there for about two years. The expenses of the expedition will be defrayed by the German Government. Colonial medical officers before going to the tropics will attend courses of instruction at the Institute for Infectious Diseases, in order to be trained in the diagnosis and treatment of tropical diseases under the special supervision of Prof. Koch and his assistants.

PROF. EDWARD S. MORSE has been decorated by the Emperor of Japan with the Order of the Third Class of the Rising Sun. The Order was accompanied by a diploma, the translation of which is as follows:—"His Majesty, the Emperor, has graciously been pleased to confer upon you this Order in recognition of your signal service while you were in the faculty of science in the Imperial University in Tokio, and also in opening in our country the way for zoological, ethnological, and anthropological science, and in establishing the institutions for the same."

ACCORDING to *Science*, the New York Fisheries, Game and Forest Commission proposes to purchase about 50,000 acres of land in the Catskills. The State already owns some 56,212 acres. The Commission reports that deer are rapidly increasing in the Catskills, it being estimated that the forty-four animals turned loose about a year ago have increased to 150, and that there will be between 400 and 500 at the expiration of the five-year period during which their killing is prohibited.

THE *British Medical Journal* states that the second Anatomical Institute of the Berlin University has been reorganised, and is in future to be called the "Anatomical-Biological Institute." As will have been gathered from the name, the Institute will be devoted to work on the borderland of anatomy and physiology. It has three departments—one for histological-biological research, one for embryological-biological work, and one for comparative anatomy.

THE twenty-fifth Congress of the German Society of Public Hygiene is at the present time being held in Cologne. Among the subjects announced for discussion are Imperial legislation on the measures necessary for combating diseases dangerous to the community, public hygiene in railway traffic, and regular supervision of private living houses, and its organisation on the part of the authorities.

THE Indiana (U.S.A.) State Board of Health has officially recommended cremation.

A BRONZE statue is to be erected in Philadelphia in memory of the late Dr. William Pepper.

THE Department of Science and Art has received information, through the Foreign Office, that a horticultural exhibition will be held at St. Petersburg in May 1899.

A COMMITTEE, consisting of Prof. Pickering, President Mendenhall and Prof. Woodward, has been appointed by the Council of the American Association "to increase the efficiency of the Naval Observatory."

PROF. LAWRENCE BRUNER, of the University of Nebraska, is making experiments to determine the methods that might be used to spread among American native species a locust disease studied by him in South Africa last year.

NEWS of a late cuckoo has been received from Mrs. E. Hubbard, Kew. On Thursday, September 1, at 6 a.m., and again on Saturday, September 3, at an earlier hour, Mrs. Hubbard states that she heard a cuckoo repeating his summer call several times. But she did not see the cuckoo.

FOR a long time the Franklin Institute have been publishing the announcement that the Boyden premium of one thousand dollars would be awarded to "any resident of North America who shall determine by experiment whether all rays of light, and other physical rays, are or are not transmitted with the same velocity." The problem has now been more specifically defined by the Board of Managers, as follows:—"Whether or not all rays in the spectrum known at the time the offer was made, namely, March 23, 1859, and comprised between the lowest frequency known thermal rays in the infra-red, and the highest frequency known rays in the ultra-violet, which, in the opinion of the Committee, lie between the approximate frequencies of 2×10^{14} double vibrations per second in the infra-red, and 8×10^{14} in the ultra-violet, travel through free space with the same velocity."

AT the recent meeting of the French Association for the Advancement of Science, the Section of Hygiene, at the suggestion of M. Nicolas, passed a resolution pointing out that the conveyance of tuberculosis by inhalation is only one of the modes of infection, and that a larger part in the diffusion of the disease is played by contagion through the alimentary canal, as proved experimentally and clinically, and urging the necessity of taking adequate measures to ensure the sterilisation and harmlessness of articles of food. The Section expressed the opinion that it is desirable in addition to take measures to suppress, or at least diminish, the causes of weakening of the constitution which make it fall an easy prey to the disease—overstrain, confined air, overcrowding, and unhealthiness of dwellings. In every dwelling a sufficient cubic space should be allowed in proportion to the number of the inmates, and all apartments must be freely ventilated and exposed to the sunlight; it is also necessary that low-built houses should be furnished with large courts to ensure perfect aëration. In this respect the English cottage system represents the ideal which should be aimed at. The Section further urged that the widest possible publicity should be given to the modern doctrines as to the contagious nature of tuberculosis and its prophylaxis; this should be done by means of public lectures, and also by the moral influence which medical men can exercise in their own sphere. The curability of the disease should also be strongly insisted upon.

THE occasions on which an original subscriber's copy of the complete set of John Gould's ornithological works comes under the hammer are exceedingly rare. Last week, however, says the *Athenæum*, such a series occurred at the sale of the library of the late Edmund Coulthurst, of Streatham Lodge, Lower Streatham. Of the forty-four volumes, thirty-six were bound in green morocco and the remainder were in parts. The series comprised the following: "Birds of Australia," and supplement; "Birds of Europe," "Birds of Great Britain," "Mammals of Australia," "Trochilidæ," or humming-birds, with supplement; "Birds of the Himalayan Mountains," monographs of the Odontophorinæ, or partridges of America; of the Ramphastidæ, or family of toucans; of the Trogonidæ, or family of trogons; and of the Macropodidæ, or kangaroos; "Birds of Asia," and the "Birds of New Guinea." The prices of all these works at auction vary from time to time, but during the past two or three seasons a set of ordinary copies (that is to say, not of the original subscribers' edition) have realised an aggregate of rather more than 373*l*. The published price of a set, including second editions, is now about 670*l*. Mr. Coulthurst's very fine set realised the total amount of 430*l*.

WE learn from *Literature* that a remarkable discovery has recently been made in Dumbartonshire on the shores of the river Clyde—viz. an undoubted crannog, or dwelling on piles. It is about a mile east of Dumbarton Castle, is below high-water mark, and about fifty yards from the river at low tide. The circumference of the crannog is 184 feet. The outer circle is composed of piles of oak, sharpened by stone axes at the lower end, and below the mud still quite fresh. The transverse beams and pavements are of wood—willow, elder and oak, the smaller branches of fir, birch and hazel, with bracken, moss and chips. The refuse-mound extends about twelve feet outside, and in this have been found the bones of stags, cows, sheep, &c., together with evidences of fire, also numerous fire-stones, and a hone or whet-stone. Near the causeway a canoe, 37 feet long and 48 inches beam, was found, hollowed out of a single oak tree. The credit of the discovery is due to Mr. W. A. Donnelly, a local antiquary. It is a unique discovery, because this is the first example of a crannog situated on tidal waters, and because only flint and bone implements have yet been discovered, which dates it back into the Neolithic Age.

THE Deutsche Seewarte has published a sixteenth large quarto volume (xxvi + 193 pp.) containing the results of meteorological observations of German and Dutch ships for one-degree squares of the North Atlantic Ocean. The present volume embraces the area known as the ten-degree square, No. 115, and includes in a tabular form all the observations collected for a number of years between latitude 30°–40° N. and 60°–70° W. In this case the whole of the observations were made on German ships, as there were no Dutch vessels in the district. The form adopted is very convenient, as other countries can, if they choose, add their own observations to those now given, and thus enhance the value of the results. This important work forms part of a regular plan, in which the Seewarte undertook to discuss that part of the North Atlantic lying between latitude 50° and 20°, for each month of the year. It adjoins the district of the nine tropical ten-degree squares lying between latitude 20° N. and 10° S., and longitude 10° and 40° W., the discussion of which was undertaken by the Meteorological Council and published in the year 1876. The data afford trustworthy information for captains of vessels navigating that ocean, and for those persons dealing with the physical geography of the sea.

AN interesting note on the introduction of aluminium into India, as a substitute for copper and brass in the manufacture of cooking pots and other utensils, appears in *Engineering*. The initiative in the matter appears to have been taken by Prof. Chatterton, of the Madras University, who, in November last, took with him from England a small quantity of aluminium, and commenced experiments with it at the metal-working classes of the School of Arts, Madras, of which he has the direction. A little later a small factory was equipped, and the products were so favourably received that the output in the course of five months amounted to considerably over a ton per month. This result is somewhat surprising, in view of the intense conservatism of the Indian peoples. Nevertheless, this latter feeling, though it has not resented very actively a change of material, is still strongly displayed, in so far as the forms and finish of these cooking vessels are concerned. The shapes of the new vessel must, to be acceptable, be exactly the same as the old; and the matter is somewhat complicated, as these traditional shapes differ in every district. Further, the vessels must be all hand-made, as drawn or spun work is disliked, in spite of its greater cheapness. An attempt to meet the native wishes in this matter, whilst at the same time reducing the cost of the utensils, is now being made. A drawing press is used to accomplish the initial stages of the work, which is then finished by hand. Some of the Indian workmen are said to be now very skilful in the use of the new material, and efforts are being made to establish similar factories elsewhere.

THE *Lancet* gives the following particulars of the United States steamship, the *Protector*, which, it is stated, is the first vessel in the world to be equipped solely for the purpose of disinfection. On the deck of the vessel, which is about 80 feet long, is a structure fitted for bathrooms. It is intended that soldiers shall come on board, take a bath, and give up their clothing, receiving new clothes in exchange. The old clothing will then be taken below, thoroughly sterilised, and then returned to the owner. In the bow of the boat are a sulphur furnace, combustion chambers, and a fan for disinfecting vessels. In the middle are a sterilising chamber and a formaldehyde generator. A boiler and a water-heater are near the stern. The sulphur furnace will be used for disinfecting vessels. The hatches of the vessel to be treated will be battened down, and piping carried from the *Protector* to the hold of the vessel. Through this tubing sulphur fumes will be pumped by the fan in the *Protector*. Air is drawn into and through the sulphur furnace, baffle-plates being so placed as to thoroughly mix air and sulphur fumes, a fairly perfect combustion being thus obtained. The sterilising apparatus consists of a cylinder, a chamber, and an exhauster. The chamber is of iron, and though open at both ends it can be hermetically sealed. The exhauster consists of a steam-jet for removing air from the chamber. The generator is a copper cylinder divided vertically into two parts, a steam coil being placed in each part. The clothes to be sterilised are placed in the chamber, the air in which is removed by means of the steam-jet exhauster. Formaline is placed in part of the generator and steam admitted to the coil, and when sufficient heat has been thus applied to generate the required amount of formaldehyde gas the gas is admitted to the chamber. At the end of half an hour ammonia, placed in the other part of the generator and similarly heated, is admitted to the chamber. This neutralises the formaldehyde, and the clothes are removed and returned to the owners.

FROM Prof. Augusto Righi we have received a reprint of his description of a new apparatus for representing the resultant of two pendulum oscillations in the same straight line. One of the two pendulums used consists of a leaden ring containing a cup filled with white sand, suspended by cords, and the length of this pendulum can be altered by raising or lowering a sliding piece. The second pendulum carries a table on which a piece of black paper is slowly drawn by clockwork in a direction perpendicular to the plane of vibration, and the sand escaping from a hole in the cup of the upper pendulum traces out the vibration curves on the paper, the thickness of the line of sand being greatest where the motion is slowest and *vice versa.* By an electric arrangement the two pendulums can be started with any required difference of phase. The use of sand is not very convenient if the drawings are to be preserved, but they can be photographed, and the figures given by Prof. Righi show distinctly the variations of thickness of the sand with the speed. Prof. Righi's paper forms the subject of a communication to the Bologna Academy of Sciences.

OUR present knowledge of the theory of errors receives an interesting addition at the hands of M. Charles Lagrange in the form of a contribution to the *Bulletin de l'Académie royale de Belgique* (vol. xxxv. part 6). Without going into details of a purely mathematical nature, certain of M. Lagrange's conclusions appear sufficiently important to be worth noticing. In taking the arithmetic mean of a number of observations as the most probable value of the observed quantity, common sense suggests that any observations differing very widely from the rest should be left out of count as being purely accidental, and thus likely to vitiate the result. But as it is impossible to draw the line from theoretical considerations between values retained and values omitted, any such omission would necessarily be unjustifiable. This discrepancy between theory and common sense is, to a large extent, reconciled by M. Lagrange's "theory of recurring means." According to this theory, the *weight* to be assigned to any observation is inversely proportional to the square of the error of the observed value relative to the most probable value. Taking, then, the arithmetic mean of a number of observations as a first approximation to the most probable value, the errors relative to this mean determine the weights of the various observations. The weighted mean is then taken as a second approximation to the most probable value. This mean determines a fresh series of weights to be assigned to the observations by which a new weighted mean—the third approximation to the most probable value—is found, and so on to any required degree of approximation. These successive means are called by M. Lagrange "recurring means," and by their use the effects of sporadic errors are, to all practical purposes, eliminated, since the weight assigned to the corresponding observations soon becomes relatively small.

IN the latter half of 1895, a new fish hatchery, under the direction of the United States Fish Commission, was established at a small place called Ten Pound Island in Massachusetts Bay, and in the autumn of 1897 there were hatched and "planted" in the waters of the bay over 60,000,000 small cod fry. At the end of the year some 30,000,000 eggs were still in process of hatching. The number of eggs successfully hatched is much greater in the early than in the latter half of the season, when only 54 per cent. of the eggs are successfully hatched in proportion to the first half. From the *Journal* of the Society of Arts, we learn that Sir D. Colnaghi, H.M. Consul at Boston, says that men proficient in stripping a codfish of its spawn are put on board the shore fishing boats which land their catch at Kittery, Maine, in the proportion of one man to each boat. As the fish are taken alive from the water, they are inspected and, if suitable for the purpose, are stripped of their eggs, which are placed in jars and forwarded to Gloucester, Massachusetts. More or less, the eggs are injured in transit, but it has been, on the whole, advantageous to forward them to Ten Pound Island, where good results in hatching have been obtained. Nature is followed as far as possible in the hatching process, the eggs being placed in perforated boxes and sea water direct from the ocean being continuously pumped through the boxes, so that the temperature may be as nearly as possible the same as that of the ocean. As soon as the eggs are hatched, the small fish are planted or released in the waters of Massachusetts Bay and have to rely on themselves, the same as the fry spawned in the open ocean. Ipswich Bay, Massachusetts, and the contiguous waters appear to be a favourite spawning ground for codfish, and the artificially-hatched fry, therefore, mingle with the many others of their kind and take the same chances in the struggle for existence. There are, of course, no data on which to base any calculation as to the percentage of artificially-hatched fry which reach maturity, but the officers of the Fish Commission claim that the fish released by them are hardier in proportion, the weaker ones having been sifted and the stronger alone planted. As regards the success of the hatchery, it is proved that since the Fish Commission commenced operations the supply has certainly increased. Some years ago so few codfish were taken by the shore fishermen, that the fishery had become unremunerative, but at the present time fish are fairly abundant, and the fishery gives employment to a good number of men, who themselves admit that the hatchery operations have been successful. After the codfish season is over, the officials turn their attention to lobster hatching, and the same operations are gone through as with the codfish.

A NUMBER of interesting facts concerning illuminated buoys are brought together in an article in the *Times* of September 6. From this description it appears that Mr. J. Pintsch was the first to successfully construct a buoy to show a light at night. The light is produced by gas, which is stored in a compressed state in the body of the buoy, and passed up to the burner through a small pipe controlled by an ingenious automatic regulator which causes the gas to be emitted at a low and uniform pressure. Stored up in the buoy in a compressed state—the pressure being equivalent to that of about five atmospheres—and passing out very slowly, the gas will last some two or three months burning always by day and by night. Coal gas cannot be used for this purpose because compression robs it of more than half of its illuminating power, while in the case of oil gas the loss is so slight that it is practically immaterial. The light itself is surrounded by a small lenticular arrangement intended to enhance the illuminating power, enclosed in a glass lantern fixed about eight or ten feet above the sea level, and in clear weather is visible five miles. At first it was found desirable to use only a fixed light, but more recent experience has shown that it is possible by suitable mechanism to show a quick flashing light and an occulting light, these variations being extended by the use of coloured glass.

RECOGNISING the great value to navigation of lighted buoys which could be depended upon, the Elder Brethren of the Trinity House (we learn from the article referred to in the foregoing note) have done much to encourage the development of the system in this country by placing gas-lighted buoys at many important points in the channels at the entrances of the Thames, in the Solent, and elsewhere. These guides to navigation have also been established by the Scottish Lighthouse Board, the local authorities for the Mersey, the Clyde, the Tees, the Ribble, King's Lynn, and sundry other seaports, and now on the coasts of the United Kingdom there are close upon one hundred gas-lighted buoys in position. In the Suez Canal, in Canadian and Australian waters, these buoys are in use. In America, also, a considerable number are employed; but the United States Lighthouse Board has, also, some electrically-lighted buoys in Gedney's Channel approach to New York. These buoys are connected to each other and with the shore by submarine cables, through which the electricity, generated on shore, is transmitted to the buoys. In France the lighting of buoys by means of gas has been largely adopted of late years, the lighthouse authorities of that country having taken up the matter with their usual vigour, and placed such buoys in many parts of their coasts. In Germany, Denmark, Russia, Holland, and Italy numerous gas-lighted buoys have replaced unlighted ones, and, in fact, the system is coming into use in all parts of the world. It may truly be said that the development of this system of illuminated buoys is the most important improvement in our coast-marking arrangements that has taken place in the last five and twenty years.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♀) from South Africa, two Egyptian Geese (*Chenalopex ægyptiacus*) from Africa, presented by Mr. J. E. Matcham; eleven Long-eared Bats (*Plecotus auritus*), European, presented by Mr. F. Cane; a Stanley Chevrotain (*Tragulus stanleyanus*, ♂) from Java, presented by Miss Norah F. L. Briggs; two Hawk-billed Turtles (*Chelone imbricata*) from the West Indies, presented by Mr. H. Skinner; a Leopard (*Felis pardus*) from Japan, a Kinkajou (*Cercoleptes caudivolvulus*, ♂), two Spotted Cavies (*Cœlogenys paca*), a Ring-tailed Coati (*Nasua rufa*), a Plumbeous Snake (*Oxyrhopus clœlia*) from South America, a Punctated Agouti (*Dasyprocta punctata*), six Spiny-tailed Iguanas (*Ctenosaura acanthura*) from Central America, a Festive Amazon (*Chrysotis festiva*) from Guiana, a Nose-horned Viper (*Bitis nasicornis*) from West Africa, deposited; a Kinkajou (*Cercoleptes caudivolvulus*) from South America, purchased.

OUR ASTRONOMICAL COLUMN.

COMET TEMPEL 1866?—A telegram from Kiel, dated September 14, tells us that Herr Pechuele discovered a comet on September 13, 15h. 47·5m., at Copenhagen, having R.A. 6h. 10m. 8s. and Dec. + 8° 55′ 40″. This, as the telegram informs us, is probably Tempel's comet of 1866.

THE VARIATION OF LATITUDE AT TOKYO.—In the *Publications of the Earthquake Investigation Committee* (Nos. I. and II.), Mr. H. Kimura gives a preliminary report of his investigation of the variation of latitude at the place of observation, namely Tokyo. The first series of observations extended from July 21, 1895, to June 26, 1896, and the second from September 13, 1896, to September 25, 1897. The instrument employed was a Wanschaff's zenith telescope of 81 mm. aperture and 100 cm. focal length, and Talcott's method of observation was used. The climatic conditions at the station were not always quite favourable, but generally the weather was dry and clear in winter, and misty and cloudy in summer. Mr. Kimura, besides giving the means and monthly means of observations, describes graphically the variation as observed by him. In 1895 the maximum occurred towards the end of November, and amounted to about 16″·835, the following minimum being reached about the end of June 1896. As a break occurred in the observations at this period, the exact time of occurrence cannot be accurately stated, but its amount was 16″·51 approximately. The time of the next maximum cannot be gathered from the curve, as the latter is very flat at maximum; its value is about 16″·865. The following minimum is sharply marked, and occurred about August 12, 1897, amounting to 16″·39.

When the whole subject of the variation of latitude comes to be studied, these observations should be found very useful.

MOTION OF STARS IN THE LINE OF SIGHT.—M. Deslandres contributes to the *Bulletin* of the Astronomical Society of France (September) a short article on the photography of the motion of stars in the line of sight by means of the spectroscope, and accompanies it by some excellent phototypes from four of his valuable negatives. Each stellar spectrum is compared with the spectrum of some terrestrial substance. Thus Capella, a solar star, is compared chiefly with iron, calcium, manganese, &c., its radial velocity being deduced as +43·8 kilometres per second. The velocities of the components of β Aurigæ were found to be −84·5 and +97 kilometres per second; while Sirius and γ Pegasi were observed to have velocities of +18·33 and −2·78 kilometres per second respectively.

M. Deslandres remarks that the observatories of Paris, Potsdam, and Pulkova are the only ones that are organised in a proper manner for this kind of work; but the time will come when these stellar motions will be determined with the regularity of meridian observations at the present time.

THE AUGUST METEORS.—The fall of meteors in August was greater than was anticipated, and was fortunately observed at a number of stations. In the *Bulletin de la Société Astronomique de France* for September will be found several accounts of the observations made in France, notably those made at the Juvisy Observatory by M. Antoniadi, and at Listrac by M. Henri Pineau. In both of these accounts the observations have been plotted on star charts, and show well the abundance of the Perseids; but, unfortunately, no mention is made of the deduced radiant point, so that we are unable to see whether any variation has occurred from the previously observed positions.

DRAWINGS OF THE MILKY WAY.—We are asked to announce that a limited number of copies of Dr. O. Boeddicker's pictures of the Milky Way, lithographed by Mr. W. H. Wesley, can now be obtained on payment of five shillings a set to defray postage and other expenses. The drawings show the Milky Way from the North Pole to 10° of South Declination, as seen by the unaided eye. They were made by Dr. Boeddicker, at the Earl of Rosse's Observatory, Birr Castle, in the years 1884–89, and are full of delicate detail. Applications for copies should be sent to Mr. R. J. Sheppard, Stationer, Parsonstown, Ireland.

THE AURORA OF SEPTEMBER 9.

THE evening of Friday, September 9, was characterised by an exceedingly brilliant auroral display, which appears to have attracted considerable attention. Immediately after dark, about 7 p.m., the main arc was distinctly seen above the northern horizon, and as the sky gradually became less luminous, numerous streamers of varying brightness made their appearance. At Kensington, where the ground lights were somewhat glaring, the main arc appeared simple, and not made up of several parallel arches, as is often the case with bright auroræ. Its extent would be about 60° in azimuth, the upper limit of the arch being about 20°. This was continuously very bright throughout the evening, and the maximum brightness was very conspicuously "*magnetic*," and not "*geographical*" north. The intensity, number, and extent of the streamers varied considerably, and in no case did any particular streamer persist more than about ten minutes. At one time, about 8 p.m., two large streamers were noticed which extended much beyond the zenith, having a length of about 130°, and frequently the whole northern arc was bounded by radiating glows extending about 40° or 50°. No corona was seen during the display, but several times a set of large streamers, in breaking up, formed masses of luminous auroral clouds which were scattered on the whole celestial hemisphere.

The only colour observed was pale violet, with, perhaps, a tinge of green, but no trace of ruddiness was at any time visible.

The dark patches frequently seen in previous auroræ bounding the northern horizon under the main arc were very distinct, and although resembling ordinary clouds in form, were evidently connected with the disturbance.

Observations with the spectroscope showed the greenish-yellow line with ease, and the spectrum was bright enough to exhibit several bands extending through the green blue and violet, a dark interval at the extreme violet end reminding one forcibly of the carbon band spectrum at this region. Several attempts were made to photograph the spectrum, exposures of thirty minutes, 1½ hours and 2½ hours respectively being given, but no spectrum was visible on development.

Several letters have reached us with reference to recent auroral displays. Mr. D. Pidgeon, writing from Leatherhead, Surrey, says:—"There was a bright aurora here on the 7th, 9th and 10th. The display on the 9th was magnificent, streamer after streamer shooting across the sky from 9 o'clock to 10.30. At a later hour the luminosity became localised in a long low arch, which stretched for many degrees east and west of north. Only stars of the first magnitude could be seen at 10 o'clock in a quite clear sky, the light of which was such as to make reading easy." Mr. W. F. Spear observed the display at Cricklewood, London, on September 9, at 8.15, and he remarks with reference to it:—

"Except in extent and duration, the phenomenon differed in a way from what I have frequently seen on clear cold evenings when wintering in the north of Norway, beyond the Arctic circle." Mr. F. C. Constable observed the display at Fambridge Station, Essex, at 8.45 p.m. on Friday, September 9. He writes:—"I saw two colourless streamers of light running from a point to the west of north up nearly to the zenith—one covered the north star, the other to the west. They disappeared in about a minute. This morning the Fambridge station-master told me that late in the evening of Friday, about the same time, many streamers were seen, and the telegraph would not work, the bells ringing of themselves."

In connection with the recent display it is interesting to note that the unusually large spot which came over the eastern limb of the sun on Saturday, September 3, was on the central meridian of the sun's disc on Friday the 9th, at about the time the aurora was at its maximum. And still further, the automatic recording instrument for magnetic declination in the Physics Department at South Kensington showed a large disturbance the same evening. From the photographic record it appears that the disturbance began about 7.30 p.m., and in 15 minutes reached a value of 30′ of arc; by 8 p.m. the declination was normal again, but immediately afterwards the needle travelled on in the opposite direction to the first displacement, and reached a second maximum eastwards about 8.15. By 8.30 the needle had again assumed its normal position, and no further disturbance, other than the usual diurnal one, has yet been recorded. Thus the declination magnet was deflected over 1° in the hour from 7.30–8.30 p.m. This leaves little doubt as to the definite connection between the position of the spot on the solar disc, the magnetic variation, and the aurora. Confirmation of this observation will be found in the announcement made by Dr. Chree, in our correspondence columns, that a conspicuous magnetic storm was recorded at the Kew Observatory while the aurora was in progress.

In addition to the displays referred to in the foregoing, a very bright aurora was recorded by several observers on the previous Friday evening, September 2, on which night the spot would be coming round the eastern limb, and a search back over the magnetic records for that evening shows that a disturbance was photographed then also. With these two coincidences it will be interesting to see if a third aurora and another magnetic disturbance accompany the passage of this large spot over the western limb, which will be some time during to-day, September 15.

Accounts have been received from several parts of the kingdom of difficulties experienced in the transmission of telegraphic and telephonic messages on Friday last, and this is a well-known sign of considerable magnetic disturbance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AT the New Mexico Agricultural College and Experiment Station, Prof. C. H. T. Townsend has been appointed bio-geographer and systematic entomologist, E. O. Wooten professor of botany, and T. D. A. Cockerell professor of entomology, in addition to being station entomologist.

THE following appointments are announced:—T. Proctor Hall to be professor of physics in Kansas City University; Robert B. Owens, late of the University of Nebraska, to be professor of electrical engineering in McGill University, Montreal; Dr. Mark V. Slingerland, of Cornell University, to be State entomologist for New York, in the place of the late Dr. J. A. Lintner.

DETAILED particulars with regard to the mode of entering the medical profession, the degrees and diplomas granted by the various universities and corporations, and the institutions where medical students are trained, are given in the educational number of the *British Medical Journal* (August 27), and the students' number of the *Lancet* (September 3). These numbers should be seen by all students who are about to commence their medical studies, and by parents who contemplate entering their sons in the medical profession. Information as to schools of pharmacy, medicine, dentistry, and veterinary-surgery will be found in the *Chemist and Druggist* of September 3, and details as to the staff, curriculum, and fees, in universities, colleges, and other institutions, are given in the *Chemical News* of September 2.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, August.—British local meteorological publications. This is a useful list, referring mostly to the year 1897, of books and pamphlets containing observations made in the British Islands, and arranged according to counties. Leaving out of consideration official publications such as issued by the Meteorological Office on the part of the Government, or those emanating from private institutions, such as the Royal and Scottish Meteorological Societies, one is struck by the numerous independent stations at which attention is paid to the subject in question, some of which might advantageously connect themselves with the Central Office. In the majority of counties the Medical Officers of Health publish valuable observations in their reports; in addition to these, we can only refer to a very few of the private organisations which publish observations for a number of stations. For Surrey and Kent, the Croydon Natural History Club prints daily rainfall values for about seventy stations. Similarly, in Hertfordshire, the Natural History Society publishes rainfall values for several stations, and there is also a county organisation in Northampton. In Norfolk, the Rev. Canon Du Port has published monthly rainfall values at about forty stations for more than a quarter of a century. The rainfall of Dorset has been discussed with great care by Mr. H. Storks Eaton, and tabulated results for many stations are published in Gloucester, Hereford, Lincolnshire (fifty stations), Nottingham, Lancashire, and many others.—Results of meteorological observations at Camden-square (N.W. London) for July for forty years, 1858–97. The highest maximum temperature for the period was 94°·6 (July 15, 1881), and the mean of all the highest readings was 85°·2; this year the maximum for the month was 82°·9. The average rainfall is 2·39 inches; the fall for July this year only amounted to 1·09 inches.

Annalen der Physik und Chemie, No. 7.—Questions concerning the motion of translation of the luminiferous ether, by W. Wien. If the ether is immovable, a thin plate possessing different radiating powers for heat rays on its two faces, could put itself into motion by virtue of the difference of pressure on the two faces. It is possible that the ether is carried along by the earth, but not by bodies of small mass.—The behaviour of kathode rays parallel to the electric force, by P. Lenard. When a beam of kathode rays is sent through a perforated condenser in the direction of the lines of electric force, its velocity is retarded, and it is more subject to deflection by a magnetic or electrostatic field.—The dark kathode space, by A. Wehnelt. The resistance of the dark space to electric discharge is considerable. When the discharge proceeds through the dark space only, it has a disruptive character, as if the dark space were a dielectric like paraffin oil. This can be shown by introducing the anode into the dark space itself. Waves proceed from the discharge tube, and may be placed in evidence by means of a coherer.—Microscopic observations of coherers, by L. Arons. The author's coherers were made by cutting a fine line across a thin strip of tinfoil stuck on glass, laying a little metallic powder across it, adding a drop of Canada balsam, and covering with a cover-glass. The newly prepared coherers had an infinite resistance. The impact of electric waves produced full contact, accompanied by a commotion of theparticles and a play of sparks, as seen under the microscope.—Electrolytic solution of platinum and gold, by M. Margules. Platinum may be dissolved in acids or caustic alkalis by sending the secondary current from an induction coil through an electrolytic cell with platinum electrodes. Gold is similarly dissolved, but its solutions are very sensitive to light.—Theoretical derivation of the constant of Dulong and Petit's law, by H. Staigmüller. The derivation is based upon the assumption that the temperature of a solid is determined by the mean kinetic energy of the atom oscillating about a position of equilibrium.

Memoirs of the St. Petersburg Society of Naturalists: Zoology and Physiology, vol. xxviii. No. 2.—Researches into the history of development of Cephalopoda; and biological observations on Lamellibranchiata, the formation of pigment in *Mytilus*, and the autotomy of the syphons in *Solen* and *Solecurtus*, by V. A. Fausseck. A detailed work, 270 pages, with 8 plates and figures in the text.—Vol. xxviii. No. 3. The changes of irritability of a muscle under the influence of a direct current, by Prof. V. A. Kovalevsky (published in *Comptes rendus*).—Ornithological researches in the Government of Pskov, by K. M. Deryughin. Based upon the author's four years' researches and collections, as also upon the collections of Profs. Zarudnyi and Karéeff. The author distinguishes between the fauna of two great lakes, the fields (very poor), and the forest region. Full lists of birds in these three regions are given.—On the wandering cells of the bowels of the Sea-urchins, by Prof. C. Saint-Hilaire. A detailed work of 170 pages, with 2 coloured plates (136 figures). Its important conclusions, especially as regards the clear distinction between the granular cells and the phagocyte cells, and the functions of the former, are fully summed up by the author, in German.

Bulletin de l'Académie des Sciences de St. Pétersbourg, September 1897, tome vii. No. 2.—On Auerbachite and the rock which contains it, by P. Ereméeff (Russian). A closer study of this mineral shows that it cannot be considered as a separate species, or even as a variety or a pseudomorph of well-known minerals.—The Gasteropods of the Baltic Lower Silurian, by Ernst Koken (German). A detailed monograph, with forty-three woodcuts; it is, however, only a preliminary report on the author's larger work upon which he was engaged for the last ten years. Over 200 species are mentioned, and more than one-half of them are new.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 5.—M. Wolf in the chair.—Observations on the planet Witt (1898, August 14), made at the Observatory of Algiers, by M. F. Sy. Positions of the planet are given for August 16, 17 and 18.—Observations on the same planet made at the Observatory of Besançon, by M. Gruey. Measurements of the planet's position on the nights of August 17 to 20, and 25 to 27 are given. The planet is about the eleventh magnitude.—On a silicide of tungsten, by M. E. Vigouroux. A mixture of silicon and oxide of tungsten on heating in the electric furnace gives a crystalline mass containing the new silicide, metallic tungsten, silica, and carbon silicide. The tungsten is first removed by making the ingot the positive pole in a 10 per cent. solution of hydrochloric acid, and passing an electric current. The crystalline residue, after treating successively with *aqua regia*, ammonia, hydrofluoric acid, and methylene iodide is the pure silicide W_2Si_3. The crystals are steel-grey in colour, very heavy (density 10·9), and are attacked by chlorine at a dull red heat.—On *Arkinolemur*, a genus found in the Parana tertiaries, representing a new type of mammifer, by M. Ameghino. An examination of the skull of a small tertiary mammal, found by M. Scalabrini in the neighbourhood of Parana, leads to the conclusion that the form does not correspond with that of any known living or fossil mammal. The shape of the incisors, the separation of the mandibular branches, the widened form of the cranium, the arrangement of the orbits suggest a form allied to the Lemuridæ; but the oblique curve of the intermaxillaries, as well as the general *facies*, appears to show affinities with the bats. Other features, amongst which may be mentioned the complete obliteration of the nasal opening, have not been met with either in mammals or reptiles.—On the anatomical structure of the stem of the beet-root, by M. Georges Fron. The thickening of the stem is produced, not by the formation of generating layers as in the root, but by the displacement of one single generating layer towards the exterior. This layer, at first of normal origin, becomes partly normal and partly pericyclic, and finally completely pericyclic.—On the toxicity of copper salts with regard to the higher vegetables, by M. Henri Coupin. Experiments were made with solutions of various salts of copper (bromide, chloride, sulphate, acetate, and nitrate) upon young wheat plants. All the salts studied had very nearly the same toxic power: a solution of copper sulphate containing only ·0055 per cent. of the salt is sufficient to prevent the germination of wheat, and hence the proposed application of this salt to kill noxious weeds is of very doubtful advantage.—The tufa of the Gaubert (Dordogne), by M. Émile Rivière.

NEW SOUTH WALES.

Linnean Society, July 28.—Mr. Henry Deane, Vice-President, in the chair.—Revision of the Australian *Curculionidæ* belonging to the subfamily *Cryptorhynchides*. Part ii. By Arthur M. Lea. Four new genera are proposed, of which three are founded on species referred by Mr. Pascoe to *Poropterus*; and four genera allied to *Poropterus* are re-described. These comprehend a total of thirty-one species which receive attention, fifteen of them being described as new.—Descriptions of new Mollusca from Victoria. By J. Brazier. Four species referable to the genera *Conus*, *Columbella* (*Mitrella*), *Lucina* (*Codakia*), and *Tellina* (*Strigella*) are described as new. *Hab.*—San Remo.—Notes on some Port Jackson plants. By J. H. Maiden and J. H. Camfield. (*a*) A well-marked variety (*brevistylis*) of *Sprengelia incarnata*, Sm., is described. (*b*) The authors propose to restore *Banksia paludosa*, R.Br. (which had been reduced by Bentham to a variety of *B. integrifolia*) to the rank of a species.—Revision of the genus *Paropsis*. Part iii. By Rev. T. Blackburn. In this paper the author takes in hand the species forming Group vi. of the classification propounded in an earlier paper; and three subgroups are dealt with. In addition to critical remarks and tabulations, descriptions of thirteen new species are given.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Machine Drawing: T. and T. G. Jones, Book 2, Part 1 (J. Heywood).—Durham College of Science, Calendar 1898–99 (A. Reid).—Mathematical Examination Papers: Rev. J. L. Robinson (Rivingtons).—Skertchly's Geology: Dr. J. Monckton, 9th edition (Murby).—The Flora of Donegal: H. C. Hart (Dublin, Sealy).—Photography Annual, 1898 (Iliffe).—Northward over the "Great Ice": R. E. Peary, 2 Vols. (Methuen).—Outlines of the Earth's History: Prof. N. S. Shaler (Heinemann).

PAMPHLETS.—Bourne's Handy Assurance Manual, 1898: W. Schooling (E. Wilson).—Chloroform: Dr. R. Bell (Glasgow, Holmes).—Die Bedentung der Reize, &c.: Dr. A. Goldscheider (Leipzig, Barth).—Studien über die Protoplasmaströmung bei den Characeen: Dr. G. Hormann (Jena, Fischer).—The Secret of the Poles: H. Campion (Birmingham, White).

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CONTENTS.

THURSDAY, SEPTEMBER 22, 1898.

THE FAUNA AND FLORA OF THE PAMIR.

Report on the Natural History Results of the Pamir Boundary Commission. By A. W. Alcock, M.B., Surgeon Naturalist to the Commission. With a List of the Plants, by J. F. Duthie, B.A., F.L.S., and a Notice of the Rock-specimens, by T. H. Holland, A.R.C.S., F.G.S. (Calcutta, 1898.)

FOR this useful addition to our knowledge of the Pamir plateau we are indebted to the enlightened policy of the Government of India, who, in attaching Mr. Alcock as naturalist to the Commission despatched in 1895 to demarcate the boundary between Afghan and Russian territory, followed the course adopted on several previous occasions, as when the late Dr. Stoliczka was sent as naturalist with the Yarkand mission in 1873–74, and when Dr. J. Anderson was added to the two expeditions to Yunnan in 1868 and 1875. The Indian Government have added to the value of the observations made by publishing the results, which comprise a few general remarks on the fauna, flora and geology, and a descriptive list of the specimens obtained.

The Commission left the valley of Kashmir on June 21, and returned to it on October 12, so that the journey occupied less than four months, whilst the time actually spent on the Pamir itself extended only from July 20 to September 16. This, however, is probably the best time in the whole year for zoological and botanical collecting at so high an elevation, and is certainly much better than April and May, when Stoliczka's collections were made in the same region.

The results, as Mr. Alcock points out, appear small, but this must be attributed to the poverty of the fauna and flora, every effort having been "made to get together as complete and representative a collection as possible." Six mammals, 37 birds, 4 fishes, 10 butterflies, and a few miscellaneous invertebrates were obtained, besides 105 phanerogamous and 10 cryptogamous plants. Four more mammals were seen, but no reptile nor batrachian was met with, despite careful search, and although specimens of both were obtained on the journey between Kashmir and the Pamir. All the fishes, except one loach, belong to the curious group of carps (the *Schizothoracinæ* of McClelland), with enlarged imbricate scales at the base of the anal fin. This group appears to be peculiar to Central Asia.

In the list of the animals obtained on the road between Kashmir and the Pamir, a very few forms with Indian affinities occur, for instance, a *Trochalopterum* among the birds, but still the great majority are Palæarctic species; even three earthworms are identified by Mr. Beddard as European. The Pamir fauna and flora show no trace of Indian affinities, but pertain strictly to the Central Asiatic phase of the Palæarctic (or Holarctic) region. At the same time, now that we know the fauna and flora of the Pamir plateau well, their most striking feature is the distinction shown from the animals and plants of Tibet. There is no great difference between the physical features of the two areas; they are both from 12,000 to about 18,000 feet in height (the Tibetan averaging rather the higher, but by not more than 2000 feet), and the two are completely united by the table-land of Western Tibet. Nevertheless very few of the animals or plants are identical, and the few that are appear to be forms of very wide range. Nor is this all, for so far as the mammalia, the best known and most important group, are concerned, the fauna of the bleak, barren plateau of Tibet appears to be considerably more numerous than that of the rather less bleak Pamir, despite the well-known rich pasture lands of the latter. Thus, taking the Ungulates alone, only two species, *Ovis poli*, Marco Polo's sheep, and *Capra sibirica*, the Asiatic ibex, are known from the Pamir; whilst in Tibet, the yak, Tibetan antelope (*Pantholops*), Tibetan gazelle, two if not three wild sheep (*Ovis hodgsoni*, *O. nahura*, and probably *O. vignei*), an ibex, and the kiang (*Equus hemionus*) occur, without taking into account *Budorcas*, two species of *Cervus* and the musk deer, which are found in parts of the plateau. The same difference is found in other mammalia; thus the golden marmot, *Arctomys aureus*, of the Pamir replaces *A. himalayanus* and *A. robustus* of Tibet, and *Lepus tibetanus* to the westward represents the *L. pallipes* and *L. hypsibius* of the great Eastern plateau.

As already stated the two plateaus, the Pamir and Tibet, are continuous, and are not separated from each other by any distinct elevation or depression. The cause of the marked difference in the fauna and flora needs explanation, and may not improbably be connected with the geological history of the two areas. It has been already shown that the specialisation of the Tibetan mammalian fauna probably indicates isolation during the latter portion of the Tertiary era, an isolation which can only be attributed to elevation. Whether it should be inferred that the elevation of the Pamir, which is believed to have been connected with the origin of the Himalayas, is of later geological date than that of Tibet, is a question that must be left to future geological explorers.

The geological observations in the present work are limited to petrological notes, the rocks found having been noted, and specimens brought away, which were examined by Mr. Holland. This proceeding, like the proverbial carrying away of a brick as a sample of a house, though apparently approved by high geological authorities, is extremely unsatisfactory, and it is to Mr. Holland's credit that he has been able to add one interesting fact, at all events, to previous observations. This is that certain rhyolites which are found on the Pamir are precisely the rocks that might be expected as the volcanic representatives of Stoliczka's "Central Gneiss," which Mr. Holland agrees with General McMahon in regarding as intrusive. This "Central Gneiss" forms the axis of the Himalayas and, as Stoliczka showed, it occupies an extensive area on the Pamir. It is curious that no allusion to Dr. Stoliczka's observations on the Pamir is to be found in Mr. Holland's notes.

In conclusion, it may be fairly stated that we are indebted to the Government of India and to Mr. Alcock for a very useful addition to the facts hitherto known as to the distribution of Asiatic animals and plants. Mr. Alcock acknowledges the assistance given by Mr. Finn in determining the birds collected, and by M. de Nicéville for the Lepidoptera. Mr. Duthie, who supplies the list of plants, has adopted the admirable plan of giving under each species a brief note of its range, a most valuable addition in a paper of which the importance is chiefly distributional. The plates consist of photo-etchings well executed in the Survey of India Office, and represent fishes, reptiles and crustaceans, the rock structure of a biotite granite, and a view of an *Ovis poli* skin on a wall of rough stones amongst small orchards. The last is so good a plate, that it is impossible to help regretting that a more congenial background has not been selected.

W. T. B.

SOCIOLOGICAL SCIENCE.

Outlines of Sociology. By Lester F. Ward. Pp. xii + 301. (New York: The Macmillan Company, 1898.)

MR. WARD'S little volume, with its clear thought and trenchant writing on more than one topic of current interest, will be welcomed by all students of sociology. It is a reprint of twelve chapters formerly contributed by the author to the *American Journal of Sociology* during the years 1895 to 1897. In the first six lectures, which bear the general title "Social Philosophy," Mr. Ward discusses the old question of the proper position of sociology in a systematic classification of the sciences. The general philosophical position adopted is that of Comte, but the author very properly restores anthropology and psychology to their lawful position in the scheme of the sciences between biology and sociology, and insists with great force upon the very special dependence of sociological on psychological science. The most interesting feature of this part of the book is Mr. Ward's able criticism of Mr. Herbert Spencer's favourite comparison of society to a huge biological organism. Following the lead of Prof. Huxley, he shows, by irresistible arguments, that it is not the whole biological organism, but only the nervous system which really corresponds to a society, and further, that society in its present state is at best a "very low form of organism."

"The most extreme socialist would shrink from the contemplation of any such absolutism as that exercised by the central ganglion of even the lowest of the recognised Metazoa. In order to find a stage comparable to that occupied by society with respect to the central control of the functions of life, it is necessary to go down among the Protozoa and study those peculiar groups of creatures that live in colonies so adapted, that, while the individuals are free to act as they please within certain limits, they are still imperfectly bound together by protoplasmic threads to such an extent that they are in a measure subordinate to the mass thus combined, and really act as a unit or body."

When conscious co-operation of society, as a whole, for its own welfare supersedes sporadic individual effort, and not before will there be a real parallelism between social institutions and the nervous structure of the higher animals.

In the second part of the book, which is entitled "Social Science," Mr. Ward describes the gradual evolution of such a higher form of social structure. Social institutions at first grow up unconsciously under the pressure of the mere "struggle for existence." As intelligence progresses this stage of mere "genesis" passes into the higher stage, called by Mr. Ward "telesis"; unconscious growth gives place to the deliberate manufacture of institutions by conscious purposive action. Hitherto such conscious creation of social institutions has been the work of a few exceptional individuals, but in a higher stage of evolution we may expect it to take the form of "collective telesis," *i.e.* the deliberate co-operation of the community as an organised whole in the work of social amelioration.

Perhaps the most valuable part of Mr. Ward's book is that in which he discusses the differences between mere unconscious growth and deliberate constructive activity. It has been too much the fashion of sociologists in recent years to argue directly from biological analogies, forgetting that society is at least as much a machine as an organism, and that the presence in all but the lowest stages of social evolution of deliberate human purpose profoundly modifies the whole character of the evolutionary process. As Mr. Ward pithily phrases it, "the environment transforms the animal, but man transforms his environment," a remark which has an obvious bearing upon the application of evolutionary principles to the problems of ethics. Altogether the student who is not content with being told that society "evolves," but wishes to know how specifically social differs from merely biological evolution, will find Mr. Ward's last six chapters singularly luminous and suggestive. The get-up and typography of the book are generally worthy of commendation, but there are some ugly misprints of classical names. A. E. TAYLOR.

OUR BOOK SHELF.

A Text-book of Botany. By Dr. E. Strasburger, Dr. Fritz Noll, Dr. H. Schenck, Dr. A. F. W. Schimper; translated from the German by H. C. Porter, Ph.D. With 594 illustrations, in part coloured. (London: Macmillan and Co., Ltd., 1898.)

THE "Text-book of Botany" issued from the famous institute at Bonn has met with such favour on the part of teachers and students, that it is a matter of surprise that the translation of it into English should have been so long deferred. However it is certain to be extensively used, as the subject is handled from a comprehensive standpoint, and the authors have succeeded in hitting the happy mean between a too elementary and a too advanced treatment.

It is the more to be regretted that, as it was passing through the press, the emendations and corrections which have some time ago appeared in the third German edition were not incorporated in the present volume, which seems based on the first edition in the original language. It is, for example, surprising, and to a student confusing, to find elaborate figures and descriptions of centrospheres in dicotyledonous cells on p. 61, when it is known that the author of this part of the book (Strasburger) has long ago abandoned his belief in their existence, and in the current German text expressly denies their presence in these plants. It may also be doubted whether the book gains at all in value by the somewhat poor coloured illustrations of certain examples of flowering plants, although in this the publishers are but following the original. If, however, they could see their way to reduce the rather high price of the book at the expense of these really useless luxuries, both its own circulation and the temper of the purchaser would improve. For it is not a little remarkable to find a work which in Germany can be bought for 7 marks, costing in its English dress 18*s*. The book is intrinsically so good that it is to be hoped that a more moderate price will place it within the means of many students who at present will certainly be debarred from possessing it, save through the intermediation of the second-hand bookseller.

Automobiles sur Rails. By G. Dumont. Pp. 184. (Paris: Gauthier-Villars et Fils. Masson et Cie.)

Régularisation du Mouvement dans les Machines. By L. Lecornu. Pp. 217. (Paris: Gauthier-Villars et Fils. Masson et Cie.)

THESE two volumes belong to the Encyclopédie scientifique des Aide-Mémoire, and, like most of the volumes in this series, they contain concise statements of the subjects with which they deal. M. Dumont examines the various systems of horseless traction in use. He begins with steam motors, and then in successive short chapters describes compressed air motors, gas and oil motors, motors driven by carbon dioxide and by ammonia, cable traction, and electric motors. The descriptions are not detailed enough to be entirely satisfactory, nevertheless the volume contains a useful survey of the condition and methods of automobile traction.

M. Lecornu gives in his volume a detailed discussion of the motions of governors of indirect and direct action. His treatment of the various problems involved, and his theorems on the conditions of equilibrium of different governors will interest students of the mathematics and mechanics of machinery.

A Pocket Dictionary of Hygiene. By C. T. Kingzett, F.I.C., and D. Homfray, B.Sc. Pp. 104. (London: Baillière, Tindall, and Cox, 1898.)

THIS pocket-book is intended to be of assistance to medical and sanitary officers in their work, by providing them with concise information upon subjects comprehended in the theory and practice of hygiene. The amount of information given is somewhat unequal, and we should hardly have thought it necessary to include such definitions as: "Adipose, fatty. Anhydrous, without water. Cardiac, pertaining to the heart. Caustic, any substance which destroys animal tissue. Combustion, the process of burning. Emanate, to issue or flow from. Morbid, diseased or unwholesome," &c. Hertz's name is spelt Herz, and Lenard is printed Lennard, in the description of Röntgen rays.

The Secret of the Poles. By Henry Campion. Pp. 48. (Birmingham: White and Pike, Ltd., 1898.)

AMONG the views advanced by the author in this booklet are the following:—The earth is hollow—there is a hollow region large enough to hide the moon and to spare—the earth's axis is hollow—it has two openings, one at each pole—meteoric swarms and ether are attracted through the axis at the south polar entrance, there producing the aurora australis, and after acting as fuel for the fire in the interior is shot out as a waste product at the north polar exit, where it produces the aurora borealis. The character of the book is sufficiently indicated by these extracts, which need no comment.

Wireless Telegraphy, popularly explained. By Richard Kerr, F.G.S. Pp. xv + 111. (London: Seeley and Co., Ltd., 1898.)

MR. W. H. PREECE expresses his general approval of this little volume in a short preface; but at the same time he mentions that he does not accept any responsibility for the controversial points raised. The author explains the principles and practice of telegraphy without intervening wires in words which will be found intelligible by readers unfamiliar with electrical terms. His descriptions possess the merit of being popular in style, and the illustrations assist in brightening the text.

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.]*

Chance or Vitalism.

PROF. JAPP'S exceedingly interesting address on "Stereochemistry and Vitalism" contains a direct challenge to those who, like myself, hold that we can at present only remain agnostic with regard to the problem of "the possibility or impossibility of living matter originating from dead matter by a purely mechanical process." Unfortunately the facts upon which he bases his view, that chemical compounds of one-sided asymmetry cannot arise save under the influence of life, touch a field so much more familiar to him than to me, that it may seem presumption on my part to make one or two suggestions drawn more directly from my own sphere of work. Still, to the philosophical side of his reasoning I think Clifford, whom he challenges, might, perhaps, have been ready with some reply. I would first state what, I think, stripped of technical language, and represented by the simplest case, is Prof. Japp's standpoint:

(1) Optically active liquids are due to asymmetrical molecules.

(2) These asymmetrical molecules arise from the replacement in a symmetrical molecule of either a right-hand or left-hand atom out of two equal atoms which are images of each other.

(3) No optically active substance can be formed unless there be a selection of purely right-handed or purely left-handed atoms, or, at any rate, unless there be a sensible majority of one or of the other.

(4) Some asymmetric solvents have a power of selective action on optically inactive mixtures of right-handed and left-handed atoms, or, to use the technical term, of two enantiomorphs.

(5) No mechanical process (chemical or physical) could select a right-handed as distinguished from a left-handed atom in a symmetrical molecule, and so produce an asymmetric compound. Any mechanical force which acts on a symmetrical molecule is as likely to affect one atom in a molecule as its image. If I. be the selecting of a right-hand atom and II. of a left-hand atom, then, as Prof. Japp puts it:

"The chances in favour of these two events being equal, the ratio,

$$\frac{\text{Number of occurrences of event I.}}{\text{Number of occurrences of event II.}}$$

will, if we are dealing with an infinitely great number of molecules, approximate to unity. We therefore obtain a mixture, optically inactive by inter-molecular compensation."

Now, putting on one side any objections to Prof. Japp's reasoning arising from the fact that it is based on a purely geometrical hypothesis as to the constitution of molecules, which is also merely descriptive, for we can have no ultimate evidence of its actuality[1]—I would draw attention to the fact that (5) is an appeal to the doctrine of chance, and that Prof. Japp tells us that the *mechanical* production of a left-handed or right-handed enantiomorph is an event like the tossing of a coin, of which the chances are precisely equal as to heads or tails. Now if Prof. Japp will toss twenty coins, ten heads and ten tails will undoubtedly be the most frequent result; but there will be a variation about this mean result, and if he goes on tossing long enough he will ultimately come to an instance of twenty heads or twenty tails alone. Cases in which there is a preponderance of heads or tails of a very sensible kind will not be very infrequent. I take it that it is only a *majority* of left- or right-handed enantiomorphs which is required to produce an optically active substance. What majority might be easily ascertained by delicate experiments on the rotatory power of mixtures of dextro- and laevo-acids which are mirror-images of each other. Now, according to Prof. Japp, chance is the factor at work in the production of optically inactive mixtures of right- and left-handed enantiomorphs. Hence, it may be in the course of indefinite ages, purely mechanical action must certainly have produced chemical compounds of one-sided asymmetry with various degrees of rotatory power, due to the greater or less

[1] Such a *geometrical* hypothesis cannot give the *dynamical* explanation of rotatory polarisation required by the physicist, and therefore the "eminent physicist" quoted by Prof. Japp was, I venture to think, right in saying that an explanation of rotatory polarisation is still wanting.

frequency of the two enantiomorphs. We might even predict that if a chemist were to spend his life in the preparation of innumerable and smallest physically sensible amounts of a normally racemoid substance, he would with fine enough apparatus ultimately be able to detect some amount of rotatory polarisation. In nature, where during countless ages (and in the past probably much more actively than at present) inorganic actions and reactions have taken place without man's aid, the production of chemical compounds of one-sided asymmetry must, on Prof. Japp's view of the relation of mechanical action to chance, undoubtedly have taken place. Further, according to Prof. Japp's fourth principle, we may look upon such asymmetrical compounds when they have once arisen as "breeders," or endowed with a power of selecting their own kind of asymmetry from other racemoid substances. Let us put this further statement on one side, however, and content ourselves solely with dissent from Prof. Japp's view expressed in the words:

"But the chance synthesis of the simplest optically active compound from inorganic materials is absolutely inconceivable. So also is the separation of two crystallised enantiomorphs under purely symmetric conditions."

On the contrary, if the theory expounded by Prof. Japp be correct, the inorganic origin of optically active compounds is not only conceivable, but it has a degree of probability which, however small, might be calculated when we know what is the minimum number of molecules in a physically just sensible solution, and what is the majority of enantiomorphs of one kind which will give a just measurable amount of rotatory polarisation.

It will indeed be a great gain if Prof. Japp's address calls more attention to this exciting subject, and leads to further experiment and research. KARL PEARSON.

The Moon's Course.

THE annual course which the moon takes in company with the earth round the sun was to me a long time a great puzzle, as it is to many others, until one day I demonstrated it to myself by the simplest method. Those who have some smattering of the heavenly bodies generally fail in their attempt to draw the moon's orbit; they find no explanation in popular works, and even in books written by well-known authors the subject of the moon's motion is altogether ignored. All that is found is a circle showing the moon's phases, and it is this circle which is fatal to the conception of the true orbit of the moon: even very young readers see the impossibility of a dozen or thirteen circles surrounding the sun.

For myself, failing to find assistance in books, I readily solved the problem by a practical method. I took a piece of wire and placed a cork on each end. I then drew a line on the table and advanced one, which I called the earth, along the line; the other cork necessarily followed it, and at the same time circulated round the earth in accordance with another force or motion given to it. Beginning with the moon behind the earth and making it pass to the right, both advancing forward, the moon made a curve until it reached the front of the earth, and then the latter still advancing, took the moon with it; this came on its left side, and then making another curve on that side, again reached the front; the two curves completing the orbit round the earth.

My object in writing at the present moment is, that when so many persons are spending their holidays at the sea-side and there is much talk of the tides together with the moon, I take the opportunity of demonstrating by a similar method the moon's course on the sands. I make one person walk in a straight line, marking this with a stick, which he drags behind him, and I call him the earth. I then place another person, the moon, at a given distance from the other, telling him to advance also, and at the same time circulate round his companion. Beginning behind, and taking the right hand, he goes forward, making a curve until he gets to the front, then passes to the left side and forms another curve just as in the other experiment. The four quarters of the moon are in this manner seen, and if the second person continually faces the earth the moon's monthly revolution is also completed.

As these demonstrations are made on a plane, the experiment may also be shown in another way. I wind some wire thirteen times (the number of the lunar months) round a cylinder, and then take off the coil thus made. I pull it out into a helix and join the ends of the wire. The course of the moon is shown in the spiral, although no correct proportions are attempted. This also gives some idea why the moon is sometimes seen on the horizon and sometimes at the zenith; the reason of which is a great difficulty to young people, as they find nothing about it in their books.

I make no pretence to be an astronomer or mathematician, and, indeed, it may be even a presumption to send this communication to a scientific journal; but if those who can teach fail to do so in popular books, there is no other method for the uninitiated to do the best for themselves. SAMUEL WILKS.

Grosvenor Street.

The Aurora of September 9.

THIS evening, at about three minutes past eight, on looking out towards the south-west, I was struck by the appearance of a shaft of white light stretching from that direction upwards towards a point 10° or 20° south of the zenith, and immediately on reaching open ground, whence a wide view was obtained, became aware that a fine display of aurora borealis was in progress. The shaft of light successively appeared and disappeared at intervals of a few seconds, and each time further eastwards, but each section was separated from the last by a space of unilluminated sky, as if there were regular spaces in the course of the beam incapable of being set aglow. Very soon after passing overhead the illumination became faint and disappeared eastwards, but now a strong glow appeared again near the horizon under a cloud south-west by west, and this rapidly grew upwards, repeating the phenomenon described in the first case. This occurred at least eleven or twelve times with little variation, except that the shaft became broader and more diffuse. The glow near the horizon south-westwards was always followed by the passage of the light across the sky within 1 to 1½ mins., and each travelling beam was separated from the last by an interval of 1½ to 2 mins. Meanwhile the sky north-westwards showed a pale white steady auroral light, which was at first attributed to the remains of twilight, but which continued to increase till about 8.30, when it was sufficiently strong to cast shadows and to show large print distinctly. This illumination extended slowly upwards from the north until it covered a great part of the sky up to the zenith, and seemed to be due to the luminosity of the great sheet of cirrus and cirrostratus which had covered the sky since 3.30 p.m., for it exactly imitated the distribution forms of the cloud which I had noted during the afternoon. This cloud, unilluminated, did not appreciably obscure the stars. The lacunæ of dark interspaces, while the surrounding sky shone with pale light, resembled bands or puffs of dark smoke, but remained fixed in the same situation, and altogether the phenomenon was strangely persistent, the only evident changes being a gradual shifting from north-west to north-east, and at about 9 p.m. a rosy streak north-eastwards. A little later fresh rays were shooting up from north-west by west, somewhat resembling those which an hour previously had emerged from south-west by west, but more steady and unbroken. At 9.55 a faint light was still to be seen in a north-westerly direction. Two hours before this grand exhibition we had been able to get a good view of the large spot on the sun, the intervening bank of cirriform cloud making his appearance through a telescope more like that of the moon. I have not seen any authoritative statements as to interruption of telegraphic messages or other magnetic disturbances coincident with or preceding the visible aurora, but no doubt some effect must have been observed.

Dunrozel, Haslemere, September 9. ROLLO RUSSELL.

A White Sea.

DURING the recent voyage of the P. and O. Co. s.s. *India* to London I had an opportunity (owing to the kindness of Captain Worcester) of witnessing what seems to be a rare phenomenon. The commander had seen it two or three times in the course of his experience. No one else on board knew anything about it, and I should be glad of a reference to any detailed description.

At 1.30 a.m. on the morning of August 22, in the Indian Ocean, the officer in charge saw ahead what seemed to be a low mist, and into which the vessel steamed. I was called about fifteen minutes later.

The whole sea was milk-white, much more luminous than the clear, starry sky, and there was a very definite horizon.

There was no moon, the wind was south-west and light—the end of the monsoon; and although the sea was, as a matter of fact, breaking here and there, it appeared a calm white sheet, only disturbed by the displacement waves near the ship and a very occasional breaker elsewhere; showing through it were occasional flashes of the ordinary brilliant phosphorescence. It will therefore be seen that the luminosity of the "white sea" was rather less than that of a breaking wave with the same illumination. A bucket of water drawn showed nothing unusual. Samples with and without alcohol were preserved.

A fireball was thrown overboard, and burnt on the surface of the water; this was done in order to see if any fog or mist was present. There was no indication of anything of the kind.

On the port side of the ship is an aperture through which the surplus water from the bath tanks is constantly ejected, slightly warmed. This water, as it fell on to the sea, appeared much blacker than the sea, and floated for a few seconds as a black mass; unfortunately, the same shoot is used for the ashes at times. But the ejected water is quite white by daylight.

The appearance of the sea lasted about an hour, then faded, then brightened again, and was quite bright at daylight, 4.15 a.m.; so that it was seen throughout a distance of nearly fifty miles. A slight recurrence was observed the following night, when the monsoon was blowing more strongly.

At 3 o'clock on the 22nd, in the midst of the "white sea," the latitude was 10° 35′ N. and the longitude 63° 25′ E.; the temperature of the air was 77° F., that of the water 77° F. Specific gravity of the water by ship's instrument No. 1314 = 25.

I shall be glad to hand over the specimens of water to any one interested. JAMES W. BARRETT.

22 Cavendish Square, September 13.

Deep-Sea Dredging, and the Phosphorescence of Living Creatures, at Great Sea Depths.

May I call attention to this most interesting subject, upon which so little is known, and with reference to the exploration of the bottom of tropical seas; *nothing is known*, though there is here a mine of natural history wealth probably of unexampled magnitude. In that interesting work on "The Depths of the Sea," by Sir Wyville Thomson, published more than twenty years ago, we get a glimpse of a hitherto unworked zoological province, which creates a desire to know more from the richness and beauty revealed, where it would be least expected.

He writes—"We had a gorgeous display of luminosity, coming down the Sound of Skye, while dredging in 100 fathoms.

"The Pavonariæ came up, resplendent with a pale lilac phosphorescence, like the flame of cyanogen gas—not scintillating, but constant and sufficiently bright to make every portion of a stem distinctly visible, and the stems were a metre long, fringed with hundreds of polyps; and from the number of specimens brought up, we must have passed through a luminous forest of them.

"Among Echinoderms, *Ophiacantha spinulosa* was one of the prevailing forms, and we were greatly struck with the brilliancy of its phosphorescence. Very young Ophiacantha shone very brightly also.

"At 344 fathoms, some of our hauls were taken late in the evening, and the tangles were sprinkled over with stars of the most brilliant uranium green. The light was not constant, nor continuous all over the stars, but sometimes it struck out a line of fire all round the disc; flashing or glowing up to the centre; then that would fade, and the whole five rays of *Ophiacantha spinulosa* would light up at the ends, and spread the fire inwards.

"At 557 to 584 fathoms, many of the animals dredged were most brilliantly phosphorescent. In some places, nearly everything brought up seemed to emit light, and the very mud itself was perfectly full of luminous specks. The Pinnatulæ, Virgulariæ, and Gorgoniæ, shone with a lambent white light, so bright that it showed quite distinctly the hour on a watch.

"The light from *Ophiacantha spinulosa* was a brilliant green, coruscating from the centre of the disc, now along one arm, now along another; and vividly illuminating the whole outline of the star-fish."

From a depth of 567 fathoms, a beautiful scarlet Urchin, *Echinus microstoma*, was obtained. In the year 1846 Keferstein mentions having seen in Stockholm a Crustacean taken from the depth of 1400 fathoms, of a bright colour. In 1869 and 1870 dredging was carried down to 2435 fathoms by H.M.'s ship *Porcupine*, and the fact that there is an abundant and characteristic invertebrate fauna at that great depth was placed beyond question; but the bottom of the deep sea that has been fairly dredged, may still be reckoned by the square yard; while every haul of the dredge, hitherto used, has brought to light new and unfamiliar forms.

In the number of NATURE for June 30 of this year, there is a most interesting article on deep-sea fishing by means of a trap, an illustration of which is given. These traps are said to have been used at a depth of three thousand fathoms, with complete success. On one occasion a trap that had been lying on the bottom of the Mediterranean, at 700 fathoms depth, for twenty-four hours, brought up 1198 fish, called *Simenchelys parasiticus*. On another occasion, a new crab, one of the largest ever known, *Geryon affinis*, was brought up, and there were sixty-four specimens of it. All this shows how much remains to be done in this province of natural history. E. L. J. RIDSDALE.

Rottingdean.

The Injection of Cocaine as a Remedy for Stings.

As no one has answered the question asked by Sir J. F. D. Donnelly in your issue of September 8, will you allow me to say that the hypodermic injection of cocaine, or indeed its use in any form, is never quite free from risk. As with most other drugs there is an element of idiosyncrasy, which sometimes produces unexpected and unpleasant results. I believe these occur more frequently, when the drug is injected, than when it is simply applied to the mucous membrane; and when they do occur, they are very alarming. I know that some dentists have given up the practice of injecting cocaine into the gums before extraction on this account, and having been present once when it was done, I should not consent to it again. What we have to remember with regard to the use of all powerful drugs is this, that a few individuals under all conditions, and nearly all under certain conditions, are specially susceptible to their action, and that we cannot determine *à priori* either the individuals so predisposed, or the conditions which render susceptible those not specially predisposed. These drugs must therefore be used with caution, and not be regarded as wholly innocuous.

I should say the hypodermic injection of cocaine into the tongue is undesirable, and only to be done if the pain is intense or the swelling such as to threaten life, in which case it would probably be useful. I would add that so far as I know no *solutions* of cocaine keep well. M.D., OXON.

THE GEOGRAPHY OF THE UNITED STATES.[1]

THIS volume completes the description of the North American continent with the exception of Mexico; but, although an excellent account of the United States, it leaves North America itself still undescribed. The general reader, of course, will not miss what he has not been trained to expect; and, if he leaves the conception of geography as a science capable of systematic study out of account, the professed geographer will find much valuable material collected with discrimination and stated clearly and modestly. Indeed, except for an implication on the first page that the United States are in many respects more civilised than Canada, the English reader will find nothing to disturb his equanimity even in the account of the revolutionary war or the feats of the *Alabama*. Mr. Gannett writes always as a good American, but is ready to recognise the defects of his country when necessary, and careful to buttress all agreeable statements with statistics which more than prove them.

Of the arrangement of the matter it is impossible to speak with the same satisfaction. The chapters do not flow in the natural sequence desirable in a literary work,

[1] "Stanford's Compendium of Geography and Travel" (New Issue). North America. Vol. II. "The United States." By Henry Gannett, Chief Geographer of the United States Geological Survey. Maps and Illustrations. Pp. xvi + 466. (London: Edward Stanford, 1898.)

nor are the subjects arranged in alphabetical order usual in a book for occasional reference. It is a little of a shock to turn from mineral resources to population, from great cities to the native Indians, and from commerce to Alaska; even although each chapter in itself is excellent reading.

Mr. Gannett was evidently anxious to resist the temptation of enlarging unduly upon his own special subject, and he has in our opinion gone to the opposite extreme, and lost an opportunity of showing how completely the structure of the country determined by its geology dominates the whole geography of the United States. The introductory chapter does contain a good deal of geology in relation to the configuration of the different natural regions, but the connecting links with the other distributions are wanting. It would be better in a book intended primarily for the general English reader to translate the statistics so freely given into the usual British units of weight and money; the "short tons" for coal and "long tons" for iron-ore are puzzling, and make comparison with other countries difficult. Besides, it would greatly assist the clear conception of such statistics if they were expressed in round numbers.

FIG. 1.—The Giant Cactus of the Arid Region.

Apart from these possibilities for improvement, the book contains nothing which we cannot heartily praise. The revision of the text is very thorough, and we have not detected a single erratum.

Many of the topics are handled with surprising freshness, and many interesting points are brought out, such as the changed manner of life of the hardy fishers of the New England coast, who have found an easy and profitable calling as caterers for holiday-makers from the great cities. The author discusses the whole question of American cities, showing how the convenience of the rectangular plan has outweighed æsthetic considerations; and explaining the relative backwardness of the old cities of the east, compared with the new growths of the west, by the vast amount of capital locked up in such archaic conveniences as gas-works and horse or cable cars, while the untrammelled new municipalities can establish electric power-houses at once for all needs. So, too, he shows that no country in the world possesses so many ruined cities as the United States—not only the abodes of the early mound-builders and cliff-dwellers, but ruins of yesterday; mushroom towns that teemed with busy thousands in a year, and were abandoned in a month on the failure of a mine or of a company, leaving only "a history of disappointed hopes, of hardships and struggles."

The movements of population are well treated, and a map showing the areas where more than 10 per cent. of the population are foreign-born, and those where more than 10 per cent. of the population are of negro race, displays the interesting fact that the former occupies the whole north and west, the latter the whole south-east, leaving a narrow belt between the two areas. The number of original statistical and physical maps is one of the most striking and satisfactory features of the book, and the illustrations also are admirably selected. At a time when the United States are entering on a new era of their national life, the publication of so accurate and impartial an account of that great country by one of its own citizens is peculiarly appropriate, and deserves a cordial welcome.

FIG. 2.—Buttes in the Plateau Region.

HUGH ROBERT MILL.

THE BRITISH ASSOCIATION.

THE concluding meeting of the British Association was held on Wednesday, September 14. Sir William Crookes occupied the chair, and the Mayor of Bristol (Sir R. H. Symes) and the High Sheriff were present, as well as the principal officers and members of the Association. The following report of the meeting is from the *Times*:—

The proceedings were opened by the announcement that the general committee had been able to pass grants to the amount of 1485*l.*—an amount which was justified largely by the success of the present meeting.

Sir Norman Lockyer proposed that the thanks of the Association be given to the Mayor, the High Sheriff, the executive committee, and the local officers. He said that the great success of the meeting was largely due to the efforts of those referred to in the resolution. Never before in his experience of the Association had local effort led to such absolute smoothness in the working of the machine. It was a pity that the work of the Association had been so hard as to prevent many members from seeing all the points of interest in this interesting city of Bristol. The magnificent educational establishments which crowded the city were themselves worthy of close attention, and at some future meeting the British Association might find Bristol at the head of some great south-western University.

Prof. Schäfer seconded the resolution.

Mr. James Scott (of Toronto), on behalf of the Canadian members, expressed high appreciation of the welcome which had been accorded to them.

The resolution was then carried with much enthusiasm.

The Mayor of Bristol, Mr. Howell Davis (chairman of the executive committee), Mr. Arrowsmith (local treasurer), and Mr. Arthur Lee and Dr. Bertram Rogers (local secretaries), each responded, Mr. Arrowsmith expressing his acknowledgments for the cheque for 120*l.* which had been given by the Council of the Association towards the Colston Hall fund.

Prof. Rücker next moved a comprehensive vote of thanks to all public bodies and private persons who had contributed to the success of the meeting. He said that if the citizens of Bristol had not supported the local officers, the success of the meeting could not have been secured in so large a measure. As President of the International Committee of the Magnetic Conference, he was charged to convey the best thanks of the foreign members to the Association and to the local authorities for the extreme kindness of their reception.

Dr. Gladstone seconded the resolution, which was carried unanimously, the High Sheriff responding.

Sir John Evans moved a cordial vote of thanks to Sir William Crookes, President, for his admirable address and for his conduct in the chair. He prophesied, when introducing Sir William to the chair, that the Association would hear from him a remarkable address, and that prophecy had been amply justified. One of the most valuable portions of that address was that in which public attention was called to the fact that there was in our atmosphere an inexhaustible supply of nitrogen, and that means should be discovered for employing that nitrogen to increase the produce of the earth. Sir William Crookes had fulfilled with courtesy and distinction all the many and various duties which the past week had imposed upon him, and the thanks of the Association were cordially due to him.

Prof. Roberts-Austen seconded the resolution, which was carried with enthusiasm.

Sir W. Crookes, in responding, said that he felt like an electrical switch-board—for really he was only the transmitter and distributor of these thanks to those whose help had been so material. He was especially grateful to the Mayor and Mayoress, whose hospitality had facilitated his work so greatly; and he regarded as one of the highest compliments ever paid to him the invitation to the remarkable smoking-symposium of the previous Friday evening. As for the President's office, the pace was getting too fast for human endurance; and in a short time the British Association would, if the work were to be got through at all, have to elect a young athletic man of five-and-twenty instead of a man over three-score years and ten.

Prof. Rücker announced that the number of tickets issued for the present meeting of the Association was 2446.

This concluded the proceedings. The next meeting will be held at Dover, and will commence on September 13, 1899.

SECTION D.

ZOOLOGY.

Opening Address by Prof. W. F. R. Weldon, M.A., F.R.S., President of the Section.

In attempting to choose the subject of the address with which custom obliges your president to trouble you, I felt that I should have the best hope of interesting you if I decided to speak to you on the subject most interesting to myself. I therefore propose to discuss, as well as I can, the principal objections which are urged against the theory of Natural Selection, and to describe the way in which I think these objections may be met.

The theory of Natural Selection is a theory of the importance of differences between individual animals. In the form in which Darwin stated it, the theory asserts that the smallest observable variation may affect an animal's chance of survival, and it further asserts that the magnitude of such variations, and the frequency with which they occur, is governed by the law of chance.

Three principal objections are constantly brought forward against this theory. The first is that the species of animals which we know fall into orderly series, and that purely fortuitous variations cannot be supposed to afford opportunity for the selection of such orderly series; so that many persons feel that if the existing animals are the result of selection among the variable offspring of ancestral creatures, the variations on which the process of Natural Selection had to act must have been produced by something which was not chance.

The second objection is that minute structural variations cannot in fact be supposed to affect the death-rate so much as the theory requires that they should. And it is especially urged that many of the characters, by which species are distinguished, appear to us so small and useless that they cannot be supposed to affect the chance of survival at all.

The third objection is that the process of evolution by Natural Selection is so slow that the time required for its operation is longer than the extreme limit of time given by estimates of the age of the earth.

Now the first of these three objections, the objection to fortuitous variation as the source of material on which Natural Selection can act, is very largely due to a misunderstanding of the meaning of words. The meaning of the word Chance is so thoroughly misunderstood by a number of writers on evolution that I make no apology for asking you to consider what it does mean.

Consider a case of an event which happens by chance. Suppose I toss a penny, and let it fall on the table. You will agree that the face of the penny which looks upwards is determined by chance, and that with a symmetrical penny it is an even chance whether the "head" face or the "tail" face lies uppermost. For the moment, that is all one can say about the result. Now compare this with the statements we can make about other moving bodies. You will find it stated, in any almanac, that there will be a total eclipse of the moon on December 27, and that the eclipse will become total at Greenwich at 10.57 p.m.; and I imagine you will all feel sure, on reading that statement, that when December 27 comes the eclipse will occur; and it will become total at 10.57 p.m. It will not become total at 10.50 p.m., and it will not wait until 11.0 p.m. You will say, therefore, that eclipses of the moon do not occur by chance.

What is the difference between these two events, of which we say that one happens by chance, and the other does not? The difference is simply a difference of degree in our knowledge of the conditions. The laws of motion are as true of moving pence as they are of moving planets; but it happens that we know so much about the sun, and the earth, and the moon, that we know the circumstances which affect their relative positions very accurately indeed; so that we can predict within less than a minute the time at which the shadow of the earth will next fall upon the moon.

But the result of tossing a penny depends upon a very large number of things which we do not know. It depends on the shape and mass of the penny, its velocity and direction when it leaves one's hand, its rate of rotation, the distance of one's hand from the table, and so on. If we knew all these things before tossing the penny, we should be able to predict in each case what the result would be, and we should cease to regard pitch and toss as a game of chance.

As it is, all we know about these complicated conditions is that if we toss a penny for a number of times, the conditions which give "heads" will occur about as often as the conditions which give "tails."

If you examine any event which occurs by chance, you will find that the fortuitous character of its occurrence always depends upon our ignorance concerning it.

If we know so little about a group of events that we cannot predict the result of a single observation, although we can predict the result of a long series of observations, we say that these events occur by chance. And this statement seems to me to contain the best definition of chance that can be offered.

If we used the word chance in this sense, we see at once that our knowledge of animal variations is precisely knowledge of the kind referred to in our definition of chance. We know with some certainty the average characters of many species of animals; but we do not know exactly the character of the next individual of these species we may happen to look at. So that in the present state of our knowledge it is *à priori* certain that the great majority of animal variations should occur by chance, in the sense in which we have used the phrase; and I will show you in a moment illustrations of the fact that they do so occur.

But before doing so, I would point out the difference between the sense in which we have used the word chance, and the sense in which it is used by many objectors to the theory of Natural Selection. Such epithets as *blind*, *lawless*, and the like, are constantly applied to chance; and a kind of antithesis is established between events which happen by chance, and those which happen in obedience to natural laws. In many German writings, especially, this antithesis between *Zufälligkeit* and *Gesetzmässigkeit* is strongly insisted upon, whenever organic variation is discussed.

This view of chance is not supported by experience; and indeed, if it could be shown that any thing in human experience were absolutely lawless, if it could be shown that in any department of nature similar conditions did not produce similar effects, the whole fabric of human knowledge would crumble into chaos, and all intellectual effort would be a profitless waste of time. There is not the slightest reason to believe that any such absolutely lawless phenomena do exist in nature; so that we need pay no further attention to the writers who assume that chance is a lawless thing.

But if chance is a perfectly orderly and regular phenomenon, then the question, whether animal variations occur by chance or not, can be settled by direct observation. I will now show you one or two examples of events which undoubtedly occur by chance, and then compare these with one or two cases of organic variation.

As events which occur by chance, I have taken the results of tossing twelve dice. My wife has spent some time during the last two months in tossing dice for you, and I will ask you to look at the results.

Her first record gives the number of dice showing more than three points in each of 4096 throws of twelve dice. There are, of course, six numbers on each of the dice; so that if all the dice were perfectly symmetrical and similar, the average number of dice with more than three points should be six in each throw of twelve. But dice are not symmetrical and similar. The points on the dice used were marked by little holes, scooped out of their faces; and the face with six such holes scooped out of it was opposite to the face with only one such hole: so that the face with one point was heavier than the face with six points; and therefore six was rather more likely to be uppermost than one. In the same way, two was opposite five; so that the five face was a little more likely to fall uppermost than the face with two points. Therefore, it is a little more likely that you will throw four, five, or six, in throwing dice, than it is that you will throw one, two, or three.

Accordingly, the average number of dice, in these 4096 throws, which had more than three points, was not six, but 6·135.

To show you that this excess of high points was due to some permanent property of the dice, she threw these twelve dice another 4096 times; and the average number of dice with more than three points was 6·139. A third series of trials gave an average of 6·104, and a fourth gave an average of 6·116.

You see that the difference between the highest and the lowest of these determinations is only about one-half per cent., so that the mean result of such a series of fortuitous events can be determined with great accuracy.

And just as the mean of the whole series can be determined, so we can know with considerable accuracy how often any possible deviation from the average result will occur. The degree of accuracy with which we can know this may be judged from Table I.

TABLE I.—*Frequency with which Dice showing more than three Points were thrown in each of Four Series of Trials, the number of throws in each Series being* $2^{12} = 4096$.

Number of dice with more than 3 points.	Most probable frequency for symmetrical dice.	Observed frequencies.			
		I.	II	III.	IV.
12	1	0	1	0	1
11	12	11	13	8	14
10	66	71	86	61	66
9	220	257	246	241	241
8	495	536	540	513	586
7	792	847	836	856	861
6	924	948	913	948	866
5	792	731	750	802	728
4	495	430	446	420	474
3	220	198	198	182	204
2	66	60	55	51	67
1	12	7	12	13	6
0	1	0	0	1	0

You see that the results of the experiments agree fairly well with one another, and differ from the results most probable with symmetrical dice, in the way which the structure of the actual dice would lead one to expect. Throws which give seven, eight, or nine dice with more than three points occur too often, throws in which only two, three, or four dice have more than three points do not occur often enough. You see then that each of these results is orderly and regular, and that the four results agree very fairly among themselves, not only in the mean value of each of them, but in the magnitude and frequency of departures from the mean. That they differ from the results which would probably be obtained with symmetrical and similar dice is only to be expected, because the dice used are neither symmetrical nor similar.

You notice that this table is very nearly symmetrical; the most frequent result is that which lies in the middle of the series of possible results; and the other frequencies would, with perfect dice, be distributed symmetrically on each side of it; so that with perfect dice one would be as likely to throw five dice out of twelve with more than three points as one would be to throw seven, and so on.

This symmetry in the distribution of the results is only found when the chance of the event occurring in one trial is even. The next table shows the result of 4096 throws of twelve dice,

TABLE II.—*Frequency of Sixes in* 4096 *throws of Twelve Dice.*

Number of sixes.	Most probable number with symmetrical dice.	Number observed.
8	0·58	1
7	4·66	7
6	27·18	24
5	116·43	115
4	363·84	380
3	808·53	796
2	1211·44	1181
1	1102·56	1145
0	459·52	447

in which sixes only were counted. The chance against throwing six with any one of the dice is of course five to one; so that in throwing twelve dice you are more likely to throw two sixes than to throw any other number. But you see that the chance of throwing only one six is very much greater than the chance of throwing three; the chance of throwing none is greater than the chance of throwing four, and while there is a chance of throwing five, six, or more, of course it is impossible to throw less than none at all; so that the diagram is all askew. You see that this time, as before, the frequency with which any number of sixes did actually occur was as near to the result most probably with perfect dice as the asymmetry of the actual dice allows one to expect.[1]

These results will be enough to show you how absurd is the attitude which so many writers have taken up towards chance when discussing animal variation. The assertion that organic variation occurs by chance is simply the assertion that it obeys a law of the same kind as that which expresses the orderly series of results we have just looked at.[2]

That is a matter which can be settled by direct observation. But in order to express the law of chance in such a way that we can apply it to animal variation, we must make use of a trick which mathematicians have invented for that purpose.

It is a well-known proposition in probability that the frequency with which one throws a given number of sixes in a series of trials with twelve dice is proportional to the proper term in the expansion of $(\frac{1}{6} + \frac{5}{6})^{12}$. The values in this table were calculated by expanding this expression. But if I had wanted to show you the most probable result of experiments with 100 dice, I should not willingly have expanded $(\frac{1}{6}+\frac{5}{6})^{100}$. The labour would be too enormous. Then again, suppose we are given a number of results, and are not told how many dice were used, how are we to find out the power to which we must raise $(\frac{1}{6}+\frac{5}{6})$, since this depends on the number of dice?

Before applying the law of chance to variations in which we cannot directly measure the number of contributory causes (the analogue of the number of dice), we must find some way out of this difficulty.

The way is shown by the diagram (Fig. 1).

The rectangles in this diagram are proportional to the various terms of $(\frac{1}{2} + \frac{1}{2})^{12}$; and they represent the most probable result of counting the number of dice with more than three points in a series of trials with twelve dice. The heights of these rectangles were determined by expanding $(\frac{1}{2}+\frac{1}{2})^{12}$; but you notice the dotted curve which is drawn through the tops of them. The general slope of this curve is, you see, the same as the general slope of the series of rectangles; and the area of any strip of the curve which is bounded by the sides of a rectangle is very nearly indeed the same as that of the rectangle itself.

The constants upon which the shape of this curve depends are easily and quickly obtained from any series of observations; so that you can easily and quickly see whether a set of observed phenomena obeys the symmetrical law of chance or not.

A good many characters of animals do vary in this symmetrical way; and I show you one, which will always be historically interesting, because it was one of the principal characters used to illustrate Mr. Galton's invaluable applications of the law of chance to biological problems. That is the case of human stature. The diagram (Fig. 2) shows the stature of 25,878 American recruits; and you see that the frequency with which each stature occurs is very close indeed to that indicated by the curve. So that variations in human stature do occur by chance, and they occur in such a way that variation in either direction is equally probable.

In cases where a variation in either direction is equally likely to occur, this symmetrical curve can be used to express the law of distribution of variations. And the great difficulty in applying the law of chance to the treatment of other cases was, until quite lately, that the way of expressing asymmetrical distributions by a similar curve was unknown; so that there was no obvious way of determining whether these asymmetrical distributions obeyed the law of chance or not.

The form of the curve, related to an asymmetrical distribution of chances, as the curve before you is related to symmetrical distributions, was first investigated by my friend and colleague Prof. Karl Pearson. In 1895 Prof. Pearson published an account of asymmetrical curves of this kind, and he showed the way in which these curves might be applied to practical statistics. He illustrated his remarkable memoir by showing that several cases of organic variation could be easily formulated by the method he described: and in this way he made it possible to apply the theory of chance to an enormous mass of material, which no one had previously been able to reduce to an orderly and intelligible form.

In this same memoir Prof. Pearson dealt with another problem in the theory of chance, which has special importance in relation to biological statistics. It has doubtless occurred to many of you that the analogy between the complexity of the results obtained by tossing dice, and the complexity of events which determine the character of an animal body, is false in an important respect. For the events which determine the result, when we throw a dozen dice on the table, affect each of the dice separately; so that if we know that one of the dice shows six points, we have no more reason to suppose that another will show six points than we had before looking at the first.[1] But the events which determine the size or shape of an organ in an animal are probably not independent in this way. Probably when one event has happened, tending to increase the size of an arm or a leg in an embryo, it is more likely than it was before that other events will happen leading to increased size of this arm or leg. So that the chances of variation in the size of a limb would be represented by a law similar to that which expresses the result of throwing dice, but different from it. They would more nearly resemble the result of drawing cards out of a pack. Suppose you draw a card out of a pack. It is an even

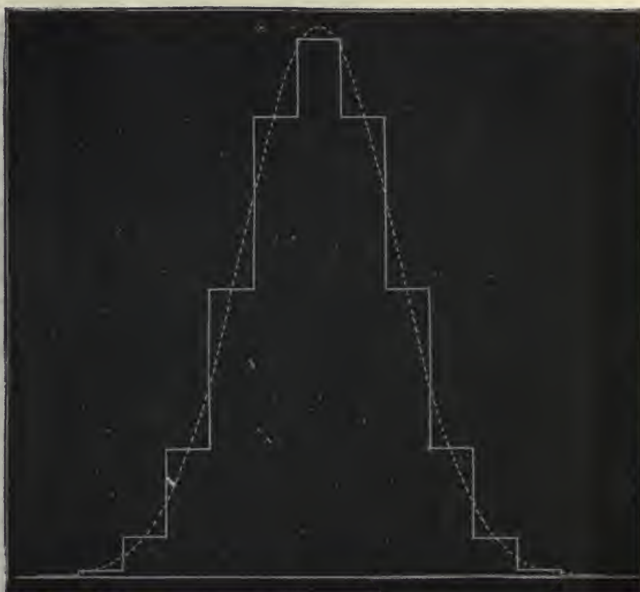


FIG. 1.

[1] It is unfortunate that I chose dice as instruments in these experiments. Dice are not only sensibly *asymmetrical*, but any ordinary dice are sensibly *dissimilar*; so that the result most probable with any actual dice is not given by a simple binomial expansion. The result theoretically most probable for the actual dice used could not be determined without very careful measurement of the dice themselves; and I was unable to attempt measures of the requisite accuracy. All that the records show, as they stand, is the amount of agreement between four successive observations of a fortuitous event.

[2] The law is not, however, identical in the two cases; see *infra*.

[1] That is to say, if we know beforehand that the dice are symmetrical.

chance whether you draw a red card or a black one. Suppose you draw a red card, and keep it. The chance that your second card will be red is not so great as the chance that it will be black; because there are only twenty-five red cards and twenty-six black cards left in the pack.

Now Prof. Pearson has shown how to deal with cases of this kind also; and how to determine, from the results of statistical observation, whether one is dealing with such cases or not.

I am no mathematician, and I do not dare even to praise the mathematical process by which this result was achieved. I will only say that it is experimentally justified by the fact that most statistics relating to organic variation are most accurately represented by the curve of frequency which Prof. Pearson deduces for the case where the contributory causes are mutually interdependent.[1]

The first case of an asymmetrical distribution in animals which I ask you to look at is the frequency of variations in the size of part of the carapace of shore crabs. The crabs measured were 999 females from the Bay of Naples. In this case the distribution of variations (see Fig. 3) is very nearly symmetrical, and in an account of these crabs which I wrote before Prof. Pearson's memoir was published, I treated them as symmetrical. The curve actually drawn on the diagram is one constructed by Prof. Pearson himself from the data given by my measurements of the crabs, and it fits the observations very sensibly better than the symmetrical curve. So that this dimension of a crab's carapace does vary by chance, but the chance of a given deviation from the mean length is not quite the same in both directions.

Now, admitting for the moment that these differences in the length of a part of the crab's carapace can affect the crab's chances of survival, you see that natural selection has abundant material on which to work. The production of this regular series of deviations from the mean length of the antero-lateral margin is as definite a character of the crabs as the mean itself; and in every generation a series of deviations from the mean is regularly produced, according to a law which we can learn if we choose to learn it.

Now suppose it became advantageous to the crabs, from some change in themselves or in their surroundings, that this part of their carapace should be as long as possible. Suppose the crabs in which it was shorter had a smaller chance of living, and of reproducing, than the crabs in which it was longer.

Suppose that crabs in which this dimension is longest were as much more productive than those in which it was shortest, as the most prolific marriages are more fertile than the least prolific marriages among ourselves. Prof. Pearson has pointed out that half the children born in England are the offspring of a quarter of the marriages. If we suppose the productiveness among crabs to vary as much as it does among ourselves, only that in crabs the productiveness is greater, the greater the length of this bit of the carapace, then half of the next generation of crabs will be produced by that quarter of the present generation in which the antero-lateral margin is longest. And as the offspring will inherit a large percentage of the parental character, the mean of the race may be sensibly raised in a single generation.

This view of the possible effect of selection seems to have escaped the notice of those who consider that favourable variations are of necessity rare, and likely to be swamped by intercrossing when they do occur. You see that in this case there are a few individuals considerably different from the mean in either direction, and a very large number which differ from the mean *a little* in either direction. If such deviation be associated with some advantage to the crabs, so that crabs which possess such abnormality are more fertile than those which do not, it is a certainty that the mean character of the next generation will change, if only a little, in the direction advantageous to the race; and the opportunity for selective modification of this kind to occur in either direction is very nearly the same.

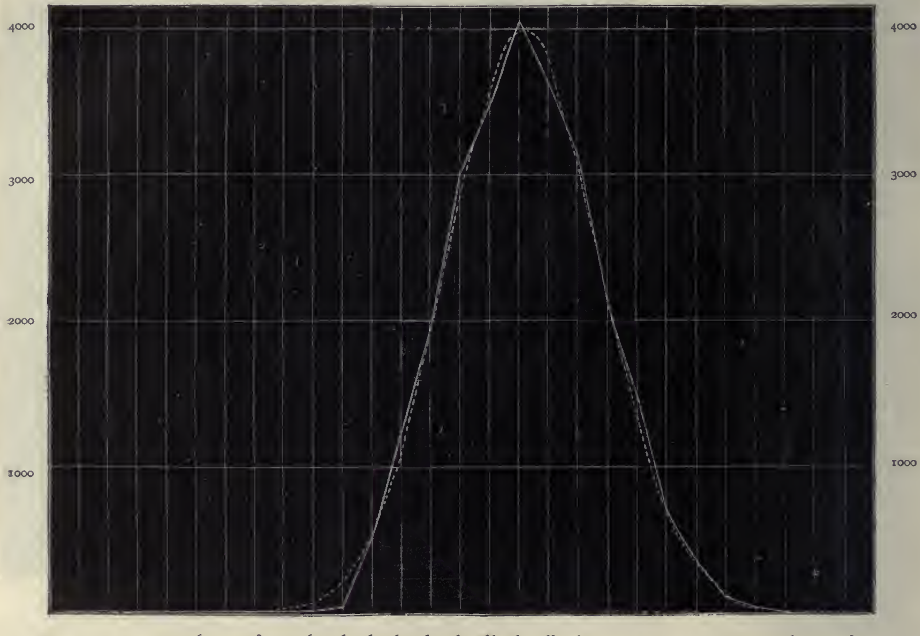


FIG. 2.—Diagram showing the height (in inches) of each of 25,878 American recruits.

[1] Even the distribution of human stature, which has been so successfully treated by the older, so-called "normal" curve, is more accurately represented by a curve of Prof. Pearson's type; but in this case the difference between the two is so slight as to be inappreciable for all practical purposes; so that Mr. Galton's practice and Prof. Pearson's theory are alike justified.

In the next case, this is not true.

The diagram (Fig. 4) represents the number of female swine, out of a batch of two thousand examined in Chicago, which have a given number of Müllerian glands in the right fore leg.

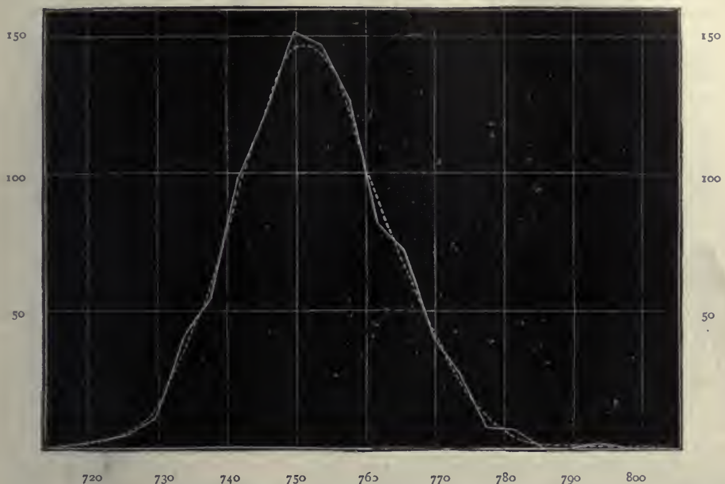


FIG. 3.—Diagram showing the magnitude of the antero-lateral margin (in terms of carapace-length) in 999 female shore-crabs from Naples.

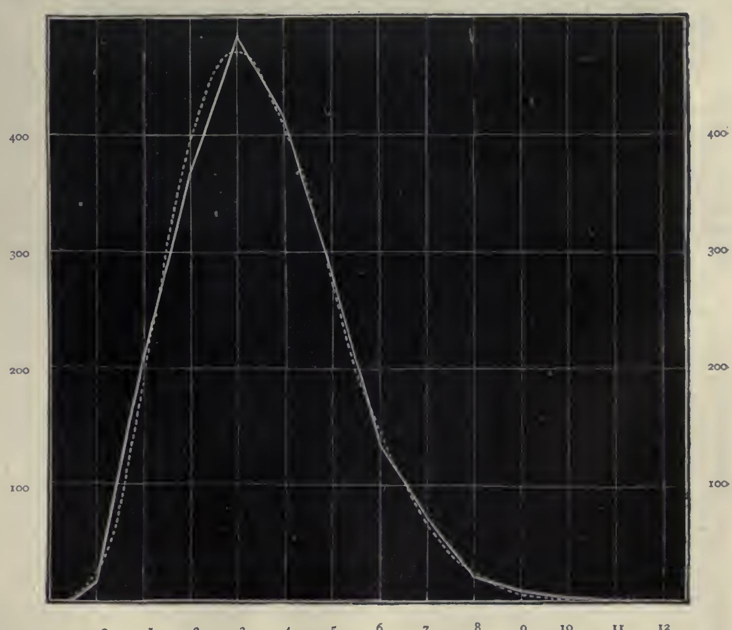


FIG. 4.—Diagram showing the number of Müller's glands in each of 2000 female swine.

The distribution is much more skew than in the case of the crabs, and you see again the very beautiful way in which Prof. Pearson's curve expresses it. You see that the range of variation is much greater on one side of the mean than on the other; and the selective destruction necessary in order to raise the mean number of glands by one would be very different from the amount of destruction necessary in order to lower the mean by one. Further, the mean number of glands in these pigs is $3\frac{1}{2}$; the number which occurs oftenest, the "modal" number as Prof. Pearson calls it,[1] is three. Now it is impossible to lower this number till it is less than 0, so that it can only be diminished by three; but it is conceivable that it should be increased by more than three. So that the amount of selective destruction required in order to change either the mean or the modal character of these pigs in one direction, would be greater than the amount required, in order to produce a change of equal magnitude in the opposite direction, and the amount of possible change is greater in one direction than in the other.

Now let us pass on to another example.

Table III. shows the variation in the number of petals in a race of buttercups studied by Prof. de Vries. You see that the most frequent

TABLE III.—*Prof. Pearson's expression for the variation in the race of Buttercups described by Prof. de Vries.*

No. of petals . . .	5	6	7	8	9	10	11
Observed frequency .	133	55	23	7	2	2	0
Pearson's theory . .	136·9	48·5	22·6	9·6	3·4	0·8	0·2

number of petals is five, and that no buttercups whatever have less than five petals, though a considerable number have more than five; and here again you see the way in which Prof. Pearson's formula fits the observations.

[1] All attempts to confine the word "average" to the most frequently occurring magnitude, and the word "mean" to the arithmetic mean of the series, have failed to secure support. Therefore Prof. Pearson's proposal to call the value which occurs oftenest the "mode" is very useful.

You see that if this diagram (which is based on very few specimens) really represents the law of variability in these buttercups, no amount of natural or other selection can produce a race with less than five petals out of them. While it is conceivable that selection might quickly raise the normal number of petals, it could not diminish it, unless the variability of the race should first change.[1]

These examples, which are typical of others, must suffice to show the way in which the theory of Chance, as developed by Prof. Pearson, can express the facts of organic variation.

I think you will agree that they also show the importance of investigating these facts. For of the four characters we have examined, we have seen that two, namely human stature and the antero-lateral carapace length of *Carcinus mœnas*, vary so as to afford nearly equal material for selective modification in either direction; one character, the number of Müller's glands in swine, offers distinctly greater facility for selective modification in one direction than in the opposite direction; and in the last character, the number of petals in a race of buttercups appears to offer scope for modification in one direction only, at least by selection in one generation.

Knowledge of this kind is of fundamental importance to the theory of Natural Selection. You have seen that the new method given to us by Prof. Pearson affords a means of expressing such knowledge in a simple and intelligible form; and I, at least, feel very strongly that it is the duty of students of animal evolution to use the new and powerful engine which Prof. Pearson has provided, and to accumulate this kind of knowledge in a large number of cases.

I know that there are people who regard the mode of treatment which I have tried to describe as merely a way of saying, with a pompous parade of arithmetic, something one knew before. This criticism of Prof. Pearson's work was actually made to me the other day by an eminent biologist, whose name I will not repeat. If there be any here who hold such an opinion, I would ask them to read Mr. Francis Galton's Essays on Heredity; where a simple and quite unexpected relation between parents and offspring is shown to be a direct consequence of the fact that they vary by chance. This is the first and the most striking deduction from the mathematical theory of organic variation, but it is not the only one. It is enough, however, to show that the new method is not only a simple means of describing the facts of variation, which facts very few people knew before, but it is a powerful instrument of research, which ought to be quickly and generally adopted by those who care for the problems of animal evolution.

I think I have said enough to convince you how entirely Prof. Pearson's method promises to confirm the assertion that organic variation obeys the law of chance.

The other objections to Darwin's theory are not so easily answered. It is said that small variations cannot be supposed to affect an animal's chance of life or death; but few persons have taken any pains to find out in any given case whether the death-rate is in fact affected by small variations or not. It is said that the process of Natural Selection is so slow that the age of the earth does not give time for it to operate, but I know of few cases in which any attempt has been made to find out by actual observation how fast a species is really changing.

I can only attempt to discuss the importance of small variations, and the rate of organic change, in the one case which I happen to know. The particular case I have myself studied is the variation in the frontal breadth of *Carcinus mœnas*.[2]

During the last six years my friend, Mr. Herbert Thompson, and I have studied in some detail the state of this character in the small shore-crabs which swarm on the beach below the laboratory of the Marine Biological Association at Plymouth.

I will show you that in those crabs small changes in the size of the frontal breadth do, under certain circumstances, affect the death-rate, and that the mean frontal breadth among this race of crabs is, in fact, changing at a rate sufficiently rapid for all the requirements of a theory of evolution.

In Table IV. you see three determinations of the mean frontal breadth of these crabs, expressed in terms of the carapace-length taken as 1000. You see that the mean breadth varies very rapidly with the length of the crab, so that it was necessary to determine it separately in small groups of crabs, such that the length of no two crabs in a group differed by more than a fifth of a millimetre. The first column of the table shows you the mean frontal breadth of twenty-five such groups, between 10 and 15 millimetres long, collected in 1893. These crabs were measured by Mr. Thompson. The second column shows you the mean frontal breadth in twenty-five similar groups of crabs, collected in 1895, and also measured by Mr. Thompson. You see that in every case the mean breadth in a group of crabs collected in 1895 is less than it was in crabs of the same size collected in 1893. The third column contains the result, so far as it is yet obtained, of my own measurement of crabs collected this year. It is very incomplete, because the 1895 crabs were collected in August and September, and I was anxious to compare them with crabs collected this year at the same season, so that there has not yet been time to measure the whole series. The measurements are sufficient, however, to show that the same kind of change has taken place during the last three years as that observed by Mr. Thompson in the interval between 1893 and 1895. Making every allowance for the smallness of the numbers so far measured this year, there is no doubt whatever that the mean frontal breadth of crabs from this piece of shore is considerably less now than it was in 1895 among crabs of the same size.[1]

TABLE IV.—*The Mean Frontal Breadth ratio of Male* Carcinus mœnas *from a particular patch of beach in Plymouth, in the years* 1893, 1895, *and* 1898.

Length of carapace.	Mean frontal breadth in terms of carapace length = 1000.			
	1893 (Thompson).	1895 (Thompson).	1898 (Weldon).	No. of crabs in the 1898 group.
10·1	816·17	809·08	—	—
10·3	812·06	804·82	—	—
10·5	807·37	803·27	—	—
10·7	808·96	801·69	—	—
10·9	805·07	799·27	—	—
11·1	802·50	794·12	784·25	4
11·3	798·18	792·38	787·36	11
11·5	797·19	788·83	784·00	9
11·7	794·28	785·29	782·44	16
11·9	791·45	786·53	780·09	11
12·1	788·38	780·61	775·25	16
12·3	783·98	779·50	773·42	12
12·5	783·99	776·50	767·00	11
12·7	783·58	773·43	772·43	14
12·9	777·38	773·63	764·67	15
13·1	776·63	771·61	760·13	16
13·3	774·60	766·21	761·29	7
13·5	766·91	763·96	759·56	16
13·7	767·63	762·00	757·00	16
13·9	763·73	759·40	756·10	10
14·1	758·94	757·00	742·00	13
14·3	756·90	755·77	747·86	7
14·5	762·60	754·45	744·44	9
14·7	753·00	749·84	739·22	8
14·9	751·32	748·03	742·83	6

These results all relate to *male* crabs. The change in female crabs during this time has been less than the change in male crabs, but it is, so far as my measurements at present permit me to speak, going on in the same direction as the change in male crabs.

I think there can be no doubt, therefore, that the frontal breadth of these crabs is diminishing year by year at a rate which is very rapid, compared with the rate at which animal evolution is commonly supposed to progress.

I will ask your patience for a little while longer, that I may tell you why I feel confident that this change is due to a selective

[1] Of course we know that selection does change the variability of a race.

[2] In 1894 I gave an account of the variation of this dimension in female specimens of various sizes (*Roy. Soc. Proc.*, vol. lvii.), and I put forward an hypothesis of the amount of selective destruction due to variation in this character. That hypothesis neglected several important facts wh ch I now know, and was open to other objections. I desire to replace it by the results of the observations here recorded.

[1] I shall, of course, consider it my duty to justify this statement by more extensive measurement as soon as possible. In the meantime I may say that I have measured other small groups of crabs, male and female, from the same place, at different seasons of the years 1896–98, and the results agree with those recorded in the table.

destruction, caused by certain rapidly changing conditions of Plymouth Sound.

If you look at the chart, you will see that Plymouth Sound is largely blocked up, and its communication with the sea is narrowed by a huge artificial breakwater, about a mile long, so that the tidal currents enter it and leave it only by two openings. This huge modern barrier has largely changed the physical conditions of the Sound.

On either side of Plymouth itself a considerable estuary opens into the Sound, and each of these estuaries brings down water from the high granite moorlands, where there are rich deposits of china clay. Those of you who know Dartmoor will remember that in rainy weather a great deal of china clay is washed into the brooks and rivers, so that the water frequently looks white and opaque, like milk. Much of this finely divided china clay is carried down to the sea; and one effect of the breakwater has been to increase the quantity of this fine silt which settles in the Sound itself, instead of being swept out by the scour of the tide and the waves of severe storms.

So that the quantity of fine mud on the shores and on the bottom of the Sound is greater than it used to be, and is constantly increasing.

But this is not all. During the forty or fifty years which have gone by since the breakwater was completed, the towns on the shores have largely increased their population; the great dockyard at Devonport has increased in size and in activity; and the ships which visit the Sound are larger and more numerous than they were. Now the sewage and other refuse from these great and growing towns and dockyards, and from all these ships, is thrown into the Sound; so that while it is more difficult than it used to be for fine silt to be washed out of the Sound, the quantity thrown into it is much greater than it was, and is becoming greater every day.

It is well known that these changes in the physical conditions of the Sound have been accompanied by the disappearance of animals which used to live in it, but which are now found only outside the area affected by the breakwater.

These considerations induced me to try the experiment of keeping crabs in water containing fine mud in suspension, in order to see whether a selective destruction occurred under these circumstances or not. For this purpose, crabs were collected and placed in a large vessel of sea-water, in which a considerable quantity of very fine china clay was suspended. The clay was prevented from settling by a slowly moving automatic agitator; and the crabs were kept in under these conditions for various periods of time. At the end of each experiment the dead were separated from the living, and both were measured.

In every case in which this experiment was performed with china clay as fine as that brought down by the rivers, or nearly so, the crabs which died were on the whole distinctly broader than the crabs which lived through the experiment, so that a crab's chance of survival could be measured by its frontal breadth.

When the experiment was performed with coarser clay than this, the death-rate was smaller, and was not selective.

I will rapidly show you the results of one or two experiments. The diagram (Fig. 5) shows the distribution of frontal breadths, about the average proper to their length, in 248 male crabs treated in one experiment. Of these crabs, 154 died during the experiment, and 94 survived. The distribution of frontal breadths in the survivors is shown by the lower curve in the diagram, and you see that the mean of the survivors is clearly below the mean of the original series, the mean of the dead being above the original mean.

Two other cases, which are only examples of a series in my possession, show precisely the same thing.[1]

These experiments seemed to me to show that very finely divided china clay does kill crabs in such a way that those in which the frontal breadth is greatest die first, those in which it is less live longer. The destruction is selective, and tends to lower the mean frontal breadth of the crabs subjected to its action. It seemed to me that the finer the particles used in the experiments, that is to say, the more nearly they approached the fineness of the actual silt on the beach, the more selective their action was.

I therefore went down to the beach, where the crabs live, and looked at the silt there. This beach is made of moderately small pieces of mountain limestone, which are angular and little worn by water. The pieces of limestone are covered at low tide with a thin layer of very fine mud, which is much finer than the china clay I had used in my experiments, and remains suspended in still water for some time. Under these stones the crabs live, and the least disturbance of these stones raises a cloud of very fine mud in the pools of water under them. By washing the stones of the beach in a bucket of sea water, I collected a quantity of this very fine mud, and used it in a fresh series of experiments, precisely as I had before used china clay, and I obtained the same result. The mean frontal breadth of the survivors was always smaller than the mean frontal breadth of the dead.

I think, therefore, that Mr. Thompson's work, and my own, have demonstrated two facts about these crabs; the first is that their mean frontal breadth is diminishing year by year at a measurable rate, which is more rapid in males than in females; the second is that this diminution in the frontal breadth occurs in the presence of a material, namely, fine mud, which is increasing in amount, and which can be shown experimentally to destroy broad-fronted crabs at a greater rate than crabs with narrower frontal margins.

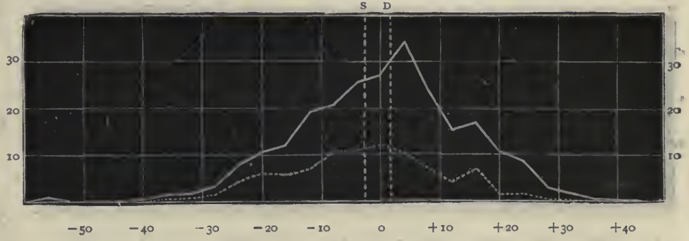


Fig. 5.—Diagram showing the effect of china clay upon 248 male crabs. The upper curve shows the distribution of frontal breadths in all these crabs; the dotted curve the distribution of frontal breadths in the survivors. The dotted line S shows the mean of the survivors; the line D the mean of the dead.

I see no shadow of reason for refusing to believe that the action of mud upon the beach is the same as that in an experimental aquarium; and if we believe this, I see no escape from the conclusion that we have here a case of Natural Selection acting with great rapidity because of the rapidity with which the conditions of life are changing.

Now, if we suppose that mud on the beach has the same effect upon crabs as mud in an aquarium has, we must suppose that every time this mud is stirred up by the water, a selective destruction of crabs occurs, the broad-fronted crabs being killed in greater proportion than the narrow-fronted crabs.

Therefore, if we could take a number of young crabs, and protect them through a certain period of their growth from the action of this selective mud, the broad-fronted crabs ought to have as good a chance of life as the rest; and in consequence the protected crabs should contain a larger percentage of broad individuals than wild crabs of the same age; and the mean frontal breadth of such a protected population ought to be greater, after a little time, than the mean frontal breadth of wild crabs, in which the broad individuals are being constantly destroyed.

It is difficult to perform this experiment, because one cannot know the age of a crab caught on the shore. But so far as one can judge the age of a crab by its length, I can show you that the thing which ought to happen, on the hypothesis that such selective destruction is going on, does actually happen.

I established an apparatus consisting of some hundreds of

[1] It is impossible in this place to give a full account of the experiments referred to, and a multiplication of mere small scale diagrams seems useless, so that only one of those exhibited when the address was delivered is here reproduced.

numbered glass bottles, each bottle being provided with a constant supply of clean sea-water by means of a system of glass syphons. Into each of these bottles I placed a crab from the beach. After a considerable number of deaths had occurred, a series of crabs was finally established, each crab living in a numbered bottle, until it had cast its shell. The process of moulting involves no distortion of the carapace, which could affect the measurements concerned, and therefore each cast shell was carefully measured. The measurements of these shells were carefully compared with measurements of wild crabs of the same size, and the mean frontal breadth of these shells was a little *less* than the mean breadth in wild crabs of corresponding length.[1]

After each crab had moulted, it was left in its bottle until it had grown and had hardened a new shell. It was then killed and measured, and the measurements obtained were compared with measurements of wild crabs of corresponding size. This time the captive crabs were unmistakably *broader* than wild crabs of their own size, and there were a few of the protected crabs which were very remarkably broad. The distribution of abnormalities before and after moulting is shown in Fig. 6.

This is precisely the result which we ought to have obtained, if the hypothesis suggested by the study of mud were true. By protecting crabs through a period of their growth, we ought to raise the mean frontal breadth, and to obtain a greater percentage of abnormally broad crabs, and that is what we have seen to occur.

Of course, this experiment by itself is open to many objections. The estimate of age by size is a dangerous proceeding, and it is difficult to exclude the possibility that confinement in a bottle may directly modify a crab during the critical period of moulting, and so on. All these points would have to be discussed at greater length than your patience would bear, before we could accept this experiment by itself as a proof that some selective agent exists on the shore, which is absent from the bottles. At the same time, the result of this experiment is exactly what we should expect to find if such a selective agent did exist, and so it is in complete harmony with the evidence already put before you.

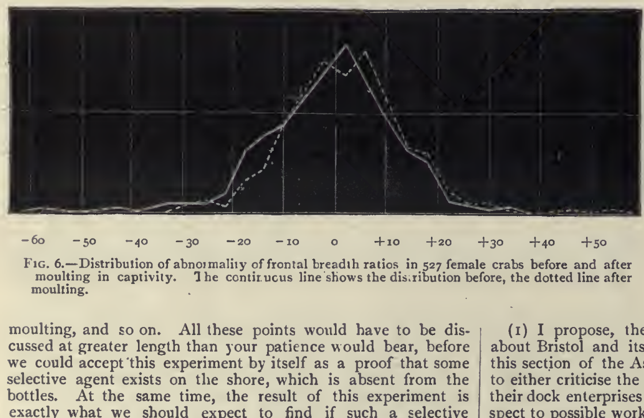


FIG. 6.—Distribution of abnormality of frontal breadth ratios in 527 female crabs before and after moulting in captivity. The continuous line shows the distribution before, the dotted line after moulting.

Of course, if the observed change in frontal breadths is really the result of selection, we ought to try to show the process by which this selection is effected.

This process seems to be largely associated with the way in which crabs filter the water entering their gill-chambers. The gills of a crab which has died during an experiment with china clay are covered with fine white mud, which is not found in the gills of the survivors. In at least 90 per cent. of the cases, this difference is very striking; and the same difference is found between the dead and the survivors in experiments with mud.

I think it can be shown that a narrow frontal breadth renders one part of the process of filtration of water more efficient than it is in crabs of greater frontal breadth.

[1] This was probably due to the death-rate during acclimatisation being selective. It was very difficult to keep the apparatus clean; and the deaths which occurred were in most cases due to the presence of putrescent bits of food, which had not been removed.

A subsequent experiment was made with the same apparatus, in which crabs were kept in putrid water until a large percentage had died: and the mean frontal breadth of the survivors was found to be distinctly less than the mean frontal breadth of the dead.

It would take too long to go into that matter now, and I shall not attempt to do so. I will only now ask you to consider one or two conclusions which seem to me to follow from what I have said.

I hope I have convinced you that the law of chance enables one to express easily and simply the frequency of variations among animals; and I hope I have convinced you that the action of natural selection upon such fortuitious variations can be experimentally measured, at least in the only case in which any one has attempted to measure it. I hope I have convinced you that the process of evolution is sometimes so rapid that it can be observed in the space of a very few years.

I would urge upon you in conclusion the necessity of extending as widely as possible this kind of numerical study. The whole difficulty of the theory of Natural Selection is a quantitative difficulty. It is the difficulty of believing that in any given case a small deviation from the mean character will be sufficiently useful or sufficiently harmful to matter. That is a difficulty which can only be got rid of by determining in a number of cases how much a given variation does matter; and I hope I have shown you that such determination is possible, and if it be possible, it is our duty to make it.

We ought to know numerically, in a large number of cases, how much variation is occurring now in animals: we ought to know numerically how much effect that variation has upon the death-rate; and we ought to know numerically how much of such variation is inherited from generation to generation. The labours of Mr. Galton and of Prof. Pearson have given us the means of obtaining this knowledge: and I would urge upon you the necessity of obtaining it. For numerical knowledge of this kind is the only ultimate test of the theory of Natural Selection, or of any other theory of any natural process whatever.

SECTION G.

MECHANICAL SCIENCE.

OPENING ADDRESS BY SIR JOHN WOLFE BARRY, K.C.B., LL.D., F.R.S., PRESIDENT OF THE SECTION.

APART from all the other considerations which so favourably affect this Congress, I think, so far as Section G is concerned, that we are fortunate in meeting in this ancient city, which has so much of special interest for engineers and for others interested in applied science.

(1) I propose, therefore, to say a few introductory words about Bristol and its neighbourhood from the point of view of this section of the Association, but it is far from my intention to either criticise the past work of the Corporation in relation to their dock enterprises or to volunteer advice to them with respect to possible works of improvement.

Bristol is, at this moment, of great commercial importance, as indicated by the value of its imports and exports, and occupied an even more important relative position among British ports at a time when the ports of Liverpool, Glasgow, Cardiff, or Southampton were almost, or altogether undeveloped. So far as Customs Revenue is concerned Bristol now stands third, and in regard to the gross value of her sea-borne trade she is thirteenth among ports of the United Kingdom.

It is unnecessary, and it would be foreign to the objects of Section G, to attempt to trace the economic reasons which have caused the long-continued importance of Bristol, or to account for the rapid growth of other ports more or less competitive with her. All such causes are to be found, at least to a great extent, in considerations apart from the merely physical characteristics of the sea, river, or land at the various sites, as, for example, in propinquity to markets or centres of production, in situation relatively to population or to means of distribution, in individual or collective enterprise, in enlightened or unenlightened administration.

These circumstances have, in truth, at least as much if not more influence in determining the history and prosperity of ports than what are termed natural advantages of respective sites, by which I mean such matters as protection from winds and currents, depth of water in the port itself and in its approaches from the sea, the possession of soil adapted to the foundations of docks or quays, and ready access to suitable materials for cheap and efficient construction.

While recognising to the full the great advantages of such physical endowments in the development of a great port, one cannot but remember that they form only part of the problem, and that the business of engineers is to modify and direct the great forces and characteristics of nature for the use and convenience of mankind. We have, in fact, to make the best of a locality which may or may not be promising in the first instance, and history shows us that there are few places which are hopeless for our purposes. Thus while, on the one hand, we see many harbours in this country which inherit from nature every feature to be desired for the establishment of a port, but which remain useless for that object, so, on the other hand, we find many of the great centres of trade established in situations which possessed no such advantages, and where almost everything has had to be supplied by painful exertion and great expenditure.

As examples of these facts, I may point to the remarkable progress of many commercial ports situated in localities which were originally the reverse of promising from an engineering point of view—to Glasgow, where twenty-six millions sterling in value of exports and imports are annually dealt with in ships of the largest draught, though it is placed on a river which only fifty years ago was nearly dry at low water for a distance of ten miles below the present docks—to Newcastle, with a present trade of 13½ millions sterling, which within the memory of this generation was approached by a shallow river, entering a much-exposed part of the North Sea over a dangerous sand bar. Sixty years ago the Tyne could only receive (and that only at high water) a small class of coasting vessels, whereas it is now navigable for deep-draughted vessels for a distance of thirteen miles from the sea. The breakwaters also at Tynemouth, which have been constructed under great difficulties on a coast without a single natural encouraging characteristic, not only make a valuable harbour of refuge, but have, practically speaking, removed the external bar.

In a similar way, as evidence of the truth of my proposition, I might point to a multitude of other instances; to the great docks of Buenos Ayres, which city, when I knew it twenty years ago, could not be approached within seven or eight miles by sea-going ships of fifteen or sixteen feet draught; to Calcutta, dependent on the dangerous navigation of the Hooghly, including the dreaded James and Mary shoals; to the creation of the port of Manchester, forty-five miles from the sea, approached by a tide-locked canal which has cost thirteen or fourteen millions of money in its construction; to the great recent developments of Rouen, Dunkirk, Antwerp, and Amsterdam; to the improvements of the Danube and the Mississippi. In all of these cases the natural characteristics of the localities were quite unsuited to the requirements of an advancing trade in modern vessels, but the inexorable demands of commercial shipping have created the supply, at the hands of engineers, of improvements and modifications of nature, which are so large and important that, to an unprofessional eye, they might now almost appear, at least in some of the cases which I have mentioned, to be physical characteristics of the locality.

I think that we may safely say that trade will produce the required accommodation, and that accommodation in itself will not create or attract trade.

Bristol is a case in point, and it is interesting to us at this meeting to note, however briefly, some of the important works which have altered and are altering its capacity as a port. At the end of last century Bristol and its capabilities were, as they have been almost ever since, the battlefield of civil engineers, and we know that reports and projects were made by most of the men who were then recognised as authorities. The diversion of the river Avon and the construction of the floating harbour of Bristol, which were carried out under the advice of William Jessop in the years from 1804 to 1809, were boldly conceived and ably executed. The result of the diversion of the Avon by means of what is still known as the New Cut enabled the old course of the river to be made into a floating harbour of about 71 acres, of which 57 acres are available for vessels of considerable size. The total cost seems to have been about 600,000*l.* Though the greatest draught of water in the floating harbour (some 20 feet) and the dimensions of the original locks (150 feet long and 36 feet wide) may appear to us at the close of the nineteenth century somewhat insignificant, they were, no doubt, up to the estimated requirements of that day, and I think we can recognise in Jessop's work the impress of a great mind.

The Cumberland Basin was deepened and improved, and the lock accommodation was increased by Brunel in 1850 by the construction of a lock, 350 feet long and 62 feet wide, and again by Howard in 1871, who made another lock, 350 feet long, 62 feet wide, with 23 feet of water at high water of neap tides. This is the present limitation of the access of shipping to the town docks, and though we realise its insufficiency for modern vessels, we can appreciate the energy of those who have gone before us, and who found the funds for or designed works which have for so many years well fulfilled their purpose.

The approach to Bristol from the sea—that is to say, from King Road in the Bristol Channel—is certainly unpromising for large ships, and indeed, when contemplated at low water, appears not a little forbidding. Something has been done, and more is now in progress, towards straightening, deepening, buoying, and lighting the tortuous course of the Avon below Bristol. More, no doubt, would have been undertaken in former years, if the great rise of tide in the river had not provided, at spring tides, a depth and width for navigation which were sufficient for practical purposes, until the size of modern ships imperatively demanded increased facilities of approach. I think it is a remarkable thing that vessels of 3000 tons burden, 320 feet in length, and drawing 26 feet of water, succeed in reaching Bristol, and that the trade in the heart of the city continues to increase.

Those acquainted with the strong tides of the Avon, or with its bends, which do not exceed in places a radius of 800 feet, and, lastly, with what might be the consequences of a long vessel grounding in a channel which has only a bottom width of 100 feet, cannot but recognise the skill and nerve of the pilots in navigating large vessels from King Road to Bristol. This is done by night as well as by day, and so successfully that the rate of insurance for Bristol is no more than it is for Avonmouth or Portishead, the entrances of which are in the Severn, or than for many ports situated on the open sea.

We have similar examples of what can be done by the systematic development of pilotage skill in the Hooghly, the River Plate, the Yangtse Kiang, the Mississippi, and other rivers where special men have been evolved, as it were, by the demand, and navigate with safety and success channels which are so full of dangers that they might well appear impracticable. Experience, indeed, shows us that, given a trade and a depth of water rendering access possible, ships will make their way to ports through all kinds of difficulties and with a wonderfully small margin of water under their keels, reminding one of the boast of the Mississippi captain that he could take his steamer wherever the channel was a little damp.

To return, however, to Bristol and the Avon; in spite of all efforts to keep pace with trading requirements, the time arrived, in 1868, for providing improved dock accommodation, which would avoid the navigation of the Avon, and at the same time afford deeper locks and more spacious quays than could be given in Bristol itself. The Avonmouth and Portishead docks accordingly were built between 1868 and 1878, and acquired by the Corporation in 1884. Both are fine works for their period; but even in their case the rapid development of modern shipping has occasioned a demand for enlargements of the facilities which they afford. Accordingly, a matter which is again agitating Bristol is still further dock accommodation, and there has been a sharp contention whether this should be effected by what is implied in the somewhat barbarous word "dockising" the Avon, or by new docks at King Road. Dockising implies the construction of a weir and locks at Avonmouth, so that the Avon would be impounded and make one sheet of water nearly six miles long to Bristol, the natural discharge of the river being provided for by outfall sluices, while the alternative of dockising the Avon is to be found in great additions to the docks either at Avonmouth or Portishead.

In the peaceful atmosphere of Section G, I will not enter upon the various aspects of these antagonistic proposals, and will merely say that I have no doubt that in some way Bristol will keep ahead of what is wanted, and that I wish the city and the engineer who may carry out any of the ideas which may be eventually adopted every success and satisfaction in such important undertakings.

(2) Leaving, then, for the present all local considerations, and seeing that a large part of my own work has lain in the

construction of new docks and in the alteration of old docks, I propose now to say a few words on what appear to me to be at present the salient points on these subjects in relation to the growth and the requirements of our merchant navy.

In the first place one cannot but be struck with the great demands which have come with some suddenness on the present generation for increased dock and quay accommodation. The British people are the chief carriers of the world, and are indeed those "that go down to the sea in ships, and occupy their business in great waters." This can be appreciated when we consider that annually our over-sea import registered tonnage is thirty-four millions, and our export registered tonnage is thirty-eight millions. Our coastwise traffic amounts to sixty-three million tons per annum, making together a tonnage to be dealt with of one hundred and thirty-five million tons. If we add to these figures the tonnage of vessels in ballast and the number of calls of those vessels in the coasting trade which touch at several ports in the course of one voyage, we must add a further fifty-five millions of tonnage, making a total of one hundred and ninety millions of tonnage using our ports yearly; and if we divide these figures by, say, three hundred days, to provide against more or less idle days, bad weather, and the like, we have the result of six hundred and thirty-three thousand tons per diem entering and leaving our ports. If we assume an average ship of three hundred registered tons, which is probably not far wrong, we have about two thousand one hundred trading vessels entering or leaving our ports daily—a flotilla of startling numbers.

In truth, the magnitude of our mercantile navy, as compared with that of other countries, is astonishing. We have ten and a half millions of tons, against a total of thirteen millions of tons belonging to all the other nations of the world, in which are included three millions of tons of steam vessels engaged in the lake and river traffic of the United States. Descending to particulars, our merchant fleet is eleven and a half times that of France, seven times that of Germany, eighteen times that of Russia (in Europe), two and three-quarter times that of the United States (inclusive of the craft on the great lakes), six and three-quarter times that of Norway, fourteen times that of Italy, and fourteen times that of Spain. Out of our total tonnage of ten and a half millions, six and three-quarter millions are steam vessels, and the proportions in relation to the steam tonnage of the other countries above referred to are approximately the same.

Again, it is instructive to note how small a proportion of the trade of other countries, even including coasting traffic, is carried in ships belonging to the country in question. Thus, whereas we as a nation convey in steamships 76 per cent. of the aggregate tonnage of our own ports, only the following proportions of the total trade of other nations are carried by the shipping of each country in question:—

France	about	30 per cent.
Italy	,,	19 ,,
Germany	,,	43 ,,
Russia (in Europe)	,,	7 ,,
Norway	,,	56 ,,
Sweden	,,	29 ,,
Holland	,,	26 ,,
United States (over-sea) ...	,,	15 ,,

Further, it is a recognised fact that a very large part of the balance of the above proportions is conveyed in British ships frequenting the various foreign ports and acting, as I have said, as the ocean carriers of the world.

Thus in the best returns available I find that British shipping conveys the following proportions of the over-sea commerce of other countries:—

Italy	44 per cent.
Germany	38 ,,
Russia	57 ,,
Norway	18 ,,
Sweden	27 ,,
Holland	54 ,,
United States	60 ,,
France	(not given)

The experience of the Suez Canal again tells the same tale, for of the total tonnage passing through that international waterway 66 per cent. is British. This is nearly seven times that of the shipping of the next largest contributor, which is Germany, and nine times that of France.

This vast amount of carrying trade is in British hands, because we can do it cheaply as well as efficiently. I believe that the whole of our commercial fleet is worked at a very narrow margin of average profit, though in the aggregate it forms one of the most important factors in our country's position among the nations of the world.

We are often reminded of how greatly the value of our imports exceeds that of our exports; but we should not forget that the profit on the transport of both goes chiefly to the British nation as shipowners, in addition to the profit which is earned by them in the carriage of merchandise from one foreign port to another.

What an important thing it thus is to the prosperity of this country, not merely that our own ports should be convenient and adequate to all demands, but that our ship-builders should be able to keep pace with the demands of this huge transport traffic! We find in this connection that we add about half a million of tons of shipping annually to our register, and that we lose about 250,000 tons annually by wreck and by vessels becoming old or obsolete, so that, as a matter of fact, the average annual increment of our mercantile navy for the past twelve years is about a quarter of a million of tons.

The remarkable development within recent years in the cheapness of steam navigation, the improved methods of building and rigging of sailing ships, and various economic causes have resulted in a large increase of the average size of ship engaged in over-sea voyages with a comparative diminution in the number of the crews of each description of vessel. Greater draught of water is consequently demanded, and as a better knowledge of ship-building has indicated that the beam of ships can be considerably increased without involving greater resistances, we may expect to see ships to increase not only in length and depth, but also in width.

The largest steamer twenty years ago (excepting of course the *Great Eastern*, which was a magnificent conception, though in advance of her time and its requirements) was, I believe, the *City of Berlin*, of 5500 tons burden. Her length was 488 feet, and her draught and beam were 25 feet and 44 feet respectively. At the present time the *Kaiser Wilhelm der Grosse* is 625 feet long, her beam is 66 feet, and her draught is 27 feet, and we know that these dimensions will soon be exceeded.

A modern liner now being built will have a length of 704 feet (or 24 feet longer than the *Great Eastern*) with a beam of 68 feet and a draught of 28½ feet. The great steamers for the transport of cattle are 585 feet long, 64 feet beam, and 30 feet draught and upwards, carrying 14,000 tons of cargo. Some of the large sailing vessels carry over 6000 tons dead weight and draw 28½ feet. Ships of war, though not so long as liners, have a beam of 75 feet with a draught of 31 feet, and though in the commercial marine we need not perhaps anticipate any great further increase of draught of water, the demand for which is largely governed by what is available in foreign ports or rivers and in the Suez canal, the fact that men-of-war can, with due regard to economy of propulsion, be built with great width of beam in proportion to length, seems to indicate that we must be prepared in the future for a considerable increase of beam for cargo-carrying vessels.

We have further to note that, owing, no doubt, to the vast improvements of marine steam engines and boilers realising unlooked-for economy in the combustion of coal, steam vessels are supplanting all but the largest class of sailing vessels as carriers of commerce, almost as rapidly as they did forty or fifty years ago in the conveyance of passengers and as ships of war.

In 1897, out of a total shipping trade (cargoes and ballast) dealt with in ships of all nations at the ports of the United Kingdom, amounting to ninety millions of tons, eighty-one millions of tons, or 90 per cent., were conveyed by steam vessels; whereas, in 1885, out of a total of sixty-four millions of tons, fifty millions of tons, or 78 per cent., were in steamers. If we take, however, the tonnage of cargoes and ballast conveyed to and from her own ports by British ships only, we find that in 1897, out of a total of sixty-four millions of tons, sixty-one millions of tons, or 95 per cent., were in steam vessels; whereas, in 1885, but 85 per cent. of the total tonnage conveyed by British vessels was in steamships.

Of the tonnage of vessels built in the United Kingdom in 1885, 50 per cent. were steamers, but in 1897 the proportion was 86 per cent.; and to sum up, we find that in the commercial fleet of the United Kingdom and British Possessions, as between 1887 and 1897, sailing ships have decreased 16 per cent. in number and have, in spite of the building of a certain number of exceptionally large vessels, decreased 9 per cent. in average size; while steamers have increased 23 per cent. in number and 16 per cent. in average size. The total sailing tonnage has decreased in the same period by 24 per cent., and the steam tonnage has increased by 36 per cent.

The problems thus confronting us, as results of the increased size of all descriptions of over-sea steamships, require much consideration from an engineering point of view, and are further puzzling, and will continue to puzzle, our financial authorities, without whose aid the engineer can do but little.

We ask, Where is all this expansion of requirements to stop, and how far are we justified in extending our view of the wants of the future from the contemplation of the conditions of the present and of what has occurred in the past? This is undoubtedly a difficult question, and he would be a bold man who thought that we had reached finality in the size of ships. Bound up with this consideration are not merely matters of first cost of the accommodation to be provided, but also of the annual expenses in working and maintenance, not only of the docks themselves, but in what is perhaps of more importance, viz. the preservation of sufficiently deep and wide approaches to them.

Apart from length, depth, and beam, the midship cross section of modern cargo ships has altered completely of late years, and is now nearly as rectangular in shape as a packing-case, excepting only that at the bilges the sides and floor are joined by a curve of small radius. The keel has almost disappeared, and bilge keels are often added. The result of these alterations of shape in the ordinary hulls of trading ships is that the sills and sides of many locks and entrances are now unsuited to what is wanted, and consequently their original power of accommodating vessels is most seriously diminished.

Until lately it was generally considered that locks 600 feet long, 80 feet wide, and 26 feet deep were sufficiently capacious, with some margin for future wants; but I think we must now go further in length and depth, and not improbably to some extent in width. We find that at Liverpool the Dock Board have ordered vestibule basins to act as locks 1150 feet long and 520 feet wide, with entrances 100 feet wide and 32 feet deep; and somewhat similar dimensions were talked of for the entrance lock of the recently proposed Windsor Dock at Penarth, which was intended to be 1000 feet long, 100 feet wide, and 34 feet deep at neap tides.

Again, apart from the question of locks and entrances, the older docks themselves are beginning to be found too shallow and too narrow for modern vessels. In docks which are deep enough at spring tides and too shallow at neap tides, and which are opened to the "tide of the day," much may be done to improve the depth by systematic pumping, so as to keep the surface always at the level of high water of spring tides. By this expedient, large areas of old docks may be to that extent modernised at the expense, perhaps, of new entrance locks and the annual cost of pumping. This latter yearly outgoing is not an important matter. At Liverpool and Birkenhead 230 acres of nearly obsolete docks have been thus improved at a capital cost of about 96,000*l*. for pumping machinery and an annual expenditure of 6000*l*. I am executing a similar improvement by pumping in one of the smaller docks on the Thames, and contemplate it on a larger scale at an important dock there, and also at Hull.

The conditions of commerce now require also, in order to realise the necessary economy of transport, the greatest despatch, for demurrage on the large and expensive modern steam vessels is a most serious question. Thus there must now be no waiting for spring tides, or, if possible, for rise of tide on the day of arrival. Every steamer expects to discharge her cargo on to the quay without waiting for much stacking, still less for trucks; and under modern conditions dock work must be got through in one-third of the time which was considered proper ten or twelve years ago. From these reasons larger quays and warehouses, better railway approaches, improved sidings, and better machinery are all necessities, as well as deeper water and better approaches.

These demands have come on us, as I have said, not so much gradually as more or less suddenly, and the call for improved docks is general, and, in my opinion, it will be continuing.

Liverpool last year undertook to spend nearly five millions on such works, and we know of very many important projects at other places. Taking the expenditure within the past decade, and adding to it the authorised expenditure at Liverpool, at the great ports on the Bristol Channel, on the Thames, at Southampton, Hull, Middlesbrough, Hartlepool, Sunderland, the Tyne and its neighbourhood, at Grangemouth, the Fife Ports, at Glasgow, the Ayrshire Ports, the Cumberland and Lancashire Ports, and so round the British coasts to Preston, I roughly estimate an expenditure, either made during the past ten years or contemplated, of from 35 to 40 millions.

These are large figures, and we ask from whence will an adequate revenue come; for it is a more or less accepted fact that docks by themselves do not produce more than a very moderate return on their cost, though, of course, there may be exceptions to every rule. Apart from the expenditure which has been undertaken much remains to be done, and the source of supply of the capital required is a highly important consideration. I venture to think on this point that we should learn to realise that under modern conditions docks should be considered largely in the light of being railway stations for goods and minerals and, in many cases, for passenger traffic. Docks and quays, together with improved approaches from the sea, are, in fact, the means of bringing traffic to the railways (and, to a less degree, to the canals) of a country, and should be looked upon as links in the chain of transport and intercommunication.

They are certainly as necessary adjuncts of a railway, at least in our country and in respect of goods and minerals, as large stations and depôts are in all important towns.

The older view of our Parliament was that docks and railways should be in different hands; but I much question whether this idea should now commend itself. It is difficult, as I have said, for a dock enterprise standing alone to make any considerable return on its cost, and though it is true that capital can be found under guarantees of an already developed trade by some of the great Dock Trusts, such as at Liverpool or Glasgow, the return is but a modest one, and not such as is likely to tempt capitalists to new ventures in constructing or enlarging many of the docks which stand in need of improvements.

On the other hand, a railway company which gets a fairly long lead for the goods to and from a dock can afford to look at the matter of expenditure on docks with some liberality. We have conspicuous examples of great public benefit being afforded at Southampton and at Hull, where the docks have lately passed from the hands of financially weak companies dependent only on dock dues, to the ownership of powerful railway companies. Similarly, several of the north-eastern ports besides Hull—the large docks at Grangemouth, Barry, Penarth, Garston, Fleetwood, and elsewhere—are further examples, amongst others, in which the revenue of railway companies has been spent on dock improvements with a spirit which would be otherwise unattainable. A dock also must necessarily be nowadays almost wholly dependent for its efficient working on the best understanding being maintained with the railway companies for the prompt and adequate provision of land transport, so that in that point of view also the two interests are one and should be recognised as such.

In the consideration of the advisability for concentration of ownership, there remain only the questions of safeguards against unfair treatment of competitive modes of transport, such as canal and road traffic, and provision against any improper results of monopoly of railway access. These, I think, can be provided by Parliamentary enactment, either by insisting on adequate access under proper conditions for all within reach, or, in any case, of inadequate facilities being accorded, by authorising the construction of other docks in the hands of competing railway companies or of other aggrieved parties, with in such cases railway privileges. With these safeguards the public could be efficiently protected, and, if this be so, I cannot but think that, *cæteris paribus*, the trading community will be better served by docks directly connected with railway companies than by separate existences and management. On the one hand, I hope that those who administer the great railway undertakings will realise this community of interest, and, on the other, that Parliament will favour intimate financial relations between docks and railways, instead of more or less systematically discouraging such connection. This question is one which is peculiarly interesting here at Bristol, where the docks are in the hands of the Corporation, and where the railway companies carry the traffic, which, but for the docks, would be largely non-existent.

(3) Leaving now the question of modern docks and shipping,

as to which, as I have said, Bristol is interesting to engineers, there are one or two other matters of history which appeal to Section G in this locality. In the first place, Bristol was the birthplace of the Great Western Railway. I. K. Brunel, its engineer, had previously, by public competition, been selected to span the gorge at Clifton by a suspension bridge of the then almost unrivalled span of 702 feet. Again, under the influence of Brunel, Bristol became the home of the pioneers of Transatlantic steamships, and the story of the initiation of the enterprise is thus told in the memoirs of his life. In 1835, at a small convivial meeting of some of the promoters of the Great Western Railway, some one said, "Our railway to Bristol will be one of the longest in England," and Brunel exclaimed, "Why not make it the longest line of communication in the world by connecting it with New York by a line of steamers?" Out of this grew the *Great Western* steamship, and the history of the enterprise and of its success is too well known, at least here, to require any allusion to the steps by which it was brought about. Suffice it to say that, in spite of much discouragement, the *Great Western*—of the then unexampled size of two thousand three hundred gross tons, and with engines of unparalleled power—was launched at Bristol in 1837, and ran successful and regular voyages till 1857, when she was broken up.

In Section G there are many who can appreciate the difficulties of such a new departure as the *Great Western* steamship, even if they had been confined to the design and study of a vessel and engines of unprecedented size; but it is not easy to realise the anxiety and trouble caused by the dictum of a man of science so universally admired as Dr. Lardner, at the meeting of the British Association in this city in 1836, that the whole idea of ocean navigation on voyages as long as from Bristol to New York was at that epoch an abstract impossibility.

In these days of criticism of the past, often involving the rehabilitation of individuals, it is interesting to note that Dr. Lardner's part in condemning beforehand the construction of the *Great Western* steamship and the ideas on which she was designed has been of late years unduly minimised. It has been said that all Dr. Lardner meant was to express a pious doubt as to the commercial prospects of ocean navigation. I have carefully read the *Proceedings* of the time, and I am brought to the conclusion that his words and writings will admit of no such interpretation. Dr. Lardner's views, arrived at after calculation and reasoning, were precisely expressed and boldly and honestly enunciated by him. The words of the discussion here appear not to have been preserved, but in an elaborate article in a *Quarterly Review* in 1837, which is, I believe, admitted as having been written by Dr. Lardner, he said, "that in proportion as the capacity of a vessel is increased, in the same ratio, or nearly so, must the mechanical power of the engines be enlarged and the consumption of coal augmented." He based his views that success was impossible on principles which he supposed to be sound, but which were, in fact, assumptions—viz. that the resistance to the progress of a ship varied directly with her capacity, that a certain number of tons of coal were required per horse-power for the voyage across the Atlantic, and that, this being so, enough fuel could not be carried in a ship, however large she might be made.

Brunel, on the other hand, contended that Dr. Lardner's views were fundamentally erroneous; for that, whereas the capacity of a ship increased in the ratio of the cube of her dimensions, the resistance to her progress varied more nearly as the square. Thus, by adopting a proper length, beam, and draught, a ship would not only carry coal for the journey to New York, but be commercially successful in respect of cargo and passengers.

It is interesting to note that 9 lbs. of coal per indicated horse-power per hour (as compared with our present $1\frac{1}{2}$ to 2 lbs.) was the approximate coal consumption which was more or less accepted by both sides in the controversies of 1836 and 1837.

We know now that the resistances encountered by a ship are not merely dependent on her dimensions, but comprise wave-making at various speeds, bringing form and proportion of dimensions largely into the necessary calculations; but I want to point out that the line of divergence of the different views of Lardner and Brunel was sufficiently precise and quite crucial. It is true that Dr. Lardner, in later criticisms of 1837, retreated somewhat from his position of 1836, introducing more of the commercial aspect of the case and stating that no steam vessel could make profitable voyages across the Atlantic, at least until marine engines were immensely improved; but, even so, it seems clear that the fundamental matter at issue in 1836 and 1837, the period of Dr. Lardner's active criticism, was the question of the resistances increasing in the same ratio as the capacity. The results of these *ex cathedrâ* statements by Dr. Lardner about the *Great Western*, then in process of being built, must have caused great anxiety to the promoters and much preliminary distrust of the ship on the part of the public. They were, unquestionably, honestly arrived at, however much they were due to reasoning on unascertained premises, and this latter is the reason for my venturing now to refer once more to them. As a matter of fact, the ship started from Bristol in 1838, and arrived at New York in fourteen days with 200 tons of coal in her bunkers.

Let me remind you of another somewhat similar instance of the way in which the anxieties of engineers have been unnecessarily increased and public alarm gratuitously, though honestly, aroused. When the designs of the Forth Bridge—of which the nation, and indeed the world, is proud—had been adopted both by the Railway Companies who were to find the capital and by Parliament, a most distinguished man of science—the then Astronomer Royal—came to the conclusion that the engineers had neglected certain laws which he enunciated respecting the resisting power of long struts to buckling, and that the bridge ought not to be constructed, as he considered that, to use his own words, "we may reasonably expect the destruction of the Forth Bridge in a lighter gale than that which destroyed the Tay Bridge." All this was stated no doubt from a strong view of public duty, in a letter to a public newspaper, though subsequently and frankly withdrawn. If the bases of his calculations were right, the conclusion might have been correct; but the fact was, that there was no foundation worthy of the name for the reasoning. Again, another distinguished mathematician publicly criticised the Forth Bridge with equal vigour, basing his views that it was fundamentally incorrect on another set of equally erroneous assumptions, maintaining again that it should not be permitted, because he proved by reasoning on those assumptions that it must be absolutely unsafe.

Once more, in ship-building, until Mr. William Froude, some years prior to 1875, made his experiments by means of models on the highly difficult and otherwise almost insoluble causes of the retardation of ships and their behaviour in waves, beginning at the beginning, taking nothing for granted, and eliminating all elements of possible errors, little or nothing was known of the laws governing these questions. Laws had been laid down by high authorities as to the causes of retardation of ships, many of which, in fact, were not true, while some of the assigned causes were non-existent and some real causes were unrecognised. Mr. Froude was told that no information could be learnt from experiments on models which would be applicable to full-sized ships, and that ships must continue to be designed and engines built on data which, scientifically speaking, were assumptions. The outcome has been that Mr. Froude's *à priori* depreciated experiments with models have solved most of the questions relating to that branch of naval architecture; and at the present time every ship in the Royal Navy, and not a few in the merchant service, are designed in accordance with the data so gained.

Another example of hasty generalisation occurs to me, and that is on the important question of wind pressure. Tredgold, who undoubtedly was one of the soundest of engineers, laid down in 1840 that a pressure of 40 lbs. per square foot should be provided for; reasoning, no doubt, from the fact that such a pressure had in this country been registered on a wind gauge of a square foot or less in area. As a consequence, he assumed that the same force could be exerted by the wind on areas of any dimensions. Thus roofs and bridges, wherever any calculations of wind pressure were, in fact, made, were designed for a pressure of 40 lbs. per square foot of the whole exposed surface, and under the alarm caused by the fall of the Tay Bridge in 1879, the piers of which were not probably strong enough to resist a horizontal pressure of one-fifth of such an amount, a further general assumption was made, and railway bridges throughout the kingdom were ordered by the Board of Trade in 1880, acting no doubt on expert advice, to be in future designed, and are designed to this day, to resist 56 lbs. of horizontal wind pressure on the whole exposed area with the ordinary factors of safety for the materials employed, as if such horizontal strain were a working load.

It had, for a long time previously to this order of Government being issued, been suspected that these small-gauge experiments were untrustworthy, and subsequent experiments at the Forth

Bridge on two wind gauges of 300 square feet and of $1\frac{1}{2}$ square feet respectively, indicated that with an increase of area the unit of pressure fell off in a very marked degree. Under the same conditions of wind and exposure, the larger gauge registered a pressure 38·7 per cent. less per square foot than the smaller gauge. I have been able to carry experiments further at the Tower Bridge by observing the pressure on the surface of the bascules of the bridge as evidenced by the power exerted by the actuating engines. In this case we have a wind gauge of some 5000 feet in area, and it has been shown that, while small anemometers placed on the fixed parts of the bridge adjoining the bascules register from 6 to 9 lbs. per square foot, the wind pressure on the bascules is only from 1 to $1\frac{1}{2}$ lbs. per square foot.

It is difficult to imagine the amount of money which has been expended in unnecessary provision against wind strains of 56 lbs. per square foot on large areas in consequence of this hurried generalisation from insufficient data. I know something of what the provision for 56 lbs. on the square foot for wind cost at the Tower Bridge, and I do not wish to mention it; but if the public had been told that the dictum of experts, arrived at however hastily in 1880, was to be set aside in the construction of that bridge, all confidence would have been beforehand destroyed in it, and I suppose no Committee of Parliament would have passed the Act.

I have mentioned these matters, which could be added to by many similar instances in other branches of applied science, not for the sake of reviving old controversies or of throwing a stone at highly distinguished men, honoured in their lifetime and honoured in their memory, nor for the sake of criticising more modern men of science or a Government Department. Still less do I wish to question the necessity and value of mathematical calculations as applied to the daily work of engineering science, but I recall the circumstances for the purpose of once more pointing out the extreme value of experimental research and of bespeaking the utmost caution against our being tempted to lay down laws based on unascertained data. We know the tendency there has been at all times to generalise and to seek refuge in formulæ, and we cannot but know that it is not at an end now. We ought to recognise and remember how few physical questions had been exhaustively examined sixty years ago, and may I say how comparatively few have even now been fundamentally dealt with by experiment under true scientific conditions? The investigation of physical facts under all the various conditions which confront an engineer requires much care, intelligence, time, and last, not least, not a little money. In urging the vital necessity of investigations, I am sure that I shall not be understood as decrying the value of the exact analysis of mathematics, but we must be quite sure that the premises are right before we set to work to reason upon them. We should, then, exert all our influence against rules or calculations based merely on hypothesis, and not be content with assumptions when facts can be ascertained, even if such ascertainment be laborious and costly. In a word, let us follow sound inductive science, as distinguished from generalisations; for "Great is truth and mighty above all things."

In connection with this subject, I may congratulate the Association generally, and this Section in particular, that there is now more hope for experimental science and some endowment of research in this country than at any former time. The vital necessity of further work in these directions has long been recognised by men of science and was notably urged by Prof. Oliver Lodge. Last year, in no small degree owing to the exertions of Sir Douglas Galton, K.C.B., who presided over the British Association in 1895, and brought the question very prominently forward in his inaugural address on that occasion, a highly influential deputation waited on the Premier to urge that England should have a Public Physical Laboratory at which facts could be arrived at, constants determined, and instruments standardised. The importance of the questions which could be determined at such an institution in their influence on the trade and prosperity of the country, independently of the advancement of purely scientific knowledge, cannot well be exaggerated.

Our Government, while somewhat limiting the scope of the inquiry, appointed a small Committee to examine and report on this highly important subject. It is no breach of confidence to say that the Committee, after taking much evidence, visiting a similar and highly successful institution on the continent, and studying the question in all its bearings, were convinced of the great public benefits which may be expected from such an institution, and have unanimously reported in favour of its establishment.

I feel sure that we shall all earnestly hope that Government will carry out the views of the Committee, and I venture to suggest that each of us should use what influence he may have, to induce the Chancellor of the Exchequer to find adequate funds for an institution which may be of the greatest benefit not merely to scientific research, but to the commerce of these islands, threatened as it is on all sides by foreign competition of the most vigorous description—a competition which is supported by every weapon which the science of other lands can forge for use in the struggle. It being acknowledged that our own work in life is to deal with physical facts and apply them for the use of our fellow-men, we may have good hopes that at such an institution as I have indicated, directed, as it no doubt will be, by the highest scientific superintendence, we shall be able, at least far better than at present, to have a sound knowledge of many facts which are obscure, and to deal with the many new conditions under which the applied science of the future will have to be carried on.

Those who know most of the problems of nature feel the more strongly how much remains which is unknown and realise how completely those who teach require throughout their lives to be always learners. Let each of us then in our special walk of life, seeking for further enlightenment on the various problems of our work and in the application of that science which we love, humbly recognise that,

"All nature is but art, unknown to thee;
All chance, direction which thou canst not see;
All discord, harmony not understood."

INTERNATIONAL SEA FISHERIES CONGRESS AT DIEPPE.

THE movement for the international discussion of matters connected with the sea-fishing industry has made such progress during the past few years that a summary of the proceedings of the recent international congress held at Dieppe should interest readers of NATURE, especially as the regulation of the industry tends more and more to be determined in accordance with the evidence accumulated by scientific investigators. The Dieppe Congress was organised by the Société d'Enseignement professionel et technique des Pêches Maritimes, and is the second international congress promoted by that society. The previous congress was held at Sables-d'Olonne in 1896, on which occasion Mr. (now Sir) John Murray was the British representative. More than 300 delegates assembled at Dieppe, among whom may be mentioned Mr. C. E. Fryer, of the Board of Trade; Dr. J. H. Fullarton, formerly of the Scottish Fishery Board; Mr. Walter Garstang, representing the Marine Biological Association; Mr. O. T. Olsen, of Grimsby; Mr. Johnsen, of Hull; Drs. Brunchorst and Bull, of Bergen; Dr. Malm, of Gothenburg; M. Tabary, of Ostend; Prof. Vinciguerra, of Rome; Dr. Valle, of Trieste; Dr. Kishinouye, of Japan; Mr. Thorndike Nourse, of the United States; and of course a large number of French delegates representing the Government and various fishery societies and schools, fishing centres and municipalities, including M. Roché, Inspector-General of Fisheries; Prof. Perrier, Baron Jules de Guerne, MM. Lavieuville, of Dieppe; Canu, of Boulogne; Odin, of Sables-d'Olonne; Gourret, of Marseilles; and Le Seigneur, of Granville. The proceedings of the Congress opened on the morning of September 2 with an address from the President, Prof. Ed. Perrier, Membre de l'Institut de France. The greater part of the President's address was devoted to an examination of purely French problems—the relative scarcity of steam trawlers and liners, the need of greater solidarity, of a spirit of co-operation and compromise among rival fishing industries, the present unsatisfactory arrangements—or lack of arrangements—for fishery research. This, he said, seemed to demand the creation of a central Fishery Board for France, similar to that of Scotland, which should be charged with the duty of coordinating the work of the numerous marine laboratories in which fishery research is now carried on without concerted aim. Proceeding then to matters of more general interest, he pointed out the advantages which would ensue if the study of plankton could be put upon an international basis by a regular organisation of the marine laboratories of different countries, or by international cooperation in deep-sea expeditions for the solution of problems connected with the migrations of fishes. At the same time, he said, it would not do to be too ambitious. The extravagant expectations which were held some years ago as to the beneficent effects of sea-fish hatcheries had not been realised either in America, in Scotland or in Norway. Even if the idea were sound, the actual plan of operation needed modification, since the young fish were being turned into the sea at too early an age. Moreover, he asked, would it not be simpler, and in the end more profitable, to complete the investigation of the whole life-history of valuable fishes before launching upon costly and problematic schemes of fish multiplication? To ensure the adequate discussion of these and similar problems, the President, in conclusion, expressed the intention of himself and his colleagues to propose the creation of a permanent international committee for the organisation of future congresses on sea-fisheries, which would extend and complete the work initiated by the French Society.

The subsequent discussions of the congress took place partly at general meetings, partly at the meetings of different sections. Four of the latter were constituted, viz. (1) Scientific Researches; (2) Fishery Apparatus, Preparation and Transport; (3) Technical Education, and (4) Fishery Regulations. The subjects which came before the general meetings dealt with oyster and mussel culture, provident institutions (insurance against accidents, &c.), international regulations for preventing collisions at sea, and co-operation amongst fishermen. As regards the sectional meetings, the topics of general interest naturally fell chiefly within the scope of the first and fourth sections. In the first section the following were the more important papers read: (1) On the natural history and fishing grounds of the Tunny in the Gulf of Gascony, by M. Odin, in which the author showed that the migrations of the Tunny of these waters are less extensive than was formerly imagined, since the fish can be taken in the Gulf throughout the year, although the actual fishing grounds shift with the seasons; (2) On the natural history of the mackerel, by Mr. W. Garstang, in which it was maintained that, as a result of researches recently carried out by the Marine Biological Association, the common species of mackerel can be subdivided into several local races, viz. an American, an Irish, and a race common to the English Channel and North Sea. These researches lead to the conclusion that the winter haunts of the mackerel cannot be situated far from the localities first visited by the several races in the spring; (3) On a proposed biological and physical investigation of the English Channel during 1899, by Mr. Garstang, in which the author invited the co-operation of French societies and naturalists with the Marine Biological Association for a joint periodic survey of the Channel during the coming year. The proposal was supported by Baron Jules de Guerne and M. Odin, and a resolution on the subject was unanimously adopted; (4) On the sea-fish hatchery at Flodevigen, by Captain Dannevig (read in his absence by Baron de Guerne). This paper gave rise to a vigorous discussion on the efficacy of hatcheries. Captain Dannevig contended that the success of his methods was attested by the statistics of cod taken in Christiania Fjord, but this statement was categorically denied by Dr. Brunchorst, and also adversely criticised by Dr. Fullarton and M. Canu.

The principal papers read in the fourth section were as follows: (1) On trawling in territorial waters, by M. Sauton; (2) On the necessity of new regulations concerning the mesh of drift and fixed nets, by M. Maraud; (3) Trawling and its effects, by M. Coutant; (4) On the territorial limits, by Mr. Olsen. The discussion which followed these papers was long and interesting, but cannot be fully summarised here. It will suffice, however, to say that at the subsequent general meeting of the congress a resolution against trawling (of all kinds) within three miles from low-water mark was carried by 37 votes to 9; and that other resolutions were carried which would have for effect the prohibition of certain kinds of fishing beyond the present territorial limits, and would prohibit the sale of immature fish, the *minimum* size for each species to be fixed hereafter by an international commission of fishermen, owners, public officials, and scientific experts.

It may be stated in conclusion that the memoirs read before the general meetings of the congress are already published (Paris, Augustin Challamel, Rue Jacob 17), and that the papers communicated to the different sections, with the final resolutions of the congress, will be published in a second volume in the course of the next few months.

NOTES.

WE are reminded that the new laboratories of Physiology and Pathology, which University College, Liverpool, owes to the generosity of the Rev. S. A. Thompson Yates, will be opened on October 8 by Lord Lister, President of the Royal Society. By his benefaction, Mr. Thompson Yates has strengthened the medical school of the College in a very marked degree, and has enabled the professors of physiology and pathology to take advantage of the most recent additions to our knowledge in their lectures and laboratory instruction. Lord Lister will be accompanied on the occasion by a large and distinguished party. The Lord Mayor will represent the city; Earl Spencer, Chancellor of the Victoria University, has promised to attend and admit Lord Lister to the degree of D.Sc. conferred on him by the Victoria University; Lord Derby, President of the College, will be present, with the authorities of the Victoria University and its Colleges. Among those who have accepted the invitation of the College Council may be mentioned: the Duke of Devonshire, Lord Derby, Lord Spencer, Lord Ripon, Lord Kelvin, Mr. A. J. Balfour, Prof. Michael Foster and Prof. Rücker (the Secretaries of the Royal Society), Prof. Virchow, Sir Douglas Galton, Sir Samuel Wilks, Sir Richard Thorne, the Bishops of Liverpool, Chester, Carlisle, and Ripon, Sir William Gairdner, Mr. Justice Kennedy, Sir James Crichton Browne, Dr. Lauder Brunton, Sir Archibald Geikie, Captain Abney, C.B., Sir George King, Mr. Thiselton-Dyer, Prof. Ramsay, Prof. David Ferrier, Dr. Pavy, Mr. R. B. Haldane, Sir John Batty Tuke, Sir Henry Littlejohn, Prof. Schäfer, Prof. Burdon-Sanderson, Prof. Kanthack, Prof. Halliburton, Prof. Meldola, Prof. Poulton, the Dean of Lichfield, Prof. Charlton Bastian, the Hon. Sydney Holland, Prof. Rose Bradford, Prof. Forsyth, Prof. Bower, Dr. Alexander Cope, Prof. Crookshank, Prof. Waller, Prof. Noël Paton, Dr. Ludwig Mond, Dr. Mott, Prof. Stirling, Prof. Liveing, Mr. Gerald Yeo, Prof. Macallum, and Dr. Byrom Bramwell. The proceedings will commence with the degree ceremony, which will take place in St. George's Hall at 3 o'clock. Lord Lister will then, with the President, Earl Derby, proceed to open the new laboratories. In the evening a banquet will be given by the Lord Mayor in the City Hall.

ON Sunday, the 11th inst., one of the most destructive hurricanes that has occurred for many years visited Barbados and the Windward Islands, causing immense damage to property and great loss of life. These storms usually occur between July and October, when the equatorial calms are furthest north of the equator; the late A. Poey, of Havana, compiled a list of all hurricanes observed in the West Indies since 1493, and of these nearly 80 per cent. occurred in those months. They usually commence to the eastward, and travel in a north-westerly direction till they reach about latitude 25° N., when they recurve in a north-easterly direction. So far as is known from the meagre reports which have yet been received, this disastrous storm followed the usual track, as the observer of the United States Weather Bureau at Jamaica seems to have forwarded notice through New York that a storm was approaching Barbados from the southward on Saturday, the 10th inst.; but, owing to an unfortunate interruption in the cable, the warning arrived too late. The late Rev. B. Viñes, S.J., formerly director of Havana Observatory, made a special study of West Indian hurricanes during a period extending over twenty-three years, and shortly before his death (in 1893) prepared a paper upon the subject for the Meteorological Congress at Chicago, which is regarded as the most satisfactory statement of the behaviour of these storms that has yet been made. This paper has just been published in a separate form by the United States Weather Bureau. In it the author discusses very completely the general laws of cyclonic circulation and translation, including the law of the recurving of the path of the hurricanes in the different months of the cyclonic season.

THE Press Association states that on Thursday last Mr. Stanley Spencer and Dr. Berson ascended from the Crystal Palace in a balloon inflated with pure hydrogen gas, and attained the remarkable altitude of 27,500 feet, or only 1500 feet less than Coxwell and Glaisher's highest in 1862. Numerous scientific instruments, including a self-recording aneroid barometer, were carried, and also compressed oxygen for inhaling at the greatest height. The descent was near Romford. At 25,000 feet the air became so rarefied that both explorers had to breathe the compressed oxygen taken with them. The balloon had a capacity of 56,500 cubic feet.

IT is reported through Reuter's Agency that a stream of lava from Vesuvius has destroyed a part of the roadway leading from the observatory to the lower station of the funicular railway. A mass of molten rock is flowing down the mountain side in three streams—one along the foot of Monte Somma, a second through the middle of the Vetrana zone, and a third along Monte Crocella. The stream running round the base of Monte Somma continues to burn the chestnut woods, and nearly reaches the observatory. The central flow has reached a point close to the Carabinier barracks, while the Crocella stream, after passing close to Messrs. Cook and Son's building, has reached the northern edge of the Canteroni ridge, whence it may also threaten the observatory. News from Naples on Saturday states that the eruption is becoming hourly more active and more menacing, and the streams of molten lava are spreading in every direction. The most threatening is that which is flowing down the immense valley of Vedrino, which is now almost filled. The observatory, which was originally situated at a height of 610 metres, is now said to have sunk over 27 metres owing to the sinking of the ground. Seven new craters have formed round the central crater, without, however, in any way diminishing the activity of the latter. The gravity with which the outbreak is regarded is chiefly based on the fact that the volcano is throwing out stones and scoriæ similar to those ejected in the great eruption of April 1872, when the lava streams covered an area of two square miles, averaging 13 feet in depth, and the damage to property exceeded three million francs.

THE Berlin Academy of Science has made the following grants for botanical work :—2000 marks to Prof. Eichler, for the continuation of his work on East African plants ; 600 marks to Prof. Graebner for the continuation of his work on German heaths ; 500 marks to Dr. Loesner, for the completion of his monograph of the Aquifoliaceæ.

TWO Walker prizes, of the value of sixty dollars and fifty dollars respectively, are annually offered by the Boston Society of Natural History for the best memoirs written in the English language on subjects proposed by a committee appointed by the Council. The subjects for 1899 are : (1) Is there fundamental difference between "equation division" and "reduction division" in the division of cells? (2) The phenomena and laws of hybridisation. The subjects for 1900 are : (1) Stratigraphy and correlation of the sedimentary formations of any part of New England. (2) A study in palæozoic stratigraphy and correlation. Memoirs must be sent in on or before April 1 of the year for which the prize is offered.

THE Mayor of Angers has appointed M. Albert Gaillard curator of the Lloyd herbarium in that town.

WE learn, from the *Botanical Gazette*, that Dr. A. Möller, of Eberswald, has undertaken the preparation of a memoir of Fritz Müller, so well known in connection with the Flora of Brazil, and with problems connected with the pollination of plants.

THE death is announced of Dr. H. Trimble, professor of practical chemistry, Philadelphia College of Pharmacy, and editor of the *American Journal of Pharmacy*.

NEWS has been received that Mr. de Windt, the geologist with the Belgian scientific expedition for the exploration of the Congo, was drowned on Lake Tanganyika on August 9, with Mr. Kaisley, a gold prospector.

THE *Pall Mall Gazette* announces that Mr. S. A. Rosenthal and Dr. S. J. von Komocki have succeeded in preparing matches which do not contain yellow phosphorus, and are capable of ignition by friction upon any surface. It is claimed that these matches can be manufactured as cheaply as the ordinary ones.

SIR W. MARTIN CONWAY has sent to the *Daily Chronicle* the news that on September 9 he reached the top of Yllimani, a peak of the Cordilleras which rises behind the town of La Paz, at a height of 22,500 feet above sea-level. With Sir Martin Conway are the two Swiss guides, Antoine Maquiguez and Louis Pellissier, who last year were in Alaska with the Duke of the Abruzzi, and made the ascent of Mount St. Elias. The party took five days to reach the top of Yllimani from the highest point of cultivation.

MRS. HUBBARD has sent us the following translation of a passage from the "Niva," recording an interesting observation : "The naturalist, Ostrovomov, director of the biological station at Sevastopol, last summer made some excursions along the coast of the Crimea. One morning, the sea being at the time calm and clear and the sky blue, he observed whole clouds of small creatures, like moths, fluttering above the smooth surface of the sea. Ostrovomov, with his son and a boy from the station, observed that each of these small creatures rested for a while on the surface of the water, as though gathering strength ; then made a spring and flew high in the air, and plunged again into the sea. They captured some of these, and examined them under the microscope ; and what was Ostrovomov's astonishment on discovering that these flying creatures were the soft-shelled crablike *Entomostraca*, belonging to the family *Pontellina mediterranea*."

THE world's record for high kite flight was (says *Science*) broken on August 26 at Mr. Rotch's observatory by Messrs. Clayton and Ferguson, who despatched a tandem of kites into the air until the highest one reached an altitude of 12,124 feet above the sea-level, a height 277 feet greater than any kite had previously reached. Five miles of line, weighing 75 pounds, was let out, while the weight of the kites, recording instruments and secondary line, was 37 pounds, making a total of 112 pounds lifted into the air. The recording instrument was made by Mr. Ferguson and was of aluminum, weighing three pounds, and registering temperature, pressure, humidity and wind velocity. The ascent was begun at 11 o'clock, and the highest point reached at 4.15 p.m. The kites passed through clouds when about a mile above the surface of the earth, but while above the clouds the instruments showed the air to be very dry. At the highest point the temperature had fallen to 38°, and the wind velocity was 32 miles an hour. At the ground at the same time the temperature was 75° and the wind velocity 32 miles. The highest wind velocity recorded was 40 miles an hour at a height of 11,000 feet. The wind on the ground at this time was from the west, while at the highest point reached by the kites it was south-west. The flight was one of a series of high ascents made during the spring and summer, averaging about a mile and a half, while on several occasions a height of over 10,000 feet has been obtained.

The results of meteorological observations made at Rousdon Observatory, South Devon, under the superintendence of Sir Cuthbert Peek, have been published. Interest in local meteorology is necessarily limited, but there are several sections of the present report which appeal to meteorologists generally. The usual comparison was made of daily forecasts issued by the Meteorological Office for the district in which the Observatory is situated with actual weather experienced. The wind and weather predictions were both correct in 85 per cent. of the forecasts. The forecasts of wind alone were correct in 90 per cent., and 92 per cent. of the weather predictions were fulfilled. The percentage of correct weather forecasts has not been below 92 for the past five years. Sir Cuthbert Peek has made a further comparison of the records of the Robinson cup anemometer and the pressure-tube anemometer. It has been assumed that the factor of the cup anemometer does not depend upon, or vary with, the velocity of the wind. To roughly test this conclusion, a comparison was made of the daily total mileages of wind passing over the Observatory, as recorded by the two instruments, during three periods of about twenty-four days each, when light airs, winds of moderate force, and strong winds, respectively, prevailed. These results show quite clearly the effect of the inertia of the cups in low velocities, the excess of the cup record over that of the pressure-tube being as much as 53 per cent., when the mean hourly velocity is as low as four miles. With a moderate wind of eleven miles per hour, however, the cups yield 3 per cent. less than the pressure-tube; and with a wind of double that velocity the difference is increased to 8 per cent. It is pointed out that these results are based on too few observations to be accepted as final, but they are suggestive, and a fuller comparison on the lines indicated may at some future time be carried out. The factor 2·2 appears, however, to be practically correct for all winds, except when the force is extremely low.

The two Cantor Lectures delivered before the Society of Arts by Dr. D. Morris, C.M.G., on sources of commercial india-rubber, have been published in a pamphlet form. In his lectures, Dr. Morris confined himself to describing the rubber plants now existing in various parts of the tropics, their geographical distribution, the conditions under which they grow, and the prospects they afford of being able to meet the increasing demand for rubber. At the outset he made a comparison between india-rubber and gutta-percha. It is very well known that india-rubber and gutta-percha are closely allied substances, not only in their origin but also in their chemical composition. They are both obtained from the latex of certain plants, and are composed wholly of carbon and hydrogen. But, as Dr. Morris points out, the similarity ends here. The most conspicuous property of gutta-percha is that of becoming soft and plastic on immersion in hot water, retaining any shape then given to it on cooling, when it becomes hard and rigid. Caoutchouc, on the other hand, does not soften in moderate heat, is impervious to water, alcohol, most acids, and gases, and retains for a long period its original elasticity and strength. Again, gutta-percha is obtained only from large trees belonging to one family of plants, the *Sapotaceæ*, confined to one small portion of the world's surface. Caoutchouc, on the other hand, is obtained from numerous families of plants, and these are distributed over almost every part of the tropical regions; they may be low herbaceous plants, shrubby climbers, small trees, or majestic giants of the forest, 150 to 180 feet high. Dr. Morris's lectures deal with these plants with special reference to the rubber industries connected with our Colonial and Indian possessions; they are, therefore, of great interest at the present time.

In the *Bulletin International* of the Imperial Academy of Science of Bohemia, Herr Franz Švec discusses the ciliated Infusoria of the Unterpočernitzer Teich, on the banks of which a biological station has been established. Sixty-nine species of Infusoria have been observed, of which ten are new; these are *Holophyra atra*, *Enchelys variabilis*, *Lacrymaria phialina*, *Pyrodon nucleatus*, *Lionotus lanceolatus*, *Loxophyllum aselli*, *Dileptus elephantinus*, *Zoothamnium limneticum*, *Epistylis rotans*, *Rhabdostyla discostyla*.

The "Communications from the Physical Laboratory at the University of Leiden," published in English under the direction of Prof. Kamerlingh Onnes, afford a striking instance of the activity of foreign Universities in the matter of research. Part 41 contains a paper by Dr. E. van Everdingen, jun., on the Hall-effect in electrolytes. The author has calculated the amount of the effect in liquids, and has compared the results with those afforded by experiments, but it appears that the observed galvanometric differences of potential in liquids differ considerably (sometimes even in sign) from those which would be caused by the Hall phenomenon. For the present, it therefore appears that we cannot use the phenomenon in electrolytes to obtain a better insight into the nature of the electric current in metals.

The *Proceedings* of the Royal Society of Queensland (vol. xiii.), just published, comprise several papers of interest. In a useful presidential address, Mr. C. J. Pound shows how the stockowner is indebted to the microscope, and explains that "all those marvellous and brilliant discoveries relating to the origin, nature, prevention, and treatment of bacterial diseases of our domesticated animals have been mainly brought about by the investigations of such brilliant epoch-making men as Pasteur, Koch, and Lister, whose names will ever be associated with the microscope and remain as lasting monuments to the science of preventive medicine."—Mr. Walter E. Roth contributes some notes on social and individual nomenclature among certain north Queensland aboriginals, personally studied by him. Mr. Roth points out that the whole question of class-systems, whereby a relationship, such as it is, is established between aboriginals living miles and miles apart, yet may be mutually unknown personally, has an important practical bearing which has hitherto been apparently overlooked. In the mind of the real North-west Central Queensland savage, all white men are believed to be similarly related; he looks upon any one European as being the brother, brother-in-law, father, or mother's brother, &c., of any other.—Mr. Thomas P. Lucus gives descriptions of Queensland lepidoptera, and Mr. Rowland Illidge contributes a list of butterflies of the Brisbane district.

A brief statement of the results of an investigation into the distribution and ethnography of leprosy in the Far East is given by Mr. Sydney B. J. Skertchly in the volume of *Proceedings* referred to in the foregoing note. The area embraced in an inquiry carried out by Mr. Skertchly and Dr. J. Cantlie, extends from the Malay Peninsula, through China, the whole of the East Indian Archipelago, Japan, and the Philippines and the islands of the Pacific; and a large amount of most valuable information as to the distribution of the disease has been obtained. As the area investigated contained every variety of surface, it was easy to determine whether physical configuration was a determining cause of leprosy. The conclusion arrived at is that neither physiographical climate nor geological conditions have any influence upon the distribution of leprosy. Contrary to the general statements, leprosy is not rife throughout the length and breadth of China, entire provinces being free from the disease. An examination of the state of affairs in the Pacific leads to the important conclusion that from the Chinese provinces of Kwantung and Fokien, leprosy spreads with diminishing intensity in all directions, and has formed a new focus in Hawaii of unparalleled virulence. Viewing the facts from an anthropological standpoint, it appears that so far from the black races being the most leprous, and the yellow the least, over the great area dealt with, the black races are quite free from leprosy, except where, as in Fiji, it has been recently introduced; and the yellow race, the Chinese, is the leper and the distributor of leprosy. In not a single instance are the native races attacked without there being Chinese lepers in the country. In other words, leprosy follows the lines of Chinese emigration, and in the East Indian Archipelago and Oceania is co-terminous and co-existent, in time and area, with the Chinese coolie. Mr. Skertchly believes that the only way to stop the spread of leprosy is to put an end to the coolie traffic from the infected provinces, and this cannot be done except by concerted action of the Governments holding possessions in the Far East.

THE Wilde lecture "On the Physical Basis of Psychical Events," delivered by Prof. Michael Foster before the Manchester Literary and Philosophical Society last March, is printed in Manchester *Memoirs*, vol. xlii. (1898), No. 12.

A COPY of "Bourne's Handy Assurance Manual" (1898), edited by Mr. William Schooling, has been received. The volume shows the position of every assurance office, and should be consulted before taking out a policy in any company. Students of statistics will also find the tables useful.

A NINTH edition of Skertchly's "Geology," revised in accordance with the latest requirements of the Science and Art Department's syllabus, has been prepared by Dr. J. Monckman, and published by Mr. Thomas Murby. A new section dealing with minerals and their microscopic characteristics has been added, but the general appearance of the book and the illustrations are behind the times.

THE additions to the Zoological Society's Gardens during the past week include a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. S. C. Rogers; two Little Armadillos (*Dasypus minutus*) from Patagonia, a Vociferous Sea Eagle (*Haliætus vocifer*), a Chameleon (*Chamæleon vulgaris*) from Africa, deposited; a Pleasant Antelope (*Tragelaphus gratus*, ♀), bred in Amsterdam, purchased; a Crested Porcupine (*Hystrix cristata*), three Swinhoe's Pheasants (*Euplocamus swinhoii*), three Mandarin Ducks (*Œx galericulata*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE NEBULA OF ANDROMEDA.—A telegram from the Centralstelle, Kiel, received here on the 20th, announces that Seraphimoff has observed a stellar-like condensation near the centre of the nebula of Andromeda.

This is not the first time that variations near the centre of this nebula have been observed. In 1885 a star of 6·5 mag. appeared suddenly near the centre, giving a continuous spectrum containing probably a few bright lines; in 1886 this had entirely disappeared. Espin thought that the nucleus was variable, and that he could see stars in it; and Young, with a 23-inch refractor, confirmed this. The fine series of photographs taken by Roberts also indicate that the nucleus of the nebula is variable.

An examination of the nebula on the early morning of the 21st, with the 30-inch reflector of the Solar Physics Observatory, South Kensington, gave the idea that the centre of the nucleus seemed more elongated and was more of a stellar nature than usual. The application of the spectroscope indicated nothing more than a continuous spectrum, although there may have been faint bright lines which could not be seen.

COMETS TEMPEL 1866 AND PERRINE-CHOFARDET.—Just after we had gone to press last week we received another telegram, concerning the comet discovered by Pechuele, saying that it was Wolf's comet and not that of Tempel.

Another telegram, dated September 15, informs us that Perrine, on September 13, discovered a comet at 16h. 14·3m. Lick Mean Time, in position of R.A. 9h. 41m. 40s. and Declination + 30° 36′. Two circulars from Kiel (Nos. 11 and 12), which have since reached us, give the elements of the comet's orbit and an ephemeris for the present month, besides telling us that Chofardet made the same discovery independently at Besançon on September 14, 16h. 37m. local time.

Both the elements calculated by Berberich from observations on September 12, 13, 15, and by Perrine and Aitken from observations on September 13, 14 and 15 are very similar, so we will confine ourselves to the former, whch are namely:—

$$T = 1898 \text{ October } 19{\cdot}9565 \text{ Berlin M.T.}$$

$$\omega = 165°\ 56'{\cdot}29$$
$$\Omega = 36\ 20{\cdot}85$$
$$i = 29\ 16{\cdot}41$$
$$\log q = 9{\cdot}57608$$

For the present month the positions of the comet for every two days are as follows:—

1898.	12h. Berlin M.T. R.A. h. m. s.	Decl. ° ′	Br.
Sept. 22	10 35 2	+25 9·9	
,, 24	10 48 3	23 32·4	2·08
,, 26	11 1 11	21 46·6	
,, 28	11 14 23	+19 52·3	2·67

CATALOGUE OF NEBULÆ.—Mr. Lewis Swift publishes in a recent number of *Astr. Nachr.* (No. 3517) a catalogue of nebulæ which have been discovered by him during the last three years. All the observations were made at the Lowe Observatory, Echo Mountain, California, the low latitude of this station, namely +34° 20′, enabling him to search further south than when he was situated at Rochester, New York. He says: "I am further south than any observatory in Europe and America north of the equator except the one at Tacubaya, Mexico, yet I find that the southern sky has been pretty thoroughly explored by Sir John Herschel, Dunlop, and others."

The present catalogue contains 243 objects, some of which are very interesting. Thus, Nos. 6 and 27 are described as being very singular. They resemble a fairly bright double star, each component being an exceedingly small nebulous disc "like an imaginary double nebulous Uranus distant about 5″ or 6″."

No. 56 is described as "a nebulous hair-line of one uniform size from end to end," while No. 91 has one side extending like a brush.

In addition to the above, this keen-eyed observer has discovered no less than four comets, one of which is of short period, and his son has discovered a fifth, also of short period.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Calendar of University College, Bristol, for the Session 1898–99 has been published. The College offers excellent opportunities for the study of science, languages, history and literature, and possesses good facilities for giving systematic instruction in the branches of applied science more nearly connected with the arts and manufactures. Medical education is provided by the Faculty of Medicine of the College; and students can complete in Bristol the entire course of study required for the various medical and surgical degrees.

IN order to encourage systematic study, a definite course of instruction extending over three years has been established in the Morley Memorial College (for working men and women), Waterloo Bridge Road. In the first and second years all students will follow almost the same course of study, but in the third year they will take up a selected group of literary, mathematical, or scientific subjects. Organised courses of this kind are of far greater educational value than the study of a large number of disconnected subjects.

MAJOR P. G. CRAIGIE's annual report to the Board of Agriculture on the distribution of grants for agricultural education and research in 1897–98, has just been issued as a Parliamentary paper. The total amount distributed during the financial year to each of the fifteen institutions receiving assistance was 7200*l.*, as compared with 7000*l.* in the previous year. The following table shows how this money was expended:—

Institutions aided.	Work.	Grant, 1897–98.
		£
University College of North Wales, Bangor	Collegiate centre	800
University College of North Wales, Bangor	College farm	200
Durham College of Science, Newcastle-on-Tyne	Collegiate centre	800
Durham College of Science, Newcastle-on-Tyne	College farm	200
University College of Wales, Aberystwyth	Collegiate centre	800
Reading College	Collegiate centre	800
Yorkshire College, Leeds	Collegiate centre	600
University College, Nottingham	Collegiate centre	600
South-Eastern Agricultural College, Wye	Collegiate centre	600
Cambridge and Counties Agricultural Education Committee	Collegiate centre	500
Eastern Counties Dairy Institute, Ipswich	Dairy instruction	300
British Dairy Institute, Reading	Dairy instruction	300
Royal Botanic Garden, Edinburgh	Class for foresters and gardeners	150
Bath and West and Southern Counties Society	Field experiments	50
Bath and West and Southern Counties Society	Cider experiments	50
Bath and West and Southern Counties Society	Cheddar cheese research	200
Highland and Agricultural Society	Agricultural experiments	100
Agricultural Research Association, Aberdeen	Agricultural experiments	100
Stewartry of Kircudbright Dairy Association	Cheese discoloration inquiry	50

The grants to the collegiate centres in England and Wales are of a general character, intended to assist and improve the local provision made for instruction in the higher forms of agricultural education. The thirty-two separate counties are thus provided with an efficient and economical means of systematising their local instruction, and of supervising demonstration plots and agricultural experiments by securing scientific advice and the assistance of qualified lecturers drawn from the collegiate educational staffs. The Durham College of Science and the University College of North Wales have been granted special assistance in consideration of their having taken farms for practical work and field experiments.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 12.—M. Faye in the chair.—Meadow land in warm dry summers, by M. Ad. Chatin. A list of those species of plants which have been found to be the most capable of resisting a hot, dry summer.—Observation of an aurora borealis, by M. H. Deslandres. An aurora was observed at Meudon on September 9 about 9 p.m., and its general direction was very nearly that of the magnetic meridian, the rays having a greenish colour.—On the crystallisation of the anhydrous sulphides of calcium and strontium, by M. Mourlot. The crystallised sulphides of these metals can be prepared in two ways, either by heating a mixture of the corresponding sulphate with carbon, or by simply fusing the anhydrous sulphide obtained by the method of M. Sabatier, the temperature employed being that of the electric furnace with a current of 1000 amperes at 60 volts. The crystallised sulphides thus produced are more stable than the corresponding amorphous salts, and are attacked with difficulty by reagents; carbon at a very high temperature converts them into carbides. Both crystallise in the cubic system, and are without action upon polarised light.—On a double carbide of iron and tungsten, by M. Percy Williams. This compound, the existence of which was indicated in an earlier paper, is prepared by heating a mixture of tungstic acid, iron and coke, in the electric furnace with a current of 900 amperes at 45 volts. The ingot formed in the reaction contains the carbide of tungsten WC, probably W_2C, and the double carbide $3W_2C.2Fe_3C$.—On the commercial extraction of thorium, by MM. Wyronhoff and A. Verneuil. The mineral is worked up by one of the usual methods as far as the production of the oxalates, these precipitated by sodium carbonate and hydroxide, and the washed precipitate dissolved in hydrochloric acid. This liquid is treated with small portions of barium peroxide, until hydrogen peroxide no longer gives a precipitate. The deposit, which is of a reddish orange colour owing to the presence of cerium, contains the whole of the thoria, with about 20 to 30 per cent. of impurities. Further treatment with hydrogen peroxide after a similar set of operations readily gives a very pure thoria. The method has been applied on the large scale, starting with five tons of monazite, with good results.—On the composition of the humic constituents of the soil, by M. G. André.—On the transformation of luminous variations into mobile relief, by M. Dussaud.—On a new coccus, by M. Louis Leger. The new species is found in the digestive tube of *Lithobius hexodus*, and belongs to the genus *Echinospora*. Its microgametes are furnished with vibratile cilia; the name *E. ventricosa* is suggested.—Influence of light on the form and structure of the branches of the wild grape and ground ivy, by M. Maige. Comparative cultures placed in light of decreasing intensities showed that both from the morphological and anatomical points of view, a feeble light increases the adaptive powers of climbing plants, diffused light favouring the conversion of a flower-bearing bud into a tendril. Direct sunlight produces the opposite effect.—On the adherence of the cupric solutions used for curing the cryptogamous diseases of the vine, by MM. Guillon and Gouirand.

BOOKS RECEIVED.

BOOKS.—The Unconscious Mind: Dr. A. T. Schofield (Hodder).—U.S. Department of Agriculture: Report of the Chief of the Weather Bureau, 1896–97 (Washington) —Bird Studies: W. E. D. Scott (Putnam).—Coffee and India-rubber Culture in Mexico: M. Romero (Putnam).—The Sphere of Science: Prof. F. S. Hoffman (Putnam).—A Text-Book of General Astronomy: Prof. C. A. Young, new edition (Arnold).—A Pocket Dictionary of Hygiene: C. T. Kingzett and D. Homfray (Baillière).—University College, Bristol, Calendar, 1898–99 (Bristol).—A Memoir of T. Sterry Hunt: J. Douglas (Philadelphia).—Infinitesimal Analysis: Prof. W. B. Smith, Vol. 1 (Macmillan).—Die Photometrie der Gestirne: Prof. G. Müller (Leipzig, Engelmann).—Die Photographie der Gestirne: Prof. J. Scheiner (Leipzig, Engelmann).—Atlas to ditto (Leipzig, Engelmann).—Untersuchungen zur Physiologie der Pflanzlichen Organisation: Prof. G. Berthold, Erster Teil (Leipzig, Engelmann).—A Text-Book of Geodetic Astronomy: J. T. Hayford (Chapman).

CONTENTS.

THURSDAY, SEPTEMBER 29, 1898.

THE RETURN FROM IDEALISM.

The Metaphysic of Experience. By Shadworth H. Hodgson. 4 vols. Pp. xix + 459; viii + 403; viii + 446; viii + 503. (London: Longmans, Green, and Co., 1898.)

DR. SHADWORTH HODGSON'S first essay in metaphysic was made a generation ago, and his well-known "Philosophy of Reflection" dates from twenty years back. In the interval his work has undergone review and development, revealed from time to time in his presidential addresses in Albemarle Street; but it is in the present volumes only that the mature results of his courage and patience appear in their due perspective. It is a matter for general congratulation that so original a thinker should have been able to put forth his system in such relative completeness.

Neither empiricism which treats unanalysed concretes as ultimate, nor materialism and idealism which lay the stress on the facts of some one order only which we have somehow and in some sense come to know, can offer us an adequate explanation of the world as it exists for common-sense. Materialism fails to explain consciousness because matter is known for what it is only in terms of consciousness. Idealism fails to solve the problems of the material world as known to science because it hypostatises thought, imputes real agency to it. Nor is the compromise which makes the material and the conscious simply diverse aspects of the same reality less vicious in its use of unproven assumptions. There is but one way left—experientialism or the interrogation of consciousness by the analysis of its process-contents. Such analysis is what Dr. Hodgson calls metaphysic, and upon it may be built a constructive and complementary philosophy with unverifiable results. The analysis and construction together constitute philosophy as a whole.

If it is possible to reach to what is in any sense of the words beyond, and independent on, consciousness, it can only be so by making distinctions in the analysis of the contents of consciousness itself. Dr. Hodgson's first book and volume then is devoted to this analysis. What exactly do we find in consciousness? If we dismiss the prejudices due to system and incident to language, we have yet to face the fact that the analysis can only be taken in hand when one has long built up his common-sense world, and the conditions of past consciousness cannot fail to affect present. Dr. Hodgson's device to reach consciousness in its lowest terms is to introduce new facts into consciousness, a note, say, and then another struck on an unseen piano, and abstracting from our knowledge of their names, significance, and associations, to inquire what is present in the empirical moment of perception. He finds two distinguishable elements involved, time and feeling. The first note is felt to have receded, though retained in consciousness, as the second is struck. Further consideration shows that time must be taken as having duration and as continuous, and that even the first note must begin to recede from the point at which it begins to be felt. Thus all perception is retrospective or reflective. This fact is important as leading us at a later stage to contrast the reflective functioning of consciousness as a knowing with its forward movement as existent; to apprehend, as we compare retention with redintegration, the significance of the phrase "below the threshold of consciousness" familiar to the physiological psychologist; to learn without surprise that there is in antithesis to consciousness an order of real conditioning, in which the neuro-cerebral system is proximate condition of consciousness as its conditionate and evidence.

But for the present Dr. Hodgson riots in pure analysis—how we become aware of time future, how we distinguish objective thoughts and objects thought of, "what" and "that," nature and genesis, essence and existence; how and in what proportions tactual and visual perceptions give us our knowledge of that pre-eminently "common sensible," space; how the external world and the localisation of consciousness in our bodies become known, and the like. Peculiarly significant is the part played by desire and disappointed expectation in leading us to distinguish the phantasmagoria of objective thoughts from the order of objects thought of as really existing.

In actual achievement as well as in fruitfulness of suggestion this analysis is a veritable triumph. Its central thought is that the agent and subject is the organism, and not any immaterial Psyche or transcendental ego implied in consciousness. The interruptions of continuity in consciousness, and the part therefore assignable to the brain and other nervous system in the explanation of memory, lead us, if we can render matter, in some sense indifferent to consciousness, intelligible as a real existent, to a theory in which it is held that in and from the cognitive order we can infer to an order of real conditioning of which consciousness is the dependent concomitant. The point on which the critic who is not prepared to deny Dr. Hodgson's other main positions would be most likely to take issue is the Lockean doctrine, that percept-matter and physical matter are so related that matter is known as it actually is. Here, perhaps, the antithesis of noumenon and phenomenon might find rehabilitation.

The order of real conditioning is the field of the positive sciences, except psychology. This deals with consciousness as an existent in dependence on its proximate conditions in the neuro-cerebral organisation.

Book ii. deals with the positive sciences and contains admirable analysis of some of their fundamental conceptions. In this section Dr. Hodgson disclaims expertise, and supports himself on authorities; but his treatment of the ultimates of mathematics and physics is wholly admirable. Corresponding to his treatment of space in Book i., which was of quite palmary merit, comes an adverse criticism of the claims of non-Euclidean space-theories. His discussion of the Newtonian conception of matter leaves nothing to be desired. In chemistry he tends to follow "the new chemistry"; in the biological sciences, though interesting, he is discursive and too little "positive" to be convincing.

With Book iii. we pass to the science of practice and practical science, to the analysis of conscious action logical poetic or æsthetic, and ethical. And here the analysis of volition, and the demonstration of the continuity of reasoning in logic and ethic are substantial contributions to speculation. It is probably in the sphere of practice and in especial in ethic and religion that Dr. Hodgson finds the true task of consciousness as something other than the fly upon the wheel of real conditioning. At any rate the denial of efficiency to consciousness and the attribution of real activity to the organism as such, to the conscious being and not to his consciousness, has not emptied morality of content. Conscience and personality have their meanings, and very full and rich ones in the new system. Conscience as self-consciousness in selective attention is no doubt wholly conditioned by the neuro-cerebral system, but it is the sole criterion of morality, its preferences are perforce imperatives, its judgments as to the anticipated effect of actions upon character are final in scorn of consequence. No system of prudence will satisfy Dr. Hodgson, but only a moral responsibility for character which requires free-will.

His treatment of this well-worn topic is somewhat unconvincing. Inward determination or self-determinism is freedom, and in this sense even the inorganic is partially free, and in each higher organisation of matter such freedom is intensified. And we are not to think that laws of nature "compel"; there is no necessity in the order of real conditioning.

So far, so good. But is this enough? The *de facto* presence of real alternatives in the order of real conditioning is what is required to justify responsibility on Dr. Hodgson's theory, and he will not allow himself to make fallacious inferences from sense of effort and so forth. Does he not tacitly rest the case on the belief that otherwise pleasure and pain, desire and volition, the whole contents of consciousness as such are illusion and inutility? In acknowledging only "apparent design" in nature, and resolving the teleological into the æsthetic judgment, he precludes himself from this escape. The influence of Kant's later critiques is all the more obvious from Dr. Hodgson's antagonism to the earlier.

Out of the moral consciousness arises the religious. And of this Dr. Hodgson is at pains to show the competence and limits.

The fourth book on "The Real Universe" is really a *Religionsphilosophie*. Approached in a characteristically analytical way. Matter or adverse occupancy of space by coherence of parts is composite even in its minima. It must therefore have been produced by non-material real conditions. Either this or the "aseity" not yet proven of matter. It is upon these unseen realities, which through matter their product work in the organism and condition consciousness, that faith fastens. Upon them it projects, in a way satisfying only to the practical reason, those conclusions which religion derives from ethic and completes ethic by. Among other vaticinations in this field consciousness stumbles pathetically upon a theory of an organism formed by the neuro-cerebral system with the growth of character, an organism perchance disengageable at death and capable of a future life with those it has loved and lost—the theory of the authors of "The Unseen Universe." But Dr. Hodgson is severe with himself and will not take any surmise for metaphysical truth.

The strength or the weakness of the system lies in the refusal to attribute agency to consciousness. Where, if it does nothing, and the neurosis all, lies the use of consciousness? and yet if we introduce final causes, what becomes of Dr. Hodgson's system? Or is its sole use the speculatively unjustifiable self-projection into the unseen which characterises the ethico-religious consciousness?

But beyond the significance of any single doctrine of "The Metaphysic of Experience," or even of its central doctrine, is that of its method. Many of its results must hold good, but, were it otherwise, the book would live, because of the unflinching sincerity which is its keynote. H. W. B.

AN INTRODUCTION TO GEOLOGICAL SCIENCE.

Geology for Beginners. By W. W. Watts, M.A., F.G.S. Pp. xvii + 352. (London: Macmillan and Co., Ltd., 1898.)

THE progress of science demands from time to time new text-books by fresh workers, and in the handy little volume before us we have presented to us the leading facts and principles of geology concisely explained and well illustrated by the light of the most recent researches. The author himself, one of the most energetic of observers and teachers, and with a varied experience both in the field and laboratory, has made excellent use of his opportunity, and in this "Geology for Beginners" he has given to the earnest student one of the best introductions to the science ever published. There are other works on elementary geology which will prove more fascinating to general readers, who seek to become acquainted only with the principles of the science; but those who desire to master the subject must enter into details, and they will do well to follow step by step the instructions given by our author.

From the study of a few selected examples of rock at home, he leads us to the study of rocks and rock-structures out-of-doors. We are then taught to observe the wear and tear of rocks by various agencies, and to understand the formation of gravels, sands, and clays, including in course of time the mode of origin of crush-conglomerates. The action of compressed air on sea-coasts, and many other little matters, not usually explained in text-books, are introduced to our notice. In all information relating to mineralogy and petrology, to metamorphism and earth-movements, the author's statements are clear, and as full as need be for an elementary student. Each chapter is divided into paragraphs with bold headings, and at the end there is a recapitulation which is followed by a series of questions. The author has planned his work on the revised syllabus of the Science and Art Department, and the questions which he quotes are those which have been set by that Department and by the Oxford and Cambridge Schools' Examination Board.

Throughout the volume the subjects are illustrated by diagrams, by photographs of hand-specimens and microscopic slides of rocks, and by photographs of natural exposures of rocks. In the chapters relating to the successive geological periods there are numerous figures of fossils. In most cases the names of the genera only are given, but in some instances the names of the characteristic species are also mentioned. This portion of the work would, we think, bear amplification in a new edition. We note that *Eozoon* is abandoned as a fossil. The Archæan system is regarded as Eozoic, as the bands of limestone and graphite which it contains are probably of organic origin, while among the Longmynd rocks "obscure traces referred to worm-tracks and trilobites have been found."

Concluding chapters deal with the origin of landscape, with escarpments, base-levels, &c., and there is a brief outline of economic geology. Too little attention is perhaps, as a rule, given to this last professional aspect of geology; but in his introduction the author rightly observes:

"Pursuing these studies we are brought into contact with constituents of the earth's crust which are of value in the arts and manufactures, and it is our business to learn about them, where they are found, and how they were formed, and if possible to point out where similar things may be found elsewhere."

Applied geology must of course be based on the firm footing of science—on a foundation the main features of which are so ably delineated in the present little volume.

OUR BOOK SHELF.

Plant Life, considered with special reference to Form and Function. By Charles Reid Barnes, Professor of Plant Physiology in the University of Chicago. Pp. vii + 428. (New York: Henry Holt and Co., 1898.)

IT is rather difficult to speak with justice about Prof. Barnes' little book. The idea, set forth in his preface, of attempting to give a general and somewhat philosophical account of plant life such as shall be useful to young readers, is an ambitious one, and the author has, here and there, almost realised parts of it. But we must confess that, taken as a whole, the book is not satisfactory—it is more provocative of yawning and somnolence than keen interest. At times, too, it is amazingly behind the times. The discredited figures of centrosomes are reproduced with a fidelity worthy of a better cause, and the account given of the ascent of sap is worse than misleading. Some of the figures, too, are very bad, and it is difficult to see the use of a delineation of a *Fucus* egg, such as presented in Fig. 42.

The physiological part is in some respects, perhaps, less open to objection than much of the rest of the volume; but here also there is a deal of useless talking round points, giving wordy definitions instead of definite ideas. What is the good of telling young students that irritability is the power of responding to a stimulus, without giving them some idea of what a stimulus itself consists? Quite enough knowledge of chemistry is presupposed in the earlier chapters to have warranted a more precise explanation of the nature of a stimulus than "the external change which brings about the reaction"; and the metaphor of the trigger and loaded gun ought to be carefully explained, if it is to be put before young readers.

These are a few of the defects which mar the execution of a task perhaps almost impossible of fulfilment within the compass of a small book; but if the author has not, at least in our judgment, succeeded in writing a book pre-eminently useful for students, it may, as a kind of note-book, prove of service to young teachers. The volume ends with tolerably good appendices containing directions for laboratory work and the collecting of suitable material for study.

Stories of Starland. By Mary Proctor. Pp. 186. (New York: Potter and Putnam Co. London: G. W. Bacon and Co., Ltd.)

TO write a book in a conversational style for the instruction of children requires a deal of art and close familiarity with the curious workings of young minds. Books of this kind have usually to be classed as failures, and the present volume only rises in parts above their level. In the first place, few of the illustrations will interest children, and the figures of Mars on p. 69, and of the Orion Nebula on p. 157, are in no way satisfactory. Then the children's questions and answers are too ready and apt for an average child to follow or retain in his mind. Thus, on the four pages 20–23, Master Harry, who plays the part of the inquiring boy, has impressed upon him that it would take a train nearly one hundred and seventy-five years to get to the sun, that at the rate of two cents a mile the fare would be nearly two million dollars, that walking at the rate of four miles an hour for ten hours a day the journey would occupy more than six thousand years, that a cannon ball would take nine years to reach the sun, and the sound of the explosion fourteen years, and that if an imaginary long arm touched the sun, the pain of burning would not be felt for one hundred and fifty years on account of the time taken in the transmission of sensation through nerves.

Now all this may be very well in a popular lecture in a country village, for grown-up people sometimes like to be impressed by statistics of the millions upon millions type, but it has no educational value whatever, and is entirely out of place in a volume intended for the instruction of children. In fact, Miss Proctor makes the common mistake of crowding too many uninteresting details into her book, and of describing too many appearances which her pupils will be unable to see for themselves.

By far the best part of the volume is that in which the chief constellations are described, and the legends connected with the constellation figures are related. These star-stories from the mythology and folk-lore of different peoples are better suited to the mental condition of a child than the descriptions of petty details concerning planetary motions and appearances.

A number of short poems of variable quality are interspersed through the pages, and may help to relieve the narrative when children of poetic temperament are the readers or listeners.

Canalisations électriques. By R. V. Picou. Pp. 172. (Paris: Gauthier Villars. Masson et C^ie^.)

DETAILS concerning the erection and working of aerial lines for electric currents are given in this volume, which belongs to the well-known Aide-Mémoire series. The first part of the volume includes descriptions of the wires used, the various forms of insulators, and different kinds of posts and supports used to carry the wires; the second part is concerned with the mounting of lines, all the details as to earths, tension, and protection against electrical and other disturbances being dealt with. In the third part of the volume the chief formulæ and tables used by electrical engineers engaged in wiring work are brought together.

Contributions a l'Étude de l'Hérédité et des Principes de la Formation des Races. By J. M. Harraca. Pp. 172. (Paris: Félix Alcan.)

HERE and there in this little volume the reader will find an interesting point referring to facts or views bearing upon heredity, but the search for this material for thought in a waste of words is very wearying. The author writes with apparent conviction that he has new things to say, and he certainly does express some ideas which appear to merit consideration, so that students of heredity may find it worth their while to glance through the volume.

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.*]

Flow of Water.

BEING away from home at this place, I did not see a copy of NATURE of September 15 in time to reply in the next issue to the letter of Prof. Osborne Reynolds. That letter is to a great extent a discussion of a point of considerable interest, viz. the clear border visible in my experiments with air injected into flowing water.

The discussion is, however, preceded by a statement which, whether intentionally or not, seems to imply that not only had Prof. Reynolds previously with similar apparatus made most of the experiments I have published during the last year or two, but had communicated to me his methods and shown me this apparatus. Apparently, therefore, my humble part has been the production of a certain number of photographs of effects slightly modified from those dealt with by him.

Now, though questions of this sort are of little interest, I have no alternative but to reply to all this, because, unfortunately, the real facts of the case as to my indebtedness to Prof. Reynolds have left quite a contrary impression on my mind to that which might otherwise be supposed.

With brevity in view, I will merely refer your readers to an article in NATURE (May 12), which gives a brief outline of my research up to that date. In that article is mentioned and duly acknowledged the only point for which I am indebted to the writings of Prof. Reynolds, viz. the idea of the two manners of motion of water, so ably worked out by him in the *Philosophical Transactions* of the Royal Society.

Beyond this I cannot recall a single idea, communicated verbally or otherwise, which I owe to Prof. Reynolds, and I certainly have never seen or heard of any other appliances which bear the remotest resemblance to those I have designed and used.

If the foregoing simple statement of fact is not sufficient, I am quite prepared to enter into the subject more in detail, although I should regret to have to do so.

My reply to the other portion of the letter will be rendered much more clear by means of diagrams, and I will therefore defer my answer to it until I return to work at Liverpool.

H. S. HELE-SHAW.

South Beach Hotel, Troon, N.B., September 26.

The Movement of Encke's Comet.

IN Prof. Poincaré's paper on the "Stability of the Solar System," the statement is made that "astronomers have only been able to explain the movement of Encke's comet by supposing the existence of a resisting medium."

It may be of interest if I state that in a paper published in the *Astrophysical Journal* for January 1896, I have shown that the movement of Encke's comet may be explained by the application of well-known physical laws, which have been verified experimentally by a number of physicists, and that no suppositious resisting mediums are necessary. It is also of interest to note that the same phenomena which explain this change of rate also explain the other cometary phenomena, such as the formation of cometary tails, the curious bridge in Biela's comet, and enable us to predict that comets are unstable bodies and must all ultimately split up into swarms of meteorites, the fragments continuously separating from each other.

I might also call attention to the fact that since, according to this theory (which has so far accounted for all the facts known without assuming any premises except well-known properties of matter), a comet can be used as a gigantic absolute electrometer (its tail being the index) for measuring the electrostatic potential of the sun and planets, accurate observation of the curvature and spectra of comets' tails are much to be desired throughout their whole period of visibility.

REGINALD A. FESSENDEN.

Western University of Pennsylvania, September 3.

A Request for Zoological Literature.

I WISH to ask my fellow zoologists, especially those on the continents of Europe and America, to be kind enough to send me, for our library here, separate copies of their papers and memoirs on zoological subjects. Here, in New Zealand, a naturalist is not only isolated, but has no efficient supply of current zoological literature; the nearest library containing modern periodicals being Sydney—a week's journey. The museum library in Dunedin, though well equipped in some respects (travels and older books), is extremely poorly provided with periodical literature. We take in the English journals and *Proceedings* of Societies, &c., but we do not purchase a single German periodical (with the exception of the Naples *Mittheilungen* and the *Jahresberichte*), and only one French journal, *Annales des Sciences naturelles*.

Hence, we are fearfully handicapped in our research work, and in our efforts to keep abreast of zoological advances. Out of sight, here, is to be out of mind to a great extent; and I would earnestly ask my colleagues in Europe and America, in their kindness, to help to remedy this disadvantage. Even if we wish to purchase a work in Europe, it takes at the very least three months before we can obtain any reply to our orders, and more usually four or five months intervene.

You dwellers in and near cities and large libraries cannot appreciate this great inconvenience.

W. BLAXLAND BENHAM.

Dunedin, New Zealand, August 14.

Stereochemistry and Vitalism.

WHEN listening to Prof. Japp's stimulating presidential address, I could not but wish that he had pursued his subject further and inquired into the antecedents of the life-made carbon compounds.

These are probably formed in the first place, not as compounds of only C, H, and O, but rather as constituents of a large molecule which has nitrogen as its centre. The growth of the C, H, and O groups depends on the lability of N compounds, *i.e.* their proneness to transfer matter and energy. If, then, the formation of the said carbon compounds is controlled by the nitrogen, whose atoms (with a valency alternating between 3 and 5) are asymmetrical or have a symmetry different from that of the carbon atoms, *does this peculiarity of the nitrogen determine the asymmetry of the resulting carbon compounds?*

F. J. ALLEN.

Mason University College, September 24.

A White, or Milky Sea.

I LEFT Bombay for England in January 1881, on board the P. and O. s.s. *Sumatra* (Captain Briscoe), and on February 1, the vessel being then in N. lat. 14° and E. long. 53° (not far from the position described by your correspondent) had an opportunity of witnessing the phenomenon known as the "Milky Sea," rarely seen except in these waters. The following extract from my book, "An Engineer's Holiday," describing and explaining the appearance, may interest Mr. Barrett:—

"The whole ocean, from the ship to the visible horizon, looked as if it were covered with snow, whose surface evidently shone by the reflected light of the sky, for Venus, being very bright, threw a distinguishable line of radiance across it, while the phosphorescent crests of waves were now and then seen breaking above the layer of shining matter which overlaid the water.

"A current, always encountered north of Socotra, set the ship, on the day in question, fourteen miles to the northward of her course. This stream was crowded with large medusæ, visible not only during the day, but also at night, when, being themselves non-luminous, they appeared as whirling black discs in the general phosphorescence of the ship's wake. The ship's officers fully believed that this current brings with it, besides jelly fish, enormous quantities of decayed and phosphorescent matter, to whose presence they attributed the appearance of the 'Milky Sea.'

"The fact, however, that the seeming snow reflects light, and is broken through by quite small waves, disposes of this explanation, and we soon convinced ourselves that the phenomenon is really due to a thin layer of mist lying on the water, exactly resembling one of those local fogs which every one has seen, and which may give to a valley or even a slight depression the appearance of being snowed up. It occurs when the sea is colder than the atmosphere, and the latter still and heavily loaded with aqueous vapour. Under these circumstances, a layer of air immediately in contact with the water is chilled below the dew point and becomes misty, while that above remains transparent: the upper surface of such a fog, which is only a few inches thick, being seen by the reflected light of the sky" ("An Engineer's Holiday," vol. ii. p. 314).

The temperature of the sea on the night in question was 70° F., while that of the air was 79°, an unusual amount of difference in the Arabian sea. Water, brought on deck by a bucket, showed no signs of milkiness, though crowded as usual with various phosphorescent organisms. DAN. PIDGEON.

The Long House, Letherhead, September 24.

Luminous Clouds?

I OBSERVED a phenomenon at the Lizard, on the night of September 10, which is new to me, but what I presume is meant by luminous clouds.

At 10.48 p.m. several others and myself saw a large patch of what looked like luminous mist suddenly appear just to the south of the constellation Perseus. It only lasted a very short time, but quickly reappeared accompanied by another which extended from near the extremity of the first to the higher part of Cassiopeia. The longer axes of these patches were in one line nearly east and west, and low down in the west in this line produced, appeared and reappeared a similar patch. Shortly afterwards a similar patch appeared with its longer axis on the same line almost at the zenith. The line of direction of these clouds formed a small angle with the Milky Way. I may state that the sky was quite clear except for a bank low down in the north, and that the light of these clouds was sufficient to attract attention although one was not looking in their direction, and although they were so high in the sky. Several fugitive patches appeared in the west at short intervals, and at 0.10 a.m. (11th) a very bright patch was to be seen in the north-east. Just afterwards the patch in the west reappeared, and with one or two short interruptions and, at first, considerable variation of intensity, remained until close on 1 a.m. The position remained, as far as I could see, constant, and at about 0.30 a.m. I fixed its position by means of a flag-staff and the top of a wall, and on the following day I took the bearings by the theodolite. The lower edge of the cloud was nearly straight and horizontal, and the angles are for the centre of this lower edge. They are as follows: N. 281° 12′ E. (mag.), elevation 7° 18′.

I thought that if any one is collecting information on the subject, a report from the extreme south and west might be useful, especially as I was able to get the bearing pretty accurately.

I may add that the aurora of the evening of the 9th was well observed throughout Cornwall, though I do not know that I can give much information that would be of value with respect to it. ARTHUR P. JENKIN.

Trewirgie, Redruth, September 13.

"Crannoges" in Estuaries.

I FIND in NATURE of September 15 a notice of certain remains near Dumbarton as the only known specimens of "crannoges" in tidal water.

The farm-house of Cranny, in the townland of the same name, parish of Inver, County Donegal, Ireland, is supposed to stand on an artificial island in a tidal estuary, that of the Eany, or Eidhneach (meaning Ivy) River. The mound is now surrounded by a masonry revetment.

Opposite it, on the right bank of the same estuary, is a low mound which seems artificial, and lower down the old church of St. Natalis stands on another.

I have nothing to propound, but the ground may be worth examining. I have known it for many years, and think all three "crannoges." There is some printed record, not now before me, of the discovery of wooden framework on the right bank of the Eany, in glebe land. W. F. SINCLAIR.

Chelsea, September 16.

Transference of Heat in Cooled Metal.

Lorsque je vous ai écrit le 30 Juin dernier pour vous prier d'appeler, dans votre estimable journal, l'attention sur un phénomène de *conduction de chaleur dans une barre;* je pensais parler d'un phénomène *bien connu ainsi que je le disais dans ma lettre.* Je désirais simplement provoquer de la part de quelques uns de vos lecteurs, soit des recherches, soit des enquêtes analogues à celle que j'avais fait de mon côté auprès des artisans et ouvriers; mais je n'avais nullement la prétention de signaler un phénomène *nouveau.* Le premier physicien qui en ait parlé est à ma connaissance M. Izarn, professeur de physique au lycée de Clermont-Ferrand (France), et qui est connu par bien d'autres travaux. Voyant qu'on a l'air de m'attribuer la découverte de ce phénomène, je vous serais très reconnaissant si vous vouliez bien détromper les lecteurs de votre journal et remettre les choses au point. HENRY BOURGET.

Observatoire de Toulouse, Septembre 13.

Horn-feeding Larvæ.

READING the correspondence in NATURE on larvæ in antelope horns, reminded me of an experience in India. I was on a shooting trip near the Niti Pass in May, and bought a sheep for food from a native. Within five minutes of it being killed its horns were removed from the head, and it was found that they contained each some dozen maggots, white, and about half an inch in length. The horns had not been perceptibly perforated, and seemed quite sound. This fact may be well known, but I give it for what it is worth.

G. G. TRAHERNE.

"Purple Patches."

IN NATURE of November 12, 1896, there appeared a letter asking for some explanation of certain purple patches frequently noticed by the writer (A. Pedder) on roadways and pavements, especially at Bath. There were but three replies, two of which suggested "copying-ink" pencils as responsible.

The following notes, made recently in Derbyshire by myself, seem so nearly to fit the case that I venture to think a cause such as here described, or one closely allied, might explain some at any rate, of the cases mentioned. Here are the verbatim notes:—

"29/8/98.—At Axe Edge last Wednesday I noticed on a coal-pit ventilating shaft (Thatch Marsh Colliery) on the moor certain deepish blue masses on a ledge near the base. Some masses brighter blue, others nearly black. Under a lens appeared to contain horny parts of larvæ and many small seeds. They are probably the droppings of birds. They leave a bluish stain on the stone.

"To-day I noticed the same on some pieces of stone on the road to Goyt's Bridge, a steep, rocky road.

"30/8/98.—Visited Axe Edge shaft again. There were no fresh deposits on it. This may be due to almost continuous rain the last four days; but the stains are still there. Also found deposit on one or two stones round shaft and on a piece of wooden staging. They were very plentiful, especially on the tops of the six posts of this staging, where one would expect birds to settle chiefly. The colour and stains were just the same—some reddish purple and some bluish purple. The colour is thus evidently due only to the excreta (?), and not to the body on which deposited. The seeds appear reddish, and it seems likely that the colour is due to them. (Bilberries are plentiful on the surrounding moor)."

"1/9/98.—The seeds are identical with bilberry, and on extracting the excreta with cold water a claret-red colour is obtained, which leaves a greenish-blue stain on paper."

Dulwich. F. SOUTHERDEN.

Re-Blossoming of Horse-Chestnut.

THERE is at present (September 20) a tree in South-End, Hampstead, showing a bunch of fresh green leaves and a well-formed spike of flowers. Some years back (1893, I think), another tree, in the same plantation, put forth leaves and blossom in September. J. J. W.

INTERNATIONAL CONFERENCES AND THE BRITISH ASSOCIATION.

THE circumstances under which the International Conference on Terrestrial Magnetism and Atmospheric Electricity met at Bristol, and its relations to the British Association, were fully described in the address of the President which we have already published. The success of the Conference leads to the hope that similar arrangements may be made in future with regard to other international reunions which may be held in this country.

The number of such gatherings is increasing, but, useful as they undoubtedly are, they make serious inroads on the summer vacation; they diminish the few short weeks which, when the necessary holiday has been taken, can be devoted either to research or to preparation for the work of the next session; and lastly they necessarily compete with, and injuriously affect, each other.

Thus it is unquestionable that the fact that physiologists foregathered in Cambridge shortly before the meeting of the British Association was one of the causes why at Bristol physiologists were conspicuous by their absence. Last year the number of British geologists who visited Canada was relatively small, as they could not be in the Caucasus and on the shores of the Pacific at the same time.

It may be impossible to prevent such meetings from interfering when they are held in different countries and when two nations are the hosts, but everything that is possible should be done to prevent it when the gatherings take place in the same summer and in the same country. Steps have recently been taken in this direction. Conferences of zoologists and physiologists were held simultaneously in Cambridge, and the Conference on Terrestrial Magnetism was affiliated to the British Association. This latter plan could not be adopted if the number of persons attending an International Conference was so large that, if the Conference were held simultaneously with the meeting of the Association, it would overtax the receptive capacity of a great town. Such cases are comparatively rare, and in others the aid of the Association is so valuable, that it may be hoped that the precedent now set will be followed frequently.

The conditions of a successful International Conference are interesting and important questions to discuss, an adequate attendance of British and foreign scientific men, and well arranged opportunities for social intercourse. Taking the first two for granted, and dealing therefore only with the last, it is well known that an elaborate scheme of entertainments and excursions is most generously and even lavishly provided by the locality in which the British Association meets. These were, and probably always would be, thrown open to members of an International Conference meeting together with and recognised by the Association. If the number of those attending the Conference was sufficiently large to justify the wish to have some special entertainments—it may be a dinner or an excursion—reserved for them alone, this could no doubt be arranged at a cost to the promoters of the Conference much less than that involved in the holding of an independent meeting. The British Association thus possesses ready-made machinery for the reception and entertainment of foreigners, which would have to be created anew for each independent Conference. On the other hand, no small part of the elaborate preparations for the meeting of the Association is now too often devoted to the entertainment of persons whose interest in science is little more than a hardy annual which blossoms in August or September, and requires a stimulating treatment of cheap excursions to bring it to maturity. No harm would be done to the Association, and good would result in many ways if these were in part replaced by distinguished foreign visitors and their English *confrères*. The authorities of the Association have shown a praiseworthy readiness to vary their arrangements so as to grapple with new conditions. Though nominally a departmeut of Section A, and working most harmoniously with the officers of that Section, the International Magnetic Conference was practically at liberty to manage its own affairs, and was in no way hampered by red-tape. The Permanent Committee, appointed not by the Association, but by the International Meteorological Conference at Paris in 1896, was added *en bloc* to the Committee of Section A, and was allowed unfettered control of the Magnetic Department of that Section.

If the authorities of the Association are thus wisely liberal in future, there is no reason why at least the smaller International Conferences which take place in this country should not meet in alliance with the British Association.

If a Section can for one year coexist with an almost independent department, there is no reason why similar temporary arrangements should not be adopted on a more extensive scale, should occasion so require. The promoters of the Conference would be saved a great deal of trouble and even of expense. The cost to the Association and to the locality would be no greater than it is now. The persons entertained would be genuine scientific workers. The meetings of the Association would gain in interest and prestige, while at most of the places where the Association meets there would be no difficulty in providing space for several additional Sections if such subdivision were necessary.

The experiment which has been tried this year on a small scale was a complete success, and it is desirable that those who may have the management of International Congresses in future should be fully aware of the readiness which the Council of the British Association has displayed to make the great organisation which it controls as useful as possible. They have much to give, and on this occasion they gave it freely; while, on the other hand, the Association gained both in the interest of its proceedings, and in the usefulness to science which is the object of its existence.

NOTES.

THE seventeenth Congress of the Sanitary Institute was opened at Birmingham on Tuesday, and will continue in session during the remainder of this week. On Tuesday afternoon Sir Joseph Fayrer, Bart., the President of the Congress, delivered an address, in which he surveyed the progress of preventive medicine during recent times; and in the evening the Lord Mayor opened a great exhibition of appliances, machinery, food products, and the like, which is the usual feature of the Congress, and lasts a month. On Wednesday municipal representatives, medical officers of health, sanitary engineers, sanitary inspectors, and ladies held conferences and discussed papers. Thursday and Friday are to be devoted to sectional work, and there are two important lectures, one to the Congress, and one to the general public. Among the topics to be discussed are the relations of medical officers to vaccinal legislation, the milk supply, water analysis, bacteria and infectious disease, hygiene in dress, and the decrease in the birth-rate.

THE death is announced at Paris of M. Gabriel de Mortillet, the eminent anthropologist.

THE annual exhibition of the Royal Photographic Society was inaugurated by a soirée held on Saturday last, September 24.

AT the meeting of the Entomological Society of London, on October 5, a paper by Mr. F. Merrifield, "On colouring of pupæ of *P. machaon* and *P. napi* caused by exposing the pupating larvæ to coloured surroundings," will be read; and also one by Mr. G. H. Verrall, "On Syrphidæ collected near Aden by Colonel J. W. Yerbury."

RECENT researches by Surgeon-Major Ronald Ross have shown that the mosquito may be the host of parasites of the type of that which causes human malaria. Ross has distinctly proved that malaria can be acquired by the bite of a mosquito, and the results of his observations have a direct bearing on the propagation of the disease in man. Dr. P. Manson describes the investigations in a paper in the *British Medical Journal*, and sums them up as follows:—The observations tend to the conclusion that the malaria parasite is for the most part a parasite of insects; that it is only an accidental and occasional visitor to man; that not all mosquitos are capable of subserving it; that particular species of malaria parasites demand particular species of mosquitos; that in this circumstance we have at least a partial explanation of the apparent vagaries of the distribution of the varieties of malaria. When the whole story has been completed, as it surely will be at no distant date, in virtue of the new knowledge thus acquired, we shall be able to indicate a prophylaxis for malaria of a practical character, and one which may enable the European to live in climates now rendered deadly by this pest.

A VALUABLE report upon the various attempts which have been made to bring China grass (obtained from *Boehmeria nivea*) and Ramie or Rhea (obtained from *B. tenacissima*) into use for manufacturing purposes is contained in the *Kew Bulletin* for September. The report describes machines which have been devised to deal with the grass, and indicates the merits and defects of the most important of them. It will be seen from the following summary of the Kew report that the problem has not yet been satisfactorily solved:—"Notwithstanding all the expenditure of mechanical skill and inventive ability, the conclusion cannot be evaded that we are still as far off as ever from being able to place upon the market a finished product which will effectually compete with silk, flax, and the better qualities of cotton. The plants can be grown with the greatest ease. But when the problem of treatment is solved, the supply of the raw material will be limited to warm countries. The cultivation of China grass in temperate regions will never be able to compete successfully with that of Ramie (or perhaps of China grass) in the tropics. It is known that when ribbons can be produced sufficiently cheaply, these can be degummed and turned into filasse at a small cost. The whole question then still turns, as in 1888, on the production of ribbons. We are still waiting for a decorticator which will not merely turn out ribbons fit for further manufacturing processes—that has been accomplished—but will turn out, say, half a ton a day at a small cost. Till this has been found, the planter cannot profitably deal with his crop, and the degumming processes now almost entirely dependent on hand-cleaned fibre from China are paralysed for want of a supply which will allow the finished product to compete with other fibres."

NEWS has been received by the *Times* that the *Antarctic*, with the Swedish Arctic Expedition under Dr. A. G. Nathorst, has returned to Tromsö, after a successful cruise to the seas and islands around Spitsbergen; and the following notes on the results of the expedition are published:—The *Antarctic* left Tromsö on June 8, and proceeded to Bear Island, which was reached on the 11th; a week was spent there. The whole island was surveyed, and a map on the scale of 1 : 50,000 was drawn by Lieut. Kjellstrov and Dr. Hamberg. After surveying and mapping Bell Sound, on the west of Spitsbergen, and visiting some points of interest in Ice Sound, the expedition proceeded westwards, and did some hydrographical work as far as the margin of the Greenland ice-pack (78° 1′ N. lat., 4° 9′ W. long.). The ship was then turned to the south and east of Spitsbergen, and reached King Charles Land, which was completely mapped on the scale of 1 : 100,000 and surveyed. From there the *Antarctic* proceeded to White Island, which was circumnavigated; the expedition landed at the only two places where landing is possible, and the geology of the island was ascertained. This island is completely covered by an ice-cap, which is broken off at the sea shore, ending in a perpendicular ice-wall, just as is found on the Antarctic Continent, though in miniature. Great table-formed icebergs are given off from this ice-sheet. From White Island, which is larger than indicated on the maps, the *Antarctic* made its way through alternating heavy ice and open water to Charles XII. Island, whence the expedition proceeded northwards and reached 81° 14′ N. lat. The expedition then passed north of the Seven Islands and proceeded to Treuenberg Bay, Grey Hook, and Danes Island, from which they steered southwards along the western coast of Spitsbergen. When the *Antarctic* reached the south end of Prince Charles Foreland the circumnavigation of the whole of Spitsbergen, with the surrounding islands, was completed. The scientific work of the expedition has been most successful; they have brought back large geological, botanical, and zoological collections. The geology, botany, and zoology of King Charles Land are now completely known, and there are evident important connections between the geology of Spitsbergen and that of Franz Josef Land.

THERE are a great number of curious superstitions as to the time of day when a dying person is most likely to draw his last breath, and the tide, the moon, and the wind have all been supposed to have some share in the matter. According to the *British Medical Journal*, Raseri, who has analysed 25,474 cases of death, and 36,515 of birth, where the exact time of day was noted, finds that the maximum number of deaths occur in the early afternoon (2–7 p.m.), and the minimum in the last hours before midnight, while the maximum number of births occur in the early hours of the morning, and the minimum in the early hours of the afternoon. As regards the cause of this, he points out that the hours of the maximum number of deaths are precisely those when the pulse rate and temperature are at their highest in health, and when there is a febrile exacerbation in illness.

THE Report of the Chief of the United States Weather Bureau upon meteorological observations made during the year 1896-97 has just been received. It consists of a volume containing more than four hundred pages, with nearly one hundred large charts and plates. The very valuable work carried on by the Weather Bureau is too well known to meteorologists to need commendation here. The vote for the service during the fiscal year 1896-97 was 883,772 dollars; but, remembering how very considerably the work has extended during the past few years, we are surprised to learn that this grant is 109,748 dollars less than that made in 1883. In the past fifteen years the number of voluntary observers has increased from 300 to about 3000, and the number of stations on the sea-coasts and the Great Lakes, where storm warnings are displayed for the benefit of mariners, has increased from 41 to 253. These storm warnings have proved of very great service. At each of the 253 stations where the signals are displayed, telegraphic messages, giving the situation, intensity and probable movement of the storm are distributed to the masters of vessels within an hour after the information has been dictated by the forecast official at headquarters. It is estimated by shipowners that one hurricane sweeping the Atlantic seaboard would cause damage to floating craft of more than 600,000*l*. During the past three years ten or more of these destructive storms have visited the coast-line of the United States, but in every case the danger warnings were displayed long in advance of the storm, and no marine disasters of importance occurred. These facts alone justify the appeal of the Chief of the Weather Bureau for an increased grant. His estimate of the money needed to meet the legitimate requests of the agricultural, marine, commercial, and manufacturing interests of the States is 1,044,050 dollars, being an increase of 160,348 dollars. The present report furnishes abundant evidence that whatever money is voted will be used in making the Bureau of service to the people of the States, and of assistance to the progress of meteorological science. In addition to the usual report upon the administrative work, the volume contains an account of the climatology of the year, and papers upon the rainfall of the United States and the floods of the Mississippi Valley, both of which have already been noticed in NATURE.

THE September number of *Annalen der Hydrographie und maritimen Meteorologie* contains two papers of more than usual interest: (1) Yearly isotherms and isabnormals of sea-surface temperature, by Dr. W. Köppen. The author has calculated the yearly isotherms from the best available sources, including those of the Deutsche Seewarte and the Meteorological Office, and in addition to the usual methods of showing simply the warm and cold currents, he has indicated the districts where the surface water is more than 2° C. above or below the temperature due to geographical position. (2) Contribution to the knowledge of wind conditions on the sailing routes between the equator and Cape Horn, by Dr. H. König. The data used are principally those collected for the sailing directions issued by the Seewarte. In addition to various tables showing the distribution of wind directions for months and seasons, and referring to different districts, the author has shown graphically for each month and each 5°-square the percentages of the three most prevalent wind directions, with numbers showing their mean force, the calms, and the total number of observations from which the results are deduced. Both the above discussions are accompanied by interesting explanatory remarks.

TELEPHONIC communication has been established between a number of farms in Australia by means of wire fences. The *Australian Agriculturist* publishes a note from a correspondent writing from a station near Cobar, stating that it was easy to converse with friends at a station eight miles distant with instruments connected on the wire fences, and the same kind of communication was established over a distance of thirteen miles. A large number of stations are connected in this way, and the system if widely adopted will do much to relieve the monotony of back country life.

PROF. ZICKLER, of Brünn, has (says the *Electrical Review*) conducted an elaborate series of experiments, which show that a telegraphic instrument can be actuated at considerable distances by a beam of ultra-violet light. He employs a powerful arc lamp as his transmitter, using a screen of glass to produce intermittent flashes of the ultra-violet beam, which embody themselves as dot and dash signals on his receiver. The receiver is an air-gap in a circuit containing an induction coil regulated to an electromotive force just below the sparking point at the air-gap. As Hertz long ago has shown, a beam f ultra-violet light falling on the kathode of a strained air-gap, near its breaking-down point, will immediately provoke a discharge. Zickler started by producing this effect over a distance of 2 m. Then, by improving the shape and material of his electrodes and enclosing them in a chamber of compressed air, he was able to increase this distance to 200 m. This is a remarkable result, and it is extremely interesting to physicists to learn that the short and easily absorbed ultra-violet light can influence a spark discharge at so great a distance.

THE attention of several physicists has been of late turned to determinations of the thermal conductivity of rocks. A large number of experimental results, chiefly statistical, and obtained by using the "Wall method," are detailed by Messrs. B. O. Pierce and R. W. Willson in the *Proceedings* of the American Academy of Arts and Sciences; while Dr. Francesco Morano has been engaged in determining the internal and external conductivity of the rocks of the Roman Campagna and the corresponding fluctuations of temperature of the soil (*Atti dei Lincei*, vii.). While these experiments lead to purely numerical results, Dr. Lees, of Manchester, in a paper read before the British Association, has succeeded in establishing the fact that pressure produces a marked increase of conductivity in the less closely-grained rocks, especially sandstone.

THE disposal of the town refuse of Naples has led to a lengthy discussion at the meetings of the Reale Istituto d'Incoraggiamento di Napoli, and the publication of a number of papers in their large annual volume of *Atti*. The subject is introduced by Prof. Paolo Boubée, who seems to rather favour treatment by the Arnold-Le Blanc system, or the use of destructors; though it would appear that the refuse of the Neapolitan streets is too wet, and also too poor in carbon, to burn without the additional consumption of coal. At present the street sweepings are taken and deposited some distance outside the city, and the accumulations ultimately used as manure; but the effluvia arising from so large a mass of putrefying matter have become prejudicial to health. It is suggested that the problem might be best solved by a series of experiments on the different alternative methods of disposal; and even the clumsy and wasteful plan of dumping the refuse at sea seems considered deserving of a trial.

AN "Improved form of Hydrometer" by means of which the effect of capillarity is eliminated, is proposed by the Rev. H. O'Toole of Blackrock College, writing in the *Scientific Proceedings* of the Royal Dublin Society. It is similar in principle to Nicholson's hydrometer, but, instead of one bulb, it has two connected by a narrow stem of the same material and sectional area as that which supports the weight. It is first loaded till the lower bulb is immersed, and then loaded till both bulbs are immersed. The additional weights put in at the second observation represent exactly the weight of a quantity of liquid equal in volume to the upper bulb between the two points of immersion.

"A CONTRIBUTION to the Study of Individual Variation in the Wings of Lepidoptera" is given by Mr. William L. W. Field in the *Proceedings* of the American Academy of Arts and Sciences, xxxiii. 21. The paper gives the results of an attempt to find in a particular species answers to the following questions: (1) Is a part developed in any given species in an extraordinary manner as compared with the development of the corresponding part in other allied species, more variable than parts which exhibit less specific peculiarity? (2) Which sex is the more variable? The species chosen is the moth *Thereus abbotii*, in which the outer margins of the primaries are excessively irregular and extraordinarily long as compared with the other dimensions of the wings. Measurements were made, for a large number of specimens, of the length of the sinuous margin, the length and breadth of the wing, and the chord of the margin; and from these the author concludes that, in the moth in question, the most aberrant dimension of the fore wing is likewise the most variable, in accordance with Darwin's law. The females show, in general, a greater degree of variability than the males; but in the one markedly aberrant feature under discussion, their variability is less than that of the males. With reference to the first conclusion, the propriety may be questioned of instituting comparisons between the lengths of the jagged contour of the outer margin and the straight lines which determine the actual dimensions of the wings. Mr. Field might with advantage make observations on some other insect in which the length or breadth of the wing was the aberrant feature.

IN a long article (to be continued) contributed to the *Zoologist*, Mr. W. L. Distant reviews the facts and theories as to assimilative coloration, and propounds some new views. He remarks in the course of his paper: "It seems possible that assimilative coloration may have been a first and very general consequent in animal development; that such a view is suggested by many facts; and that the subsequent protective resemblance acquired by numerous living creatures through the process of natural selection, when life had advanced to the competitive stage, is far too frequently used as an explanation for whole series of uniform phenomena in coloration, which have probably survived unaltered from remote antiquity, and which by their very essence were outside the law of natural selection, or unaltered survived as the 'fittest.'"

THE *Biologisches Centralblatt* (No. 17) contains a paper by Hartvig Huitfeldt-Kaas on the Plankton of the fresh-water lakes of Norway. The author follows the methods of Apstein, and finds that in general the Plankton is richer in shallow waters than in deep, except in regions where the rainfall is excessive, *i.e.* where the lake is subject to sudden large additions to the volume of water. The seasonal variations in the quantity of Plankton in a number of lakes are exhibited graphically.

THE *National Geographic Magazine* for August contains a paper by Mr. W. J. McGee on Papagueria, the land of the Papago or Papaf Indians, an arid region lying beyond the Sierra Madre, partly in Mexico and partly in Arizona; and covering an area of about 50,000 square miles. The study of the natives presents some remarkable features; their whole existence may be said to be occupied with the search for water, and the tribe is distinguished by exceptional force and stability of character. More than three centuries of contact with white races has produced little or no effect upon them.

THE issue of the Belgian *Moniteur International* of August 7 last is largely devoted to the new *Société Anonyme d'Études et d'Éditions Géographiques Élisée Reclus*. The laws and constitution of the Society are printed in full, and there are special articles by M. Reclus and others. The new Society has for its object the furthering of geographical study and exploration in all directions, by means of co-operation with existing foreign institutions and with foreign branches of the Society itself; and special attention is to be given to the working-up and publishing of geographical information relating to particular regions, in a form adapted for economic and commercial purposes.

THE number of the *Naturwissenschaftliche Wochenschrift* for September 11 contains an excellent popular account of the Adschidarja, the gulf connected with the Caspian Sea by the narrow strait of Karabugas, and often known by the latter name. A current flows from the Caspian to the Adschidarja, varying in speed at different seasons, but never changing its direction, and the waters of the gulf are intensely salt—28 per cent.—compared with about 1·4 per cent. in the Caspian. Actual measurements made at different dates since its discovery in 1836 show that the Adschidarja and the Karabugas are being rapidly filled up, and the fossil remains show that for a long period the waters of the former have been growing steadily salter. The description of the chemical deposits, both organic and inorganic, is of extreme interest, the latter specially so in relation to the formation of oil-bearing strata.

DR. H. CARRINGTON BOLTON has discovered in a cavern at Lake Minnewaska, New York, a grotto in which are reproduced on a small scale many of the beautiful phenomena seen at the celebrated Blue Grotto of the island of Capri. The lake is situated on the Shawangunk range of mountains at an elevation of about 1700 feet; it lies in a basin, excavated in glacial times, about half a mile long and less than a quarter in width, and of a depth reaching seventy feet. The rock on all sides is a white quartzite, which rests upon shale, but no outcrop of the latter is visible at the lake. The water varies in colour from Nile green through turquoise blue and sky blue to deep indigo blue, and in all these shades exhibits the silvery appearance, when agitated, characteristic of the grotto at Capri. A body immersed in the water has a beautiful silvery sheen, similar to the reflection of moonlight. The water has these colours at all hours, but they are strongest when the sun is in the zenith; late in the afternoon the slanting rays of the sun enter the opening and light up the cavern, greatly diminishing the optical effects.

THE last two issues (vol. i. Nos. 9 and 10) of the Records of the Botanical Survey of India comprise a contribution to the Botany of the Chitral Relief Expedition, 1895, by Mr. J. F. Duthie; and a Botanical Tour in Chamba and Kangra, by Mr. G. A. Gammie.

A VALUABLE list of the Freshwater Algæ of Queensland is issued by the Department of Agriculture, Brisbane (*Botany Bulletin*, No. 15). The compiler, Mr. F. M. Bailey, has incorporated with his own observations those of the European algologists, Askenasy, Moebius, Nordstedt, Schmidle, and Borge, who have worked at the algology of Australia.

THE Geological Survey of Queensland (Department of Mines) has issued a list of Additions to the Fossil Flora of Queensland, compiled by Mr. John Shirley. The species described are mainly from the Ipswich formation, Trias-Jura system, and are mostly Gymnosperms and Pteridophyta, with a few Dicotyledones. The list is accompanied by twenty-five plates.

IT is recorded in the *Kew Bulletin of Miscellaneous Information* (No. 140) that the Queen's Cottage Grounds (between 37 and 38 acres) have now been formally added to the precincts of the Royal Gardens; but that public access to them cannot be given until provision for their maintenance and supervision has been made in the estimates for the next financial year. It is intended to preserve the grounds as far as possible in their present condition.

THE numbers of the *Journal of Applied Microscopy* for June and July, published by the optical firm of Bausch and Lomb, Rochester, New York, contain a number of very useful articles on microscopical technique, and on the structure of the microscope, as well as some which are more purely biological. The *Journal* should be in the hands of all microscopists.

THE *Biologisches Centralblatt* continues to publish useful epitomes of recent research in various branches of biological science. In the number for August 15 we find a paper, by Bernhard Jacobi, on the results of the newest researches on the locality and conditions of the formation of proteids in green plants, with a bibliography appended. The same number contains an article, by J. E. W. Ihle, on the phylogeny and systematic position of the Pentopodæ.

THE illustration of lectures and lessons by lantern slides is now so widely used, that attention may profitably be called to the supplementary list of slides just published by Messrs. Newton and Co. Among the lantern slides of interest to teachers of science, we notice in this list a set of 111 bacteriological slides, reproduced from original negatives by Dr. Spitta; numerous recent astronomical photographs, including pictures of the Indian eclipse; views taken by Prof. Crookshank during the meeting of the British Association in Toronto last year; geological formations in the neighbourhood of Barmouth; and fifty-five pictures of English birds, photographed from the well-mounted specimens in the Natural History Museum. In addition to the titles of slides, the list contains descriptions of new lanterns and lantern accessories of service in science demonstrations.

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes*, ♂) from West Africa, presented by Mr. Claude E. Bird; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. C. Ganz: a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Miss May Hill; two White-throated Capuchins (*Cebus hypoleucus*) from South America, presented by Mrs. C. E. Cregan; three Black-eared Marmosets (*Hapale penicillata*) from South-east Brazil, presented by Mrs. Dal Young; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. W. E. Raynes-Cole; a Red-vented Bulbul (*Pycnonotus hæmorrhous*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN OCTOBER:—

October 2.	10h. 27m. to 11h. 35m. Occultation of 47 Arietis (mag. 5·9) by the moon.
4.	Tempel's comet (1867 II.) due at perihelion.
5.	9h. 46m. Minimum of Algol (β Persei).
5.	16h. 6m. to 17h. 27m. Occultation of 132 Tauri (mag. 5·1) by the moon.
7.	Saturn. Outer minor axis of the outer ring = 16″·09.
7.	17h. 0m. Mars in conjunction with the moon (♂ 1° 25′ N.).
8.	6h. 35m. Minimum of Algol (β Persei).
13.	11h. 0m. Jupiter in conjunction with the sun.
15.	Venus. Portion of illuminated disc = 0·521. Diameter 34″·0.
15.	Mars. Portion of illuminated disc = 0 880. Diameter 8″·0.
16.	4h. 0m. Mercury 2′ S. of Jupiter.
18–20.	Meteoric shower from Orion (radiant 91° + 15°).
20.	Perrine-Chofardet's new comet due at perihelion.
22.	3h. 44m. to 4h. 57m. Occultation of π Capricorni (mag. 5·2) by the moon.
22.	5h. 5m. to 5h. 51m. Occultation of ρ Capricorni (mag. 5·0) by the moon.
23.	5h. 13m. to 6h. 13m. Occultation of 18 Aquarii (mag. 5·4) by the moon.
24.	Uranus 54′ S. of β Scorpii.
27.	5h. 0m. Venus at greatest brilliancy.
29.	13h. 21m. to 14h. 10m. Occultation of μ Arietis (mag. 5·8) by the moon.

THE PLANET BETWEEN THE EARTH AND MARS.—Herr G. Witt, of the Urania Observatory, Berlin, is to be congratulated on the fortunate discovery he has made while searching photographically for minor planets. On August 14 last he found on the plate he had exposed, in addition to the trail of the minor planet he was hoping to catch, a second trail which indicated the presence of another of these small bodies moving round the sun with a more than usual velocity. Herr Witt was not content, however, to let the matter rest thus, so he undertook a series of eye observations and measurements which are necessary for the determination of the elements of the body in question. Herr Berberich undertook the task of investigating its motion from these observations, and the result, as far as is known, is surprisingly interesting. Instead of the object being a new or a previously observed member of that system of bodies which travels round the sun between Mars and Jupiter, it proves to be quite an exception, its orbit lying *within* that of Mars; in other words, it travels in a path which is nearer to the earth than that of Mars. It completes its revolution in a period of about 600 days; that is, roughly, 80 days less than Mars takes: both the eccentricity and inclination of the orbit are considerable. This small body thus becomes our nearest neighbour after the moon, and, although small, will shine when closest to us as a star of the sixth magnitude. No doubt the discovery of this new planet will incite afresh observers of these small bodies; and who will say that this new object is the only member of its kind that performs its revolution round the sun in an orbit between the earth and Mars?

PHOTOGRAPH OF THE CHROMOSPHERE.—In the *Astrophysical Journal* for August there is reproduced one of the photographs taken by Prof. Naegamvala during the recent eclipse of the sun in January last. Prof. Naegamvala, it will be remembered, was stationed at Jeur, and although his chief instrument (a six-inch Taylor Cooke triplet and two objective prisms of 45°) arrived from the makers as late as January 11, he was very fortunate in being able to adjust it as well as he did in the small amount of time he had at his disposal. The advantage of the prismatic camera over an ordinary slit spectroscope has during the late eclipse been abundantly proved, for one is easily able to differentiate at a glance between the spectra of the corona, the chromosphere and the prominences. There are, however, several points in photographs taken during an eclipse with such instruments which must be carefully considered, and which, when overlooked, are liable to lead to errors. An oversight of this kind occurs in the text describing the photograph referred to above. The writer states: "Perhaps the most interesting feature of the photograph is the prominence shown in two lines between H and Hδ, but invisible in H and K and the hydrogen lines."

A glance at the photograph tells us that the prominence is recorded in both the H and K light, but the peculiar position of the prominence in the spectrum is due to the fact that the two "lines" are the images of the upper portion of a prominence on the chromosphere obscured by the dark moon on the side opposite to that represented by the arcs. This same prominence is depicted on most of the negatives that were secured at Viziadrug, and is recorded not only in the H and K lines, but in the hydrogen and other lines.

OBSERVATIONS OF JUPITER DURING THE OPPOSITION 1898.—Sig. J. Comas Solá, observing at the Observatory of Català with an equatorial of 22 cm. aperture, made some very interesting observations of the surface markings on Jupiter during the period extending from January 18 to June 12 during the present year (*Astr. Nachr.*, 3519). The general aspect of the surface did not offer evidence of very great change, but rather indicated that the planet was in a state of relative calm. More especially was this the case with the northern equatorial belt, which last year was very large, double and perhaps triple, but recently has been observed to be very simple, showing a uniform structure of a deep ruddy colour. The equatorial zone was found to be of an intense reddish yellow or yellowish orange colour, and was especially rich in details. In addition to the oblique grey markings usually seen, the whole zone appeared flaky, and when the definition was good this was found to be made up of large and small dark round spots. The south equatorial belt did not offer any new markings, but appeared in its normal condition. The red spot, according to Sig. Solá, was always very pale and grey, but in spite of its feebleness he could see the whole of its elliptic contour. The eastern portion always appeared darker than the rest, and sometimes a small dark spot could be seen in this position. From three transits of the eastern portion of this spot in April, May and June, the mean Jovian longitude was found to be 36°·6 for May 23. In the map showing the planisphere of this planet, which accompanies the article, the reader will gather a good general idea of the positions and shape of the markings which were seen by this observer.

PERIODIC COMETS.—In the *Bulletin Astronomique* for September there is a most interesting article, by M. Schulhof, concerning periodic comets and the present state of theories connected with them. The article covers no less than forty-one pages of the *Bulletin*, so we cannot do more than give a very brief outline of its contents. M. Schulhof restricts his remarks simply to the movements of the comets and their accompanying perturbations, but does not touch on their chemical or physical characteristics. After a brief summary of the general ideas concerning the motions of each of these comets, and the part taken by the several investigators who have worked out the orbits, he draws attention to the great similarity between groups of comets, caused, as he mentions, by the presence of our planets exerting their influence as these bodies approach our system. The origin of comets and their relation to meteor swarms are further discussed, also the views of Schiaparelli, Faye, and Tisserand. In concluding, M. Schulhof makes mention of the difficulty connected with a complete reduction of the observations of a comet of short period, with which all computers are familiar, pointing out that the perturbatory actions of all the planets except Neptune have to be taken into account.

THE BRITISH ASSOCIATION.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY E. W. BRABROOK, C.B., F.S.A., PRESIDENT OF THE SECTION.

I AM very sensible of the honour of presiding over this Section at a Bristol meeting. Bristol, from its association with the memory of J. C. Prichard, may be regarded as the very birthplace of British anthropology.

In submitting to this Section some observations on the past progress and the present position of the Anthropological Sciences, I use the plural term, which is generally adopted by our French colleagues, in order to remind you that Anthropology is in fact a group of sciences. There is what in France is called pure anthropology or anthropology proper, but which we prefer to call physical anthropology—the science of the physical characters of man, including anthropometry and craniology, and mainly based upon anatomy and physiology. There is comparative anthropology, which deals with the zoological position of mankind. There is prehistoric archæology, which covers a wide range of inquiry into man's early works, and has to seek the aid of the geologist and the metallurgist. There is psychology, which comprehends the whole operations of his mental faculties. There is linguistics, which traces the history of human language. There is folk-lore, which investigates man's traditions, customs, and beliefs. There are ethnography, which describes the races of mankind, and ethnology, which differentiates between them, both closely connected with geographical science. There is sociology, which applies the learning accumulated in all the other branches of anthropology to man's relation to his fellows, and requires the co-operation of the statistician and the economist. How can any single person master in its entirety a group of sciences which covers so wide a field, and requires in its students such various faculties and qualifications? Here, if anywhere, we must be content to divide our labours. The grandeur and comprehensiveness of the subject are among its attractions. The old saying, "I am a man, and therefore I think nothing human to be foreign to me," expresses the ground upon which the anthropological sciences claim from us a special attention.

I may illustrate what I have said as to the varied endowments of anthropologists by a reference to the names of four distinguished men who have occupied in previous years the place which it falls to my lot to fill to-day—most unworthily, as I cannot but acknowledge, when I think of their pre-eminent qualifications. When the Association last met at Bristol, in 1875, Anthropology was not a Section, but only a Department, and it was presided over by Rolleston. There may be some here who recollect the address he then delivered, informed from beginning to end with that happy and playful wit which was characteristic of him; but all will know how great he was in anatomy, what a wide range of classical and other learning he possessed, and how he delighted to bring it to bear on every anthropological subject that was presented to his notice. In 1878 Huxley was the Chairman of this Department. It is only necessary to mention the name of that illustrious biologist to recall to your memory how much anthropology owes to him. Eight years before, he had been President of the Association itself, and seven years before that had published his "Evidence as to Man's Place in Nature." Brilliant as his successes were in other branches of scientific investigation, I cannot but think that anthropology was with him a favourite pursuit. His writings upon that subject possess a wonderful charm of style. In 1883 the Chairman was Pengelly, who for many years rendered service to anthropology by his exploration of Kent's Cavern and other caves, and who happily illustrated the close relation that exists between geology and anthropology. His biography, recently published, must have reminded many of us of the amiable qualities which adorned his character. Finally, in 1886, two years after anthropology had become a Section, its President was Sir George Campbell, a practical ethnologist, a traveller, an administrator, a legislator, a geographer, who passed through a long career of public life with honour and distinction. All my other predecessors are, I am glad to say, still living, and I make no mention of them. The few names I have cited—selected by the accidental circumstance that they are no longer with us—are sufficient to show what varied gifts and pursuits are combined in the study of anthropology.

There is another side to the question. Great as is the diversity of the anthropological sciences, their unity is still more remarkable. The student of man must study the whole man. No true knowledge of any human group, any more than of a human individual, is obtained by observation of physical characters alone. Modes of thought, language, arts and history must also be investigated. This simultaneous investigation involves in each case the same logical methods and processes. It will in general be attended with the same results. If it be true that the order of the Universe is expressed in continuity and not in cataclysm, we shall find the same slow but sure progress evident in each branch of the inquiry. We shall find that nothing is lost, that no race is absolutely destroyed, that everything that has been still exists in a modified form, and contributes some of its elements to that which is. We shall find that this, which no one doubts in regard to physical matters, is equally true of modes of thought. We may trace these to their germs in the small brain of the palæolithic flint-worker; or, if we care to do so, still farther back. This principle has, as I understand, been fully accepted in geology and biology, and throughout the domain of physical science—what should hinder its application to anthropology? It supplies a formula of universal validity, and cannot but add force and sublimity to our imagination of the wisdom of the Creator. It is little more than has been expressed in the familiar words of Tennyson:—

> "Yet I doubt not thro' the ages one increasing purpose runs,
> And the thoughts of men are widen'd with the process of the suns;"

and supports his claim to be "the heir of all the ages, in the foremost files of time."

I propose, in briefly drawing your attention to some recent contributions to our knowledge, to use this as a convenient theory and as pointing out the directions in which further investigation may be rewarded by even fuller light.

Applying it, first of all, to the department of physical anthropology, we are called upon to consider the discovery by Dr. Dubois at Trinil in Java of the remains of an animal called by him *Pithecanthropus erectus*, and considered by some authorities to be one of the missing links in the chain of animal existence which terminates in man. In his presidential address to this Association last year, Sir John Evans said, "Even the *Pithecanthropus erectus* of Dr. Eugène Dubois from Java meets with some incredulous objectors from both the physiological and the geological sides. From the point of view of the latter the difficulty lies in determining the exact age of what are apparently alluvial beds in the bottom of a river valley." In regard to these objections, it should be remembered that though the skull and femur in question are the only remains resembling humanity discovered in the site, it yielded a vast number of fossil bones of other animals, and that any difficulty in settling the geological age must apply to the whole results of the exploration. The physiological difficulties arise in two points—do the skull and femur belong to the same individual? are they or either of them human, or simian, or intermediate? As to the first, it is true that the two bones were separated by a distance of about fifty feet, but as they were found precisely on the same level, accompanied by no other bones resembling human bones, but by a great number of animal remains, apparently deposited at the same moment, the theory that they belonged to different individuals would only add to the difficulty of the problem. With regard to the skull, a projection of its outline on a diagram comparing it with others of low type belonging to the stone age shows it to be essentially inferior to any of them. With regard to the thigh, you will recollect that at the Liverpool meeting of this Section, Dr. Hepburn displayed a remarkable collection of femora from the anatomical museum of Edinburgh University, exhibiting pathological and other conditions similar to those in the femur of Trinil. Though this evidence tends to show that the bone is human, it is not inconsistent with, but on the contrary goes to support, the conclusion that it belongs to an exceedingly low and ancient type of humanity. Whether, therefore, we call the remains *Pithecanthropus erectus* with their discoverer, or *Homo pithecanthropus* with Dr. Manouvrier, or *Homo Javanensis primigenius* with Dr. Houzé, we are in presence of a valuable document in the early evolution of mankind.

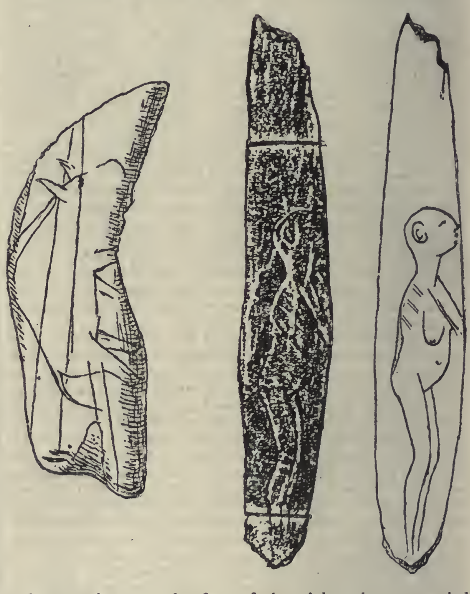
One element of special interest in this discovery is that it brings us nearer than we have ever been brought before to the time when man or his predecessor acquired the erect position. I believe that it is acknowledged by all that the femur belonged to an individual who stood upright, and I presume that the capacity of the skull being greater than that of any known anthropoid is consistent with the same inference. The significance of that has been most clearly set forth by my predecessor, Dr. Munro, in his address to this Section at Nottingham in 1893. He showed that a direct consequence of the upright position was a complete division of labour as regards the functions of the limbs—the hands being reserved for manipulation and the feet for locomotion; that this necessitated great changes in the general structure of the body, including the pelvis and the spinal column; that the hand became the most complete and effective mechanical organ nature has produced; and that this perfect piece of mechanism, at the extremity of a freely moving arm, gives man a superiority in attack and defence over other animals. Further, he showed that, from the first moment that man recognised the advantage of using a club or a stone in attack or defence, the direct incentive to a higher brain development came into existence. The man who first used a spear tipped with a sharp flint became possessed of an irresistible power. In his expeditions for hunting, fishing, gathering fruit, &c., primitive man's acquaintance with the mechanical powers of nature would be gradually extended; and thus from this vantage point of the possession of a hand, language, thought, reasoning, abstract ideas would gradually be acquired, and the functions of the hand and the brain be developed in a corresponding manner. I do injustice to Dr. Munro's masterly argument by stating it thus crudely and briefly. It amounts to this—once the erect position is obtained, the actions of man being controlled by a progressive brain, everything follows in due course.

The next stage which we are yet able to mark with certainty is the palæolithic, but there must have been a great many intermediate stages. Before man began to make any implements at all, there must have been a stage of more or less length, during which he used any stick or stone that came to his hands without attempting to fashion the one or the other. Before he acquired the art of fashioning so elaborate an implement as the ordinary palæolithic axe or hammer, there must have been other stages in which he would have been content with such an improvement on the natural block of flint as a single fracture would produce, and would proceed to two or three, or more fractures by degrees. It must have been long before he could have acquired the eye for symmetry and the sense of design, of adaptation of means to ends, which are expressed in the fashioning of a complete palæolithic implement. It is probable that such rude implements as he would construct in this interval would be in general hardly distinguishable from flints naturally fractured. Hence the uncertainty that attaches to such discoveries of the kind as have hitherto been made public. Prof. McKenny Hughes, who speaks with very high authority, concludes a masterly paper in the *Archæological Journal* with the statement that he has "never yet seen any evidence which would justify the inference that any implements older than palæolithic have yet been found." The name "palæotalith" which had been suggested for pre-palæolithic implements seems to him unnecessary at present, as there is nothing to which it can be applied; and as it will be long before it can be asserted that we have discovered the very earliest traces of man, he thinks it will probably be long before the word is wanted. An elaborate work on the ruder forms of implement, just published by M. A. Thieullen, of Paris, who has for many years been engaged in collecting these objects, adds materially to our knowledge of the subject.

Another line of argument bearing strongly in the same direction is afforded by the discovery in various places of works of art fabricated by early man. The statuettes from Brassempouy, the sculptures representing animals from the Bruniquel, the well-known figure of the mammoth engraved on a piece of ivory from Périgord, and many other specimens of early art attest a facility that it is not possible to associate with the dawn of human intelligence. M. Salomon Reinach tells an amusing story. A statuette in steatite of a woman, resembling in some respects those of Brassempouy, was discovered in one of the caverns of Mentone, as far back as 1884, but when the discoverer showed it to a personage in the locality, that authority advised him not to let it be seen, lest it should take away from the belief in the antiquity of the caves, it being then thought too artistic to be consistent with early man. The finder acted on this advice, in ignorance of the real interest of the statuette, until April 1896, when he showed it to M. Reinach and M. Villenoisy, who promptly interviewed the sage adviser in question, and obtained a confirmation of the statement. Some interesting additions to our gallery of prehistoric art have been recently made by M. Emile Rivière and M. Berthoumeyrou, at Cro-Magnon in the Dordogne. These are a drawing of a bison and another of a human female in profile, which M. Rivière has kindly allowed me to reproduce. Among the other objects found in the same place were some flint implements brought to a fine point, suitable for engraving on bone or horn.

The idea of making in any form a graphic representation of anything seen has never, so far as I know, occurred to any lower animal; and it could hardly have been among the first ideas formed in the gradually developing human brain. When that idea is found carried out with remarkable artistic skill, by means of implements well adapted for the purpose, we may surely assume that the result was not obtained till after a long interval of time, and was approached by gradual steps marked by progress in other faculties, as well as in the artistic faculty. It may be that some day all uncertainty on this head will be removed by decisive discoveries.

The interval between the Palæolithic and Neolithic periods rests in the like condition of incertitude. That by some means,



and somewhere on the face of the globe, the one period gradually passed into the other we cannot but believe. That the transition between them may have involved innumerable degrees is also highly probable. Where and when, and how each step was taken we do not know at present, and possibly never shall know. The problem is not satisfactorily solved by the production of palæolithic implements resembling neolithic forms, or neolithic implements resembling palæolithic forms; inasmuch as between the one period and the other an interval of time involving geological and other changes has to be accounted for.

In this respect, also, our best authorities are the most cautious and conservative. In the excellent address which Prof. Boyd Dawkins delivered to the Royal Archæological Institute at the Dorchester meeting last year, on the present phase of prehistoric archæology, he contrasted the few primitive arts, such as sewing, and the manufacture of personal ornaments and rude implements of the chase, possessed by the palæolithic hunters—apart from their great proficiency in the delineation of animals—with the variety of arts, such as husbandry, gardening, spinning, weaving, carpentry, boat-building, mining, and pottery-making, possessed by the neolithic herdsmen, and held that between the two there is a great gulf fixed. Somewhere that gulf must be bridged over. Prof. Boyd Dawkins says that the bridge is not to be found in the caverns of the South of France. It is difficult to meet his argument that the presence of grains of barley and stones of the cultivated plum at Mas d'Azil are evidences of neolithic civilisation. His objections to other discoveries are not so strong as this, but are strong enough to make us pause. The tall, long-headed, people whose remains were found at Cro-Magnon, he holds to be early neolithic and not palæolithic, to stand on the near side and not on the far side of the great gulf.

These considerations lend importance to the discoveries which have been laid before this Association at previous meetings by Mr. Seton-Kerr, and which have also been commented upon by Prof. Flinders Petrie and Sir John Evans. If we are compelled to admit a breach of continuity in Europe, is it in Africa that we shall find the missing links? That is another of the great problems yet unsolved. The evidence we want relates to events which took place at so great a distance of time that we may well wait patiently for it, assured that somewhere or other these missing links in the chain of continuity must have existed and probably are still to be found.

The next stage, which comprises the interval between the neolithic and the historic periods, was so ably dealt with by Mr. Arthur J. Evans in his address to this Section at the Liverpool meeting, that it does not call for any observations from me. Two Committees appointed by the Association in connection with this Section touch upon this interval—the Committee for investigating the lake dwellings at Glastonbury, and the Committee for co-operating with the explorers of Silchester in their well-conducted and fruitful investigation of the influence of Roman civilisation on a poor provincial population. I pass on to consider the very great progress that has been made of late years in some of the branches of anthropology other than physical and prehistoric, and especially in that of folk-lore. I do this the more readily because I do not recollect that folk-lore has ever before been prominently referred to in an address to this Section. It is beginning to assert itself here, and will in time acquire the conspicuous position to which it is becoming entitled, for the British Association is sensitive to every scientific movement, and responds readily to the demands of a novel investigation. Already, for three or four years, a day has been given at our meetings to folk-lore papers; and at the Liverpool meeting an exceeding philosophic, and at the same time practical, paper was read by Mr. Gomme, and is printed *in extenso* in the *Proceedings* as an Appendix to the Report of the Ethnographic Survey Committee. The term "folk-lore" itself is not without a certain charm. It is refreshing to find a science described by two English syllables instead of by some compound Greek word. The late Mr. W. J. Thoms had a happy inspiration when he invented the name. It is just twenty years since the Folk-lore Society was established under his direction. It has accumulated a vast amount of material, and published a considerable literature; it is now rightly passing from the stage of collection to that of systematisation, and the works of Mr. J. G. Frazer, Mr. E. Sidney Hartland, and others, are pointing the way towards researches of the most absorbing interest and the greatest practical importance.

A generalisation for which we are fast accumulating material in folk-lore is that of the tendency of mankind to develop the like fancies and ideas at the like stage of intellectual infancy. This is akin to the generalisation that the stages of the life of an individual man present a marked analogy to the corresponding stages in the history of mankind at large; and to the generalisation that existing savage races present in their intellectual development a marked analogy to the condition of the earlier races of mankind. The fancies and ideas of the child resemble closely the fancies and ideas of the savage, and the fancies and ideas of primitive man.

An extensive study of children's games, which had been entered into and pursued by Mrs. Gomme, has been rewarded by the discovery of many facts bearing upon these views. A great number of these games consist of dramatic representations of marriage by capture and marriage by purchase—the idea of exogamy is distinctly embodied in them. You will see a body of children separate themselves into two hostile tribes, establish a boundary line between them, demand the one from the other a selected maiden, and then engage in conflict to determine whether the aggressors can carry her across the boundary or the defenders retain her within it.

There can be little doubt that these games go back to a high antiquity, and there is much probability that they are founded upon customs actually existing, or just passing away at the time they were first played. Games of this kind pass down with little change from age to age. Each successive generation of childhood is short: the child who this year is a novice in a game becomes next year a proficient, and the year after an expert, capable of teaching others, and proud of the ability to do so. Even the adult recollects the games of childhood and watches over the purity of the tradition. The child is ever a strong conservative.

Upon the same principle, next to children's games, children's stories claim our attention. Miss Roalfe Cox has collected, abstracted, and tabulated not fewer than 345 variants of Cinderella, Catskin, and Cap o' Rushes. These come from all four quarters of the globe, and some of them are recorded as early as the middle of the sixteenth century. These elaborate stories are still being handed down from generation to generation of children, as they have been for countless generations in the past. Full of detail as they are, they may be reduced to a few primitive ideas. If we view them in their wealth of detail, we shall deem it impossible that they could have been disseminated over the world as they are otherwise than by actual contact of the several peoples with each other. If we view them in their simplicity of idea, we shall be more disposed to think that the mind of man naturally produces the same result in the like circumstances, and that it is not necessary to postulate any communication between the peoples to account for the identity. It does not surprise us that the same complicated physical operations should be performed by far distant peoples without any communication with each other: why should it be more surprising that mental operations, not nearly so complex, should be produced in the same order by different peoples without any such communication? Where communication is proved or probable, it may be accepted as a sufficient explanation; where it is not provable, there is no need that we should assume its existence.

The simple ideas which are traceable in so many places and so far back are largely in relation with that branch of mythology which personifies the operations of nature. Far be it from me to attempt to define the particular phase of it which is embodied in the figure of Cinderella as she sits among the ashes by the hearth, or to join in the chase after the solar myth in popular tradition. The form of legend which represents some of the forces of nature under the image of a real or fictitious hero capable of working wonders appears to be widely distributed. Of such, I take it, are the traditions relating to Glooscap, which the late Dr. S. T. Rand collected in the course of his forty years' labours as a missionary among the Micmac Indians of Nova Scotia, where, Mr. Webster says, Glooscap formerly resided. The Indians suppose that he is still in existence, although they do not know exactly where. He looked and lived like other men; ate, drank, smoked, slept and danced along with them; but never died, never was sick, never grew old. Cape Blomidon was his home, the Basin of Minas his beaver-pond. He had everything on a large scale. At Cape Split he cut open the beaver dam, as the Indian name of the cape implies, and to this we owe it that ships can pass there. Spencer's Island was his kettle. His dogs, when he went away, were transformed into two rocks close by. When he returns he will restore them to life. He could do anything and everything. The elements were entirely under his control. You do not often meet with a mischievous exercise of his power. It is a curious part of the tradition, possibly a late addition to it, that it was the encroachments and treachery of the whites which drove him away.

The early inhabitants of the island of Tahiti appear to have had a whole pantheon of gods and heroes representing the various operations of nature. Even the Papuans have a legend in which the morning star is personified acting as a thief. But it is needless to multiply instances. Lord Bacon—who says "The earliest antiquity lies buried in silence and oblivion. . . . This silence was succeeded by poetical fables, and these at length by the writings we now enjoy; so that the concealed and secret learning of the ancients seems separated from the history and knowledge of the following ages by a veil or partition wall of fables interposing between the things that are lost and those that remain"—has shown in his "Wisdom of the Ancients" that classical mythology was in truth a vast system of nature-worship, and in so doing has done more than even he knew, for he has affiliated it to those ideas which have been so commonly formed among rude and primitive peoples. It is true, he says, fables in general are composed of ductile matter, that may be drawn into great variety by a witty talent or an inventive genius, and be delivered of plausible meanings which they never contained. But the argument of most weight with him, he continues, "is that many of these fables by no means appear to have been invented by the persons who relate and divulge them, whether Homer, Hesiod, or others; but whoever attentively considers the thing will find that these fables are delivered down and related by those writers, not as matters then first invented and proposed, but as things received and embraced in earlier ages. The relators drew from the common stock of ancient tradition, and varied but in point of embellishment, which is their own. This principally raises my esteem of these fables, which I receive, not as the product of the age, or invention of the poets, but as sacred relics, gentle whispers, and the breath of better times, that from the traditions of more ancient nations came, at length, into the flutes and trumpets of the Greeks."

Except that he supposes them to be a relic of better times, the poet's dream of a golden age no doubt still ringing in his ears, Bacon had, in this as in many other matters, a clear insight into the meaning of things.

Another idea that appears among very early and primitive peoples, and has had in all time a powerful influence on mankind, is that of a separable spirit. The aborigines of North-west Central Queensland, who have lately been studied to such excellent purpose by Dr. Walter Roth, the brother of a much-esteemed past officer of this Section, are in many respects low in the scale of humanity; yet they possess this idea. They believe that the ghost, or shade, or spirit of some one departed can so initiate an individual into the mysteries of the craft of doctor or medicine-man as to enable him, by the use of a death-bone apparatus, to produce sickness and death in another. This apparatus is supposed to extract blood from the victim against whom it is pointed without actual contact, and to insert in him some foreign substance. They will not go alone to the grave of a relative for fear of seeing his ghost. It appears that they have the fancy that Europeans are ghosts. The Tasmanians also, as Mr. Ling Roth himself tells us, had the same fancy as to the Europeans, and believed that the dead could act upon the living. The Pawnee Indians, we are assured by Mr. Grinnell, believe that the spirits of the dead live after their bodies are dust. They imagine that the little whirlwinds often seen in summer are ghosts. The Blackfeet think the shadow of a person is his soul, and that while the souls of the good are allowed to go to the sand-hills, those of the bad remain as ghosts near the place where they died. The Shillooks of Central Africa are said to believe that the ghostly spectres of the dead are always invisibly present with the living, and accompany them wherever they go. The aborigines of Samoa believed in a land of ghosts, to which the spirits of the deceased were carried immediately after death. The religious system of the Amazulu, as described by Bishop Callaway, rests largely on the foundation of belief in the continued activity of the disembodied spirits of deceased ancestors.

Mr. Bryce, in his "Impressions of South Africa," says that at Lezapi, in Mashonaland, are three huts, one of which is roofed, and is the grave of a famous chief, whose official name was Makoni. "On the grave there stands a large earthenware pot, which used to be regularly filled with native beer when, once a year, about the anniversary of his death, his sons and other descendants came to venerate and propitiate his ghost. Five years ago, when the white men came into the country, the ceremony was disused, and the poor ghost is now left without honour and nutriment. The pot is broken, and another pot, which stood in an adjoining hut, and was used by the worshippers, has disappeared. The place, however, retains its awesome character, and a native boy who was with us would not enter it. The sight brought vividly to mind the similar spirit worship which went on among the Romans, and which goes on to-day in China; but I could not ascertain for how many generations back an ancestral ghost receives these attentions—a point which has remained obscure in the case of Roman ghosts also."

The aborigines of New Britain are said to believe that the ghosts of their deceased ancestors exercise a paramount influence on human affairs, for good or for evil. They have the poetical idea that the stars are lamps held out by the ghosts to light the path of those who are to follow in their footsteps. On the other hand, they think these ancestral ghosts are most malicious during full moon. Not to multiply instances, we may say with Mr. Staniland Wake, it is much to be doubted whether there is any race of uncivilised men who are not firm believers in the existence of spirits or ghosts. If this is so, and the idea of a separable spirit, capable of feeling and of action apart from the body, is found to be practically universal among mankind, and to have been excogitated by some of the least advanced among peoples; and if we observe how large a share that idea has in forming the dogmas of the more specialised religions of the present day, we shall not see anything inherently unreasonable in the generalisation that the group of theories and practices which constitute the great province of man's emotions and mental operations expressed in the term "religion" has passed through the same stages and produced itself in the same way from these early rude beginnings of the religious sentiment as every other mental exertion. We shall see in religion as real a part of man's organisation as any physical member or mental faculty. We shall have no reason to think that it is an exception to any general law of progress and of continuity which is found to prevail in any other part of man's nature.

The same inference may be drawn from many other considerations. Take, for instance, the belief in witchcraft, which is so characteristic of uncivilised man that it is hardly necessary to cite examples of it. The Rev. Mr. Coillard, a distinguished missionary of the Evangelical Society of Paris, in a delightful record, which has just been published, of his twenty years' labours as a missionary pioneer among the Banyai and Barotzi of the Upper Zambesi, "on the threshold of Central Africa," says: "In the prison of the Barotzi, toiling at earthworks, is a woman—young, bright, and intelligent. She told me her story. A man of remarkably gentle character had married her. The king's sister, Katoka, having got rid of one of her husbands, cast her eyes on this man and took him. He had to forsake his young wife—quite an easy matter. Unfortunately, a little later on, a dead mouse was found in the princess's house. There was a great commotion, and the cry of witchcraft was raised. The bones did not fail to designate the young woman, and she was made a convict. A few years ago she would have been burnt alive. Ah, my friends, paganism is an odious and a cruel thing!" Ah, Mr. Coillard, is it many years ago that she would have been burnt alive or drowned in Christian England or Christian America? Surely the odiousness and the cruelty are not special to paganism any more than to Christianity. The one and the other are due to ignorance and superstition, and these are more hateful in a Matthew Hale or a Patrick Henry than in a Barotzi princess in the proportion that they ought to have been more enlightened and intelligent than she. It is only 122 years since John Wesley wrote: "I cannot give up to all the Deists in Great Britain the existence of witchcraft"; and I believe that to this day the Order of Exorcists is a recognised order in the Catholic Church.

The same line of argument—which, of course, I am only indicating here—might be pursued, I am persuaded, in numberless other directions. Mr. Frazer, in his work on the Golden Bough, has most learnedly applied it to a remarkable group of beliefs and observances. Mr. Hartland has followed up that research with a singularly luminous study of several other groups of ideas in the three volumes of his "Legend of Perseus." More recently, Mr. Andrew Lang has sought to show that the idea of a Supreme Being occurs at an earlier stage in the development of savage thought than we had hitherto supposed. Striking as these various collocations of facts and the conclusions drawn from them may appear, I am convinced there is much more for the folk-lorist to do in the same directions.

The principle that underlies it all seems to be this: man can destroy nothing, man can create nothing, man cannot of his own mere volition even permanently modify anything. A higher power restrains his operations, and often reverses his work. You think you have exterminated a race: you have put to the sword every male you can find, and you have starved and poisoned all the survivors of the community. In the meanwhile, their blood has been mingled with yours, and for generations to come your bones and those of your descendants will preserve a record of that lost race. You think you have exterminated a religion; you have burned to death all of its teachers you can find, and converted forcibly or by persuasion the rest of the community. But you cannot control men's thoughts, and the old beliefs and habits will spring up again and again, and insensibly modify your own religion, pure as you may suppose it to be.

Huxley, in his address to the department of Anthropology twenty years ago, said, with the force and candour that were characteristic of him: "Anthropology has nothing to do with the truth or falsehood of religion—it holds itself absolutely and entirely aloof from such questions—but the natural history of religion, and the origin and the growth of the religions entertained by the different kinds of the human race, are within its proper and legitimate province." I do not presume to question that as an absolutely accurate definition of the position—it could not be otherwise; but if there be any here to whom what I have been suggesting is in any sense novel or startling, I should be glad to be allowed to say one word of reassurance to them. When my friend Mr. Clodd shocked some of the members of the Folk-lore Society by his frank statement of conclusions at which he had arrived, following the paths I have indicated, it was said we must fall back on the evidences of Christianity. What more cogent evidence of Christianity can you have than its existence? It stands to-day as the religion which, in most civilised countries, represents that which has been found by the operation of natural laws to be best suited for the present circumstances of mankind. You are a Christian because you cannot help it. Turn Mahometan to-morrow—will you stop the spread of Christianity? Your individual renunciation of Christianity will be but a ripple on a wave. Civilised mankind holds to Christianity, and cannot but do so till it can find something better. This, it seems to me, is a stronger evidence of Christianity than any of the loose-jointed arguments I find in evidential literature.

Upon this thorny subject I will say no more. I would not have said so much, but that I wish to show that these considerations are not inconsistent with the respect I entertain, and desire now as always to express, for those feelings and sentiments which are esteemed to be precious by the great majority of mankind, which solace them under the adversities of life and nerve them for the approach of death, and which stimulate them to works of self-sacrifice and of charity that have conferred untold blessings on humanity. I reverence the divine Founder of Christianity all the more when I think of him as one who so well "knew what was in man" as to build upon ideas and yearnings that had grown in man's mind from the earliest infancy of the race.

To return. If continuity be the key that unlocks the receptacle where lie the secrets of man's history—physical, industrial, mental, and moral; if in each of these respects the like processes are going on—it follows, as I have already said, that the only satisfactory study of man is a study of the whole man. It is for this reason that I ask you to take especial interest in the proceedings of one of the Committees of this Section, which has adopted such a comprehensive study as the guiding principle of its work—I mean the Ethnographical Survey Committee. I have so often addressed this Section and the Conference of Corresponding Societies on the matter, since the Committee was first appointed at the Edinburgh meeting, on the suggestion of my friend Prof. Haddon, that I can hardly now refer to it without repeating what has been already said or forestalling what will be said when its report is presented to you, but its programme so fully realises that which has been in my mind in all that I have endeavoured to say that I must make one more effort to enlist your active interest in its work.

The scheme of the Committee includes the simultaneous recording in various districts of the physical characters, by measurement and by photography, the current traditions and beliefs, the peculiarities of dialect, the monuments and other remains of ancient culture, and the external history of the people. The places in the United Kingdom where this can be done with advantage are such only as have remained unaffected by the great movements of population that have occurred, especially of late years. It might have been thought that such places would be very few; but the preliminary inquiries of the Committee resulted in the formation of a list of between 300 and 400. So far, therefore, as the testimony of the very competent persons whose advice was sought by them is to be relied on, it is evident that there is ample scope for their work. At the same time, the process of migration from country to town is going on so rapidly, that every year diminishes the number of such places. One thinks with regret how much easier the work would have been one or two or three generations ago; but that consideration should only induce us to put it off no longer. The work done by the lamented Dr. Walter Gregor for this Committee in Dumfriesshire and other parts of Scotland is an excellent type of the way in which such work should be done. His collections of physical measurements and of folk-lore have been published in the fourth and fifth reports of the Committee. There can be no doubt that few men possess the faculty he had of drawing forth the confidence of the villagers and getting them to tell him their superstitions and their old customs. He succeeded in recording from their lips not fewer than 733 items of folk-lore. They not merely form exceedingly pleasant reading, such as is perhaps not often met with in a British Association report, but they also will be found to throw considerable light on the views which I have ventured to lay before you. It is much to be wished that others who have the like faculty, if even in a lesser degree, could be induced to take up similar work in other districts, now that Dr. Gregor has so well shown the way in which it ought to be done.

The work done by the Committee for the Ethnographical Survey of Canada; the completion of the Ethnographical Survey of the North-western tribes which has been ably conducted for many years; and the progress made in the Ethnographical Survey of India will also be brought under your notice, the latter in a paper by Mr. Crooke, who has worked with Mr. Risley upon it.

Another movement, which was originated by this Section at the Liverpool meeting, and was referred to in the report of the Council of the Association last year, has made some progress since that report was presented. Upon the recommendation of this Section, the General Committee passed the following resolution and referred it to the Council for consideration and action:—

"That it is of urgent importance to press upon the Government the necessity of establishing a Bureau of Ethnology for Greater Britain, which, by collecting information with regard to the native races within and on the borders of the Empire, will prove of immense value to science and to the Government itself."

The Council appointed a Committee, consisting of the President and General Officers, with Sir John Evans, Sir John Lubbock, Prof. Tylor, and your esteemed Vice-President, Mr. Read, the mover of the resolution. Their report is printed at length in last year's Report of Council, and shows clearly how useful and how easily practicable the establishment of such a Bureau would be. The Council resolved that the Trustees of the British Museum be requested to consider whether they could allow the proposed Bureau to be established in connection with the Museum. I understand that those Trustees have returned a favourable answer; and I cannot doubt that the joint representations which they and this Association will make to Her Majesty's Government will result in the adoption of a scheme calculated to realise all the advantages which we in this Section have so long looked for from it. In the Secretary of State for the Colonies and the Chancellor of the Exchequer we have statesmen who cannot fail to appreciate the benefits the community must derive from acquiring accurate and scientific knowledge of the multifarious races which compose the Empire.

Those of us who visited the United States last year had the opportunity of observing the excellent work which is done by the Bureau of Ethnology at Washington, and those who stayed at home are probably familiar with the valuable publications of that department. An Act of Congress twenty years ago appropriated 4000*l*. a year to the Smithsonian Institution for the continuance of researches in North American anthropology. The control of the Bureau was entrusted to the able hands of Major Powell, who gathered round him a band of skilled workers, many of whom had been previously engaged on ethnographic research under the direction of the Geographical and Geological Survey of the Rocky Mountain region. In field work and in office work, to use Major Powell's convenient distinction, ample return has ever since been rendered to the United States Government for the money thus appropriated, which has since been increased to 8000*l*. a year. Our own Bureau of Ethnology would have a wider sphere of operations, and be concerned with a greater number of races. It would tend to remove from us the reproach that has in too many cases not been without foundation—that we have been content to govern races by the strong hand without caring to understand them, and have thus been the cause of injustice and oppression from ignorance rather than from malevolence. If that were only a record of the past, we might be content with mere unavailing regret; but the colonial empire is still expanding, and we and our competitors in that field are still absorbing new districts—a practice which will probably continue as long as any spot of ground remains on the face of the globe occupied by an uncivilised race.

Would it not be worth while at this juncture to extend to the peoples of Africa, for instance, the principles and methods of the Ethnographic Survey—to study thoroughly all their physical characters, and at the same time to get an insight into the working of their minds, the sentiments and ideas that affect them most closely, their convictions of right and wrong, their systems of law, the traditions of the past that they cherish, and the rude accomplishments they possess? If for such a service investigators like Dr. Roth, who began his researches in Queensland by so close a study of the languages and dialects of the people that he thoroughly won their confidence, could be found, the public would soon learn the practical value of anthropological research. If the considerations which I have endeavoured to urge upon you should lead not only the scientific student but the community at large to look upon that which is strange in the habits and ways of thinking of uncivilised peoples as representing with more or less accuracy a stage in that long continuity of mental progress without which civilised peoples would not be what and where they are, it could not but favourably affect the principles and practice of colonisation. *Tout comprendre c'est tout pardonner.* The more intimate our acquaintance with the races we have to deal with and to subjugate, the more we shall find what it means to stand with them on the same platform of common humanity. If the object of government be, as it ought to be, the good of the governed, it is for the governing race to fit itself for the task by laying to heart the lessons and adopting the processes of practical Anthropology.

PHYSICS AT THE BRITISH ASSOCIATION.

THE reputation for industry which Section A has acquired in past years will not suffer in any way by the proceedings of the recent meeting in Bristol. In addition to the ordinary meetings of the Section, the International Magnetic Conference met on four days; and as all communications to the Section relating to terrestrial magnetism and atmospheric electricity were referred to the Conference, it may be said that the Section sat in duplicate on five out of its six days of meeting. On Saturday, when the Magnetic Conference did not meet, the two departments were devoted to mathematics and meteorology respectively, and on Wednesday the Section was not divided. On two occasions the Section was associated with others in joint discussions, namely with Section B, on the results of the recent solar eclipse expeditions, and with Section G, on the magnetic and electrolytic effects of electric railways. The members of the International Magnetic Conference also took part in the latter discussion. The papers read before the Section were representative of almost every branch of physics. In the following account they are grouped according to subject, and are not arranged in the order in which they were read.

Before the commencement of his address the President, Prof. Ayrton, referred to the loss to science occasioned by the death of Dr. John Hopkinson. The address, which was published in NATURE of September 8, suggests a new field for physical and chemical research, namely the investigation of the phenomena of smell. For the physicist the most striking experiments described are those which show the slowness of diffusion of odorous particles in still air, and the absorption of scents by glass, while the physiologist cannot fail to be interested in the superior sense of smell possessed by the female sex. In moving a vote of thanks to the President, Lord Kelvin referred to the identity of the senses of taste and smell, including both as the chemical sense, and hoped Prof. Ayrton's address would lead to another bond of union between the chemist and the physicist. Prof. Mascart seconded the vote, specially thanking the President for his welcome to the members of the International Magnetic Conference.

In the subject of heat Prof. Rosa described the continuation of important work by himself and Prof. Atwater, the object being to determine whether the law of conservation of energy holds good for the vital processes going on in the human body. For this purpose a space large enough for a man to live in was enclosed as a calorimeter, and surrounded by alternate jackets of flowing water and air, in such a manner that the heat evolved from the "calorimeter" could be accurately measured. The details of construction of the apparatus were described at the Toronto meeting last year. During the past twelve months the authors have made experiments on men living in the calorimeter for periods varying from four to eight days, and doing different kinds of work. The heat-value of the food supplied and of the excreta were obtained by combustion, and the amount and composition of the gases entering and leaving the calorimeter were also determined. A full description of the work is to be published by the United States Government, under whose auspices the experiments have been carried out; it may, however, be stated that the law of conservation of energy is found to be true within the limits of experimental error. The ratio of the mechanical work done by a man to the total energy supplied to him, that is to say his efficiency as an engine, is usually about 7 per cent., and may be as high as 10 per cent. These figures are higher than the efficiency of a perfect heat-engine working between the same limits of temperature, and lead us to the conclusion that the energy transformation in the human body is not effected solely by heat, but is most probably analogous to that in a circuit containing a battery and electromotor.

Another series of experiments to decide a question of theoretical interest was described in a paper by Dr. A. Galt, on the heat of combination of metals in the formation of alloys. Lord Kelvin has shown how a lower limit to the size of atoms may be found by comparing the work done by the approach of the electrical charges on a thin film of zinc and a thin film of copper, their difference of potential being that due to contact, with the heat of combination of the films to form brass. On the other hand Prof. Oliver Lodge has pointed out[1] that on the chemical theory of electromotive force of contact the heat of formation of an alloy should be much smaller than Lord Kelvin assumes it to be, and an exact determination of its value would form a crucial test between the rival contact and chemical theories. In Dr. Galt's experiments a thin glass bulb with holes in its sides contains the alloy or the mixed metals, and is lowered into a calorimeter of glass containing nitric acid; as the acid passes through the holes the metal is dissolved, and the evolved gases do not escape. The rise of temperature of the acid is noted, and the heat of combination calculated. The results are so far preliminary, and the Association has made a grant for their continuation. Mr. W. N. Shaw read a paper on Dalton's law, in which he called attention to Regnault's experiments on the pressure of mixtures of air and saturated ether vapour; these experiments show a discrepancy between the saturation pressure of ether in air and in a vacuum. The explanation afforded by Regnault is that errors are introduced owing to the condensation of vapour on the vertical walls of the barometer tube; but from experiments on mixtures of air and water-vapour, Mr. Shaw considers that a real departure from the law of Dalton is indicated. The subject is to be investigated in the Cavendish Laboratory. Dr. C. H. Lees described experiments on the thermal conductivity of rocks at different pressures, according to which the conductivities of slate, granite and marble are very slightly increased by increased pressure, while in the case of a rather soft sandstone the increase amounted to 3 per cent. under a pressure of about sixty atmospheres. Mr. S. R. Milner and Prof. Chattock read a paper on the thermal conductivity of water, which they find to be 0·00143 C.G.S. units at 20° C.

Among papers relating to light Mr. J. W. Gifford read a communication on lenses, not of glass, in which he compared the transparency of calcite, quartz and fluor-spar for extreme ultra-violet rays, the last-named being the most transparent. Lord Kelvin discussed the various theories of refraction and anomalous dispersion, and stated that none of the dynamical theories hitherto proposed is satisfactory or free from difficulties. Prof. T. Preston described his experiments on radiation in a magnetic field. Zeeman found that when the spectrum of the sodium light emitted from a source in a magnetic field is viewed at right angles to the lines of force, the bright lines are tripled and the polarisation of the side lines is in a plane perpendicular to that of the central line. By using a very large grating and photographing the lines, Prof. Preston finds that all bright lines in a spectrum are not treated alike; some are unchanged, some become doublets, triplets, quartets, or even sextets. He explained how absorption of the original radiation by vapour surrounding the source might account for the multiplication of lines, but he considers from the sharpness of definition of the lines that the effect is not due to absorption. Prof. S. P.

[1] *Philosophical Magazine*, vol. xix., 1885.

Thompson described and exhibited an experiment by Righi on the production of the Zeeman phenomenon by absorption. A beam of plane polarised white light is passed along the lines of force of a magnetic field, and received in an analyser adjusted to extinction with zero field; in the magnetic field is a sodium flame or a tube filled with nitric oxide. On setting up the field a brilliant yellow light is seen, which cannot be extinguished by rotating the analyser; spectroscopic examination shows it to consist of doubled sodium lines, the constituents of each doublet being slightly more and slightly less refrangible respectively than the original lines. In the case of nitric oxide the light seen is bluish-green, being complementary to the colour of nitric oxide by transmission, and the spectrum consists of doublets. Profs. Lodge and Glazebrook thought that the phenomenon might be fully explained by supposing the magnetic field to alter the period of vibration of the ions so that they respond to waves of slightly higher or lower frequency than their natural one. Dr. C. E. Curry read a paper on the electromagnetic theory of reflexion on the surface of crystals.

A communication from Mr. J. Burke referred to the luminosity produced by striking sugar. The rim of a rapidly revolving disc of sugar is struck automatically by a hammer at the rate of about two blows per second; this causes an almost continuous luminosity extending from the hammer inwards and downwards. The spectrum of the light is confined to the more refrangible side of the F line, and the nature and appearance of the luminosity are unchanged by altering the medium surrounding the sugar. No satisfactory explanation of the phenomenon has yet been found.

The report of the Electrical Standards Committee is a record of progress made in the determination of the standard ampere. Profs. Ayrton and J. V. Jones have designed an ampere balance, for the construction of which a grant has been made by the Association. The details of the instrument were described to the Section. An appendix to the report contains an account of the determination of the temperature-coefficients of two coils used in the determination of the ohm by Profs. Ayrton and Jones, the measurements having been made by Mr. M. Solomon. The coils do not appear to have changed since 1896, but their resistances as measured in 1894 were slightly lower (0·006 to 0·007 per cent.) than the present values. The Electrolysis Committee has investigated the electrical conductivity and the freezing point of several dilute solutions of salts, which furnish some unexpected and, therefore, interesting results. The data are, however, not yet complete. The report was accompanied by a paper from Mr. Whetham on the measurement of the electric conductivity, and one from Mr. E. H. Griffiths on the freezing point determinations. Mr. S. Skinner has investigated the carbon-consuming cell of Jacques, consisting of an iron crucible into which is put fused caustic soda with a carbon rod as electrode, the crucible forming the other electrode. In order to maintain the electromotive force of the cell, air is blown into the caustic soda. Mr. Skinner found that the air acts by cleaning the surface of the iron crucible, and can be usefully replaced by adding sodium peroxide to the caustic soda. By measuring the current furnished by the cell, and the loss of weight of the carbon electrode per second, the author hopes to determine the electro-chemical equivalent of carbon. Messrs. Cahen and Donaldson communicated the results of some comparisons of the output and efficiency of a secondary cell (Tudor type) when charged at constant current and constant electromotive force respectively. By charging at constant potential the time of charging is reduced to less than half that required at constant current, the capacity is thirty per cent. greater, but the energy efficiency is ten per cent. less. Neither method of charging appears to damage the cell. Mrs. Ayrton read a paper on the drop of potential at the terminals of the electric arc, in which she described the exploration of potential distribution in the arc by means of a third electrode of carbon inserted laterally. If the arc be maintained at constant length the power expended at each carbon is a linear function of the current, and if the current be maintained constant the power expended at each carbon is a linear function of the arc-length. The experiments are subject to errors pointed out by Mrs. Ayrton in her paper: (1) the third carbon may not take up the potential of the point of the arc in which it is placed; (2) it alters the potential-distribution and the length of the arc. The author proposes to repeat her experiments, using an insulating third carbon. Prof. Chattock described experiments to determine the velocity of electricity in the electric wind. He finds that the electricity in the electric wind travels much more rapidly than the gaseous particles themselves, reaching in hydrogen a velocity of 900 cm. per second. Profs. Rosa and A. W. Smith have investigated the heating effect of alternating currents upon the dielectric of a condenser, measuring the net watts supplied to the condenser and the heat developed per second in the dielectric. Their results were communicated to the Section by Prof. Rosa. Mr. F. B. Fawcett described standard high resistances constructed by depositing kathode films on glass and heating them for a long time in a partial vacuum; this process renders them constant. Prof. Callendar exhibited a platinum voltmeter, in which the change of temperature of a platinum wire on passing a current through it is utilised to measure the current, and hence electromotive force; the instrument is made self-recording. Mr. E. H. Griffiths exhibited an apparatus for the measurement of resistance, by which the resistance of a coil can be measured to within one part in three millions. Prof. Lodge described a new magnifying telephone, for calling up the operator at the receiving end in systems of wireless telegraphy. The minute current set up in the receiving circuit passes through a small, light coil suspended in a strong magnetic field and rigidly attached to the disc of a microphone transmitter; the coil moves, and so sets the microphone disc in motion. A relay current in the microphone circuit is thus interrupted, and can be sent through the coil of a second similar apparatus. By using three or four magnifications a slight sound can be made to approximate in intensity to the human voice. Prof. Barrett, Messrs. W. Brown and R. A. Hadfield communicated the results of some determinations of the electrical conductivity and magnetic permeability of various nickel-steels. Prof. S. Lemström and Dr. E. H. Cook read papers on the action of electricity on plants. Both agree that the growth of plants is accelerated by electrical discharges or currents; Dr. Cook, however, considers that the increased growth takes place only during germination of the seed and its growth underground, the mature plant being unaffected by electrical actions. In another paper Dr. Cook described experiments on the reflexion of the brush discharge.

The discussion on the magnetic and electrolytic actions of electric railways was opened by Dr. Schott, who described the total destruction of two American magnetic observatories by the approach of electric street-railways. Prof. Rücker indicated disturbances of a magnetometer needle due to the South London Electric Railway felt as far away as 3½ miles, and referred to the complete destruction of the Greenwich vertical force and earth-current records. He pointed out that the trouble could be remedied if electrical engineers would meet physicists in a friendly way, as they had done hitherto in this country. The principal disturbances arise from want of insulation of the return circuits of railway systems and the excessive distance between the outward and return circuits; the former gives rise to earth-currents, and the latter to magnetic induction. Dr. Eschenhagen stated that in conjunction with Prof. von Bezold he had found a disturbance of magnetic instruments at a distance of 15 kilometres from electrical railways near Potsdam. Mr. W. H. Preece claimed protection for telegraphs and telephones as well as for magnetic observatories; the telephone, however, when provided with a complete twisted metallic circuit, is not capable of being disturbed, but earth-currents due to leakage seriously interfere with telegraphic work. Signor Palazzo described a method of damping the swings of a magnetometer needle so as to make it unsensitive to small-period oscillations. Prof. Fleming gave many instances of corrosion of gas and water pipes by electrolytic action, the pipes forming part of the earth-return of a leaky circuit. Prof. S. P. Thompson suggested the use of alternating currents and no earth-return, or of continuous currents with well-insulated circuits and the return wire very close to the outward circuit. Prof. Ayrton pointed out that it was to the advantage of the electrical engineer himself to use a well-insulated return-circuit.

In the discussion on the results of the recent solar eclipse expeditions, Prof. Turner classified the work of solar eclipses as referring chiefly to the shape, movements, nature and brightness of the sun's surroundings. The success of Mrs. Maunder in photographing a long coronal streamer has led to a discussion on the efficacy of triple-coated plates and a small camera, such as she used. Again, evidence is very conflicting concerning the relations of coronal extensions and solar prominences; from their positions they appear to be connected, but spectroscopically there is no evidence of any such connection. Another unsettled point is the question whether the corona takes part in the sun's rotation. Sir Norman Lockyer explained the connection between the spectra of stars and their temperature, and referred to the discovery that the spectrum of the sun's chromosphere is similar to that of the principal absorbing layer in γ Cygni, which he characterised as a Rosetta stone of solar and stellar spectroscopy. He showed how the spectra of the various layers of the chromosphere indicate a gradual increase of temperature from without inwards, and announced with reserve, that the Indian photographs suggested that the wave-length of the chief coronal line required revision. Sir William Crookes suggested the appointment of a joint committee of chemists and physicists to examine quietly the question of solar spectra. Captain E. H. Hills exhibited his photographs of the spectrum of the inner corona. Captain Abney and Prof. Thorpe, who intended to take part in the discussion, were unable to be present at the meeting.

In meteorology, the Ben Nevis Committee sent a report of extended work, a station having been established at a point halfway up the mountain, and observations taken hourly during a portion of the year. The Committee on Meteorological Photography reported through Mr. Clayden that the work of simultaneously photographing clouds near the sun from two stations in an east and west line had been continued, the results showing that in hot, thundery weather the alto-cumulus and cirro-cumulus clouds attain great heights, sometimes reaching 90,000 feet. In order to make observations in the early morning and late afternoon a change of base line to a north and south direction is contemplated. The report of the Seismological Observations Committee deals with many phases of earthquake work, and in introducing it Prof. Milne emphasised the importance of securing better accommodation for seismological apparatus. He compared the seismological laboratories of Italy and Japan with the only one of this country, namely his own house at Shide, Isle of Wight. The Sectional Committee has taken steps towards securing the aid of the Government in providing suitable housing for seismological apparatus. The Montreal Meteorological Observatory reports having obtained successfully in McGill University Physical Laboratory records of the temperature on the top of Mount Royal; the installation of other apparatus recording at a distance is being proceeded with. Prof. Callendar described an application of his platinum thermometer as a sunshine recorder, by registering the temperature-difference between a bright and a blackened thermometer. Mr. A. L. Rotch recorded an ascent of the Hargrave kite to a height of 11,440 feet at Blue Hill, Mass., U.S.A. Dr. van Rijckevorsel drew attention to a similarity, even in details, between the annual curves of temperature, air-pressure, rainfall, magnetic declination, vertical and horizontal magnetic force. He considered this to be a proof of similarity of origin of magnetic and meteorological phenomena. Mr. Douglas Archibald indicated a classification of weather types in western Europe, lasting for several days, and thus permitting the possibility of extending the present daily forecast. Simultaneous telegraphic reports from a greater number of stations would be necessary. Mr. Hopkinson read a paper on the climate of south-western England.

Among papers on general physics, Mr. W. N. Shaw exhibited a pneumatic analogue of the potentiometer, in which air-currents set up by gas jets at the lower ends of two tubes take the place of electric currents. The author pointed out its application to some problems of ventilation. Mr. A. W. Warrington described hydrometers of total immersion, which are hydrometers loaded with platinum weights until they are on the point of sinking; a slight rise of temperature of the liquid then causes them to do so. For liquids, the method is accurate to one part in a million. For solids, a kind of Nicholson hydrometer without tray is used, and the temperature is determined at which the instrument has no weight in water (1) loaded with mercury alone, (2) loaded with the solid and mercury. The results are accurate to one part in 100,000. Mr. W. R. Barker described and exhibited some interesting old weights and measures of Bristol. In sound, if we except Lord Kelvin's communication on the continuity of undulatory theory for sound, elastic-solid and electric waves, the only paper presented was that of Dr. R. J. Lloyd on the articulation and acoustics of the spirate fricative consonants. In this paper the differences between the articulation and resonance of the consonants *f*, *th*, *h*, *s*, *sh* and *ch* are discussed, and the author points out that the first three differ in the length and width of the frictional passage of the throat producing them, whereas the last three require some kind of fore-cavity which modifies and subdues the frictional noises. In the case of *s* and *sh* there is strong resonance from both the fore-cavity and the hinder cavity, the two sounds being differentiated by the second friction against the tips of the lower teeth in producing *s*.

We shall take another occasion to refer to the proceedings of the Magetic Conference.

During the meeting a collection of physical apparatus was exhibited in the physical laboratory of University College by Messrs. J. J. Griffin and Sons. It included an assay balance entirely free from steel, carrying 5 grammes and weighing to 0·00002 gramme, and a chemical balance weighing to 0·0001 gramme, both of which were provided with arrangements for weighing fractions of a gramme without opening the case. Holloway's crucible furnace, Davis' induction coil and X-ray bulbs, were also exhibited, as well as a simple form of apparatus for the measurement of expansion of solids, in which a rod fixed in a water bath between two glass rods is heated and displaces the glass rods; these pass through the sides of the water bath, and their displacement is measured directly by micrometer screws. The absence of optical devices for measurement increases greatly the simplicity of the instrument, which is said to yield fairly good results for lecture purposes.

MATHEMATICS AT THE BRITISH ASSOCIATION.

SATURDAY in the British Association week is a holiday for most of the Sections; the mathematicians and physicists, thus freed from competition, bid for two audiences instead of one, and take papers on mathematics and meteorology in separate rooms. This year the mathematical session, over which Lord Kelvin presided, was very well attended.

The first paper, read by Colonel Allan Cunningham, was a report on the work of the Committee appointed some years ago, with Lord Kelvin as chairman, for calculating tables of certain mathematical functions. It was explained that a set of tables has been prepared, giving the residues of powers of 2 for all prime moduli less than 1000. The plan is much the same as that of Jacobi's Canon Arithmeticus; but Jacobi uses as base a primitive root of the prime number concerned, which is inconvenient in practical calculations. The tables are now complete in MS., and nothing remains but to print them. It is to be hoped that the Association will see its way to printing them separately in quarto, as their usefulness will be much diminished if they are printed on the smaller page of the Annual Report; but it seems likely that, partly for financial reasons, they will not be published at all for another year.

The next paper, "The mathematical representation of statistics," by Prof. Edgeworth, was read in abstract by one of the Secretaries, in the absence of the author; and the following one, "On the use of logarithmic co-ordinates," by Mr. J. H. Vincent, was taken as read, but is to be published in full in the Annual Report.

One seldom sees lantern illustrations to a paper read at the mathematical session. But the next two subjects on the list can be treated experimentally as well as mathematically. In the first, "A new method of describing cycloidal and other curves," Prof. Hele-Shaw, of Liverpool, showed a new instrument for drawing the curves which can be got by rolling one circle on another. Perhaps its most striking feature is that the radii of the fixed and rolling circles may be as great as we please, their centres not being restricted, as in the ordinary instruments, to the limited range of a drawing board. Thus the radius of the fixed circle may be made infinite, when its circumference becomes a straight line, and the common cycloid is traced on the paper.

Another considerable advantage is, that the complete curve required can be drawn in many cases where the ordinary methods would only give a portion of it, or would only give the whole curve after several operations.

Since an ellipse of any eccentricity may be described by means of a point attached to a circle rolling within another of twice its diameter, it is clear that this instrument can be used for drawing ellipses. It differs from the elliptograph of Messrs. Alexander and Thomson, which depends on the same property, in having two pairs of toothed wheels instead of one; this improvement gets rid of some of the defects of the older arrangement, with which ellipses can only be got under limited conditions.

The inventor expressed his opinion that mathematicians would find this instrument a help in explaining to beginners the properties of roulette curves in general. While most teachers will probably reply that machines of this kind are more trouble than they are worth in teaching, no one will question their interest to the full-grown mathematicians themselves.

A second paper by the same author dealt with his experiments on the motion of a viscous fluid between two parallel plates. A remarkable theorem, due to Sir George Stokes, which was communicated together with the experimental paper, renders this work of great importance. In Prof. Hele-Shaw's arrangement, liquid is forced between close parallel plates, past an obstacle of any form; and the conditions chosen are such that, whether from closeness of the walls, or slowness of the motion, or high viscosity of the liquid, or from a combination of these circumstances, the flow is regular. This is best attained by using glycerine as the fluid; then by colouring the jets which enter between the plates at certain points, the lines of flow in the liquid are made visible, and can be thrown on a lantern-screen or copied. Now Sir George Stokes's discovery is this, that the stream-lines thus experimentally obtained are the same as the stream-lines in the steady motion of a *perfect* (*i.e.* absolutely inviscid) liquid flowing past an infinitely thin long rod, a section of which is represented by the obstacle between the parallel walls which confine the viscous liquid. A complete graphical solution is thus experimentally obtained of a problem which, from its complexity, baffles the mathematician except in a few simple cases.

Owing to the similarity, so far as mathematics are concerned, between problems relating to the motion of a perfect fluid and the problems of electricity and magnetism, this gives also a method of investigating electrical and magnetic problems, in which the effect of placing a body of any required form and resistance (*i.e.* with any value of μ) in a uniform field can be obtained.

The beauty of the experiments greatly interested the audience, many of whom were probably unable to follow easily Sir George Stokes's mathematics; it is to be hoped that some of the results will figure before long as diagrams in hydrodynamical text-books.

Of the next paper, "Graphic representation of the two simplest cases of a single wave," by Lord Kelvin, an account will subsequently appear in these columns.

At meetings of the mathematical session in future years it is proposed to have a number of reviews of recent progress in various branches of pure mathematics, similar to those frequently prepared by German and American mathematicians. Several such reports are being arranged for next year, and this year a paper on "The recent history of the theory of the functions used in analysis" was given by Mr. E. T. Whittaker. The paper traced some of the more notable developments in the theories of special classes of functions, notably the automorphic functions and the functions of harmonic analysis. Then, speaking of the way in which most of the knowledge reviewed has been gained, "Isolated functions are invented, as Legendre's and Bessel's functions were invented, for the solution of physical problems. The work of the pure mathematician is to find the connection between them, to assign them places in an ordered series, and to develop their common theory. The arrangement once made, the gaps in the series are manifest. Every gap points to a function hitherto unknown, which is discovered and returned to the physicist, as the interest on his original deposit."

Two papers by Dr. Johnstone Stoney followed. The first, "The dynamical explanation of certain observed phenomena of meteor streams," attempts to account for the facts observed in meteoric showers on the earth, by considerations as to the streams of meteors which cause them. A shower may be very short, or it may last several days; its radiant—the point in the sky from which the stars appear to shoot—may remain fixed, or it may move; the disposition of the shower about its maximum may be symmetrical, or it may not; and in all these respects, the showers due to the same stream of meteors may behave differently in different years.

At each encounter of the meteors with the earth a number are caught and blaze themselves out in the atmosphere; a still larger number narrowly escape, and are deflected from their course by the earth's attraction. Dr. Stoney showed how the subsequent history of these "clino-meteors" will account for the facts noticed. This is especially interesting in view of our approaching encounter with the Leonid meteors.

In a second paper, "A survey of that part of the scale upon which nature works, about which man has some information," Dr. Stoney reviewed the range of our knowledge of magnitudes, and discussed what might be if the scale of our conceptions were of another order.

The last paper on the day's list was by Prof. G. J. Stokes, of Cork, on "The imaginary of logic." The search for a philosophical theory of $\sqrt{-1}$ has occupied men's minds ever since it was found that "impossible" quantities were useful. After classifying various views on the matter, the author said that the generally adopted position, that $\sqrt{-1}$ is uninterpretable in single or pure algebra, is paradoxical; for how can what is essentially meaningless possess an important meaning in its extraneous use? Then explaining the logical theory of the imaginary, he applied it to De Moivre's Theorem. The paper concluded with a comparison of the Calculus of Boole's Laws of Thought with that of Grassmann's Ausdehnungslehre, and some remarks on the relation of non-commutative algebras to ordinary mathematics.

FORTHCOMING BOOKS OF SCIENCE.

IN the list of M. Félix Alcan (Paris) are to be found:—"Névroses et Idées Fixes," by Prof. Raymond and Prof. Pierre Janet; ii. "Fragments de leçons cliniques sur les névroses, les maladies produites par les émotions, les idées, obsedantes et leur traitement"; "L'education de Sentiments," by P. F. Thomas; "La Méthode dans la Psychologie des Sentiments," by Prof. F. Rauh; "Operçus de Taxinomiè," by Durand de Gros; "Cherurgie du péricarde et du cœur," by Prof. F. Terrier; "L'auditiers et les organes," by le Dr. Gellé (Bibliothèque scientifique Internationale); "La céramique anciênne et moderne," by Guignet and Garnier (Bibliothèque scientifique Internationale); "La géologie expérimentale," by Prof. Stanislas Meunier.

The list of Messrs. Baillière, Tindall, and Cox includes:—"Aids to Psychological Medicine," by T. A. Beadle; "Chronic Nasal Obstruction, and Deformities of the Upper Jaw, Teeth, and Palate," by Dr. M. P. Mayo Collier; "Dictionary of Medical Terms," by H. de Méric, Part i., English-French, Part ii., French-English; "A Text-book of Operative Veterinary Surgery," by Dr. George Fleming, Part ii.; "Cattle Tuberculosis; a Practical Guide to the Farmer, Butcher, Meat Inspector, by Dr. T. M. Legge; "Aids to Materia Medica," by Dr. W. Murrell; "Essays for Students," by Stephen Paget; "The Analysis of Food and Drugs," in five parts, by T. H. Pearmain and C. G. Moor, Part ii., "The Chemical and Biological Examination of Water"; and new editions of "Heart Disease, with Special Reference to Prognosis and Treatment," by Sir Wm. H. Broadbent, Bart., F.R.S., and Dr. J. F. H. Broadbent; "The Throat and Nose and their Disease," by Lennox Browne, illustrated; "Manual of Physiology, with Practical Exercises," by Prof. G. N. Stewart, illustrated; "Handbook of Surgical Pathology," by Drs. W. J. Walsam and A. A. Kanthack; "Aids to the Diagnosis and Treatment of Diseases of Children (Medical)," by Dr. J. McCaw; "A Guide to the Examinations of the Conjoint Board in England, and for the Fellowship of the College of Surgeons, with Examination Papers," by F. J. Gant; "Handbook for Attendants on the Insane, Prepared by Authority of the Medico-Psychological Association; "Practical Guide to the Public Health Acts, and Correlated Acts for Officers of Health and Inspectors of Nuisances," by Dr. T. W. Hime.

Messrs. Blackie and Son, Ltd., promise:—"Recent Advances in Astronomy," by Dr. A. H. Fison; and "The Science of Life," by J. Arthur Thomson.

Messrs. W. Blackwood and Sons give notice of:—"A Text-Book of Agricultural Zoology," by Fred. V. Theobald, illustrated; "Intermediate Text-Book of Geology," by Prof. Lapworth, F.R.S., founded on Dr. Page's "Introductory Text-Book of Geology," illustrated; and a new edition of "Introductory Text-Book of Zoology," by Prof. Henry Alleyne Nicholson, F.R.S., and Alexander Brown, illustrated.

The list of the Cambridge University Press includes:—"Collected Mathematical Papers," by Prof. P. G. Tait; "The Scientific Papers by John Couch Adams," vol. ii., edited by Profs. W. G. Adams and R. A. Sampson; "A Treatise on Octonions," a development of Clifford's bi-quaternions, by Prof. Alexander McAulay; "On the Kinetic Theory of Gases," by S. H. Burbury, F.R.S.; "A Treatise on Spherical

Astronomy," by Prof. Sir Robert S. Ball, F.R.S.; "A Treatise on Geometrical Optics," by R. A. Herman; "A Treatise on Dynamics of a Particle," by Dr. E. J. Routh, F.R.S.; "The Strength of Materials," by Prof. J. A. Ewing, F.R.S.; "Zoological Results based on material from New Britain, New Guinea, Loyalty Islands, and elsewhere, collected during the years 1895, 1896, and 1897," by Dr. Arthur Willey; the work will embody the zoological results of the expedition, and will, it is expected, be completed in five or six parts; it will be illustrated. "Fossil Plants," a manual for students of botany and geology, by A. C. Seward, F.R.S., in two vols., vol. ii.; "Vertebrate Palæontology," by A. S. Woodward; "The Soluble Ferments and Fermentation," by Prof. J. Reynolds Green, F.R.S. (Cambridge Natural Science Manuals, Biological Series). "Electricity and Magnetism," by R. T. Glazebrook, F.R.S.; "Sound," by J. W. Capstick (Physical Series). "Crystallography," by Prof. W. J. Lewis; "The Principles of Stratigraphical Geology," by J. E. Marr (Geological Series). "Man, Past and Present," by A. H. Keane (Geographical Series). "An Introduction to Psychology," by G. F. Stout and Johns Adams; and "The Teacher's Manual of School Hygiene," by Dr. E. W. Hope and E. Brown.

In Messrs. Cassell's list we find:—"Wild Life at Home: how to Study and Photograph It," by R. Kearton, illustrated; and "Michael Faraday: his Life and Work," by Prof. Silvanus P. Thompson, F.R.S.

Messrs. Chapman and Hall, Ltd., announce:—"Wild Animals in Captivity," being anecdotes and reminiscences of the birds and beasts of the Zoological Gardens, with descriptions of their habits, food, management, &c., compiled from the notes and writings of A. D. Bartlett, and edited by his son, Edward Bartlett, illustrated; "Rambles in Lion Land," by Captain Francis B. Pearce, illustrated; "The Exploration of the Niger"; personal narrative of Lieut. Hourst, commander of the 1895–96 expedition from Timbuktu to Bussa; translated by Mrs. Arthur Bell (N. D'Anvers), illustrated; "Medical Works of the Fourteenth Century," consisting of transcripts with notes, from four MS. volumes (contemporary with the works of Wiclif and Chaucer); three being in the British Museum and one in the possession of Prof. Henslow; with an alphabetical list of upwards of 700 medical and other plants mentioned in works of the fourteenth century; compiled and identified with their modern English and Latin equivalent names, by the Rev. Prof. George Henslow; "Measurement and Weighing," a first year's course in elementary practical physics, for organised science schools, by Edwin Edser; and a new edition of "A Text-Book of Mechanical Engineering," by Wilfrid J. Lineham.

Messrs. J. and A. Churchill promise:—"A Text-Book of Materia Medica," by Prof. Henry G. Greenish; and new editions of Allen's "Commercial Organic Analysis," vols. i., ii., iii., Part 1; Thresh's "Simple Method of Water Analysis," with a section added on "Sewage Effluents"; Morris's "Human Anatomy"; Clouston's "Clinical Lectures on Mental Diseases," with nineteen plates, four of which are new; Taylor's "Manual of the Practice of Medicine"; Hartridge's "Refraction of the Eye"; and Goodhart's "Diseases of Children."

Among the books to be issued by the Clarendon Press may be mentioned a translation of Goebel's "Organographie der Pflanzen," by Prof. I. Bayley Balfour, F.R.S.

Messrs. Duckworth and Co. promise:—"Tom Tit Tot," an Essay on Savage Philosophy in Folk-Tale, by Edward Clodd; "A Glossary of Botanic Terms," by B. Daydon Jackson; and "A Text-Book of Agricultural Botany, Theoretical and Practical," by Prof. John Percival.

Messrs. R. Friedländer and Sohn (Berlin) announce:—"Icones Fungorum in Pannoniis Observatorum," C. Clusius, Cum Commentariis mycologicis edidit Prof. Gy. de Istvánffi, illustrated; "Das Tierreich," edited by the Deutschen Zoologischen Gesellschaft, General Editor, Franz Eilhard Schulze; Lieferung (5) Sporozoa, by Dr. A. Labbé; (6) Sarcoptidae et Demodicidae, by Prof. G. Canestrini und Prof. P. Kramer; (7) Pedipalpi et Scorpioninae, by Prof. K. Kraepelin; (8) Copepoda I., by Dr. W. Giesbrecht und Dr. O. Schmeil; (9) Trochilidae, by E. Hartert; (10) Hydrachnidae et Halacaridae, by R. Piersig und Dr. H. Lohmann. "Gerberti (Papae Silvestri II) Opera Mathematica," primum collegit et edidit N. M. Bubnow; "Supplement zum Zoologischen Adressbuch," edited by the Deutschen Zoologischen Gesellschaft; "Geschichte und Systematik der Indigo-Synthese," Dr. A. Reissert; "Catalogus Mammalium tam viventium quam fossilium," Dr. E. L. Trouessart, v. Fasciculus, nova editio.

Messrs. Wells Gardner, Darton, and Co. promise:—"Wonders of the Bird World," by Dr. R. Bowdler Sharpe.

The list of Messrs. Gauthier-Villars et Fils (Paris) contains:—"Bibliographie générale de l'Astronomie," Houzeau et Lancaster, Tome iii. Observations; "Compositions d'Analyse, de Mécanique et d'Astronomie," Prof. E. Villié, III^e Partie; "Traité pratique de Radiographie et de Radioscopie," A. Londe; "Les Objectifs," P. Moëssard; "Le développement de l'image latente, Théorie et pratique," A. Seyewetz; "Traité pratique de Photogravure en relief et en creux," Léon Vidal; "La Photolithographie, la Photogravure et leurs applications aux impressions monochromes et polychromes," Léon Vidal; and several volumes in the "Encyclopédie scientifique des Aide-Mémoire" Series.

The list of Messrs. Gebrüder Borntraeger (Berlin) includes:—"Allgemeine Dermatologie oder Allgemeine Pathologie, Diagnose und Therapie der Hautkrankheiten," by Dr. Ernst Kromayer; and a new edition of "Flora des Nordostdeutschen Flachlandes (ausser Ostpreussen), by Drs. P. Ascherson and P. Graebner.

The list of Messrs. Ginn and Co. (Boston, Mass.) contains:—"General Physics," by Prof. Charles S. Hastings and Frederick E. Beach; "Elementary Physical Geography," by Prof. William M. Davis; and a new edition of "Elements of the Differential and Integral Calculus," by Prof. James M. Taylor.

The list of Messrs. Charles Griffin and Co., Ltd., is as follows:—"The Design and Construction of Locomotive Engines," with an historical introduction, by William Frank Pettigrew, with a Section on American and Continental Engines, by Albert F. Ravenshear, illustrated; "Engine-room Practice," by John G. Liversidge, illustrated; "Light Railways at Home and Abroad," by William Henry Cole, illustrated (Griffin's Engineering Series); "A Manual of Algebra," by Richard C. Buck; "A Text-book of Physics: comprising Properties of Matter, Sound, Heat, Magnetism and Electricity, and Light," by Prof. J. H. Poynting, F.R.S., and Prof. J. J. Thomson, F.R.S., illustrated; (the volume on "Sound"); "The Metallurgy of Lead," by H. F. Collins, illustrated; "Dairy Chemistry for Dairy Managers, Chemists, and Analysts," by H. Droop Richmond (Griffin's Technological Manuals); "The Art of the Goldsmith and Jeweller," by Thos. B. Wigley, assisted by J. H. Stansbie, illustrated; "Atlas of Urinary Sediments: with Special Reference to their Clinical Significance," by Dr. Hermann Rieder, translated by Dr. Frederick Craven Moore, edited and annotated by Prof. Delepine; "The Microbic Diseases of Animals," by Prof. Ed. Nocard and Prof. E. Leclainche, translated, with annotations and additions, by Prof. John Rose Bradford, F.R.S.; "The Diseases of Children," by Dr. George Elder and Dr. J. S. Fowler, illustrated; "Outlines of Bacteriology," by Dr. L. H. Thoinot and E. J. Masselin, translated and adapted for English use, with additions, by Prof. Wm. St. Clair Symmers, illustrated; and new editions of:—"The Chemistry of Gas Manufacture," by W. J. Atkinson Butterfield, illustrated; "Aids in Practical Geology," by Prof. Grenville Cole; "Jamieson's Elementary Manual of Steam and the Steam Engine," with many illustrations and examination questions; "Jamieson's Applied Mechanics (Introductory Manual)," with numerous illustrations and examination questions; "Photography: its History, Processes, Apparatus, and Materials," by A. Brothers, illustrated; "Mental Diseases: with Special Reference to the Pathological Aspects of Insanity," by Dr. W. Bevan Lewis, illustrated.

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The Lippincott Company call attention to:—"A Laboratory Manual of Physics," by C. C. Balderston, illustrated; "Boilers and Furnaces, considered in their Relations to Steam Engineering," by William M. Barr, illustrated; and a new edition of "A Text-book of Chemistry," by Dr. Samuel R. Sadtler and Henry Trimble, in two volumes, illustrated.

Messrs. Crosby Lockwood and Son's announcements include:—"Aërial or Wire-Rope Tramways, their Construction and Management," by A. J. Wallis-Tayler, illustrated; "The Marine Engineer's Guide to Board of Trade Examinations," by A. C. and E. W. I. Wannan, illustrated; "The Marine Engineer's Pocket-Book," by A. C. Wannan; "Sewage: its Treatment and Purification," by Dr. Sidney Barwise, illustrated; "Underground Steam Pumping Machinery," by Stephen Michell; and new editions of "Cyanide Process of Gold Extraction," by N. Eissler; "Baker's Land and Engineering Surveying," by F. E. Dixon.

Messrs. Longmans and Co., call attention to:—"Psychology in the Schoolroom," by T. F. G. Dexter and A. H. Garlick; "A Treatise on Surgical Treatment," by Prof. W. Watson Cheyne, F.R.S., and Dr. F. F. Burghard, to be published in parts; "The Structure and Classification of Birds," by Frank E. Beddard, F.R.S.; "An Epitome of Human Histology, for the Use of Students in connection with Lectures and Laboratory Work," by Dr. Arthur W. Weysse; "The Telephone: Outlines of the Development of Transmitters and Receivers," by Prof. William J. Hopkins, illustrated; "A Text-book of Theoretical Naval Architecture," by Edward Lewis Attwood; "My Inner Life: being a Chapter in Personal Evolution," by J. B. Crozier.

The announcements of Messrs. Sampson Low and Co., Ltd., include;—"Burma," by Max. and Bertha Ferrars, illustrated; "Portuguese Nyassaland: an Account of the Discovery, Native Population, Cultural and Mineral Resources, &c.," illustrated; "Photographic Optics," by R. S. Coles, with diagrams; "Mammalia of South Africa," by Dr. Sclater; "Twentieth Century Practice," an international encyclopædia of modern medical science by leading authorities of Europe and America, edited by Dr Thomas L. Stedman, vols. xv.-xx.; "Child Culture in the Home," by Martha B. Mosher; and new editions of: "Through the Yangtse Gorges: Trade and Travel in Western China," by Archibald J. Little, illustrated; "How to Get Strong and How to Stay So," by W. Blaikie, illustrated.

The list of Messrs. Macmillan and Co., Ltd., includes:—New volume of the Cambridge Natural History: vol. ix., "Birds," by A. H. Evans, illustrated; "A Manual of Zoology," by the late Prof. T. J. Parker, F.R.S., and Prof. W. A. Haswell, F.R.S.; "General Physiology: an Outline of the Science of Life," by Prof. Max Verworn, translated and edited by Dr. Frederic S. Lee, illustrated; "The Living Organism: an Introduction to the Problems of Biology," by Alfred Earl; "Elements of Palæontology," by Prof. Karl A. von Zittel, translated and edited by Dr. Charles R. Eastman; this English edition is revised and enlarged by the author and editor in collaboration with numerous specialists; "Steam, Gas, and Oil Engines," by Prof. John Perry, F.R.S., illustrated; "A System of Medicine," by many writers, edited by Dr. Thomas Clifford Allbutt, F.R.S., vols. vi. and vii.; "Diseases of the Breast," by Dr. Marmaduke Sheild; "Vaccination: with Special Reference to its Natural History and Pathology," Milroy lectures by Dr. S. Monckton Copeman; "The Witwatersrand Goldfields Banket and Mining Practice," by S. J. Truscott, with numerous plans and sections; "Australasian Goldfields," by R. Schmeisser, translated and edited by Prof. Henry Louis, illustrated; "A Text-Book of Metallurgy," by Carl Schnabel, translated and edited by Prof. Henry Louis, 2 vols., illustrated; "West African Studies," by Miss Mary Kingsley, illustrated; a translation of "In the Australian Bush and on the Coast of the Coral Sea: being the Experiences and Observations of a Naturalist in Australia, New Guinea, and the Moluccas," by Prof. Richard Semon, illustrated; "Observations of a Ranch-woman in New Mexico," by Mrs. Nicholl; the completion of "The History of Mankind," by Prof. Friedrich Ratzel, translated from the second German edition by A. J. Butler, 3 vols., illustrated; "The Valley of Light: Studies with Pen and Pencil in the Vaudois Valleys of Piedmont," by W. Basil Worsfold, illustrated; and new editions of "A History of Chemistry from the Earliest Times to the Present Day: being also an Introduction to the Study of the Science," by Prof. Ernest von Meyer, translated, with the author's sanction, by Dr. George M'Gowan; and "An Atlas of Practical Elementary Biology," by Prof. G. B. Howes, F.R.S.

Messrs. Methuen and Co.'s announcements include:—"Through Asia," by Sven Hedin, 2 vols., illustrated; "The Highest Andes," by E. A. FitzGerald, illustrated; "Volumetric Analysis," by J. B. Russell; Handbooks of Technology: "Carpentry and Joinery," by F. C. Webber, illustrated; and "Practical Mechanics," by Sidney H. Wells, illustrated; a new edition of "British Central Africa," by Sir H. H. Johnston, K.C.B., illustrated.

Mr. John Murray calls attention to:—"Organic Evolution Cross-examined: or, some Suggestions on the Great Secret of Biology," by the Duke of Argyll, K.G., F.R.S.; "The Tides and Kindred Phenomena in the Solar System," by Prof. George Howard Darwin, F.R.S., illustrated; "Early Chapters in Science," by Mrs. Awdrey, illustrated; "Among the Celestials," abridged from "The Heart of a Continent," with additions, by Captain Francis Younghusband (illustrated); "Marine Boilers," a treatise on the construction and working of boilers of all classes, dealing more especially with recent developments of tubulous boilers and the results obtained, based on the work of M. Bertin, translated and edited by Leslie S. Robertson, illustrated; "The Story of Marco Polo," for children and young people, edited by N. Brooks, illustrated; "The Five Windows of the Mind," by Edward Hamilton Aitken; "A History of Astronomy," by Arthur Berry (University Extension Manuals); "Colour in Nature," by Marion Newbigin.

In Messrs. T. Nelson and Sons' list we notice:—"The White North, with Nordenskiöld, De Long, and Nansen," by M. Douglas.

Messrs. George Newnes, Ltd., announce:—"Flashlights on Nature," by Grant Allen, illustrated. In the Library of Useful Stories:—"The Story of the Cotton Plant, its Cultivation and the Manufacture of its Product," by F. Wilkinson, illustrated; "The Story of the Mind," by Prof. J. M. Baldwin, with diagrams: "The Story of the British Race," by John Munro, with maps; "The Story of Geographical Discovery: How the World became Known," by Joseph Jacobs, with maps, &c.; "The Story of the Metals," by H. C. Fyfe.

The announcements of Messrs. C. Arthur Pearson, Ltd., include:—"The Land of the Pigmies," by Captain Guy Burrows, illustrated; "Spinifex and Sand, a Narrative of five years' Pioneering and Exploration in Western Australia," by the Hon. David W. Carnegie, illustrated.

Mr. Young J. Pentland's announcements are:—"Contributions to Clinical Medicine," by Dr. T. McCall Anderson; "Text-Book of Physiology," by British Physiologists, edited by Prof. E. A. Schäfer, F.R.S., vol. ii.; "Diseases of the Heart and Aorta," by Dr. G. A. Gibson; "The Principles of Treatment," by Dr. J. Mitchell Bruce; "Lectures on Giddiness and on Hysteria in the Male," by Sir Thomas Grainger Stewart; "Text-Book of Medicine," by British teachers, edited by Dr. G. A. Gibson; "The Radical Cure of Hernia, Hydrocele, and Varicocele," by C. B. Lockwood; "Manual of Midwifery," by Dr. R. Milne Murray; "The Journal of Pathology and Bacteriology," edited by Dr. G. Sims Woodhead, vol. v.; and a new edition of "The Principles and Practice of Medicine," designed for the use of practitioners and students of medicine, by Dr. William Osler, F.R.S.

Messrs. G. P. Putnam's Sons announce:—"Electricity in the Diagnosis and Treatment of Diseases of the Nose, Throat, and Ear," by Dr. W. Scheppegrell, illustrated; and a new edition of "Camping in the Canadian Rockies, an Account of Camp Life in the Wilder Parts of the Canadian Rocky Mountains, together with a description ot the Region about Banff, Lake Louise, and Glacier, and a Sketch of the Early Explorations," by Walter D. Wilcox, illustrated.

The Rebman Publishing Company, Ltd., will issue:—"Atlas of Legal Medicine," by Dr. E. R. von Hofmann, edited by Dr. Frederick Peterson; "Atlas of Laryngology," by Dr. L. Grünwald, edited by Dr. Charles P. Grayson; "Atlas of Operative Surgery," by Dr. O. Zuckerkandl, edited by Dr. J. Chalmers Da Costa.

Messrs. Lovell Reeve and Co., Ltd., announce:—The fifth and the seventh volumes of the "Flora of Tropical Africa"; the seventh volume of the "Flora Capensis"; the third volume of Mr. F. Moore's Lepidoptera Indica"; the fifth volume of Mr. Barrett's "Lepidoptera of the British Islands"; and further instalments of Miss Bowdler Sharpe's "Teracolus" and Mr. Alfred Fryer's "Potamogetons."

Mr. Grant Richards announces:—"The Philosophy of Greece, considered in relation to the Character and History of the People," by Alfred W. Benn.

Messrs. Routledge and Sons' list contains:—New editions of Stonehenge's "The Horse," revised by Harold Leeney; and of "The Microscope: its History, Construction, and Application," by Dr. Jabez Hogg.

Messrs. Schleicher Frères (Paris) call attention to:—"La Fatigue intellectuelle," by A. Binet and V. Henri, illustrated; "Contribution a l'Étude de la Méthode dans les Sciences expérimentales," by Louis Favre; and "Traité complet des Variations du Système Musculaire de l'Homme et de leur signification au point de vue de l'Anthropologie Zoologique," by Prof. le Double.

Mr. Gustav Schmidt (Berlin) will issue:—"Die Alpenpflanzen in der Gartenkultur der Tiefländer," by Erich Wocke, illustrated.

The list of the Scientific Press, Ltd., is as follows:—"An Atlas of Bacteriology," by Charles Slater and Edmund J. Spitta; "Hospital Expenditure: the Commissariat," reprinted from the *Hospital*; "Some Medical Aspects of Education," by Dr. Percy G. Lewis. The "Burdett Series"—"The Rational Use of Antiseptics in Midwifery Practice," by Dr. James Morrison; "Nursing of Sick Children," by Dr. J. D. E. Mortimer; "Mental Nursing," by Dr. William Harding.

Messrs. Walter Scott, Ltd., promise:—"The Natural History of Digestion," by Dr. A. Lockhart Gillespie, illustrated; "Degeneracy: its Causes, Signs, and Results," by Prof. Eugene S. Talbot, illustrated (the Contemporary Science Series).

The S. P. C. K's. list contains:—"British Birds," by Dr. R. Bowdler Sharpe, illustrated in colours; "Matter, Ether, and Motion, the Factors and Relations of Physical Science," by Prof. A. E. Dolbear, with diagrams.

Messrs. Swan Sonnenschein and Co., Ltd., give notice of:—"Aristotle's Psychology, including the Parva Naturalia," translated and edited, with Commentary and Introduction, by Prof. William A. Hammond; "Ethics," by Prof. W. Wundt, translated from the second German edition, vol. iii. "The Principles of Morality and the Sphere of their Validity," translated by Prof. E. B. Titchener; "Physiological Psychology," by Prof. W. Wundt, translated by Prof. E. B. Titchener, 2 vols. illustrated; "History of Contemporary Philosophy," by Prof. Friedrich Ueberweg, edited by Prof. Max Heinze, translated by Prof. W. A. Hammond; "Text-Book of Palæontology for Zoological Students," by Theodore T. Groom, illustrated; "Text-Book of Embryology: Invertebrates," by Profs. Korschelt and Heider, vol. ii. "Crustacea and Arachnoids," translated by Matilda Bernard, and edited by Martin T. Woodward, illustrated; "Elementary Text-Book of Botany," by Prof. Sydney H. Vines, illustrated; "Eclipses of the Moon from A.D. 300 to 1900," by Robert Sewell; "Common Salt, its Use and Necessity for the Maintenance of Health and the Prevention of Disease," by C. Godfrey Gümpel; "Fishes," by the Rev. H. A. Macpherson (Young Collector Series): "Grasses, Handbook of," by W. Hutchinson, illustrated (Young Collector Series); "Mammalia," by the Rev. H. A. Macpherson (Young Collector Series); "Birds' Eggs and Nests," by W. C. J. Ruskin Butterfield (Young Collector Series); and new editions of "Text-Book of Embryology: Man and Mammals," by Prof. Oscar Hertwig, translated by Prof. E. L. Mark, illustrated; "Handbook of Practical Botany, for the Botanical Laboratory and Private Student," by Prof. E. Strasburger, edited by Prof. W. Hillhouse. illustrated; "Ants, Bees, Wasps, and Dragon-flies," by W. H. Bath; and "Fungi, Lichens, &c.," by Peter Gray, in the Young Collector Series.

The list of Messrs. Thacker and Co. contains:—"The Medical Monograph" Series, edited by Dr. David Walsh. A new series of medical monographs, dealing with subjects of everyday practice, and embodying all recent scientific advances.

The announcements of the University Correspondence College Press include:—First Stage "Physiology," "Botany," "Hygiene," "Inorganic Chemistry (Practical)," by Dr. F. Beddow; "Agriculture," "Advanced Magnetism and Electricity," by Dr. R. W. Stewart; "Advanced Inorganic Chemistry (Theoretical)," "Tutorial Algebra," Part ii. "Advanced Course," Part i. "Elementary," by Wm. Briggs, and Prof. G. H. Bryan, F.R.S.; "Manual of Psychology," by G. F. Stout, vol. i.; "Text-Book of Botany," by J. M. Lowson; and "Introduction to Carbon Compounds," by Dr. F. Beddow.

In Mr. Fisher Unwin's list we find:—"Through New Guinea and the Cannibal Countries," by Captain H. Cayley-Webster; "The Psychology of Peoples," by G. Le Bon, translated by M. Derechef; and "Life of Man on the High Alps: Studies made on Monte Rosa," by Prof. A. Mosso, translated by Mr. and Mrs. Kiesow.

Messrs. Ward, Lock, and Co., Ltd., announce:—"With Nansen in the North," by Lieut. Hjalmar Johansen, illustrated; and "Fishing and Fishers," by J. Paul Taylor.

Messrs. Whittaker and Co. will issue:—"The Inspection of Railway Material," by G. R. Bodmer; "Electro-Mechanical Series," adapted from the French of Henry de Graffigny by A. G. Elliot, vol. iii. "Electro-Chemistry," vol. iv. "Electric Distribution"; "Central Station Electricity Supply," by Albert Gay and C. H. Yeaman; "Elementary Mathematics: Arithmetic, Geometry and Algebra," by J. L. S. Hatton and G. Bool; "Lathes: English and American," by J. Horner; "Electric Wiring, Fittings, Switches and Lamps," by W. Perren Maycock; "Outlines of Physical Chemistry," by Prof. A. Reychler, translated by Dr. J. McCrae; "Electric Traction," by J. H. Rider (Specialist's Series); "Horseless Road Locomotion: its History and Modern Development," by A. R. Sennett, 2 vols. illustrated.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE distribution of medals, prizes, &c., to students of the Royal College of Science, South Kensington, will take place on Thursday, October 6, at 2.30 p.m., in the Lecture Theatre of the Museum of Science and Art. Sir Norman Lockyer, K.C.B., F.R.S., will deliver an address upon this occasion.

DR. GEORG KLEBS, professor of botany at Basle, has been called to Halle, and is succeeded at Basle by Dr. Wilhelm Schimper, assistant professor at Bonn.

DR. JAMES LEICESTER, late chief lecturer on chemistry and metallurgy at the Merchant Venturers' Technical College, Bristol, has been appointed as head of the chemical department at the Municipal Technical College at Derby.

THE anniversary of the birth of Michael Faraday was commemorated on Thursday last at the "Michael Faraday" Board School, Walworth, by a gathering of the boys and girls of the upper standards in one of the large rooms to hear a commemoration address from Dr. Gladstone, F.R.S. A bust of Faraday which had been presented to the school by the Royal Institution was prettily decorated with plants brought by the children, and round the walls were cards giving some of the chief facts relating to Faraday's career. Every encouragement should be given to the adoption of such means as these for keeping in mind the work and high character of men like Faraday, and so inspiring a spirit of emulation.

THE following items from the *London Technical Education Gazette*, concerning the new session just commenced in the eleven polytechnics of London, are worthy of mention:—At Battersea Polytechnic special attention is being devoted to the organisation of preliminary courses in technical arithmetic, mensuration and elementary physics, chemistry and mechanics, adapted to the requirements of trade students. It is of great importance that young students before commencing the regular technical and trade classes should be provided with a sound elementary training in the above subjects. The syllabus recently issued by the Technical Education Board has called attention to the need for such instruction, and at many of the polytechnics and technical institutes students can now find opportunities for acquiring it.—Among the principal developments at the Borough Polytechnic is a new bakery, which has been built and equipped in the most complete manner, and provides exceptional accommodation and facilities for the teaching of baking. A new physical laboratory has also been erected.—At the Woolwich Polytechnic great additions have also been made last session by the erection of a new wing containing chemical and physical laboratories and increased accommodation for art teaching. A special laboratory has also been erected for the teaching of mechanical engineering, a subject which is naturally much in demand among the employees of the Arsenal.—In the day engineering department at the South-Western Polytechnic a civil engineering section has been added to the sections for mechanical and electrical engineering.—At the Regent Street Polytechnic a new departure has been made by the establishment of a school for carriage builders.—The opening of the new session at the Northampton Institute is marked by several important developments. Rooms have been specially fitted up for the teaching of electro-chemistry in special relation to the trades of the district, and valuable courses in electrolysis, electro-plating and electrotyping have been arranged. A metallurgical department has also been established, and a special laboratory has been fitted up in connection with it. Special classes for opticians have been arranged in conjunction with the Spectaclemakers' Company, a laboratory has been equipped for the practical teaching of optics, and a graded series of examinations has been drawn up.

THE work of the two London polytechnics which are independent of the Board's Technical Education aid, the East London Technical College and the Goldsmiths' Institute, continues to show increased activity. In the chemical department at the Goldsmiths' Institute a special course has been organised for brewers and sugar refiners; while the art department continues to take a leading position among the art schools of the country. At the East London Technical College (People's Palace) last year's work has been marked by conspicuous success, the college having secured an open science scholarship at Merton College, Oxford, two Whitworth exhibitions of 50*l.*, and two National scholarships, besides numerous other distinctions.

A SERIES of articles upon Dr. John Radcliffe, the generous benefactor of Oxford University, has recently appeared in the *Pharmaceutical Journal*. Dr. Radcliffe was born in 1650, the year after the execution of Charles I. He went to London in 1684, and rapidly became a most successful, though eccentric, physician. He died in the year 1714, leaving the great bulk of his large fortune, consisting of money and of lands and houses in Yorkshire, Northamptonshire, Bucks, and Surrey to Oxford University. He bequeathed 40,000*l.* to build a library in Oxford, with 150*l.* a year for the salary of the librarian, and another yearly 100*l.* for the purchase of books. The Radcliffe Library, one of the finest buildings in Oxford, was opened in 1749, and furnished mainly with medical and scientific books. The building has since been annexed to the Bodleian as a reading room, when the contents of the library, greatly increased in the course of years, were transferred to a building specially affected to them in the new University Museum. It is now a magnificent collection of books on medical, physical, natural, biological and general science, kept up to date, easily accessible, and has given a considerable impulse to scientific study at Oxford. In order to make provision for select Oxford alumni studying medicine, to learn what was doing in medical science abroad, Radcliffe made over for ever to his own first and favourite Oxford College—University—his Yorkshire estates, for the foundation of two travelling fellowships of 300*l.* a year each and tenable for ten years, to be given to carefully selected alumni studying medicine at Oxford. At present there are three such Radcliffe travelling fellowships, with an annual income of 200*l.* each and tenable for only three years instead of the original ten. Besides this he left 5000*l.* to enlarge the buildings of University College. Any surplus accruing from the Yorkshire estates after the foregoing objects were effected was to be applied to the purchase of advowsons to be given to members of University College. Finally, mention of minor benefactions to Oxford and to individuals being omitted, he left, after payment of his specified bequests, all his estates in the various counties already enumerated to trustees to be applied to such useful purposes as they in their discretion should think best. And well have the Radcliffe trustees fulfilled their duty, remembering the claims both of philanthropy and science. With the funds at their disposal was built the Oxford Public Infirmary, opened for the reception of patients in 1779, and the Radcliffe Observatory at Oxford, supplied with all the instruments and appliances of modern astronomy, and a dwelling house for the Observer.

SCIENTIFIC SERIALS.

American Journal of Science, September.—Transition temperature of sodic sulphate, a new fixed point in thermometry, by T. W. Richards. Sodium sulphate, $Na_2SO_4 + 10H_2O$, "melts" at almost exactly 32·48° according to the mean mercury thermometer, and this temperature is so easily obtained by means of that salt and so constant as to be of great use in the future for thermometric and thermostatic purposes.—Distribution and quantitative occurrence of vanadium and molybdenum in rocks of the United States, by W. F. Hillebrand. Vanadium occurs in quite appreciable amounts in the more basic, igneous and metamorphic rocks, up to 0·08 per cent. or more of V_2O_3, but seems to be absent, or nearly so, from the highly siliceous ones. The heavy ferric aluminous silicates like biotite and amphibole are indicated as sources. Molybdenum is probably confined to the more siliceous rocks, where it occurs in very minute quantities.—Electrosynthesis, by W. G. Mixter (second paper). Gaseous mixtures are subjected to a glow discharge in a eudiometer. Concentration of the discharge does not affect the total amount of compound formed. Thus, a mixture of hydrogen and oxygen will give the same amount of water vapour whatever the form of the glow discharge. The combination increases with the pressure, but not in proportion to it. A mixture of oxygen and ammonia forms ammonium nitrite, which is deposited as a white coating. —Notes on species of *Ichthyodectes*, including the new species *I. cruentus*, and on the related and herein established genus Gillicus, by O. P. Hay. The supposed new species is primarily founded on a somewhat imperfect left maxilla from Butte Creek Canyon in Western Kansas. It differs from Cope's *I. anaides* in having larger teeth. For Cope's *I. arcuatus* and Crook's *I. polymicrodus* the author proposes the new generic name Gillicus, being a saurocephalid with maxilla falciform, relatively short. Gape of mouth smaller than in *Ichthyodectes*.—Origin and significance of spines, by C. E. Beecher (continued). Natural selection could not originate a spine, but after a spine had appeared this agency would tend to preserve and allow the spine to develop along certain lines. The simple antlers of the Tertiary deer may have reached the highest degree of efficiency as weapons by ordinary natural selection. The subsequent increasing complexity of the antlers cannot have improved their usefulness, and probably arose according to the law of multiplication of effects, aided by a process of sexual selection.

Symons's Monthly Meteorological Magazine, September.—British local meteorological publications. Some important additions have been made to the list given in the last number of this journal, among which we may mention (1) an annual report of about thirty pages, by Mr. Chandler, Borough Meteorologist of Torquay, and a separate report on the climate of Devon; (2) a valuable summary of all Manx meteorological observations, by Mr. A. W. Moore; and (3) some remarks on the climate of Oban, with averages for the ten years 1887–96, by the Medical Officer of Health.—Evaporation and temperature, by Prof. Carpenter. This is an abridgment of a paper in the *U.S. Monthly Weather Review* of May 1898, showing the difficulty of determining from ordinary observations of the vaporimeter the quantity of water added to the atmosphere daily by evaporation from the oceans, lakes and continents. The principal elements of uncertainty in determining the quantity of evaporation from a surface of water are the temperature of the water and the velocity of the wind at the surface.—Rockall. The August number of the *Scottish Geographical Magazine* contains an excellent account of this rocky islet, by Mr. M. Christy. The possibility of building a lighthouse and observatory, and connection by a telegraphic cable, is discussed. The value of the latter would be very great for the purpose of weather telegraphy, but at present the difficulty of expense is insurmountable.—Results of meteorological observations at Camden Square, London, in August, for forty years, 1858–97. The mean of all the highest maxima was 84°·0, and the mean rainfall 2·39 inches; in this year the maximum temperature reading was 87°·9, and the rainfall 1·18 inches.

THE nineteenth volume of the *Memoirs* of the Caucasian branch of the Russian Geographical Society is perhaps even better than its remarkably good predecessor. Its chief feature is a map, on the scale of 13 miles to an inch, of Transcaucasia, upon which all the divisions into provinces, districts, cantons and villages are given, and the religions of the inhabitants of each village are shown in different colours. The map is accompanied by full ethnographical-statistical lists of the whole population. The next map of great interest is one of Kurdistan, upon which the distribution of the Kurd population (the Sunnites, the Kizilbashs, and the Yezids separately) is shown, together with the Armenian and Nestorian population and the percentage of Christians in each separate district. This map accompanies a paper, by Colonel Kartseff, on the Kurds, in which their geographical distribution, their division into stems, their history, and their present institutions and general conditions are discussed. In the same volume we find a most valuable list of 597 trigonometrically-determined spots in Transcaucasia and the Terek province, with their latitudes, longitudes and altitudes, indexed according to latitudes and alphabetically; four very good geographical, economical and statistical descriptions of the provinces of Stavropol, Terek and Zakataly, with a map of the province of Stavropol giving the distribution of landed property; an interesting paper on the forests, the forestry, and the inhabitants of the woodlands of Ichkeria, in Daghestan; and a list of the Alpine plants (270 species) of Central Caucasus, by Prof. Akinfieff—the result of seven years' work. In an appendix we find two long papers, one, by N. Dinnik, containing a graphic account of his Caucasian journey—this time to the head waters of the Urushten and Byelaya rivers (with a large-scale map, 3½ miles to the inch); and another, on the common law of the Svanes, their habits and customs, written by such an excellent authority on this subject as Prince Raphael Eristoff.—The twentieth volume of the same periodical, just received, contains an admirable map of all Caucasia and Transcaucasia, with very carefully drawn mountains, on the scale of 27 miles to the inch. It accompanies the first instalment of a work, "Transcaucasia," in which Colonel Lisovskiy gives a general physico-geographical description of Transcaucasia—its physical features, its geology, its vegetation, and its animal world.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 19.—M. Wolf in the chair.—On the clinical value of the agglutination of Koch's bacillus by human blood serum, by MM. S. Arloing and Paul Courmont. The results of over one hundred cases show that the aggregation of the tubercle bacilli when the blood serum is introduced into a culture may furnish, very rapidly, an important element of information in the early diagnosis of true tuberculosis. There were, however, two remarkable cases where the test failed, though tuberculosis was undoubted and in an advanced stage. The fact that positive results were almost always obtained when the tuberculous lesions were in an early stage renders the serum reaction the more valuable. Feeble aggregation was induced in some cases where tuberculosis was not found by the ordinary clinical methods, and the inference is drawn that latent tuberculosis may be consistent with the appearance of perfect health. One of the latter cases afterwards developed into tubercular laryngitis.—Observations and elements of the Perrine-Chofardet comet by M. G. Fayet.—Observations on the Perrine-Chofardet comet, made with the large equatorial at the Observatory of Bordeaux, by MM. L. Picart and Courty.—Synopsis of the solar observations made at the Royal Observatory of the Roman College during the first quarter of 1898, by M. P. Tacchini.—On the colorations of the less fusible porcelain enamels, by MM. A. Le Charpentier and P. Charpy. A list of the colours obtainable from various metals, all of which have been tested upon the manufacturing scale. The compositions are given of erbium and neodymium blues, erbium and neodymium greens, neodymium violet and erbium red.—Influence of gravity and light upon the dorsiventral organisation of the branches in inflorescences, by M. H. Ricome.—On the balloon ascents of June 8, 1898, on the occasion of the fourth international experiment, by MM. Hermite and Besançon.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (Mathematico-physical Section), part 2 for 1898, contains the following memoirs communicated to the Society:—

April 30.—W. Voigt: Thermo-dynamical contributions on the interrelations of galvanism and heat.

May 14.—E. Riecke: Second memoir on the theory of galvanism and heat. W. Voigt: On the magnitude of the stresses and strains involved in the production of shearing in Iceland spar. E. Marx: The dispersion of the electrical spectrum of water. P. Stäckel: On transformations of motions.

June 11.—W. Voigt: Is the pyroelectricity of crystals entirely referable to piezoelectric action?

June 25.—E. Riecke: The reactive pressure of kathode rays. J. Orth: Fifth report on the work of the Göttingen Pathological Institute.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Nine Years at the Gold Coast: Rev. D. Kemp (Macmillan).—Stories of Starland: Mary Proctor (Bacon).—The Discharge of Electricity through Gases: Prof. J. J. Thomson (Constable).—Canalisations Électriques: R. V. Picou (Paris, Gauthier-Villars).—Organographie der Pflanzen, &c.: Prof. K. Goebel, Zweiter Teil, 1 Heft (Jena, Fischer)—Fourteenth Report of the U.S. C.S. Commission (Washington).—Second Stage Mathematics: edited by W. Briggs (Clive).

PAMPHLETS.—A Determination of the Ratio of the Specific Heats at Constant Pressure and at Constant Volume for Air, Oxygen, Carbon-Dioxide, and Hydrogen: O. Lummer and E. Pringsheim (Washington).—Meteorology in Mysore for 1897: J. Cook (Bangalore).—Cape of Good Hope: Report of the Meteorological Commission for the Year 1897 (Cape Town).—Contributions to the Morphology of Lepidoptera: Dr. K. Jordan.—An Examination of the Classificatory and some other Results of Eimer's Researches on Eastern Papilios; Dr. K. Jordan.—Zweckmässigkeit und Anpassung: Prof J. W. Spengel (Jena, Fischer).—Clinical Observations on 2000 Obstetric Cases: Dr. G. P. Mathew (Simpkin).

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CONTENTS.

THURSDAY, OCTOBER 6, 1898.

NORTH AMERICAN BIRDS.

Bird Studies, an Account of the Land Birds of Eastern North America. By W. E. D. Scott. 4to, pp. xii + 363. (New York and London: G. P. Putnam's Sons, 1898.)

IF it be permissible to judge from the books with which they are respectively supplied, there must be an inherent constitutional difference between the English and the American reader of popular bird-lore. In almost all the numerous works written for the benefit of the former there is a more or less rigid adherence to a systematic arrangement of some kind or other. As we have had previous occasion to remark, American books, on the other hand, are characterised by their partiality for methods of arrangement other than systematic. Personally we confess to a deep-rooted prejudice in favour of the English plan; but if American readers find this too cut and dried for them, and prefer some less inelastic classification, little fault can be found with the writers who endeavour to gratify their taste.

In his preface the author tells us that the present volume is an invitation to a more intimate acquaintance with the land birds of Eastern North America. And since under that somewhat vague geographical expression he includes not only the portion of the continent lying east of the Mississippi together with Lake Winnipeg and the western border of Hudson Bay, but also the whole of Greenland and the islands which naturally group themselves with the mainland of the region, it is obvious that the fauna to be dealt with is a very extensive one.

In place of a systematic classification, the birds, which range from the ordinary song-birds to the quails, have been made to group themselves around a series of familiar stations. We have, in the first place, the birds frequenting the house and homestead, followed by those to be met with along the highways and lanes, and these again succeeded by the denizens of the woods and the inhabitants of fields and meadows. Finally, we have the marsh and swamp birds, together with those to be found along the margins of streams and ponds. Not that the true water-birds are included, since of these the author proposes to make a companion volume, should his present effort meet with a satisfactory reception on the part of the public. At the end of the volume is given a systematic table of all the species treated.

If a miscellaneous arrangement of some kind or another be inevitable, the one selected is, perhaps, among the least open to criticism. There is, however, considerable difficulty in certain cases whether a bird should be assigned to one group or another, and there is the decided objection that nearly allied forms are often widely sundered. More serious is the absence of any attempt on the part of the author to lift his readers above the level of mere collectors and observers, and to point out that the bird-fauna of the extensive tract under consideration contains elements pertaining to more than one zoological province. There is, for example, no indication that the one species of humming-bird found in Eastern North America is essentially an immigrant from the South American fauna, and as strange to the Holarctic fauna as is the armadillo met with in Texas. The inclusion, too, of rare stragglers from Europe is certainly a mistake in a work of this nature; the most glaring instance being the introduction of the common kestrel, on the strength of a single specimen obtained in Massachusetts.

Another point open to criticism is the popular nomenclature of certain species. In the review of another work on American birds, attention has been already drawn in this journal to the inconvenience arising from the application of the names of well-known European birds to totally different American species; but this sinks into insignificance when compared with the practice of using a name belonging to a South American bird for a North American songster. In the Argentine and other parts of South America there exists a well-known group of *Dendrocolaptidæ*, universally termed oven-birds (*Furnarius*); and it is accordingly in the highest degree inconvenient to employ the same title for a North American representative of the *Mniotiltidæ*, especially when the bird in question (*Seiurus aurocapillus*) has the alternative name of golden-crowned thrush.

The descriptions of the various birds referred to seem for the most part well adapted for popular use; and the author's practice of frequently italicising one or more of the leading distinctions is decidedly worthy of commendation. We are also fully in accord with the author when he says that the meaning of colour-descriptions can only be fully grasped by observation and experience, seeing that no two describers will ever designate one particular shade of red or other colour by precisely the same term. And if this be true of colour, still more is it so with regard to song, which Mr. Scott regards as inexpressible, either in words or by instruments.

With regard to the numerous photogravures with which the volume is illustrated, the author states that these have been prepared under his own immediate supervision. "Some," he writes, "are taken from live birds, others from dead ones, some are from stuffed birds; others from prepared skins. All are faithful and accurate pictures, just what the camera presents, with its keen interpretation." This is candid, and enables the reader without much difficulty to arrive at the nature of the subjects for the different photographs. Although by no means all on the same level, these latter are on the whole of a high standard of excellence, and serve to render the volume attractive not only to students of bird-life, but to lovers of nature in general. Among the most successful effects, mention may be made of the purple finch (p. 49), the screech-owl (p. 72), and the nest of the flicker (p. 176). Interspersed in the text are a number of photographs of dead birds, for the most part lying on their backs, with their feet in the air. Although these may be valuable as aids to the identification of the species, to our own mind they convey a somewhat melancholy impression, especially in the case of song-birds, which should be the incarnation of life and joy.

Limitations of space have probably been the reason that the author's descriptions of habits are for the most part brief; and this is the more to be regretted seeing that he writes in a manner well calculated to attract the attention of his readers. Apparently he is one of those who think that everything has been arranged for the best in this best of possible worlds. For example, after stating that, owing to its parasitic habits, maledictions are poured down on the devoted head of the cowbird by all, he proceeds as follows :—

"This may be to an extent warranted, but the fact that the great laws of nature have developed a necessity for such a bird seems to bespeak for it at least patient and careful consideration. There are few, if any, unmixed evils allowed to survive in the great struggle for existence, but the good results are not always patent even to the most careful student."

With the exception of undue weight, owing to the employment of heavily clayed paper, the style in which the book is produced is worthy of all praise, and renders it an attractive addition to the library or drawing-room table. Probably its circulation in this country will be somewhat limited; but in the land of its birth the volume should command an extensive sale, which we may hope will be sufficient to induce the author to favour the public with its promised companion. R. L.

THE CASE AGAINST VACCINATION.

A Century of Vaccination, and what it teaches. By W. Scott Tebb, M.A., M.D. (Cantab), D.P.H. (London: Swan Sonnenschein and Co., Ltd., 1898.)

DR. TEBB says that on the assumption that the father of a family ought to be able to form a judgment upon vaccination, a practice established and enforced by law, he will attempt in the work before us to discuss a great question in an unbiassed fashion. In this attempt he is not altogether successful. After stating that he does not reject, or even attack the belief that a certain degree of immunity in the case of certain diseases is conferred by a first attack, he goes on to draw a distinction between the immunity conferred by small-pox and that conferred by cow-pox. He appears to beg the whole question by accepting, as conclusively proved by Dr. Creighton and Prof. Crookshank, the proposition that cow-pox is a disease radically different from that from which it is said to protect. This point is one, however, that no amount of asseveration can settle, and most people prefer to be guided by the results of recent experiments rather than by polemical statement.

In a piece of rather clever special pleading, Dr. Tebb makes a statement that

"should there be an epidemic in a locality where 85 per cent. of the population are vaccinated, it is obvious that the 95 per cent. of the population should escape the epidemic, assuming, as before indicated, that a maximum of 5 per cent. attacked by it will largely coincide with the 85 per cent. vaccinated, and thus vaccination gains credit, but it will be objected if the 5 per cent. attacked coincide, in however small a degree, with the 15 per cent. unvaccinated, this is strong testimony to the risk of being unvaccinated, and so no doubt it would be but for the fact that in localities where the vaccination law is vigorously carried out the unvaccinated as a class will be found to consist largely of the outcasts of society, nomads whom the law has failed to reach, and of weakly children who, on account of their health, have been excused the operation. This class, therefore, is likely to furnish a disproportionate number of the victims of the epidemic; and thus again the prophylactic acquires reputation."

This, as we have said, is nothing more than special pleading, especially when Dr. Tebb attributes bias to those who have to do with the collection and arrangement of the statistics on which vaccination arguments are based. It is for this reason that we refer to the bias imported into this controversy by Dr. Tebb at the very outset. Further, one cannot help feeling that the imputation by the author of the term "public endowment practice" indicates a state of mind not conducive to the calm and dispassionate consideration of this very important question. For example, he speaks of a "body of officials ostensibly paid to promote the practice of vaccination, but also, partly at least, paid to vindicate it theoretically and to explain away its failures and its accompanying disasters." "Take away," he says, "first the compulsory law, and then take away (if vested interest is not too strong for you) the endowment of the practice, and when this has been done medical men will find themselves, for the first time since 1803, free to discuss the vaccination question as a scientific one on its own merits." This is imputing motives with a vengeance—motives of a most sordid character. When an author holds such an opinion, no question with which he deals can be reasonably or profitably discussed.

After going carefully over "A Century of Vaccination," and granting the absolute accuracy of every stated fact put forward in this work, we are compelled (and we believe that most people will agree with us on this point) to come to the conclusion that Dr. Scott Tebb, if he started in an absolutely unfettered condition of mind, has been very easily brought to his present position, and that his marshalling of facts has been of such a one-sided character, that he has been enabled to argue far too readily from the special and the isolated to the general. He has placed his isolated facts in one scale and has left out the accumulated knowledge of all kinds that appears to tell against his theory, and has then struck a balance, of course in favour of the argument for which he is contending. So convinced are we on this point, that we are confident that it would be a safe plan for those who believe in the efficacy of vaccination to place this work in the hands of most anti-vaccinators, and ask them to read it on the condition that they would also read the context of many of the quoted passages; we believe such a course could have but one result. It may be stated generally that in the summary and conclusion Dr. Scott Tebb entirely misses or ignores the position taken up by those who are in favour of vaccination. He mixes up the risk to the individual with the risk to the community—a good system of vaccination with a system carelessly carried out; he bases the statement that it is valueless entirely on the assumption that cow-pox and small-pox are in no way generically related; and, putting aside the question of immunity as the result of an attack of small-pox, he contends that cow-pox is a specifically different disease, and can therefore exert no protective influence against small-pox. However, as we have already stated, those who read Dr Tebb's book will, unless we are much mistaken, remain vaccinators; whilst those who are already convinced in the opposite direction may be brought to consider the question from another standpoint, if they will only read a little wider into the context than the author allows them to do in his work. We do not wish to impugn Dr. Tebb's absolute honesty in this matter; we are only astonished that, with the materials at his disposal, much of which he has evidently read very carefully, he has arrived at the position indicated in this work.

OUR BOOK SHELF.

The Heat Efficiency of Steam Boilers: Land, Marine, and Locomotive. With tests and experiments on different types, heating value of fuels, analyses of gases, evaporation, and suggestions for testing boilers. By Bryan Donkin, M.Inst.C.E. Pp. xvi + 311. (London: Charles Griffin and Co., Ltd., 1898.)

THE main value of this book will undoubtedly lie in the tables, which fill about 100 of its pages, and give in an admirably complete form the results of no less than 405 tests of the efficiency of steam boilers of almost every type. The labour of collecting the material must have been great, and the author has selected with judgment the information needed, practically everything wanted is to be found in the twenty-six columns of the tables, and no useless matter has been incorporated. The only addition which might have been made with advantage is the temperature of the feed-water, especially in those cases where no economiser was in use. Useful summary tables are given on pp. 116, 117 and 118, and in chapter xiii. the author discusses the general conclusions to be drawn from these trials, but without coming to any definite decision. As pointed out in the book, the wide variations in the efficiency of the same type of boiler when worked under different conditions makes it impossible to lay down any general laws, though the graphic representation on p. 223 of the relationship between efficiency and rates of evaporation per square foot of heating surface per hour, is of much value, and should be of use to the designer.

In reference to the calculation of the heating value of coal by Dulong's formula, there can be no doubt that it gives results which are too small when compared with calorimeter tests; the figures will be found, however, to agree much better when in the calculation no deduction is made from the hydrogen for the portion assumed, apparently without reason, to be chemically united with the oxygen. A valuable chapter is that dealing with the transmission of heat through boiler plates, because Blechynden's and Durston's recent experiments on this important question are given in a very clear and concise fashion for reference.

The author hardly devotes enough space to the description of the instruments for analysing furnace gases and their use, and those unfamiliar with the appliances and their working will find it difficult to teach themselves much by merely reading these paragraphs; they might well have been amplified since, as the author points out, the accurate analysis of the gases is the most important, and certainly the most difficult, point in boiler testing.

In addition to dealing with boiler testing, the author describes many of the important accessories which have been introduced of recent years to reduce the cost of steam generation, such as mechanical stokers, patent grates, economisers, superheaters, &c., and much information as to the value of these devices will be found in the chapters devoted to them. The author may be congratulated, for his book is one which cannot fail to be a standard reference work to all engaged either in boiler construction or in steam generation. An admirable little bibliography finishes up a series of useful appendices which give full directions for carrying out boiler trials.

H. B.

A Text-book of Geodetic Astronomy. By John F. Hayford, C.E. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1898.)

WE must confess that the examination of this book has proved a little disappointing. This disappointment was probably inevitable from the circumstances in which the book has been produced, and the object which it is intended to serve. It appears that in the Cornell University the students of civil engineering devote five hours a week during one term to the study of astronomy. In this short space of time it is found impossible to master the contents of such a book as Chauvenet or other recognised standard work, and to meet this difficulty this book is put forward, not on the ground that it contains as much information as a student should acquire, but as much as he can acquire in the short time at his disposal. The sacrifice of thoroughness and completeness to the necessities of a particular University course can neither meet with general approval nor result in the production of a satisfactory treatise.

The title scarcely describes the character or the purpose of the book, which is mainly devoted to the practical determination of stellar positions by means of portable instruments. Considered from this point of view, and as showing in detail the methods employed in the United States Coast and Geodetic service, the book is not without its interest. On its practical side, we can conceive that it would be of use to those who have carefully read the theoretical; but to regard it as an efficient substitute for Chauvenet, would be to make a great mistake in the training of the student. The mathematical processes are, the author tells us, purposely omitted; but it would seem that other things besides mathematics have been omitted, which one would expect to meet in a work of this description. We should hope to find here a discussion of the figure of the earth, and, as a practical matter of great importance, a description of the method of measuring a base line. These matters are passed over entirely, and other important, but minute, results of observation get a very bare mention. For instance, to the variation of latitude only a page and a half is devoted. Pendulum experiments and their results do not come within the scope of the book. On the other hand, we get a fairly good account of the sextant, the transit, the zenith telescope, of the determination of the errors of these instruments, and the method of combination of observations. Some astronomical tables are added which are likely to prove useful.

Machine Drawing. Book 2. Part i. Machine Tools. By Thomas Jones, M.I.Mech.E., and T. Gilbert Jones, M.Sc. (Vic.). (London and Manchester: John Heywood, 1898.)

THIS work is intended "for the use of engineering students in science and technical schools and colleges." It contains twenty-five lithographed plates, upon which are represented the elevations and details of important machine tools in actual use by expert engineers at the present time. The plates include drawings of a drilling machine, planing machine, stroke slotting machine, stroke shaping machine, and forms of gearing. The complete drawings of the three first-named machines are coloured, and all of them are well executed. With the explanatory text the engineering student will find the work instructive and of real assistance.

A Student of Nature. By R. Menzies Fergusson, M.A. Pp. 246. (London: Alexander Gardner, 1898.)

THE late Rev. Donald Fergusson was many-sided in his pursuits, and among his pleasures was the study of natural history. One of the sections of the present volume contains the papers written by him on rural life and scenes, and they show that he was filled with "deep feeling" by nature and its wild life, but neglected the minute examination of natural objects essential to scientific study.

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.*]

Undercurrents in the Strait of Bab-el-Mandeb.

AN interesting observation has recently been made by one of H.M. surveying vessels, and I forward the Preface to the account of the details published by the Hydrographic Department, which contains the principal facts, and also the Analysis of the observations, both of which may be of interest to some of your readers. W. J. L. WHARTON.

Hydrographic Department, Admiralty, Whitehall, London, S.W., September 27.

UNDERCURRENTS IN THE STRAIT OF BAB-EL-MANDEB.

IT has long been known that in the Bosporus and Dardanelles when the surface water sets strongly from the Black Sea to the Mediterranean, the lower strata of the water for a certain height from the bottom sets strongly in the opposite direction.

While in this instance it is probable that the many large rivers which discharge their waters into the Black Sea have a share in producing the surface current, the observations by which the undercurrent was revealed appeared to plainly indicate that the surface drift, caused by the generally prevailing N.E. wind heaping the water up in the south-western part of the Black Sea, was the main factor.

The somewhat similar conditions which occur in the strait of Bab-el-Mandeb offered another opportunity of observation on this interesting form of oceanic circulation, and for many years such observations have been a desideratum.

In this strait for nearly half the year a more or less strong easterly wind prevails, driving much water before it into the Red Sea, and, great as is the evaporation from the surface of that sea, which must be made up wholly by an inflow of water through the strait of Bab-el-Mandeb, it appeared on the whole probable that during this season the phenomenon of the Dardanelles would be repeated.

The observation is, however, difficult. The water is deep, over 100 fathoms; the sea generally heavy; there is a tidal current to complicate matters; and it seemed doubtful whether the somewhat crude apparatus which served to unravel the movement of the lower strata in the shallower and smoother Dardanelles would give good results in this locality.

Nevertheless, Captain W. Usborne Moore was directed to attempt it in H.M.S. *Penguin* in 1890, but the results, while showing that the under strata were not running with the surface, were two ambiguous to afford much definite information.

The possession, however, of a deep-sea current meter, originally devised by Lieutenant Pilsbury, U.S.N., and considerably altered after a series of experiments by Captain Usborne Moore in the English and Færoe Channels, seemed to offer a chance of more success.

Lieutenant and Commander Gedge, commanding H.M. surveying ship *Stork*, was therefore directed to endeavour to get further observations in Bab-el-Mandeb by means of this instrument, and has admirably and most successfully carried them out.

On January 19, 1898, the *Stork* was anchored in 118 fathoms about seven miles S.W. by W. from Perim Island, and remained constantly observing, during daylight, for four days, when the parting of the cable brought the series to a close. Had not the wind been unusually light, varying from force 3 to 6, it is probable that the observations could not have been continued so long.

The observations are appended (in publication quoted), but the broad result may be briefly stated.

There was a permanent current on the surface setting into the Red Sea of about 1½ knots per hour.

There was at 105 fathoms depth a permanent current setting outwards of probably the same velocity.

The tidal stream was about 1¾ knots at its maximum, and flowed for about twelve hours each way, as might be expected from the fact that in this locality there is practically only one tide in the day.

This tidal stream prevails to the bottom, with variations of strength.

Somewhere about 75 fathoms is the dividing line between the two permanent currents, but it would require a longer series of observations to determine this point with any precision.

Analysis of Tidal Streams observed in the Large Strait of Bab-el-Mandeb by H.M.S. Stork *in January* 1898.

Time of tide at Perim.	At surface.		At 5 fms.		At 25 fms.		At 50 fms.		At 75 fms.		At 105 fms.	
	Direction.	Rate.	Direction.	Rate.	Direction.	Rate.	Direction.	Rate.	Direction.	Rate.	Direction.	Rate.
High water ...	N.W. ½ W.	2¼	N.W. by W.	3¼	N.W.	3	Slack	—	—	—	—	—
1h. after ...	N.W. ½ W.	2¾	N. ½ W.	3⅓	—	—	S. by E.	¼	Variable	—	—	—
2 „ ...	N.W.	2¾	N.W.	4	N.W.	2	N.W. by W.	⅔	—	—	—	—
3 „ ...	N.W. ½ W.	2⅓	N.W. by N.	3	—	—	N.W. by N.	¼	N.N.W. ½ W.	½	—	—
4 „ ...	N.W.	2	N.W. by N.	2½	N.N.W. ½ W.	2	N.W.	1⅔	N. ½ E.	1	S. by W.	¼
5 „ ...	N.W.	1¾	N. by W.	2	—	—	N.N.E,	½	N. by E. ½ E.	¾	S. by W.	1¼
6 „ ...	N.W. ½ W.	1¼	N.W. ½. N.	¾	N.W. ¾ W.	1	E. by S.	½	S.S.E.	⅔	South	1⅓
7 „ ...	N.W. ½ W.	¾	N.W.	½	N.N.W.	½	West	1	—	—	S. E. ½ S.	1½
8 „ ...	W.N.W.	½	S.W. ½ W.	½	—	—	South	1½	S.E. by E.	1⅓	S.S.E. ½ E.	3
9 „ ...	W.N.W.	¼	W.N.W.	½	Slack.	—	S.S.E.	1	S.E.	1	S.S.E. ½ E.	2½
10 „ ...	N.N.W.	¼	N.W.	¼	E. by N.	½	—	—	S.S.E. ½ E.	1½	E.S.E.	1¾
11 „ ...	North	¼	N.N.W.	½	S.E.	½	S.E.	1	E. by S.	2¼	—	—
12 „ ...	N.W.	¾	N. by E.	½	—	—	—	—	—	—	—	—
13 „ ...	N.W. by N.	1¾	—	—	N.W. by N.	¾	—	—	E.S.E.	2	S.E. by E.	1¾

Fourier's Series.

IN all expositions of Fourier's series which have come to my notice, it is expressly stated that the series can represent a discontinuous function.

The idea that a real discontinuity can replace a sum of continuous curves is so utterly at variance with the physicists' notions of quantity, that it seems to me to be worth while giving a very elementary statement of the problem in such simple form that the mathematicians can at once point to the inconsistency if any there be.

Consider the series

$$y = 2\,[\sin x - \tfrac{1}{2}\sin 2x + \tfrac{1}{3}\sin 3x - \ldots]$$

In the language of the text-books (Byerly's "Fourier's Series and Spherical Harmonics") this series "coincides with $y = x$ from $x = -\pi$ to $x = \pi$ . . . Moreover the series in addition to the continuous portions of the locus . . . gives the isolated points $(-\pi, 0)$ $(\pi, 0)$ $(3\pi, 0)$, &c."

If for x in the given series we substitute $\pi + \epsilon$ we have, omitting the factor 2,

$$-y = \sin\epsilon + \tfrac{1}{2}\sin 2\epsilon + \tfrac{1}{3}\sin 3\epsilon + + \frac{1}{n}\sin n\epsilon + \ldots$$

This series increases with n until $n\epsilon = \pi$. Suppose, therefore, $\epsilon = k\frac{\pi}{n}$, where k is a small fraction. The series will now be nearly equal to $n\epsilon = k\pi$, a finite quantity even if $n = \infty$.

Hence the value of y in the immediate vicinity of $x = \pi$ is not an isolated point $y = 0$, but a straight line $-y = nx$.

The same result is obtained by differentiation, which gives

$$\frac{dy}{dx} = \cos x - \cos 2x + \cos 3x - \ldots$$

putting $x = \pi + \epsilon$ this becomes

$$-\frac{dy}{dx} = \cos\epsilon + \cos 2\epsilon + \cos 3\epsilon + \ldots + \cos n\epsilon +$$

which is nearly equal to n for values of $n\epsilon$ less than $k\pi$.

It is difficult to see the meaning of the tangent if y were an isolated point. ALBERT A. MICHELSON.

The University of Chicago Ryerson Physical Laboratory, September 6.

Helium in the Atmosphere.

C. FRIEDLÄNDER and H. Kayser have independently claimed to have found helium in the atmosphere. On examination of some photographs of the spectrum of neon I have identified six of the principal lines of helium, which thus establishes beyond question the presence of this gas in the air. The amount present in the neon it is, of course, impossible to estimate, but the green line (wave-length 5016) is the brightest, as would be expected from the low pressure of the helium in the neon.

E. C. C. BALY.

University College, London, Gower Street, W.C., September 28.

THE discovery of helium lines in the spectrum of neon, by Mr. E. C. C. Baly, will necessitate a modification of the views we have expressed in our communication to the British Association at Bristol. We there estimated the density of neon at 9·6, allowing for the presence of a certain proportion of argon unavoidably left in the neon. As it contains helium, however, this is probably an under-estimate. It is unfortunately not possible to form any estimate of the amount of helium mixed with the neon from the relative intensity of spectrum lines, as has been already shown by Dr. Collie and one of us; we do not despair, however, of removing a large part, if not all of this helium, by taking advantage of the greater solubility of neon than helium in liquid oxygen.

The presence of helium, however, in no way alters our view as to the position of neon in the periodic table. The number 9·6 implies an atomic weight of 19·2; and a somewhat higher atomic weight would even better suit a position between fluorine, 19, and sodium, 23. WILLIAM RAMSAY.

University College, London, Gower-street, W.C., September 28. MORRIS W. TRAVERS.

Chance or Vitalism?

I AM glad to see that Prof. Karl Pearson has called attention to Prof. Japp's address at Bristol. Only that one does not like to criticise adversely a presidential address, I would at the time have pointed out the weakness in the argument that Prof. Pearson criticises. He does not go nearly so far in this criticism as the circumstances warrant. It is conceded that right- and left-handed crystals of quite sensible size are produced sufficiently separated to be seen and handled as separate crystals. Now assuming, what there is every reason otherwise to think quite probable, that life started from some few centres, the chances are, not that it was equally divided between right- and left-handed forms, but that one or other of these forms preponderated. In fact, if life started from a single centre, it *must* have been either right- or left-handed. Hence the fact adduced only shows, what was otherwise very probable, that life started from a small number of origins, possibly only one.

Another reason for either a right- or left-handed structure in living organisms on the earth, and one which diminishes the force of the foregoing argument for a small number of origins, is that it probably started either in the northern or in the southern hemisphere, and in either case the rotation of the sun in the heavens may be a sufficient cause for a right- or left-handed structure in an organism growing under its influence.

GEO. FRAS. FITZGERALD.

Trinity College, Dublin, September 27.

IN his presidential address to Section B of the British Association, Prof. Japp argues the necessity of supposing a "directive force," or intelligence, to have guided the formation of the first asymmetric substance. "Vitalism," which at one time was supposed to regulate the physiology and even the mechanics of organised beings, has passed more and more from the foreground, till, in the vision of some it remains only as a point in the vast distance of time at the origin of life. Is it to disappear altogether?

A sensible quantity of a mixture of enantiomorphs contains an enormous number of molecules. Chance determines the relative proportion present of right- and left-handed forms. Each molecule, having resulted from the action of symmetric forces, has an even chance of being of one or the other. Hence, the improbability of there being present a great preponderance of one form over the other is so great, that it is inconceivable that an optically active solution could result. To the above contention of Prof. Japp, the reply is made by Prof. Karl Pearson, in NATURE of September 22, that a chance result, however improbable, will occur, if sufficient opportunity be allowed. He postulates the vast ages of the earth's history. May we not, however, invoke chance to deal with masses instead of molecules, and thus perhaps substitute weeks for ages?

Let us consider a solution, in which the numbers of right- and left-handed molecules are very approximately equal, and which is consequently optically inactive. In the slow evaporation of the solvent, the right- and left-handed nuclei, about which the substance crystallises, will *most probably* be evenly distributed. Their number will be extremely small in comparison with that of the molecules, and, as chance determines their distribution, it is not so highly improbable—it is at least conceivable—that the crystals will be unevenly grouped. Suppose such to take place and a partial re-solution, roughly in the lines of the distribution of the two varieties of crystals—a not very improbable event—and we have an optically active solution. Chance has here acted the part played by organised matter in the person of M. Pasteur, by selecting and rejecting the oppositely formed crystals.

Is it yet possible to deny that the first ancestor of lævo-rotatory protein could have been built up from an asymmetric substance, separated in some such way as the above, by the play of chance upon the natural working of symmetric forces?

CLEMENT O. BARTRUM.

17 Denning Road, Hampstead, N.W., September 24.

The Moon's Course.

MAY I refer Sir S. Wilks to the simple and beautifully written autobiography of James Ferguson, F.R.S., self-taught mechanician and astronomer? I will quote a passage.

"Soon afterwards" (the previous date was 1743) "it appeared to me, that although the moon goes round the earth, and that the sun is far on the outside of the moon's orbit—yet the moon's motion must be in a line—that is, always concave toward the sun: and upon making a delineation representing her absolute path in the heavens—I found it to be really so. I then made a simple machine for delineating both her path, and the earth's, on a long paper laid on the floor. I carried the machine and the delineation to the late Martin Folkes, Esquire, President of the Royal Society, on a Thursday afternoon. He expressed great satisfaction at seeing it, as it was a new discovery, and took me that evening to the Royal Society, where I showed the delineation and the method of doing it. When the business of the Society was over, one of the members desired me to dine with him the next Saturday at Hackney, telling me that his name was Ellicott, and that he was a watchmaker. I accordingly went and was kindly received by Mr. Ellicott, who then showed me the very same kind of delineation and part of the machine by which he had done it, telling me that he had thought of it twenty years before. I could easily see by the colour of the ink and paper that it must have been done many years. He then told me, what was very certain, that he had neither stolen the thought from me, nor had I from him; and from that time till his death, Mr. Ellicott was one of my best friends."

The editor of my copy of Ferguson's works, "David Brewster, A.M., 1803," adds that James Ferguson was elected a Fellow of the Royal Society without paying the usual admission fees. This honour he shared with Sir Isaac Newton and Mr. Thomas Simson, the self-taught mathematician. Two Scottish philosophers—David Hume and James Ferguson—died in 1776, both leaving autobiographies of singular beauty and pathos. Our own Huxley, who like James Ferguson was afflicted with "an ineradicable tendency to try to make things clear," has done the same in recent times. Two questions instantly present themselves: (1) On how many distinguished men has this honour been conferred by the Royal Society since these times? and (2), Is there a "watchmaker" now in that learned body? J. HUGHES HEMMING.

Kimbolton, September 24.

A Case of Inherited Instinct.

I THINK the interesting cases mentioned by Captain Hutton on p. 411 will hardly bear the interpretation he puts upon them. In New Mexico three genera of *Stenopelmatinæ* are common, viz., *Stenopelmatus*, *Centhophilus* and *Udeopsylla*. These locusts are nocturnal, and live under logs or in holes in the ground during the day. It is natural, therefore, that they should be attracted by any dark place, such as a cave. The species of *Centhophilus*, like the crickets, are found in houses, which are well adapted to their tastes. There is no new instinct, or revival of a dormant one, exhibited in this choice. Similarly, in Colorado I have found the species of *Centhophilus* to live in mines, which are practically caves of recent origin.

The cave-seeking instinct, therefore, has been practically continuous, and if in New Zealand one genus (*Pachyrhamma*) lives in caves, while its ally (*Gymnoplectron*) is arboreal, it is probable that the former retains the instincts of their common ancestor, while the latter has lost them, so far as the arboreal habit is concerned. T. D. A. COCKERELL.

Mesilla Park, New Mexico, U.S.A., September 15.

Maggots in Sheep's Horns.

IN a letter which appeared in your issue of September 29, Captain Traherne writes under the heading of "Horn-feeding Larvæ," of maggots of about half an inch in length and of a white colour, having been found in the horns of a newly killed sheep, which he had obtained in India, but where there were no perceptible signs of perforation. These were not the larvæ of a Lepidopterous insect, but of one of the Diptera, known as *Œstrus ovis*, a well-known parasite. The fly lays her eggs in the region of the anterior naies, and the larvæ penetrate the nasal passage, finding their way into the turbinal bones, and from thence into the frontal cavity to the base of the horns. Captain Traherne does not say how far up the horn he found them; they are not usually found beyond the base, but as a rule locate themselves at the back of the throat, where they feed on the mucous substance. They are not horn-feeders. *Œstrus ovis* is distributed pretty generally wherever sheep are to be found.

Mr. Austen, of the British Museum (Nat. Hist.), showed me some very fine specimens, both of the fly and the larvæ.

W. H. MCCORQUODALE.

"Luminous Clouds," or Aurora?

SURELY the "luminous clouds" reported from Cornwall on September 10, in your issue of September 29, were auroral. It is a pity if no other record of altitude has been made, when one observation of such precision is available. I myself have a fairly good record of the upper edge of the bright arch, low down in the N.W. on the previous evening at 11 p.m., as seen from Croydon. If others have a record of this, a comparison might be of value.

It may be worth noting the very probable recurrence of auroræ on the evenings beginning with the 6th inst., when the solar revolution produces the conditions of the last magnetic outbreak, so far as the aspect of the sun is concerned. I have been much struck by this recurrence in working up a series of unpublished auroral observations from York, dating back to 1832.

112 Wool Exchange, E.C., J. EDMUND CLARK.

September 30.

A Hairless Rat.

I SHOULD like to draw the attention of your readers to a peculiar case which may be worth notice.

About ten days ago a man employed at the Ordnance Store Department, Stonehouse, brought me what he termed a "real curio." It was a rat, adult though not very old, without any hair on its body. It was caught in an ordinary trap at the Victualling Yard, and it is still alive, active and, to all appearance, healthy.

In appearance the rat is of a brownish colour, and with the exception of its whiskers, which are normal, and an occasional long woolly hair on the body, it is quite hairless. When at rest the skin is thrown into numerous small folds or corrugations, and its colour is heightened by the dirt which collects in these folds. In active movement the folds disappear. The tail, except an inch at the base, is normal in appearance, though devoid of hair. The ears appear rather larger than usual, and the eyes are somewhat prominent.

On communicating with the Superintendent of the Zoological Society's Gardens, I was referred to a paper by J. S. Gaskoin, in the *Proceedings* of the Zoological Society for 1856. A precisely similar case is there described, concerning four mice captured at Taplow in 1854. One of these gave birth to five young, shortly after capture, and these resembled the parent in every respect. There is no plate in the copy of the *Proceedings* that I have referred to, and the only difference in the description of the mice which does not fit my specimen is the colour of the ears, which are light coloured. T. V. HODGSON.

Municipal Museum, Plymouth, September 29.

THE DYNAMICAL THEORY OF REFRACTION, DISPERSION AND ANOMALOUS DISPERSION.[1]

THE dynamical theory of dispersion, as originally given by Sellmeier,[2] consisted in finding the velocity of light as affected by vibratory molecules embedded in ether, such as those which had been suggested by Stokes[3] to account for the dark lines of the solar spectrum. Sellmeier's mathematical work was founded on the simplest ideal of a molecular vibrator, which may be taken as a single material particle connected by a massless spring or springs with a rigid lining of a small vesicle in ether. He investigated the propagation of distortional waves, and found the following expression (which I give with slightly altered notation) for the square of the refractive index of light passing through ether studded with a very large number of vibratory molecules in every volume equal to the cube of the wave-length:—

$$\mu^2 = 1 + m\frac{\tau^2}{\tau^2 - \kappa^2} + m_{\prime}\frac{\tau^2}{\tau^2 - \kappa_{\prime}^2} + m_{\prime\prime}\frac{\tau^2}{\tau^2 - \kappa_{\prime\prime}^2} + \&c.$$

where τ denotes the period of the light; κ, $\kappa_{\prime}$, $\kappa_{\prime\prime}$ &c., the vibratory periods of the embedded molecules on the supposition of their sheaths held fixed; and m, $m_{\prime}$, $m_{\prime\prime}$ &c., their masses. He showed that this formula agreed with all that was known in 1872 regarding ordinary dispersion, and that it contained what we cannot doubt is substantially the true dynamical explanation of anomalous dispersions, which had been discovered by Fox-Talbot[4] for the extraordinary ray in crystals of a chromium salt, by Leroux[5] for iodine vapour, and by Christiansen[6] for liquid solution

1 Abstract of part of the substance of a communication by Lord Kelvin, G.C.V.O., to Section A of British Association at Bristol, on September 9.
2 Sellmeier, *Pogg. Ann.*, vol. 145, 1872, pp. 399, 520; vol. 147, 1872, pp. 386, 525.
3 See Kirchhoff-Stokes-Thomson, *Phil. Mag.*, March and July 1860.
4 Fox-Talbot, *Proc. Roy. Soc. Edin.*, 1870–71.
5 Leroux, *Comptes rendus*, 55, 1862, pp. 126–128.
6 Christiansen, *Ann. Phys. Chem.*, 141, 1870, pp. 479, 480; *Phil. Mag.*, 41, 1871, p. 244; *Annales de Chimie*, 25, 1872, pp. 213, 214.

of fuchsin, and had been experimentally investigated with great power by Kundt.[1]

Sellmeier himself somewhat marred[2] the physical value of his mathematical work by suggesting a distinction between refractive and absorptive molecules ("refractive und absorptive theilchen"), and by seeming to confine the application of his formula to cases in which the longest of the molecular periods is small in comparison with the period of the light. But the splendid value of his formula for physical science has been quite wonderfully proved by Rubens (who, however, inadvertently quotes[3] it as if due to Ketteler). Fourteen years ago Langley[4] had measured the refractivity of rock-salt for light and radiant heat of wave-lengths (in air or ether) from ·43 of a mikron to 5·3 mikrons (the mikron being 10^{-6} of a metre, or 10^{-4} of a centimetre), and without measuring refractivities further, had measured wave-lengths as great as 15 mikrons in radiant heat. Within the last six years measurements of refractivity by Rubens, Paschen, and others, agreeing in a practically perfect way with Langley's through his range, have given us very accurate knowledge of the refractivity of rock-salt and of sylvin (chloride of potassium) through the enormous range of from ·4 of a mikron to 23 mikrons.

Rubens began by using empirical and partly theoretical formulas which had been suggested by various theoretical and experimental writers, and obtained fairly accurate representations of the refractivities of flint-glass, quartz, fluorspar, sylvin, and rock-salt through ranges of wave-lengths from ·4 to nearly 12 mikrons.[5] Two years later, further experiments extending the measure of refractivities of sylvin and rock-salt to radiant heat of wave-lengths up to 23 mikrons, showed deviations from the best of the previous empirical formulas increasing largely with increasing wave-lengths. Rubens then fell back[6] on the simple unmodified Sellmeier formula, and found by it a practically perfect expression of the refractivities of those substances from ·434 to 22·3 mikrons.

And now for the splendid and really wonderful confirmation of the dynamical theory. One year later a paper by Rubens and Aschkinass[7] describes experiments proving that radiant heat after five successive reflections from approximately parallel surfaces of rock-salt and again of sylvin, is of mean wave-length 51·2 and 61·1 mikrons respectively. The formula which Rubens had given in February 1897, as deduced solely from refractivities measured for wave-lengths of less than 23 mikrons, made μ^2 negative for radiant heat of wave-lengths from 37 to 55 mikrons in the case of reflection from rock-salt, and of wave-lengths from 45 to 67 mikrons in the case of reflection from sylvin! (μ^2 negative means that waves incident on the substance cannot enter it, but are totally reflected).

A FOURTH SPECIMEN OF "NOTORNIS MANTELLI," OWEN.

NATURALISTS in New Zealand have this week been thrown into a great state of excitement by the capture of the fourth entire specimen of this very rare flightless Rail.

On August 8 I received a telegram informing me of the acquisition, and asking advice as to its preservation. Fortunately, a skilled taxidermist is attached to the Otago Museum, and I was able to arrange that the bird should be sent to that institution: it arrived two days later, and its remains are now in my care.

The last specimen of *Notornis* was captured twenty years ago; and it was almost universally considered by Maories, as well as by whites, to be extinct; hence the interest that attaches to the present specimen.

It may not be uninteresting to naturalists at home to be reminded of some facts in the history of *Notornis* as recorded in Buller's "Birds of New Zealand." The name was originally bestowed by Owen on some fossil bones discovered in the North Island, New Zealand.

Some years later (1849), Mr. W. Mantell was able to secure a freshly killed specimen, taken in the south-west of the Middle Island (the southern of the two main islands of New Zealand). This bird, the skin of which is in the British Museum, was declared by competent ornithologists at home to be identical with the fossil form. The second specimen was killed by Maories in 1851, and its remains are also in the National Collection. The third specimen was obtained nearly thirty years later, in 1879, and was purchased for the Dresden Museum. (From an examination of the bones Dr. A. B. Meyer declared it to be distinct from the fossil form, and named it *N. hochstetteri.*) These three specimens were killed at three spots about 100 miles apart, in very rugged country. Later, an incomplete skeleton was discovered, which is at present in the Otago Museum.

The bird recently killed is thus the fourth specimen seen in the flesh, and its future fate is at present uncertain. It was killed by a dog in the bush adjoining Lake Te Anau, in the same district as the other three specimens.

I have examined and made sketches of its viscera, which, like all parts of the bird, are carefully preserved for the owner. The specimen is a young female, in excellent health and splendid plumage.

During the present month I have been fortunate enough to obtain, on deposit, an egg of the Moa—the third or fourth, I believe, in anything like a complete condition. Although the egg is much broken, one side remains practically complete; the pieces of the other side had fallen inwards, and are embedded in the sand within the shell. The egg was discovered in a sandy deposit, and when it reached me was partially enveloped in sand. This has been removed, as far as safety would permit, from the more complete side of the egg, and the whole was thoroughly soaked in weak gelatine to bind sand and shell together. The specimen closely agrees in size and shape with the cast, which is familiar in all museums, and alongside of which it is now on exhibition. As in the case of the eggs previously discovered, it was one of a pair; the other was unfortunately broken, on handling, by those concerned in its excavation.

W. BLAXLAND BENHAM.

Dunedin, August 14.

A LIVING REPRESENTATIVE OF THE OLD GROUND-SLOTHS.

ALL naturalists will unite in congratulating Señor Florentino Ameghino on the remarkable discovery it has been his good fortune to make. It appears that several years ago he was informed by Ramon Lista—a traveller in Patagonia—of an encounter with a strange nocturnal beast, which, after being fired at and apparently hit, succeeded in escaping unharmed. It was described as like an Indian pangolin in size and form, but with the skin covered with greyish red hairs instead of scales; and from the rapidity with which it disappeared among the bushes, seemed to have been an animal of comparatively active habits. Till quite recently, nothing more had ever been heard of the strange creature seen by Lista in Santa Cruz; most of those to whom the story

1 Kundt, *Pogg. Ann.*, vols. 142, 143, 144, 145, 1871–72.
2 *Pogg. Ann.*, vol. 147, 1872, p. 525.
3 *Wied. Ann.*, vol. 53, 1894, p. 267. In the formula quoted by Rubens from Ketteler, substitute for $\mu\infty$ the value of μ found by putting $\tau = \infty$ in Sellmeier's formula, and Ketteler's formula becomes identical with Sellmeier's. Remark that Ketteler's "M" is Sellmeier's "$m\kappa^2$" according to my notation in the text.
4 Langley, *Phil. Mag.*, 1886, 2nd half-year.
5 Rubens, *Wied. Ann.*, vols. 53, 54, 1894–95.
6 Rubens, *Wied. Ann.*, vol. 60, 1896–97, p. 454.
7 Rubens and Aschkinass, *Wied. Ann.*, vol. 64, 1898.

was narrated receiving it with more or less marked incredulity.

A short time ago, however, Señor Ameghino was shown a number of fresh ossicles from Patagonia, of somewhat smaller size than coffee-berries, which he at once recognised as comparable with the somewhat larger bones commonly found in association with the remains of certain species of *Mylodon* from the pampean deposits of the Argentine, and which have always been regarded as indicating the presence of a dermal armour in those animals. These ossicles, it appears, were extracted from a badly preserved body-skin, which seems to have been exposed for some time to the action of the weather, and consequently to have become considerably discoloured. In thickness this skin measured about two centimetres; and its hardness and toughness were such that it could be cut only with a chisel or hatchet. In its deeper layer were embedded the ossicles; and in those places where it was least damaged it was covered with coarse reddish grey hair, from 4 to 5 centimetres in thickness.

The skin evidently belonged to an animal hitherto unknown to science; and, in spite of the absence of the limbs, the presence of the ossicles seems to afford decisive evidence that it indicates an existing small representative of the ground-sloths, more or less intimately related to the typical group of the genus *Mylodon*. Moreover, in the colour of the hair it agrees with Lista's description of his unknown animal, which he confidently asserted to be an Edentate. Señor Ameghino seems, therefore, to be fully justified in regarding the two specimens as pertaining to one and the same species, and that species to be a living representative of the *Megalotheriidæ*, hitherto known only in the fossil. For this animal the name of *Neomylodon listai* is proposed, but the specific title should be amended to *listæ*.

Dermal ossicles are only known to be developed in certain species of *Mylodon* and *Glossotherium*, and have not been detected among the remains of the smaller ground-sloths characteristic of the Patagonian formations. The presumption accordingly is that the new animal is more or less closely allied to these genera, from which, indeed, its right to distinction has yet to be demonstrated.

This animal is doubtless nocturnal, and also of rare occurrence, and some time may therefore probably elapse before a perfect specimen is obtained. Till that event happens naturalists must be content with the fact that a survivor of the old ground-sloths exists in the interior of Patagonia.

REPORT ON A NATIONAL PHYSICAL LABORATORY.

THE Committee appointed in August, 1897, to consider the desirability of establishing a National Physical Laboratory have issued their report. The Committee consisted of Lord Rayleigh, F.R.S. (chairman), Sir Courtenay Boyle, K.C.B., Sir Andrew Noble, K.C.B., F.R.S., Sir John Wolfe Barry, K.C.B., F.R.S., Prof. W. C. Roberts-Austen, C.B., F.R.S., Mr. Robert Chalmers, Prof. A. W. Rücker, F.R.S., Mr. Alexander Siemens, and Dr. T. E. Thorpe, F.R.S. The questions referred to them were as follows:—

"To consider and report upon the desirability of establishing a National Physical Laboratory for the testing and verification of instruments for physical investigation; for the construction and preservation of standards of measurement; and for the systematic determination of physical constants and numerical data useful for scientific and industrial purposes—and to report whether the work of such an institution, if established, could be associated with any testing or standardising work, already performed wholly or partly at the public cost."

The following are extracts from the report of the Committee:—

In general, the committee are of opinion that the appliances and facilities of the Standards Office and of the Electrical Standardising Laboratory are fairly adequate for the performance of their statutory duties. They understand, however, that on account of the want of means for the chemical analysis of the materials used in the construction of standards, those offices would find some difficulty, without extraneous assistance, with regard to any new standards that might be required.

They further desire to point out that many physical constants and data and numerical expressions are necessarily used in connection with standards and the standardising of instruments. Some of the data now in use at the Standards Office are known to require correction, and in the case of others further investigations appear to be desirable. There is, however, no legal obligation on the Board of Trade to establish new data and numerical expressions, and, in consequence of the smallness of the staff of the office the work of the Department is limited to that which is strictly enjoined by the Acts of Parliament. The Department is at the present time chiefly dependent for more exact knowledge on such investigations as may be undertaken at the Bureau International des Poids et Mesures at Paris, or by foreign institutions similar to that contemplated in this country.

There is much evidence that further facilities are needed by the public for standardising and verifying of instruments, both for scientific and commercial use; and also that it would be of great benefit to trade if means were provided for the public testing of the quality of certain classes of materials. In particular the committee desire to draw attention to the evidence which has been laid before them as to the difficulties arising in certain Government departments in their dealings with contractors and others which might be overcome by the establishment of an independent testing authority. It would neither be necessary nor desirable to compete with or interfere with the testing of materials of various kinds as now carried out in private or other laboratories; but there are many special and important tests and investigations into the strength and behaviour of materials which might be conducted with great advantage at a laboratory such as is contemplated in the reference. As illustrations we may mention investigations into the behaviour of metals and other substances under continuous or alternating stresses, which investigations are not, so far as we know, conducted at the present time at any testing institution in this country, and which could only be undertaken with satisfactory and authoritative results at a public laboratory.

For many years the testing of certain instruments has been carried out at the Kew Observatory under the direction of the Kew Observatory Committee of the Royal Society. There is much evidence that the existence of these tests has been of great benefit to both science and industry. On the one hand it enables the maker to give, or the purchaser to obtain, an independent and trustworthy statement as to the quality of the instrument. On the other hand, the existence of the tests has led in many cases to a marked improvement of the instruments; and similar results may be anticipated by an extension of these facilities to other branches of industry.

The Kew Observatory is a Government building leased to the Royal Society at a nominal rent, situate in the Old Deer Park, Richmond, which is Crown property. The institution has no endowment, the Gassiot Fund producing about 470*l.* per annum. From the Meteorological Office it receives annually 400*l.*, part of which is the ordinary grant made to a first-class meteorological station, the remainder being for scientific assistance. The fees received for the verification and testing of instruments amount to about 2000*l.* per annum. The institution is self-supporting, and has usually a small annual balance which is devoted to scientific investigation and to the extension of the work, including the erection of new buildings, when required. The funds at the disposal of the Observatory Committee are, however, quite inadequate to any considerable extension of its operations. The work done with restricted means has been very useful. The total number of instruments annually verified or tested is about 22,000. Among these are included watches, thermometers, sextants, barometers, and other apparatus used for scientific or industrial purposes. Evidence was given of the beneficial effect which Kew has exerted on the watchmaking trade, and it is noteworthy that this is due to the introduction of tests for which there was little or no previous demand on the part of the trade, though there is now keen competition among the best makers to secure a high place in the report which is annually issued.

In the opinion of the committee the principles which underlie the proposal for the establishment of a national physical laboratory have been tested on a comparatively small scale at the Kew Observatory with the most satisfactory results.

In addition to the physical constants and numerical *data* needed in connection with standards, there are numerous facts, a knowledge of which would be of great value to science and industry. The determination of such data usually involves an investigation as to the method of making the determination, and a considerable expenditure of skilled labour in carrying out the determination. The committee are of opinion that, although the former part of this work will in general be initiated by individual experimenters of great skill and originality, it may in special cases be usefully undertaken by a public body. It is rather to the improvement in the details of the method of making the determination that they think that the work of a public institution will for the most part be directed. This cannot usually be carried out by private investigators on account of the expense and the length of time over which the experiments must extend. The scientific reputation to be gained is often incommensurate with the labour involved; and even when the results are of industrial importance in many cases they cannot be protected by patents.

There is evidence that many questions of this nature are partially investigated for technical purposes by private persons, the results being not infrequently kept secret. More complete investigations carried out at a public institution and freely published would often be of great service to industry, and there is reason to believe that a large part of the cost of such work might be defrayed by the persons directly interested in the results.

One difficulty in connection with a scheme for the determination of constants and data arises from the fact that the number of subjects which might be pressed for investigation would be very large. The opinion was, however, generally expressed by the witnesses that a strong governing body would have no difficulty in selecting those branches of work which were the most important, and that it would be possible to confine the work of the proposed institution, if established, within moderate limits. Nearly all the witnesses, also, have expressed the opinion that those interested in industry as well as persons devoted to the study of pure science would be willing that the Royal Society should be ultimately responsible for the management of the proposed institution, provided that industry were adequately represented on the governing body, and that the choice of the members of that body, though nominated by the Council of the Royal Society, were not confined to Fellows of the Society.

After consideration of the evidence the committee have come to the conclusion that an institution should be established for standardising and verifying instruments, for testing materials, and for the determination of physical constants. Work useful both to science and industry could therein be performed for which no adequate provision is at present made, either in this country or at the Bureau International des Poids et Mesures. Such work could not, or, at all events, in all probability would not, be undertaken by individual workers, or by institutions primarily devoted to education. In the opinion of the committee the proposed institution should be established at the national expense on lines similar to, though not at present on the scale of, the Physikalisch-technische Reichsanstalt referred to above. The possibility of future extension should, however, be kept in view from the first.

To secure the efficient performance of the work, the committee are of opinion that the director of the institution should be a man of high scientific attainments, and should act under a governing body containing representatives of both science and industry. The director should not be called upon or allowed to undertake work not connected with the institution except with the consent of the governing body. He would require the support of an adequate staff. As regards locality, while it is desirable that the institution should be near London, it is necessary that the site be free from mechanical and electrical disturbance.

Among the most important questions considered by the committee was whether the proposed institution should be founded independently or should be a development of an existing institution. The duties of the Board of Trade, as custodian of certain standards, are defined by statute, and the committee consider that it is undesirable to alter existing arrangements in this respect. They are of opinion that the proposed laboratory if established should be managed by a governing body constituted and appointed as hereinafter described, and should not be under the direct control of a Government department. They recommend that the Board of Trade, as custodian of the standards, should be placed in close connection with the said governing body.

The character of the work done at the Kew Observatory suggests that all that is really necessary might be attained by the development of that institution.

RECOMMENDATIONS.

(1) That a public institution should be founded for standardizing and verifying instruments, for testing materials, and for the determination of physical constants.

(2) That the institution should be established by extending the Kew Observatory in the Old Deer Park, Richmond, and that the scheme should include the improvement of the existing buildings, and the erection of new buildings at some distance from the present observatory.

(3) That the Royal Society should be invited to control the proposed institution, and to nominate a governing body, on which commercial interests should be represented, the choice of the members of such body not being confined to Fellows of the society.

(4) That the permanent secretary of the Board of Trade should be an *ex officio* member of the governing body; and that such body should be consulted by the Standards Office and the Electrical Standardising Department of the Board of Trade upon difficult questions that may arise from time to time or as to proposed modifications or developments.

NOTES.

IN connection with the forthcoming conference upon an International Catalogue of Scientific Literature, a reception will be held at the Royal Society on Monday next, October 10. A dinner has been arranged by the President for Fellows of the Society and their friends who are interested in the subject of the Catalogue. It will take place at the Hôtel Métropole on Tuesday, October 11.

IN connection with the opening of the winter session of the Charing-cross Hospital Medical School on Monday, Prof. Rudolf Virchow, Director of the Berlin Pathological Institute, delivered the second of the Huxley lectures, his subject being "Recent Advances in Science, and their Bearing on Medicine and Surgery." Lord Lister, President of the Royal Society, occupied the chair, and a large number of members of the medical profession, and distinguished men of science were present. Prof. Virchow was most cordially received, and his address, printed in another part of this number, was followed with deep interest and attention.

MR. T. MELLARD READE informs us that the gypsum boulder, weighing at least thirteen tons, found in the Boulder Clay of Great Crosby, and described in a previous number of NATURE (p. 132), has been presented to the District Council by Mr. Peters, and is now being moved from its original bed with the intention of erecting it in an open space in Liverpool Road, Great Crosby. A concrete platform has been prepared to receive the boulder. From the depth of the clay pit in which it lay, and its great weight and irregular form, the lifting, carriage and setting up of the boulder is one of considerable difficulty. The boulder will be protected with wrought-iron railings, and no doubt will prove an object of abiding interest to the neighbourhood and to geologists generally.

NEWS has been received from Sitten (Canton Valais, Switzerland) that, on Monday, Captain Spelterini attempted the passage over the Alps in his balloon the *Vega*. He was accompanied by Prof. Heim, of Zürich, Dr. Mauer, director of the Meteorological Bureau of Zürich, and Dr. Biederman, of Warsaw. The balloon contained 3268 cubic metres of gas, was nearly 200 feet in height, and was capable of carrying a weight of 110,000 kilos, or about 100 tons. Owing to unfavourable winds, the object of crossing the Alps was not attained. The balloon was carried in the wrong direction, and descended near Dijon in France. It reached a height of 6300 metres (20,670 feet).

Attention has already been called to the fact that the executors of the late Baron von Mueller are collecting donations for the erecting upon his grave in the St. Kilda Cemetery, Melbourne, of a monument worthy of his fame. The monument is of grey granite, 23 feet in height, all highly polished, and will stand in the centre of a grave-plot 12 feet square, planted out with choice specimens of the Australian flora. We are now informed that the distinguished phytologist's supplemental volume of the "Flora Australiensis," upon which he had worked for years, and was preparing for the press at the time of his death, is to be published, together with two volumes on his administration as director of the Botanical Gardens, Melbourne, and embracing a biography and complete bibliograph of his writings. The executors would feel favoured by the loan of any of his letters, or the communication of incidents in the Baron's life which friends may deem worthy of notice in the biography. Subscriptions and letters should be addressed "Rev. W. Potter, 'Vonmueller,' Arnold Street, South Yarra, Melbourne, Australia."

We regret to see the announcement of the death of Dr. J. E. T. Aitchison, F.R.S., Brigade-Surgeon (retired) of H.M. Bengal Army, at the age of sixty-three.

Mr. Charles F. Brusch has sent us a copy of a paper read by him before the American Association, on August 23, upon a new gas which he has detected in the atmosphere, and designated *Etherion*. We shall refer to this paper later, when we receive a spectroscopic demonstration of the existence of the new gas.

Referring to the death of M. Gabriel de Mortillet, the well-known naturalist and anthropologist, the *Athenæum* says that he was born in 1821 at Meylan, and educated at Chambéry and Paris. He left France in 1849 to escape imprisonment for a socialistic publication, retiring to Savoy and Switzerland, where he arranged the museums of Annecy and Geneva. In 1856 he took scientific work in Italy; in 1864 he returned to Paris, and founded a periodical dealing with the primitive history of man. Henceforth he was occupied with organising congresses of prehistoric anthropology and archæology. He was appointed curator of the Museum of Antiquities at St. Germain in 1868, and in 1875 he helped to found the Anthropological School at Paris, of which he was subsequently professor. Among his numerous books may be mentioned studies on the mollusca and geology of Savoy, the sign of the cross before Christianity, the potters of the Allobroges, and the prehistoric problem, while his work in learned periodicals was extensive.

An exhibition of optical, mathematical, and scientific instruments is being held this week at the Mansion House, under the auspices of the Worshipful Company of Spectacle Makers, of which the Lord Mayor, Lieut-Col. H. D. Davies, M.P., is the master. The formal opening ceremony was performed on Monday afternoon, under the presidency of the Lord Mayor. The exhibits comprise a number of ancient as well as modern scientific instruments. Mr. Lewis Evans (of King's Langley) displays, *inter alia*, seven astrolabes of the fourteenth to the seventeenth centuries, and a large number of portable sun dials from England, France, Germany, Italy, &c., showing the development of the various types from the fifteenth century to the present time. Among other exhibits are the maximum and minimum thermometers used by Captain Ross in his various voyages round the world. The exhibition will be opened daily until Saturday inclusive, from two o'clock until nine, and a band will play every evening between five and eight o'clock.

The announcement that *Natural Science* will cease at the close of the present year, will be received with regret by students of biological sciences in many parts of the world. The periodical has taken a high place among monthly reviews of scientific progress, and it will be widely missed. The cessation of the journal could be prevented if some one with sufficient time and means will come forward to take over the responsibilities of the present editor, who announces that "all stock, appurtenances, and goodwill" will be handed over to any scientific man who is prepared to take over the responsibility, and continue the journal as an independent organ. It is to be hoped that this opportunity will not be missed, and that the journal will not be permitted to drop out of existence.

An interesting description of the electric railway on the Jungfrau, the first section of which was opened a few days ago, appears in the *Electrician* of September 23 and September 30, and from it we derive the following particulars:—The existing Wengern Alp Railway—a rack and pinion railway driven by steam locomotives—starts from Lauterbrunnen and ascends the Wengern Alp to the Little Scheidegg (an elevation of 6770 feet above sea-level) from whence it descends on the other side of the mountain to Grindelwald. The Jungfrau electric railway starts from the Little Scheidegg station of the Wengern Alp Railway and ascends the Jungfrau from the north side. There will be seven stations in all—namely, Little Scheidegg, Eiger Glacier (7610 feet), Eiger Wand (9220 feet), Eismeer (10,360 feet), Jungfraujoch (11,210 feet), Lift (13,430 feet), Summit of Jungfrau (13,670 feet). On the section of the line already opened there is only a distance of about 85 yards in tunnel, but from the Eiger Glacier onwards the railway will not touch the surface except at the stations. Almost immediately after leaving the Little Scheidegg station the gradient is 10 per cent., and this is increased to 20 per cent. at about half-way to the Eiger Glacier station. From this station the gradient increases to the maximum of 25 per cent. and the line enters the long tunnel, about 450 yards of which has been driven up to the present. The remaining stations from Eiger Wand onwards will be built within the rock, and it is intended to fit them with restaurants and sleeping accommodation for those passengers who may wish to break the journey. From the Eiger Wand and Eismeer stations there will be no egress on to the mountain, and tourists will merely be able to enjoy the view from windows or balconies, but from the Jungfraujoch station it will be possible to go out on to the Jungfraufirn and sledge over the perpetual snowfield to the Aletsch Glacier. The Jungfrau line is one of the most interesting applications of three-phase transmission and distribution yet made. Water-power is made use of in the valley to generate three-phase current at 7000 volts, and this is transmitted by means of overhead wires to transformer stations at the Little Scheidegg and the Eiger Glacier, where it is transformed to 500 volts by means of stationary transformers. Not only is electrical energy employed for traction purposes but also for lighting, heating, and for working the rock-drills used in the tunnels. The permanent way is built on the Strub rack system, and the locomotive truck geared to it carries two induction motors driven directly by the 500-volt three-phase current. The passenger cars, which are not pulled but pushed by the locomotive, are built for forty passengers. It is estimated that the railway will be completed by 1904.

It must now be accepted as one of the established facts of medicine that in almost all outbreaks of human plague rats are affected by a similar disease both before and during the epidemic. In an article upon the plague in Calcutta, Dr. F. G. Clemow points out in the *Lancet* that the evidence that the two diseases are the same is of exactly the same character as that which has established the identity of human and bovine tuberculosis, and there seems to be but little more reason for suspension of judgment in the one case than in the other. It may therefore be accepted that plague in man and plague in the rat are, as far as our present knowledge of the two diseases goes, one and the same disease. Evidence has also been published that the disease may attack other animals than the rat, such as dogs, pigs, pigeons, and domestic fowls. Some interesting evidence pointing to the possibility that rats were the means of introducing the plague infection into Calcutta, is given by Dr. Clemow. Before the date of the first recognised case of plague in man, intimation was received at the Health Office that a number of dead rats had been found in an office situated near the river; and a little later, other dead rats were found in a street close to and parallel with the river and in the warehouses of a shipping company near to the wharfs where ships unload. The occurrence seems to have been so unusual as to have at once attracted attention, and the premises were cleansed and disinfected. Some of these animals were examined at the municipal laboratory, and cultures of the plague bacillus were obtained from them. Right from the beginning of the outbreak dead rats in large numbers have been found in various parts of Calcutta, but more particularly in and near houses where cases of human plague had occurred.

In a report to the Administrator of St. Vincent, dated September 14, Mr. H. Powell, Curator of the Botanic Garden, Kingstown, gives some trustworthy meteorological statistics relating to the recent hurricane in that Colony. He states that the barometer gave timely indication of the coming storm; at 3h. p.m. on September 6 the corrected reading was 29·926 inches, and at 3h. p.m. on the 10th the mercury had fallen to 29·838 inches. This reading caused alarm, and cautionary notices were issued to various centres for dissemination. At 5h. 55m. the next morning the reading was 29·724 inches, and the wind was blowing in fitful gusts from N. and N.W. At 9h. a.m., the usual hour for recording observations, the reading was 29·606 inches, and the wind was rushing from N. to W. At 10h. a.m. the barometer had fallen to 29·539 inches, and the storm had commenced in earnest, the wind blowing from N.N.E. and W., and increased in such force at 11h. a.m. that the largest trees were uprooted. By 11h. 40m. the barometer had fallen to 28·509 inches, after which time there was almost a dead calm for about three-quarters of an hour. The rain gauge was emptied, and 4·94 inches were found to have fallen between 9h. a.m. and noon. At about 12h. 25m. p.m. the wind suddenly commenced to blow from S., and increased in force every minute. Trees and houses which had withstood the first part of the hurricane were now hurled to the ground, the wind force far exceeding that of the forenoon; this continued till about 2h. 30m. p.m., when the wind slackened considerably. During the lull between 11h. 40m. and 12h. 30m. the barometer remained steady at 28·509 inches, and then commenced to rise slowly, and afterwards rose as rapidly as it had previously fallen; at 3h. p.m., the usual recording hour, it had risen to 29·533 inches. Up to this time the rain had fallen in torrents, but the gauge had been overturned. The total rainfall measured was over 9 inches in the twenty-four hours, and it was estimated that another 5 inches was lost by the upsetting of the gauge. Distant thunder and lightning were recorded at intervals during the morning and afternoon. Persons living in St. Vincent who remember the "Great Hurricane" of August 11, 1831, state that the recent one was in every way far more destructive.

By a decree dated August 30 last, the Belgian Government has separated the astronomical from the meteorological service (see Nature, vol. lvi. p. 183), each of these departments being placed under a responsible scientific director; while administrative duties, care of instruments, library, &c., are to be under the control of an inspector. The astronomical service is placed under M. C. Lagrange, and meteorology under M. A. Lancaster, each of whom will submit a report quarterly to the Minister of the Interior upon the work of his particular department.

The record of an active and useful life is contained in a memoir of Dr. T. Sterry Hunt, F.R.S., by Mr. James Douglas, read before the American Philosophical Society in April last, and just published in separate form by Messrs. MacCalla and Co., Philadelphia. As a chemist Dr. Hunt was prominent nearly half a century ago, not only in the field of original investigation, but as one of the first interpreters of the new chemistry then being taught by Gerhardt. As a geologist his work was almost confined to the crystalline and palæozoic rocks, and he brought his chemical knowledge to bear upon the geological problems concerning their genesis. Mr. Douglas's memoir contains a number of interesting notes. The following extract from a letter written by Hunt from Paris in 1855 is of interest in connection with the production and cost of aluminium at the present time:—"I bring you some aluminium with a little note from Ste. Claire Deville, the discoverer. As for aluminium, it is still very rare; perhaps 100 lbs. have been made by Deville for the Emperor, who has defrayed from his own purse the experiments. Rousseau, the greatest fabricant of rare chemicals in France, sells it, however, at three and a-half cents a grain—the price of gold—and everybody buys specimens of it at that price, so that he can hardly supply the demand." In Mr. Douglas, Dr. Hunt's work has found an appreciative recorder.

The British Mycological Society held a most successful meeting, under the auspices of the Dublin Naturalists' Field Club, at Dublin, from September 19–24. Prof. Johnson arranged a most interesting series of excursions to Houth, Powerscourt, Brackenstown, Ballyarthur, The Woodlands, Lucan, and Dunran, and his labours were rewarded by more than 100 species being added to the published list of Mr. Greenwood Pim of "the fungi of the counties of Dublin and Wicklow." Some rare fungi were collected, including *Amanita strobiliformis*, *Naucoria erinacea*, *Polyporus Wynneæ* and *Hypocrea splendens*. Interesting papers were read by the President, Dr. C. B. Plowright, on "Notes and comments on the Agaricineæ of Great Britain," "A clover destroying Fungus," "Eriksson's cereal rusts"; Mr. H. Wager, on "A parasitic fungus on Euglena"; Mr. Greenwood Pim, "Notes on new and rare moulds"; " Dr. McWeeney, "Observations on two sclerotia occurring on the stems of potato"; and Mr. Soppitt, "Notes on rare Uredineæ."

The *Agricultural Gazette of New South Wales* for July contains an interesting account, by Mr. J. H. Maiden, Government Botanist at Sydney, of a botanical exploration of Mount Kosciusko, the highest mountain in Australia, 7328 feet above the level of the sea. Even at midsummer (January 1897) the temperature was only 1·5° above the freezing point at noon, and the climate of the mountain is not adapted for a sanatorium, as has been suggested, owing to the searching south-westerly winds. A list of the species gathered is given, the most largely represented orders being the Rununculaceæ, Leguminosæ, Myrtaceæ, Compositæ, and Gramineæ. There is no mention in the list of any species of Saxifragaceæ or Primulaceæ, and only one each is recorded of Crassulaceæ and Gentianaceæ.

In a "Note on Stokes's Theorem," Mr. A. G. Webster contributes to the *Proceedings* of the American Academy of Arts and Sciences, xxxiii. 20, a very simple proof of the expressions for the components of the curl of a vector point-function in terms of orthogonal curvilinear coordinates, which he obtains without the laborious process of transformation from rectangular axes.

THE *Revue générale des Sciences* has brought to light a new student of geometry in the form of Father Cyprien, of the Monastery of Mount Athos. This monk, who turns out to have been formerly a well-known explorer, Prince C. Wiasemsky, contributes to the pages of the *Revue* an interesting note on what he calls the "transinscribed spheres" of regular polyhedra, viz. spheres touching the edges of polyhedra, and various relations between the radii of spheres transinscribed to the regular tetrahedron, cube, octohedron, dodecahedron, and icosahedron are established.

PROF. ORESTE MURANI contributes to the *Rendiconti* del R. Istituto Lombardo, xxxi. 4, some interesting observations on stationary Hertzian waves as studied with the use of a coherer. The experiments were undertaken with a view of elucidating the phenomenon of multiple resonance indicated by the experiments of Sarasin and De la Rive, who by using resonators of different sizes had obtained indications of waves of different lengths. Instead of a resonator, Prof. Murani used a coherer, whose distance from the metallic reflector could be varied. On the hypothesis that the waves given off by the oscillator were simple waves, it would be natural to expect that the galvanometric deviations due to the coherer should vanish at the nodes and become a maximum at the loops. The actual observations, however, give no indications of such maxima and minima, thus favouring the view that the radiations emitted by the primary are not simple, but are composed of an infinity of waves of different periods.

THE invention of the kinematograph has led to a large demand for films, and these of considerably greater length than was previously required. We read in the *British Journal of Photography* (September 23) that the Eastman Kodak Company of Rochester, New York, have contracted to manufacture three photographic films of a length of 50,000 feet each, *i.e.* 9 miles 826 yards 2 feet long. These films have been ordered by Mr. Dunn for use in a machine of the kinetoscope type, the "Cellograph," of which he is the inventor. It is interesting to note the cost of such strips. The Eastman Company, according to the same account, charges 10,000 dollars for each roll, making in all 30,000 dollars for 150,000 feet, or about 1000 dollars a mile. It is possible now literally to take photographs by the mile.

A CATALOGUE of the scientific works in the Royal Zoological Anthropological-Ethnographical Museum in Dresden has been prepared under the direction of Dr. A. B. Meyer, and is published by Messrs. R. Friedländer and Son, Berlin. The works are arranged alphabetically according to authors, and systematically in subjects.

HELMINTHOLOGISTS will welcome the contributions to the anatomy and histology of Nemertean worms, which Dr. Böhmig publishes in the current number of the *Zeitschrift für Wissenschaftliche Zoologie*. Two species are described in detail; the one (*Stichostemma græcense*) discovered by Dr. Böhmig himself six years ago in a freshwater pond in the botanic gardens of Graz; and the other (*Geonemertes chalicophora*), found by Prof. von Graff in one of the hot-houses of the same gardens in 1879. The same number of the *Zeitschrift* contains also a paper, by W. Karawaiew, on the changes which the internal organs of ants undergo during their metamorphosis. The observations recorded were made on female larvæ of *Lasius flavus*, and are chiefly of a histological nature.

A PAPER on induction coils, read by Mr. A. Apps before the Röntgen Society, and one by Dr. J. Macintyre on contact breakers, appear in the *Archives* of the Roentgen Ray (vol. iii. No. 1), together with a report of the discussions which took place upon them at the meeting at which they were read. Unstinted praise is awarded to the excellent mechanical construction and performance of British-made instruments. Thus, "The possessor of a good induction coil made by our leading instrument-makers should cherish it as the violin-player cherishes his Stradivarius or his Guarnerius." Mr. T. C. Porter gives an extended account of his researches on Röntgen rays, already briefly described by him in these columns; Mr. Campbell Swinton summarises some of his recent work; and Drs. Norris Wolfenden and F. W. Forbes-Ross describe the action of Röntgen rays upon the growth and activity of bacteria and micro-organisms.

THE second edition of a "Catalogue of Scientific and Technical Periodicals," by Prof. H. Carrington Bolton, has just been published by the Smithsonian Institution. The catalogue contains particulars concerning the principal independent periodicals of every branch of pure and applied science published in all countries from 1665 to the present time. Medicine has been excluded from the list, but anatomy, physiology, and other branches of medical science have been admitted. The periodicals are arranged in alphabetical order, and they number nearly nine thousand. The date of publication of each volume of the journals entered in the catalogue is shown by means of chronological tables, by the use of which it is possible to find the date of a given volume in a given series, or the number of a volume when the date is known. The periodicals are indexed according to subjects, as well as arranged alphabetically according to their titles. The preparation of the volume (which runs into 1247 pages) must have involved an immense amount of work, and men of science will be grateful to the Smithsonian Institution for the new edition of this useful bibliography of the scientific press.

THE following are among the forthcoming publications announced by Mr. Wilhelm Engelmann (Leipzig):—"Repetitorium der Zoologie," by Karl Eckstein, second revised edition; "Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus," by C. G. de Dalla Torre, Volumen iv. Braconidae; "Monographieen afrikanischer Pflanzen-Familien-und-Gattungen," edited by A. Engler, i. Moraceae (excl. Ficus), prepared by A. Engler; ii. Melastomataceae, prepared by E. Gilg; "Elemente der Mineralogie begründet," by Carl Friedrich Naumann. Thirteenth completely revised edition by Ferdinand Zirkel, second part, completion of the work; "Kritik der wissenschaftlichen Erkenntnis Eine vorurteilsfreie Weltanschauung," by Dr. Heinrich von Schoeler; "Grundriss der Psychologie," by Prof. Wilhelm Wundt, third revised edition; "Untersuchungen über Strukturen," by Prof. O. Bütschli; "Grundriss einer Geschichte der Naturwissenschaften," by Friedrich Dannemann, vol. ii.; "Monographie der Turbellarien," by Ludwig von Graff, vol. ii.; "Handbuch der Blütenbiologie," founded upon Hermann Müller's work, by Paul Knuth; vol. ii. second part, Lobeliaceae bis Coniferae; "Die Vegetation der Erde Sammlung pflanzen-geographischer Monographieen," edited by A. Engler and O. Drude, vol. iii. Caucasus, by G. E. Radde.

MR. EDWARD ARNOLD announces:—"Lectures on Theoretic and Physical Chemistry," by G. R. Van 't Hoff, translated by Prof. R. A. Lehfeldt; "An Experimental Course of Chemistry for Agricultural Students," by T. S. Dymond; "Elementary Physical Chemistry," by Ch. Van Deventer, with an introduction by G. R. Van 't Hoff, translated by Prof. R. A. Lehfeldt; "An Illustrated School Geography," by Dr. Andrew J. Herbertson; and a new edition of "Animal Life and Intelligence," by Prof. C. Lloyd Morgan.—Messrs. G. Bell and Sons' list includes: "Domestic Hygiene," by Dr. W. A. Williams.—Messrs. J. and A. Churchill's announcements include: "A Synopsis of Surgery," by R. F. Tobin; and a new edition of Squire's "Companion to the British Pharmacopœia."—Messrs. Harper and Brothers' list contains: "A Thousand Days in the Arctic," by F. G. Jackson, 2 vols., illustrated.—Mr. W. Heinemann promises: "A View of the World in 1900," a new geographical series, edited by H. J. Mackinder, in 12 vols.: (1) "Britain and the North Atlantic," by the editor; (2) "Scandinavia and the Arctic Ocean," by Sir Clements R. Markham, F.R.S.; (3) "The Mediterranean and France," by Elisée Reclus; (4) "Central Europe," by Dr. Joseph Partsch; (5) "Africa," by Dr. J. Scott Keltie; (6) "The Near East," by D. G. Hogarth; (7) "The Russian Empire," by Prince Kropotkin; (8) "The Far East," by Archibald Little; (9) "India," by Colonel Sir Thomas Holdich; (10) "Australasia and Antarctica," by Dr. H. O. Forbes; (11) "North America," and (12) "South America," by American authorities.—Messrs. Smith, Elder, and Co. will publish: A new edition, with additional plates, of "Electric Movement in Air and Water," by Lord Armstrong, F.R.S.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. Cecil Alden: a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. W. C. Way; six Spotted Tinamous (*Nothura maculosa*) from Buenos Ayres, presented by Mr. Ernest Gibson; two Chameleons (*Chamæleon vulgaris*) from North Africa, presented by Mr. W. F. H. Rosenberg; three young Lions (*Felis leo*, ♂ ♂ ♀) from Africa, a Sumatran Rhinoceros (*Rhinoceros sumatrensis*, ♀) from Malacca, two Emus (*Dromæus novæ-hollandiæ*), ten Cunningham's Skinks (*Egernia cunninghami*), a Black and Yellow Cyclodus (*Tiliqua nigro-lutea*) from Australia, a Jardine's Parrot (*Pœocephalus gulielmi*) from West Africa, a Red-sided Eclectus (*Eclectus pectoralis*) from New Guinea, two Reticulated Pythons (*Python reticulatus*) from the East Indies, deposited; a Common Sandpider (*Tringoides hypoleucus*), two Little Ringed Plovers (*Ægialitis curonica*), European, purchased.

OUR ASTRONOMICAL COLUMN.

THE LARGE SUN-SPOT.—The spot on the solar disc which appeared on September 3 last at the eastern limb, and which, when on the central meridian (September 9), was the probable origin of the aurora and magnetic storm, has again (September 30) made its appearance on the eastern limb, having been of sufficient dimensions to last a period of rotation of the sun. The spot is accompanied by several others of smaller size, and its umbra is divided into three separate parts, which form objects of interesting observation. Even in one day considerable changes have been noted to have taken place in the smaller spots in its neighbourhood, although the large one has not shown any marked change. It will be interesting to know whether another aurora and concurrent magnetic storm will be observed and recorded when the spot reaches the central meridian (which will take place on October 6), as was the case at its last meridian passage.

NEW TEACHING OBSERVATORY FOR THE CALIFORNIAN UNIVERSITY.—We have received a circular from the director (Mr. A. O. Leuschner) of the students' observatory of the University of California, from which we make the following brief summary:—The trustees of the "Phebe Hearst Architectural Plan for the University of California" have inaugurated an international competition to secure the most suitable plan for the erection of new buildings in place of the present ones on the University grounds at Berkeley. The buildings are to satisfy every need of a modern University of the highest rank. Among these buildings will be an astronomical observatory especially adapted to the training of young men and women for the profession of astronomy in all its branches, and its equipment will be such as best to serve the purposes of the highest instruction in all branches of astronomy. It is stated that the new observatory is not meant to conflict with the Lick Astronomical Department of the University, for there students are only admitted who are supposed to have shown a marked ability for observation and independent research, and who receive from the astronomers a higher inspiration, and are guided by them in their first investigations in such special lines as can be best carried on at the Lick Observatory. While the main feature of the Berkeley department will be to give proper instruction to its students, the equipment of the observatory is proposed to be sufficiently complete to give ample opportunity for the higher work of research that the instructors and advanced students may be in a position to undertake. The object of the circular is, as the writer mentions, "to state in detail my ideas concerning the proposed new observatory, and to seek the advice of men prominent in the science of astronomy and in astronomical instruction elsewhere." That the observatory will be fully equipped and suitable for the work intended to be accomplished there will be little doubt, and the question of cost is evidently a minor detail, for the Trustees of the Plan invite opinion and request "suggestions irrespective of cost which . . . will better adapt the new observatory for the purposes which it is to serve."

Some of the instruments suggested are: an equatorial refractor of an aperture not greater than 16 inches; four smaller telescopes ranging from 6–10 inches aperture, one being a reflector; complete accessories for visual photographic, spectroscopic and photometric work; a 4-inch meridian circle, and four transit and zenith telescopes. The circular gives also details of the sizes of all the rooms for the instruments, laboratories, lectures, library, &c., which it is proposed to build.

ANNUAL REPORT OF THE CAMBRIDGE OBSERVATORY.—In his report to the Observatory Syndicate, which covers a period twelve months ending May last, Sir Robert Ball states that the meridian instrument of the observatory has been devoted especially to the perfection of a complete catalogue (which is ready for the press), by re-observing stars of which a single observation had only been obtained. It has also been employed in the determination of accurate places of a list of occultation stars at the request of Colonel Tupman. The Northumberland equatorial has been occasionally used for examining fixed stars and planets, but is chiefly employed when visitors are admitted.

The work of the Newall telescope has been continued by Mr. H. F. Newall on the same lines as in former years, namely, the determination of the velocities of stars in the line of sight as measured photographically. The stars chiefly used were those of the solar type. In all 111 photographs of sixty minutes' exposure each were obtained, giving material for the determination of velocity of forty-four stars. Twenty of these stars were of magnitudes greater than 2·5, and are included in the Potsdam observations made in 1888–91; the remainder lie between magnitudes 2·5 and 4·0, and were fainter than could be successfully dealt with at Potsdam. Of these plates eighty-three have been measured once, and twenty twice.

The report further states that the new photographic telescope is now finished at Sir Howard Grubb's works, and that the building to house it has been practically completed.

ANNUAL PUBLICATION OF THE OBSERVATORY OF RIO DE JANEIRO FOR 1898.—This yearly publication of the Astronomical Observatory of Rio de Janeiro is the fourteenth of the present series, and will be found to contain a great deal of useful information in addition to the ordinary data usually found in astronomical almanacs. There will be found tables for the reduction of meteorological observations, and for calculating altitudes from barometric observations by the methods of Laplace, Bessel, Cruls, Weilenmann: meteorological observations for several towns, such as Rio de Janeiro, Santa Cruz, Uberaba, contained in Part vi., which also includes the magnetic elements observed at Brazil by the Holland Commission. The last section is devoted to some miscellaneous data, and contains, among other matters, tables for determining, rapidly and approximately, the elements of a triangulation by the method proposed by Mr. Francis Galton.

RECENT ADVANCES IN SCIENCE, AND THEIR BEARING ON MEDICINE AND SURGERY.[1]

THE honour of being invited to deliver the second Huxley Lecture has deeply moved me. How beautiful are these days of remembrance which have become a national custom of the English people! How touching is this act of gratitude when the celebration is held at the very place wherein the genius of the man whom it commemorates was first guided towards its scientific development! We are filled not alone with admiration for the hero, but at the same time with grateful recognition of the institution which planted the seed of high achievement in the soul of the youthful student. That you, gentlemen, should have entrusted to a stranger the task of giving these feelings expression seemed to me an act of such kindly sentiment, implying such perfect confidence, that I at first hesitated to accept it. How am I to find in a strange tongue words which shall perfectly express my feelings? How shall I, in the presence of a circle of men who are personally unknown to me, but of whom many knew him who has passed away and had seen him at work, always find the right expression for that which I wish to say as well as a member of that circle itself could? I dare not believe that I shall throughout succeed in this. But if, in spite of all, I repress my scruples it is because I know how indulgently my English colleagues will judge my often incomplete statements, and how fully they are inclined to pardon deficiency in diction if they are convinced of the good intentions of the lecturer.

PROFESSOR HUXLEY'S WORK.

I may assume that such a task would not have been allotted to me had not those who imposed it known how deeply the feeling of admiration for Huxley is rooted within me, had they not seen how fully I recognised the achievements of the dead master from his first epoch-making publications, and how greatly I prized the personal friendship which he extended towards me. In truth, the lessons that I received from him in his laboratory—a very modest one according to present conditions—and the introduction to his work which I owe to him, form one of the pleasantest and most lasting recollections of my visit to Kensington. The most competent witness of Huxley's earliest period of development, Prof. Foster, presented in the first of these lectures a picture of the rapidly increasing extension of the biological knowledge, which must have excited not only our admiration, but also the emulation of all who study medicine. Upon me the duty is incumbent of incorporating with this presentment the newer strides of knowledge and of stating their influence upon the art of healing. So great a task is this that it would be presumptuous even to dare to attempt its accomplishment in a single lecture. I have decided, therefore, that I must confine myself to merely sketching the influence of biological discoveries upon medicine. In this way also will the example of Huxley be most intelligible to us. I must here make a confession. When I tried to ascertain how much time would be required to deliver my lecture as I had prepared it, I found, to my regret, that its delivery would occupy nearly double the time assigned to me. I had therefore to reduce it to about half of its original dimensions. This could only be done by means of very heroic cuts, seriously damaging in more than one place my chain of ideas. If, therefore, you should find, gentlemen, that my transitions from one point to the other occasionally are of a somewhat sudden and violent character, I trust you will bear with me and remember that, if you should take the trouble of reading my address afterwards, you will be less shocked than you may be to-day by my statements when they appear in print.

THE BEGINNINGS OF BIOLOGY.

Huxley himself, though trained in the practical school of Charing-cross Hospital, won his special title to fame in the domain of biology. As a matter of fact, at that time even the name of biology had not come into general use. It was only recently that the idea of life itself obtained its full significance. Even in the late middle ages it had not sufficient strength to struggle through the veil of dogmatism into the light. I am glad to be able to-day for the second time to credit the English nation with the service of having made the first attempts to define the nature and character of life. It was Francis Glisson, who, following expressly in the footsteps of Paracelsus, investigated the *principium vitæ*. If he could not elucidate the nature of life, he at least recognised its main characteristic. This is what he was the first to describe as "irritability," the property on which the energy of living matter depends. How great was the step from Paracelsus to Glisson, and—we may continue—from Glisson to Hunter! According to Paracelsus, life was the work of a special *spiritus*, which set material substance in action, like a machine; for Glisson, matter itself was the *principium energeticum*. Unfortunately, he did not confine this dictum to living substances only, but applied it to substance in general, to all matter. It was Hunter who first announced the specific nature of living matter as contrasted with non-living, and he was led to place a *materia vitæ diffusa* at the head of his physiological and pathological views. According to the teaching of Hewson and Hunter, the blood supplied the plastic materials of physiology as well as the plastic exudates of pathology. Such was the basis of the new biological method, if one can apply such an expression to a still incomplete doctrine, in 1842, when Huxley was beginning his medical studies at Charing-cross Hospital. It would lead too far afield were I to recount in this place how it happened that I myself, like Huxley, was early weaned from the pernicious doctrines of humoral pathology.

THE DEVELOPMENT OF BIOLOGY.

When Huxley himself left Charing-cross Hospital, in 1846, he had enjoyed a rich measure of instruction in anatomy and physiology. Thus trained, he took the post of naval surgeon, and by the time that he returned, four years later, he had become a perfect zoologist and a keen-sighted ethnologist. How this was possible, any one will readily understand who knows from his own experience how great the value of personal observation is for the development of independent and unprejudiced thought. For a young man who, besides collecting a rich treasure of positive knowledge, has practised dissection and the exercise of a critical judgment, a long sea-voyage and a peaceful sojourn among entirely new surroundings afford an invaluable opportunity for original work and deep reflection. Freed from the formalism of the schools, thrown upon the use of his own intellect, compelled to test each single object as regards properties and history, he soon forgets the dogmas of the prevailing system and becomes first a sceptic, and then an investigator. This change, which did not fail to affect Huxley, and through which arose that Huxley whom we commemorate to-day, is no unknown occurrence to one who is acquainted with the history, not only of knowledge, but also of scholars. We need only point to John Hunter and Darwin as closely-allied examples. The path on which these men have achieved their triumphs is that which biology in general has trodden with ever-widening strides since the end of last century—it is the path of genetic investigation. We Germans point with pride to our countryman who opened up this road with full conviction of its importance, and who directed towards it the eyes of the world—our poet-prince Goethe. What he accomplished in particular from plants others of our fellow-countrymen achieved from animals—Wolf, Meckel, and our whole embryological school. As Harvey, Haller, and Hunter had once done, so these men began also with the study of the "ovulum," but this very soon showed that the egg was itself organised, and that from it arose the whole series of organic developments. When Huxley, after his return, came to publish his fundamental observations he found the history of the progressive transformations of the contents of the egg already verified; for it was by now known that the egg was a cell, and that from it fresh cells, and from them organs, arose. The second of his three famous papers—that on the relationship between man and the animals next beneath him—limned in exemplary fashion the parallelism in the earliest development of all animal beings. But beyond this it stepped boldly across the border-line which tradition and dogma had drawn between man and beast. Huxley had no hesitation in filling the gaps which Darwin had left in his argument, and in explaining that "in respect of

[1] The second Huxley lecture, delivered by Prof. R. Virchow at the opening of the winter session of Charing Cross Hospital Medical School, on October 3. Reprinted from the *Times*.

substance and structure man and the lower animals are one." Whatever opinion one may hold as to the origin of mankind, the conviction as to the fundamental correspondence of human organisation with that of animals is at present universally accepted.

Omnis Cellula e Cellula.

. . . The greatest difficulty in the advance of biology has been the natural tendency of its disciples to set the search after the unity of life in the forefront of their inquiries. Hence arose the doctrine of vital force, an assumption now discarded, but still revealing its influence from time to time in isolated errors. No satisfactory progress can be made till the idea of highly-organised living things as units had been set aside; till it was recognised that they were in reality organisms, each constituent part of which had its special life. Ultimate analysis of higher animals and plants brings us alike to the cell, and it is these single parts, the cells, which are to be regarded as the factors of existence. The discovery of the development of complete beings from the ova of animals and the germ-cells of plants has bridged the gap between isolated living cells and complete organisms, and has enabled the study of the former to be employed in elucidating the life of the latter. In a medical school where the teaching is almost exclusively concerned with human beings this sentence should be writ large:—"The organism is not an individual, but a social mechanism." Two corollaries must also be stated—(1) that every living organism, like every organ and tissue, contains cells; (2) that the cells are composed of organic chemical substances, which are not themselves alive. The progress of truth in these matters was much retarded by that portion of Schwann's cell-theory which sought to establish the existence of free cell-formation, which really implied the revival of the old doctrine of spontaneous generation. This belief was gradually driven out of the domain of zoology, but in connection with the formation of plastic exudates found a sanctuary in that of pathology. I myself was taught the discontinuity of pathological growths—a view which would logically lead back to the origin of living from non-living matter. But enlightenment in this matter came to me. At the end of my academical career I was acting as clinical assistant in the eye department of the Berlin Hospital, and I was struck by the fact that keratitis and corneal wounds healed without the appearance of plastic exudation, and I was thus led to study the process of inflammation in other non-vascular structures, such as articular cartilages and the intima of the larger vessels. In no one of these cases was plastic exudation found, but in all of them were changes in the tissue cells. Turning next to vascular organs, and in particular those which are the common seats of exudation processes, I succeeded in demonstrating that the presence of cells in inflammatory exudates was not the result of exudation, but of multiplication of pre-existing cells. Extending this to the growth in thickness of the long bones—which was ascribed by Duhamel to organisation of a nutricious juice exuded by the periosteal vessels—I was thus eventually able to extend the biological doctrine of *omnis cellula e cellula* to pathological processes as well; every new formation presupposing a matrix or tissue from which its cells arise and the stamp of which they bear.

Heredity.

Herein also lies the key to the mystery of heredity. The humoral theory attributed this to the blood, and based the most fantastic ideas upon this hypothesis; we know now that the cells are the factors of the inherited properties, the sources of the germs of new tissues and the motive power of vital action. It must not, however, be supposed that all the problems of heredity have thus been solved. Thus, for instance, a general explanation of theromorphism, or the appearance of variations recalling the lower animals, is still to be found. Each case must be studied on its merits, and an endeavour made to discover whether it arose by atavism or by hereditary transmission of an acquired condition. As to the occurrence of the latter mode of origin, I can express myself positively. Equally difficult is the question of hereditary diseases; this is now generally assumed to depend on the transmission of a predisposition which is present, though not recognisable, in the earliest cells, being derived from the paternal or maternal tissues. But the most elaborately constructed doctrines as to the hereditariness of a given disorder may break down before the discovery of an actual *causa viva.* A notable example of this is found in the case of leprosy, the transmission of which by inheritance was at one time so firmly believed in that thirty years ago a law was nearly passed in Norway forbidding the marriage of members of leprous families. I myself, however, found that a certain number of cases at any rate did not arise in this way, and my results were confirmed by the discovery of the leprous bacillus by Armauer Hansen. In a moment the hereditary theory of the disease was overthrown and the old view of its acquirement by contagion restored. Precisely the same happened a few decades earlier with regard to favus and scabies. Another instructive condition is that known as Heterotopia in which fragments of tissues or organs are found dwelling in a situation other than that which is normal to them. This is particularly the case with certain glands, such as the thyroid and suprarenal, but is also known with cartilage, teeth, and the various constituents of dermoids. It no doubt occurs by process of transplantation, the misplaced tissues developing no new properties, but merely preserving their normal powers of growth. The attempt to generalise from this fact and to attribute all tumour-formation to this cause carries the idea beyond its proper scientific limits.

Parasitism and Infection.

With regard to the subject of parasitism, the progress of scientific observation was retarded for centuries by the prevalence of the assumption made by Paracelsus that disease in general was to be regarded as a parasite. Pushed to its logical conclusion, this view would imply that each independent living part of the organism would act as a parasite relatively to the others. The true conception of a parasite implies its harmfulness to its host. The larger animal parasites have been longest known, but it is not so many years since their life-history has been completely ascertained and the nature of their cysts explained, while an alternation of generations has been discovered in those which are apparently sexless. Very much more recent is the detection of the parasitic protozoa, by which the occurrence of the tropical fevers may be explained. As yet we have not complete knowledge as to their life-history, but we hold the end of the chain by which this knowledge can be attained. The *élite* of the infectious diseases are, however, the work of the minutest kind of parasitic plants, bacteria, the scientific study of which may be said to date from Pasteur's immortal researches upon putrefaction and fermentation. The observation of microbes under exact experimental conditions, and the chemical investigation of their products opened up the modern field of bacteriology, a science among the early triumphs of which were the discoveries of the bacilli of tubercle and Asiatic cholera by Robert Koch. In connection with this subject, three important landmarks require comment. One is the necessity for distinguishing between the cause and the essential nature of infectious diseases, the latter of which is determined by the reaction of the tissues and organs to microbes. Secondly, there is the relation between the smaller parasites and the diseases determined by them. This may be summed up in the general word (introduced by Prof. Virchow himself) "infection." But to assume that all infections result from the action of bacteria is to go beyond the domain of present knowledge, and probably to retard further progress. The third point is the question as to the mode of action of infection. It is only the larger parasites whose main effect is the devouring of parts of their hosts; the smaller act mainly by the secretion of virulent poisons. The recognition of this latter fact has led to the brilliant work of Lister on the one hand, and to the introduction of serum-therapeutics on the other.

Antiseptic Surgery.

It would be carrying coals to Newcastle were I to sketch in London the beneficial effects which the application of methods of cleanliness has exercised upon surgical practice. In the city wherein the man still lives and works who, by devising this treatment, has introduced the greatest and most beneficent reform that the practical branches of medical science have ever known, every one is aware that Lord Lister, on the strength of his original reasoning, arrived at practical results which the new theory of fermentative and septic processes fully confirmed. Before any one had succeeded in demonstrating by exact methods the microbes which are active in different diseases, Lister had learnt, in a truly prophetic revelation, the means by which protection against the action of putrefactive organisms can be attained. The opening up of further regions of clinical medicine to the knife of the surgeon and a perfect revolution in the basis of therapeutics have been the consequence. Lord Lister, whom I am proud to be able to greet as an old friend, is already and always will be reckoned amongst the greatest benefactors of the human race. May he long be spared to remain at the head of the movement which he called into existence.

Artificial Immunisation.

It remains for me to say a word concerning the other great problem, the solution of which the whole world is awaiting with anxious impatience. I refer to the problem of immunity and its practical corollary, artificial immunisation. It has already happened once that an Englishman has succeeded in applying this to the definite destruction of at least one of the most deadly infectious diseases. Jenner's noble discovery has stood its trial as successfully, except in popular fancy, as he hoped. Vaccine is in all hands; vaccination is, with the aid of Governments, spreading continually. Pasteur also laboured with determination; others have followed him, and the new doctrine of antitoxins is continually acquiring more adherents. But it has not yet emerged from the conflict of opinions, and still less is the secret of immunity itself revealed. We must become well accustomed to the thought that only the next century can bring light and certainty on this point. Prof. Virchow, having referred with pride to the influence of cellular pathology in modern treatment, entailing, as it does, the principle of destroying the focus of disease by early operation, concluded his lecture in these words:—May the Medical School of Charing-cross Hospital continue upon the newly-opened path with zeal and good fortune. But may its students at the same time never forget that neither the physician nor the naturalist dares to dispense with a cool head and a calm spirit, with practical observation and critical judgment.

CHEMISTRY AT THE BRITISH ASSOCIATION.

ALTHOUGH no epoch-making discoveries can be recorded amongst the contributions to the Chemical Section this year, the work of the Section was full of interest and attraction. A very wide range of subjects was included in the programme, and the presence of many past-presidents of the Section added very considerably to the success of the meeting. The announcement of the discovery of two new elements, *Monium* and *Xenon*, must constitute a record for the first two days of the meeting, although new elements, especially amongst the rarer earths and gases, hardly excite the interest that similar discoveries did some years back. Monium is described in Sir William Crookes' address. It is an added element culled "from the waste heaps of the mineral elements," characterised by a group of distinctive lines in the ultra-violet end of the spectrum, and having an atomic weight of about 118, between those accepted for yttrium and lanthanum respectively. "Xenon" was described by Prof. Ramsay and Dr. Travers in their paper on "The extraction from air of the companions of Argon and on Neon." It accompanies krypton and metargon in the last fractions of liquefied argon, and is easily separated from the latter on account of its higher boiling point. It remains behind after the other two gases have evaporated, and is the heaviest of the three gases. Xenon, "the stranger," shows an analogous spectrum to argon, but differing entirely in the position of the lines. With the ordinary discharge the gas shows three lines in the red, and about five very brilliant lines in the blue; while with the jar and spark-gap these lines disappear, and are replaced by four brilliant lines in the green, intermediate in position between the two groups of argon lines. The remainder of the paper dealt with the successful issue of the search for "an undiscovered gas"—the subject of Prof. Ramsay's presidential address to the Section at Toronto. This gas should have an atomic weight higher than that of helium by about 16 units, and lower than that of argon by about 20. The determination of the atomic weight of neon gave the figure 19·2; it would therefore follow fluorine, and precede sodium in the periodic table. Like argon and helium it is monatomic; it is present in the air in the proportion of about 1 part in 40,000. Prof. Emerson Reynolds added a note on the position of helium, argon, krypton and neon in his diagrammatic representation of the relations of the elements, and pointed out that their atomic weights as yet determined were well in accord with his representation of the periodic law. Amongst other papers on inorganic chemistry, Prof. F. Clowes gave an account of his work on the action of magnesium on cupric sulphate solutions, under the title of "Equivalent replacement of metals." The reaction was studied with both hot and cold solutions, and under various conditions of concentration. In all cases cuprous oxide is formed, and hydrogen is evolved side by side with the deposition of the copper. This evolution of hydrogen is attributed in part, but not wholly, to the presence of free sulphuric acid formed by hydrolysis of the cupric sulphate and accompanied by the separation of a basic salt. Prof. Hodgkinson and Mr. Coote, in a paper on "Alkaline chlorates and sulphates of the heavy metals," pointed out that many solid sulphates, whether containing water of crystallisation or anhydrous, give off chlorine in addition to oxygen when gently heated with potassium or sodium chlorate. A residue of the alkaline sulphate and chloride and the oxide and chloride of the metal is left behind. The evolution of chlorine and oxygen occurs at temperatures very little above 100° C. Mr. R. G. Durrant described a series of "Green cobaltic compounds" he had obtained by oxidising potassium cobaltous oxalate with hydrogen peroxide; similar results follow the oxidation of cobaltous salts in presence of glycollates, citrates, malates, lactates or succinates of the alkali metals.

In another branch of the science, physical chemistry, Prof. Sydney Young contributed a most lucid and interesting account of his researches on the "Thermal properties of gases and liquids." The subject is one which has engaged Prof. Young's attention for the past eleven years, and his descriptive summary of his labours was therefore received with special interest. One chief aim of these investigations has been to ascertain whether the generalisations of Van der Waals regarding the relations of pressure, temperature and volume for both gases and liquids, are really true, and if not, whether the observed deviations would throw any light on the modifications which must be made in Van der Waals's fundamental formula in order to bring it into accurate agreement with the experimentally determined isothermals for liquids and gases. The vapour pressures and specific volumes of a number of substances were therefore determined, both as liquid and as saturated vapour, from low temperatures to their critical points. Twenty-six substances have been examined altogether, including paraffins, benzene and its haloid derivatives, esters, alcohols and acetic acid, and the data obtained allow of a simple classification in respect to their physical constants. Amongst other points of interest the results show that the molecules of the alcohols at moderate temperatures are polymerised in the liquid, but not in the gaseous state, whilst there is polymerisation in both states in the case of acetic acid; also, that the molecules of the alcohols and acetic acid appear to be polymerised to a considerable extent at the critical point. Prof. Young also described his methods for the determination of the critical constants and of the specific volumes of both liquid and saturated vapour. Ample proof was obtained in the course of these investigations that the views of Andrews regarding the behaviour of a substance in the neighbourhood of the critical point are correct, and also that the vapour pressure of a pure substance is quite independent of the relative volumes of liquid and vapour. The method of fractional distillation of liquids adopted for the preparation of pure substances was described, and the apparatus was exhibited at work; it has thus been found quite feasible to separate perfectly pure normal and iso-pentane from American petroleum. The Earl of Berkeley described the methods he has adopted for the more exact determination of the densities of crystals, in which special precautions are taken to eliminate errors in the measurement of temperature, volume and mass, occlusion of mother liquor, and absorption of moisture. The determinations recorded were made in carbon tetrachloride, a maximum divergence of 0·04 per cent. being shown as the result of four determinations of the density of potassium carbonate crystals. Under the head of physical chemistry the joint-meeting with Section A on the "Results of the recent Eclipse expeditions," has been referred to in connection with the doings of the Physical Section. The modern photographic plate as a sensitive medium for the recording of chemical action was the subject of several interesting communications, notably that of Dr. W. J. Russell on "The action exerted by certain metals and other organic substances on a photographic plate." Some account of these researches has already been given in Nature. Dr. Russell showed a series of slides illustrating the action of printer's ink, wood, dry copal varnish, turpentine, drying oils, essential oils and metals on a photographic plate, in the dark, and detailed his method of experiment. Actual contact is not necessary to obtain the action; it takes place also at a distance. The time required is dependent upon the temperature; in the earlier experiments it required a week to produce a developable image, but by raising the temperature to 55° C. considerable action was recorded in five minutes. Sheets of gelatine, celluloid, gutta-percha and collodion do not hinder the action, when placed as screens between the active surface and the plate. Hydrogen peroxide is regarded by Dr. Russell as most probably the active agent in all these actions, but further experiments are in progress to decide this more definitely. In a complementary paper by Mr. C. H. Bothamley, on "The action of certain substances on the undeveloped photographic image," evidence was adduced to show that printer's ink can after a time act on a photographic plate and destroy the "latent image." The vapour of hydrogen peroxide and turpentine have the same effect. Whereas, therefore, hydrogen peroxide acting for a short time or in small quantity produces a developable image, by more prolonged action or in a more concentrated form it acts as an oxidiser and destroys the image. Probably both actions take place simultaneously, and the result at any given instance depends on their relative rates. Prof. Percy Frankland contributed an additional photographic action—that of bacteria. By placing gelatine cultures of *Bacillus coli communis* and of *Proteus vulgaris*, either in juxtaposition or at a distance of half an inch from a photographic plate, definite developable images were obtained. The action is stopped by glass or mica, and is therefore not due to radiation, but to the evolution of some volatile matter which reacts with the plate. Bacterial growths which are luminous in the dark (*Photobacterium phosphorescens*) have a still greater action. The investigation is to be extended to other organic structures vegetable and animal, living and dead. Amongst these contributions may be included an account by Dr. J. H. Gladstone and Mr. Hibbert of their further work on "The absorption of the Röntgen rays by chemical compounds," which dealt chiefly with their attempts to perfect quantitative methods of estimating the comparative densities of their radiographs. Mr. Hibbert also described an instrument he had devised for ascertaining the relative grades of the Röntgen rays.

Applied chemistry received attention under various headings. Special local interest naturally centred in Dr. J. Gordon Parker's paper on "Recent advances in the tanning industry," in which the lack of scientific methods amongst the tanners of this country was sternly criticised. Dr. Parker referred to the employment of extracts in tanning as a marked advance which had also brought about improved methods of estimating the tanning value of the materials employed in the industry, but bateing and "puering" of hides by means of dog and hen excrement was stigmatised as a standing disgrace to the leather trade. American and continental tanners appear to be far ahead of their English brethren in respect to the extraction of tanning materials in the tanyard. The cold extraction processes employed here mean loss and waste. Analyses of over 300 samples of so-called waste-spent tan from forty tanyards in Great Britain having shown an average of over 9 per cent. of available tannic acid. With valonia alone this represents a loss of 1*l*. 13*s*. 4*d*. a ton, about 500,000*l*. annually. In Germany and America warm extraction, which means practically complete extraction, has proved successful. The fear of darker colour in leather from the use of warm extracts is much exaggerated; as the temperature of extracting is raised, more colouring matter is dissolved, but it is difficultly soluble, and much of it is re-deposited on cooling. Mr. Vernon Harcourt exhibited and described his new "10-candle pentane lamp," which was most favourably commented on by Prof. Vernon Boys as a standard of light. Mr. Vernon Harcourt pointed out the advantages of a 10 or 16-candle standard for testing illuminating gas, over that now employed, and also the need of a large but compact standard flame. The burner is supplied with a mixture of air and gaseous pentane from a reservoir placed on a bracket at the top of the lamp. As this mixture falls down a siphon tube connecting the reservoir and the lamp, fresh air enters the former, which is provided with cross partitions, causing the air to travel backwards and forwards over the surface of the pentane and to mix with a proportion of pentane, which varies in amount with the external temperature. The arrangement of the lamp is such, however, that the variation in the proportion of pentane does not affect the output of light. There is a casing round the burner with a conical top which steadies the flame, the upper part of which is drawn together in a long brass chimney which cuts off the light of this part of the flame. The lamp is so constructed that a cool air current issues through the middle of the argand burner, which thus gives a steady flame 60–70 mm. high, having an illuminating value of rather more than ten candles. By adjusting the tube which receives the top of the flame at a height of 47 mm., the light shed horizontally is reduced to exactly ten candles. Comparisons made between four different lamps showed concordant results, their values being also in accord with the one-candle pentane standard. Prof. Emerson Reynolds's experiment, illustrating "The effect on the acetylene flame of varying proportions of carbon dioxide in the gas," was of considerable interest. The experiment had arisen from a chance observation by Mr. Goodwin that expired air when mixed with acetylene appeared to increase the luminosity of the acetylene flame, and also to decrease the tendency to deposit carbon in the burners. More careful study had shown that 5–8 per cent. of carbon dioxide in the gas decreased the smokiness of the flame, and especially prevented the clogging of the burners. The increase in illuminating power was certainly not marked, but the mixture containing 5 per cent. of carbon dioxide gave as much light as the acetylene itself, and therefore there is a gain to this extent per volume of acetylene burned. The action of the carbon dioxide was regarded as probably due to its exerting some oxidising effect.

Agricultural chemistry was dealt with in the report of the Committee on the Carbohydrates of Cereal Straws, and by Dr. Luxmoore, who described a scheme of analysis for Dorsetshire soils, which is to be carried out with the view of obtaining a general knowledge of the soils of the county. Dr. Armstrong also contributed a preliminary report of the Committee established last year for the promotion of agriculture. Dr. Gladstone's report on the "Teaching of science in elementary schools" was followed by an interesting discussion, and Dr. Armstrong gave a suggestive account of methods he had adopted for training children in methods of original inquiry under the title of "Juvenile research." Reports were submitted by the several committees of the Section, which will be published *in extenso* in the *Transactions* of the Association. Amongst these, those on the action of light upon dyed colours, on isomeric naphthalene derivatives, on the wave-length tables of the spectra of the elements, on the bibliography of spectroscopy, and on the electrolytic methods of quantitative analysis were a continuation of previous work. Two new Committees were formed, one to investigate the relation between the absorption spectra and constitution of organic substances, and the other on the chemical and bacterial examination of water and sewage, especially in reference to establishing a uniform method for recording results. The sewage problem was also treated of by Dr. Rideal, in a paper on "Standards of purity for sewage effluents."

Organic chemistry received a fair share of attention, several papers of importance and interest being read. Prof. Noetling, of Mülhausen, described a new series of colours he had obtained from amidated aromatic amidines, the first series of amidine colours prepared. Dr. Laurie and Mr. Strange showed the results they have obtained in studying the cooling curves of fatty acids. The curve, which is very characteristic for pure fatty acids, such as palmitic and stearic, shows a marked change if 1 per cent. of another fatty acid is present, and when a larger proportion of the second acid is introduced a second latent-heat point is developed, the curve showing a discontinuity below the solidifying point of the mixture. The curves given by these mixtures indicate a reproduction of the phenomena observed by Prof. Roberts-Austen in the case of certain alloys. Messrs. Fenton and Jackson showed that the oxidation of polyhydric alcohols in presence of ferrous iron proceeds on analogous lines to that of tartaric acid, "glycerose," the mixture of glyceraldehyde and dihydroxy-acetone being formed from glycerol; whilst Dr. Morrell and Mr. Crofts recorded a corresponding result on the oxidation of glucose, the alcohol group next to the aldehyde group being oxidised. The contributions in this branch of chemistry are usually too technical to interest many of the followers of the Association, but this year all organic chemists felt a special debt of gratitude to the President of the Section, Prof. Japp, not only for the value of his address to them, but also for the manner in which he had placed the methods and limitations of modern organic chemistry before a far wider field of scientific workers.

GEOLOGY AT THE BRITISH ASSOCIATION.

So far as Section C was concerned, the Bristol meeting of the British Association was decidedly successful. The attendance at the sectional meetings was above the average, and the interest well sustained, a larger proportion than usual of the papers and reports being of a character to give rise to discussions on broad general principles, for which these occasions are pre-eminently adapted.

In some cases these discussions were curtailed from lack of time, and there was a little discontent among the more steadfast adherents to the indoor work of the meeting that the whole of the papers should have been crowded into four days, and the Saturday and Wednesday half-day sessions dispensed with. But in a region so rich in geological interest it was desirable that every opportunity for outdoor investigation should be given to the members of the Section, especially as the weather during the meeting was singularly favourable for field-work. The popularity of the short afternoon excursions arranged for Friday, Monday and Tuesday, under the leadership of Prof. C. Lloyd Morgan and Mr. H. Pentecost, to classical sections in the vicinity of Bristol, proved that to the visiting geologists the chance of inspecting the best exposures under competent guidance was at least of equal importance to the indoor proceedings. These afternoon excursions have, during the last three or four years, become an important feature in the arrangements of the Section, and though it has been sometimes objected that they are detrimental to the attendance indoors during the later stages of the daily session, it is doubtful whether such be really the case. The difficulty of holding together an audience of notable dimensions when the sitting of the Section is prolonged late into the afternoon was felt at these meetings long before the institution of the short excursions.

The papers and reports submitted to the Section are too numerous for adequate mention, and special reference can only be made here to such as possessed wide interest or led to much debate. As frequently happens, some of the papers containing the most solid and original work attracted the least discussion.

At the opening day of the sectional meeting, after the presidential address, Prof. C. Lloyd Morgan gave a clear general account of the more interesting features of the local geology, dealing especially with the places to be visited during the excursions. The lantern slides by which this address was illustrated were unfortunately almost invisible owing to the insufficient darkening of the room.

Mr. E. Wethered followed with a paper on "The building of the Clifton rocks," in which he contended for the importance of certain micro-organisms in the formation of the local limestones. These "incrusting organisms," along with other forms which he described, all hitherto usually held to be of inorganic origin, are regarded by Mr. Wethered as organic growths, to which in some cases the structure of the limestone is due; and these he considers to be serviceable aids in identifying the strata. At a later session Mr. Wethered brought forward a second paper on "The work of incrusting organisms in the formation of limestone," in which he urged the claims of Girvanella and allied forms in the production of the oolitic structure in Jurassic rocks. Both papers were illustrated by beautiful lantern slides of rock-slices prepared by the author. These papers gave rise to lively discussions, in which by some speakers the organic origin of some of the structures was strenuously denied; in his able reply, Mr. Wethered claimed that a thorough investigation of his slides by a committee of experts would convert the partial recognition which his views had already won into a thorough-going acceptance of all his conclusions.

Mr. A. Strahan brought before the meeting an account of the results of the revision of the South Wales Coal-field by the Geological Survey, showing the great advances which have been made in our knowledge of the structure of this important area, and the methods adopted for representing the new information upon the maps.

In a paper on "The comparative action of sub-aërial and submarine agents in rock decomposition," Mr. T. H. Holland, of the Geological Survey of India, drew attention to the wide-reaching difference between the manner of decomposition of the crystalline and igneous rocks in Southern India and in Europe, especially in the degree of hydration of the minerals. This difference, he thought, might be due to the absence of submarine action in the central portion of Southern India during the later geological periods, so that the rocks have been affected only by sub-aërial weathering, and deeper portions of the earth's crust have, by long denudation, been exposed at the surface than in Europe.

Friday's session was opened by a suggestive discourse by Prof. O. C. Marsh, on "The comparative value of different kinds of fossils in determining geological age," in which the claims of the vertebrates, wherever they existed, were pressed as being the best for the purpose. As a side-issue, Prof. Marsh drew renewed attention to the Jurassic affinities of the English Wealden fauna, so that his paper provided almost unlimited scope for discussion. Most of the speakers on the subject, while acknowledging that the main point of Prof. Marsh's contention might be theoretically correct, dwelt upon the practical difficulties to the field-geologist in the collection and determination of vertebrate remains, and urged that this must prevent these fossils being used for zonal purposes except in rare instances. Another paper which provoked an interesting discussion was that of Prof. J. F. Blake, on "Aggregate deposits and their relation to zones." The author proposes the term "aggregate deposits" for strata in which fossils characterising more than one zone occur together in the same rock-band. He considers that in such deposits the fossils do not lie in their natural position, but have been swept together tumultuously by strong currents. In the debate on this paper, while general approval of the term "aggregate" was expressed, there was much difference of opinion as to the manner in which such deposits had accumulated, and it was suggested that Prof. Blake had included strata of diverse origin in his proposed classification.

The two papers contributed by Mr. T. Groom, on "The age and geological structure of the Malvern and Abberley Ranges," were good examples of careful stratigraphical investigation, and were well received. Mr. Groom's conclusions are that the Malvern axis was not an island in Cambrian and Silurian seas as generally supposed, but that it was elevated chiefly by Upper Palæozoic crustal movements and its folds belong to the Great Hercynian system formed towards the close of the Carboniferous Period. At the same session Mr. E. Greenly announced the discovery of Arenig shales beneath the Carboniferous rocks near the Menai Bridge, and in another paper described a clear case of boulder-uplift at Llandegfan, Menai Straits, where a train of blocks has been raised about 300 feet in the distance of one mile. Mr. Greenly also called attention to the impending destruction by quarrying operations of the most important portion of the drift section of Moel Tryfaen, and his suggestion that a committee should be appointed for the purpose of securing, while there was yet time, photographic and other records of this celebrated section was at once acted upon, and a small grant was obtained to cover the expenses.

In his paper on "The age and origin of the granite of Dartmoor, and its relations to the adjoining strata," Mr. A. Somervail put forward the view that the intrusion of the granite in question took place after the folding of the Lower Culm strata, but before the Upper Culm series was deposited. In the discussion, while the importance of Mr. Somervail's conclusions was acknowledged, the speakers generally expressed themselves unable to form an opinion until the fuller details of the sections on which the author based his views should be published.

The first paper taken on Monday was that of Mr. R. Etheridge, on "The relation and extension of the Franco-Belgian Coal-field to that of Kent and Somerset." After reviewing the history of the discovery of coal at the Dover boring, where it is expected that the Coal Measures will shortly be reached by the shafts now being sunk, Mr. Etheridge proceeded to discuss the general bearing of this discovery and the probable extension of the southern coal-fields under the Secondary rocks. A new section recently obtained by a deep exploratory boring at Brabourne, near Ashford, was then described, where after passing through Lower Greensand, Wealden, Portlandian, Kimeridge Clay, Corallian, Oxford Clay, Lower Oolites, and Middle and Lower Lias, red conglomerates believed by the author to be Old Red Sandstone have been encountered at a depth of 1875 feet from the surface. The Jurassic strata in this section are about 450 feet thicker than at Dover. In the discussion on this important paper, Prof. Boyd Dawkins and Mr. W. Whitaker both expressed doubts whether the Old Red Sandstone age of the lowest portion of the Brabourne section could be considered sufficiently established; and the former speaker stated that he fully expected some of the Kentish borings would draw blank, but others would succeed, and all would supply valuable information. Sir John Evans called attention to the fact that in one section in Belgium, where the Palæozoic strata were extremely folded, Coal Measures had been met with beneath a wedge of Old Red Sandstone. Mr. E. Wethered suggested that the Coal Measures showed a tendency to become less and less productive when traced eastward from the South Wales basin; and Prof. Louis asked how the supposed horizontality of the Dover Coal Measures could be explained, while in their supposed prolongation in Belgium they were so greatly disturbed. Mr. Etheridge, in concluding the discussion, thought there could be no doubt that the bottom rock at Brabourne was Old Red Sandstone, and remarked on the evidence now forthcoming for the continuous underground extension of this formation from Bristol across the south of England, under London and parts of Kent, into Belgium.

The next paper was that of Dr. Marsden Manson, of Sacramento, Cal., on "The laws of climatic evolution"—a highly speculative attempt to explain the Glacial Period as a critical and unique stage in the evolution of this and other planets when the climate passed from "internal" to "external" control. According to Dr. Manson, the climatal conditions of all times preceding the Glacial Period were determined by planetary heat, and were independent of latitude; but the dissipation of the continuous cloud-envelope, through the loss of the planetary heat by which it had been sustained, brought about a new set of conditions. After a Glacial Period, due to the more rapid cooling of the land than the sea, a gradual rise of temperature along with a zonal distribution of climate would occur, through the trapping of solar heat by the lower layers of the atmosphere. This latest of the many ingenious attempts which have been made, on both sides of the Atlantic, to explain the Glacial Period was admirably presented by the author to a large audience, but was subjected to severe criticism in the discussion, the general feeling being that such speculations scarcely fell within the scope of Section C.

Prof. E. Hull brought before the meeting a wide subject of more tangible character, in a paper on "The sub-oceanic physical features of the North Atlantic." By tracing out the depth-contours of the Admiralty Charts, Prof. Hull showed that the British and continental submarine platform breaks off abruptly in a "Grand Escarpment" at depths varying from 100 to 250 fathoms. This escarpment, from 6000 to 7000 feet high, is, according to Prof. Hull, indented by deep bays and old river-channels, the latter, almost cañon-like in places, often prolongations of the river valleys of the existing land. These and other submarine features lead him to agree with Spencer and Upham that the whole area of the North Atlantic to a depth of 10,000 feet was a land surface at a very recent period, and that the conditions of the Glacial Epoch may be thus explained. This paper was followed by another on the same subject by the President of the Section, in which it was shown that the exaggeration of the vertical scale made Prof. Hull's diagrams misleading as to the slopes of the supposed escarpments and submerged river-valleys; and evidence was adduced to prove that extensive earth-movements were frequently in progress on the edge of the continental platform. Hence, it was urged, the features to which Prof. Hull had called attention might possibly be due to subterranean causes, a view which was shared by several speakers in the subsequent debate.

On the subject of earth-movement, Prof. J. Milne presented the report of the Committee for Seismological Investigation; and Mr. R. D. Oldham, of the Geological Survey of India, gave a lucid description, illustrated by lantern slides, of the Great Indian Earthquake of 1897. The surface indications of faulting and overthrusting which characterised this earthquake were very clearly demonstrated.

At the opening of Tuesday's meeting the President, in exhibiting a portrait of the late E. Wilson, referred feelingly to the loss which geological science had sustained by Mr. Wilson's untimely death, and other speakers bore testimony to his painstaking and self-denying services to the Bristol Museum.

On behalf of Prof. H. F. Osborn, who had expected to attend the meeting but was at the last moment prevented, an exhibit was made of some beautiful water-colour drawings of restorations of *Brontosaurus*, *Phenacodus*, and other extinct vertebrates, executed by Mr. C. Knight for the Museum of Natural History of New York. A brisk discussion sprang up, in which Prof. H. G. Seeley, Prof. O. C. Marsh, Sir John Evans, Prof. W. Boyd Dawkins, Prof. W. J. Sollas, and others took part, as to the advisableness of giving reins to the imagination in the production of these restorations, upon which point widely diverse opinions were expressed.

There was scarcely sufficient time at this meeting to do justice to the carefully prepared paper by Mr. W. H. Wheeler on "The action of waves and tides on the movement of material on the Sea-coast." It was shown by Mr. Wheeler that the travel of shingle is not usually coincident with the prevailing winds, but is in the direction of the flood-tide, and is mainly due to wavelets set up by tidal action, whose total kinetic energy is very large.

Among the other papers brought before the Section were the following on cave exploration: by Mr. H. Bolton and the late E. Wilson, on the exploration of two caves at Uphill, Weston-super-Mare; by Rev. G. C. H. Pollen, on further exploration of the the Ty Newydd Caves; by Mr. T. Plunkett, on further exploration of the Fermanagh Caves; and the Report of the Committee on the fauna of caves near Singapore. Mr. P. M. C. Kermode, in the Report of the Committee for investigating the mode of occurrence of the Irish Elk in the Isle of Man, announced the discovery of a large and nearly complete skeleton of that animal near Peel. Mr. J. Lomas brought forward evidence in favour of the occurrence of worked flints in the Glacial deposits of Cheshire and the Isle of Man, but it was felt that further research was necessary before the author could be considered to have established his case. Mr. C. W. Andrews gave an account of the discovery of a portion of the skeleton of a huge Dinosaur in the Oxford Clay of Northampton. Papers were also contributed by Mr. J. R. Dakyns on the probable source of the upper Felsitic lava of Snowdon; by Mr. H. B. Woodward on arborescent Carboniferous Limestone from near Bristol; and by Mr. W. L. Addison and Mr. L. J. Spencer on crystallographic and mineralogical subjects. Several of the Reports of Committees possessed matter of much interest, especially that presented by Prof. A. P. Coleman on the Interglacial deposits near Toronto (where fresh facts of importance have been gained by excavations), and that of Prof. P. F. Kendall on Erratic Blocks; while the Committee for collecting Geological Photographs, that on Fossil Phyllopoda, and that on Life-zones in British Carboniferous rocks were all able to report steady progress in their investigations. New committees were formed and grants obtained to investigate the caves at Uphill and at Ty Newydd, and as already mentioned to preserve photographic and other records of the Moel Tryfaen section; and most of the old committees connected with this Section were re-appointed.

PHOSPHORESCENCE.[1]

IT is not possible in one lecture on phosphorescence to give any historical sketch which shall do justice to the work of those who have made a study of the phenomena. In a list of the names of the many who have enriched the subject with facts and with theories, those of Becquerel, of Stokes, and of Crookes stand out most prominently. Any attempt to make a sketch of our knowledge of phosphorescence and fluorescence must be to a very large extent an adaptation of the work and of the views of these masters.

The phenomena themselves may be divided into two main classes—those in which the evolution of light is associated with chemical change, and those in which there is no evidence of such direct alteration. In the first class the commonest instances are connected with the process of oxidation. Examples of this kind are numerous. It is hardly possible to take any very easily oxidisable substance and to fail to get some evolution of light. Phosphorus, sodium and potassium, ether, many aldehydes, and a host of organic compounds may be cited as instances. The experimental illustrations of these are not, however, suited to an audience of more than a very few. The same may be said of the examples of animal and vegetable phosphorescence. It is proposed, therefore, to deal more especially with the second class, and to limit the experiments to the cases where the light given out is visible and not of such a character as to necessitate the use of a photographic plate. This evolution of light may occur in varying conditions. In instances such as solutions of quinine and fluorescein and many solids, of which thallene is a good example, the duration of the phosphorescence is so short that it may be said to last only while

[1] A discourse delivered before the British Association on September 12, by Mr. Herbert Jackson.

light is acting. Balmain's luminous paint is an illustration of the persistence of the phosphorescent light. With many minerals, notably some fluorspars and felspars, light is given out when they are slightly heated, or in some cases only crushed.

The most brilliant phenomena are those which can be studied when many bodies are excited with electric discharges inside a Crookes' vacuum tube, while outside of a slight modification of his focus tube fairly brilliant phosphorescence can be obtained by the action of Röntgen rays upon several substances, notably upon some of the platinocyanides.

In dealing with the whole subject of phosphorescence with the view of attempting to connect all the various phenomena together, it is convenient to divide it into—the nature of the substance giving out the light, the nature of the light given out, and the nature of the exciting causes.

With regard to the nature of the substance, either very much or little might be said; very much from the details of numerous experiments with a great number of compounds, but little from the point of view of general principle. The most important question in this respect is probably the question of the relation of phosphorescence to the purity of the substance giving out the light. Experiments with carefully prepared compounds of many metals make it clear that not a few substances can be made to exhibit phosphorescence when they are so free from impurities that none can be detected by any analytical methods. In some cases, however, there is either no light given out under any of the conditions for exciting phosphorescence, or the light is so feeble that it is necessary to add impurities so as to obtain a suitable molecular condition for rendering a substance responsive to excitement. That the light given out is not to be ascribed to the impurity has been determined by many experiments with varying impurities and careful examination with the spectroscope. The further consideration of these physical and chemical conditions is better left until the other two aspects of the subject have been dealt with.

If a large number of observations be made of the phosphorescent lights given out by compounds of such metals, for example, as sodium, potassium, calcium, strontium and barium, magnesium and aluminium, it is hardly possible to avoid coming to the conclusion that the colours of these lights have a close resemblance to the colours of the lines and bands seen in the various spectra of the different metals and some of their compounds. Examination by the spectroscope confirms this conclusion in several instances. It is not suggested that the lines of the metals and the bands of their compounds are reproduced in the spectra of the phosphorescent lights. What is noticeable is that the maxima of light are grouped about these bands and lines, fading away from them and extending to other parts, so that a more or less continuous spectrum is seen with positions of greatest brilliancy. In the case of some specimens of lime these positions are well defined, and in some kinds of fluorspar the green and some red bands are well seen, either when the fluorspar is heated or when it is excited by discharge in vacuo. The questions of exact coincidence and of the shifting of the positions of the maxima of brightness seen with different compounds of the same metal need not be considered here. The intention is only to emphasise the similarity between the phosphorescent spectra of several metallic compounds and the spectra of these compounds, or of the metals in them, obtained in other ways.

In experimenting with phosphorescent compounds it is frequently noticed that specimens of the same substance in apparently the same state of purity give different colours. Confining attention for the present to lime, as a very infusible substance easily obtained in a state of purity, what follows will be made clearer by a brief consideration of the spectrum of the coloured flame produced by holding some compound of calcium, *e.g.* calcium chloride, in the flame of a bunsen burner.

The spectroscope breaks this red flame up into red, orange and green bands and a blue line. For the moment the suggestion may be taken that these differently coloured bands are indications of the existence in the flame of groups of particles of calcium compounds of varying degrees of complexity—the red being related to more complex groups, the orange to less, and so on. It seemed not unlikely that it might be possible by preparing lime from a great many calcium salts to obtain separate specimens which might preserve in the solid state some relation in their own molecular complexity to that of the salts from which they were obtained, or the conditions of decomposition of the different calcium salts might impress upon the residual limes different characters of molecular structure. The preparation of about 350 specimens of lime showed that it was quite possible to get specimens some of which phosphoresced red, some orange-red, some orange, others green, and some blue. Examination of their phosphorescent lights with the spectroscope showed, as referred to before, that the maxima of brilliancy in their spectra were grouped about the bands and lines of the usual spectrum of calcium oxide. The details of the preparation of these specimens of lime are too elaborate to enter into here, nor is it possible to do more than just to refer to their varying densities and different rates of hydration. Out of the number of specimens tried the most satisfactory were analysed to make sure that it was really lime and only lime which was being dealt with in each case. In general terms it may be said that the most complicated organic salts of calcium yielded the best attempts at lime giving blue phosphorescence, simpler bodies gave green, while the best orange was obtained from Iceland spar, and the red from specially prepared calcium carbonate. That lime yielding a blue colour was obtained from highly complicated organic salts does not contradict the former suggestion that perhaps it is really of simpler molecular structure than the others. Chemists are familiar with the conception that the complexity in structure arising from the massing of many molecules together in groups is probably often greater in bodies of apparently simple chemical composition than in those of a much more highly complicated nature.

The colours seen in the specimens of lime shown are not pure. In each one the other colours are present; thus the orange contains also the red, green and blue, only these are masked by the greater proportion of the one colour. Compare for example the light obtained from a vacuum tube containing the gas helium. In this case the colour is yellow, although the spectrum contains beautiful red, green and blue lines. If the different colours are related to varying molecular complexity in the substances, then it might be said that the lime showing a green light contains a large proportion of groupings of such a nature as to be capable of oscillating in a way to give rise to green light, and in like manner for the red, orange and blue specimens. Whether it will be possible or is in the nature of things to separate out the different kinds in a state of purity can only be decided by further experiment.

The examples of different forms of lime have been so far exhibited only under the conditions obtaining in a high vacuum with an electric discharge. Before trying to show the points in common between these phenomena and the phenomena of phosphorescence in other conditions, it may be as well to consider briefly the character of the action in a high vacuum. The suggestion which follows is not intended to be anything but an imperfect attempt to bring all the phenomena of phosphorescence into line with one another.

When a discharge passes through a vacuum there can be little doubt that the transferring medium is the residuum of gas in that partial vacuum. If the particles of this gas behave as visible masses are seen to do, they are probably attracted or are driven to the electrode, which is at high potential. Receiving the same kind of charge as this electrode, they fly off from it in that charged condition.

But if these particles consist of more than one unit, each unit, after the group has travelled a certain distance from the electrode, must repel each other unit in the same way as the whole little group was repelled from the electrode. If, however, the units making up the group are held together by that something which is called chemical attraction, a condition of strain is set up in which the electrical repulsion is striving to overcome the chemical attraction. Travelling unimpeded through the high vacuum this condition of strain would be maintained until the charged group met with something capable of discharging it. At that moment of discharge the chemical attraction would assert itself; there would be a rushing together of the units composing the group, and an over-rushing, whereby oscillations would be set up. These oscillations, considered as blows or pulses, either directly or ethereally transferred to a substance, would set it in turn oscillating in a manner fitted to its own molecular structure, and its oscillations would in their turn give rise to the undulations which appeal to our eyes as the phosphorescent light. If instead of the discharge taking place on a substance capable of responding to and absorbing most of the energy of the consequent oscillations, it were to occur on glass, platinum, or any of the materials which have been employed, it is conceivable that the oscillations would appear as short ethereal waves or, in other words, Röntgen rays. In the case of a low vacuum, or of no vacuum at all, the charged particles would discharge themselves against the intervening gas, which would in its turn respond to the rapid oscillation and give out its own particular coloured light. The expression "short ethereal waves" is used intentionally, for if there should be forthcoming experimental evidence of the complex molecular structure of a gas, it is reasonable to suppose that in a high vacuum, with consequently a high potential at the electrode, the internal electrical repulsion in a group would tend to a dissociation resulting finally in the simplest form of system capable of separate existence in those conditions. It might be expected that the oscillation frequency of so simple a system would be very high.

Here it may be stated that this comes to practically the same thing as Sir William Crookes' original conception of radiant matter.

Leaving the method of electrical excitation in vacuo for obtaining phosphorescence we may now turn to light as a source of oscillations. For the sake of simplicity it will be best to continue the experiments with the same substance, viz. lime. If this body be exposed to the light of the sun, of the electric arc, of a hydrogen flame, and of a great many other substances in a state of vigorous combustion, a phosphorescent effect is obtained, feeble in comparison with the results in vacuo, but apparently similar in kind. The best light for inducing the phosphorescence is the spark from a fairly powerful coil with a Leyden jar in circuit. Many specimens of lime go on giving out light for a considerable time after exposure. A cylinder of lime such as is used in the production of the lime-light glows quite visibly when it is rotated before a jar-spark.

The light from the sun is not so active in inducing this glow; but with suitable arrangements a fairly visible result can be obtained. The colour of the glow from most lime made from limestones is an orange-red becoming a golden orange when the lime is heated. The introduction of glass, mica or Iceland spar between the spark and the lime, cuts off the glow at once; since these bodies are opaque to the undulations to which lime of this kind responds. Quartz, rock salt, and selenite are quite transparent.

It is found that the different forms of lime which have already been exhibited in vacuum tubes yield when exposed to the jar-spark their specially coloured phosphorescent glows. But these are difficult to see; they are very faint when pure specimens of lime are used. However, there is a way out of the difficulty. The faint light scarcely visible at the ordinary temperature may be increased very considerably by raising the temperature. As an extreme instance of this a specimen of calcium sulphide may be taken. After exposure to almost any source of white light this glows with a bluish phosphorescence which becomes quite brilliant when the sulphide is heated. A similar change is noticeable in the case of the different limes. The orange, green and blue varieties exposed to a series of jar-sparks, and subsequently dusted over hot plates, give with easy visibility the colours which they exhibited in the vacuum tubes and which may, for the present, be considered as sensible indications of their molecular constitutions.

Two important considerations have to be dealt with at this point. In the first place the question arises how far one and the same light, *i.e.* one and the same oscillation frequency, will excite the different specimens of lime. Without entering into dry numerical details, it is not possible to give a complete answer to this question. In a general sense, however, it is apparently true that, although the range of frequency is large, the red and orange varieties of lime respond to oscillations less rapid than those which readily affect the varieties giving a green or blue phosphorescence. It is possible to obtain a form of lime which illustrates this experimentally. It is not easy to make. It is prepared from calcium urate by heating this for many hours to a dull red heat, and afterwards raising the temperature of the blackened mass sufficiently to burn off all the organic matter and leave only lime. The residue on analysis was shown to be really lime. Such a specimen exposed freely to jar-sparks, and afterwards heated, shows mainly an orange phosphorescence; but if glass or mica or Iceland spar be placed between the lime and the source of light, then the effect of heat is to intensify greatly a phosphorescence of a blue colour. It must be clearly understood that this blue was there before, only masked by the superior brilliancy of the orange colour; the undulations which would otherwise have affected the molecular groupings capable of giving out the orange light being cut off by the glass or mica. It would be tedious to give all the reasons for assuming that the oscillations exciting the blue phosphorescence are probably the more rapid. To some extent the transparency of glass and mica to X-rays may be taken as confirmatory; but to follow the argument out from spectroscopic evidence and measurements would involve a discussion unsuited to a lecture dealing with general questions. Referring, however, to the suggested explanation of the action taking place in a vacuum tube, it is not inappropriate to mention now that it is possible to make a specimen of lime give an orange glow in a moderate vacuum while a portion of the same specimen is exhibiting a blue glow in a high vacuum. The readiness with which this blue glow appears, and the time which it takes to develop, must be taken into account in dealing with its supposed origin, and with its relevancy with the question of the relation of the rapidity of the exciting undulation to the wave-length, *i.e.* to the colour, of the phosphorescent light. Perhaps it is advisable to leave this point for the moment, and to turn to the second consideration. This deals with the question of the duration of the phosphorescence.

At the beginning it was shown that some bodies glow only while light is acting upon them, or while they are under the direct influence of an electric discharge. In others there was a marked after-glow; while still others required the application of heat before any phosphorescence was visible, or, as in the case of the limes, before the phosphorescence was easily visible. With Balmain's luminous paint, or with any body which gives a marked phosphorescence that lasts for some time after withdrawal from the exciting influence, it can be readily shown that lowering the temperature reduces the brilliancy of the glow, but lengthens the time during which it lasts. The effect of heat has already been mentioned as vastly increasing the brilliancy; but it greatly diminishes the duration of the light. On the other hand, Prof. Dewar has shown that great reduction of the temperature will cause the phosphorescence to linger for a considerable time in many substances which had hitherto been considered as practically non-phosphorescent. The different behaviours of substances in this respect can, perhaps, be best brought under one explanation by applying the idea of a statical charge or a condition of strain to the phosphorescent substances themselves. Duration of phosphorescence would then be a measure of rapidity of discharge. If it be supposed that, the strain having been set up in the particles of a substance, these discharge themselves against one another, or rather against uncharged particles, then a substance with great freedom of transference of movement among its particles would fail to show any sign of phosphorescence; since the strain would be released or conducted away by rapid transference before a condition could be set up, out of which oscillations of sufficient amplitude could arise. With rather less freedom of movement among the particles the non-conducting state might be reached by restricting the extent of that movement by cold, as in Prof. Dewar's experiment. Still less freedom of interchange may be considered to obtain in Balmain's luminous paint, and even less in the limes, which require heating to show up their phosphorescence; while, in the case of the chlorophane and many other minerals, the condition of strain, however set up, can apparently be retained indefinitely. Specimens of lime after exposure to the jar-spark have been found to give out light when heated after being four years in the dark. It seems not altogether improbable that the influence of impurities in promoting phosphorescence may often be attributed to their interfering with the freedom of movement, and so permitting the groupings of the substance to be sufficiently highly charged. The effect of heat in rendering a substance a better conductor can be well studied with pure substances in vacuo under the electric discharge.

Under the vigorous bombardment of radiant matter the temperature of the substance rises. In some substances this leads to an increase in the brilliancy of the glow maintained often even when the heating is very considerable; in others the hotter portions are marked out by a complete absence of phosphorescence. Observation seems to favour the conjecture that this absence is in many cases to be explained on the hypothesis that the heat endows the molecules with such freedom as to practically render them uninsulated. To pursue this part of the subject any further would lead to a discussion of a question that can only be referred to. It is the consideration of how far the change of glow in some specimens of lime from a red or orange colour in a low vacuum to a green or blue glow in a high vacuum is to be attributed to shorter oscillations in the exciting cause, and how far the change is connected with a dissociation of complex groupings into simpler ones; a dissociation which may be considered to be brought about by the rapid oscillations breaking up the lime groups into two or more smaller groups. Connected with this is also the question dealing with the possibility of phosphorescence being coincident with the recombination of the separated smaller grouping; but this part of the subject can only be illustrated by experiments of too minute a character to be suitable to a lecture, and involves besides the study of too many details. One other thing which must be taken into account in drawing any deductions from the change in the colour of the glow as the temperature rises is that in some cases the effect of heat is to discharge some colours in a complicated substance, and so leave visible others which were before masked.

The whole question of the inter-relations of the molecular weights of the phosphorescent substances, of the wave-lengths of the exciting undulations, and of the wave-lengths of the resulting glows is an important and interesting one; but it must be left alone in the present lecture with the statement, somewhat unsatisfactory it is feared, that, while there is no doubt that special undulations of measurable wave-length are most efficient in exciting phosphorescence in some substances, the same effects can be produced, though to a less degree, by vibrations which can perhaps be best described as undifferentiated and irregular pulses.

Returning to the sources of oscillations, there is one other source which has yet to be considered, and that is chemical combination. The fact that many substances will phosphoresce during and after exposure to the flame of hydrogen has already been alluded to. The flame of coal-gas burnt in a Bunsen burner will excite phosphorescence in many specimens of lime; but the effect is not strong enough to be shown to an audience.

Naturally this effect would be stronger the nearer the lime was placed to the source of light. Inside the flame itself would be the nearest attainable position, but then the heating effect practically masks or destroys all others. In phenomena such as the glow of phosphorus the temperature does not rise to any very marked extent. It is possible to obtain chemical combination in the presence of many bodies of a porous nature without, during the early stages of the action, getting very marked heating effects. The action of spongy platinum in inducing the oxidation of coal-gas or alcohol vapour may be taken as a familiar illustration of the use of a porous material for this purpose.

In the case of a conducting metal it could not be expected that the oscillations arising from the chemical combination would cause phosphorescence even in the early stages, when the temperature has not risen to any extent; but if such a body as lime could be obtained in a very porous condition it might, while acting as an inducer of chemical combination, itself respond to the oscillations arising out of that combination.

This is found to be the case. A jet of unlighted coal-gas allowed to play over warm porous lime produces a slight phosphorescence, very faint, but quite visible in a dark room.

By dusting easily volatile substances, such as finely powdered resin, over slightly heated lime, the oxidisable vapour is brought more closely into contact with the lime, and the phenomenon of phosphorescence is made more visible. So far, however, it has not been obtained with sufficient brilliancy to be shown to more than a few people at a time. When the different limes that have already been experimented with are subjected to oscillations from this chemical source, they yield their respective colours in the same way as before. The lime, which showed a green glow in the vacuum tube, or when dusted on to a hot plate after exposure to the jar-spark, gives a green glow with the powdered resin. So also in the cases of the orange and blue yielding limes. The possibility of the phosphorescence being due to the resin vapour itself is excluded by control experiments with other porous bodies which do not phosphoresce, but yet are equally active in bringing about oxidation.

This phosphorescence was often well seen when some of the limes were being prepared in a furnace. (It has been already mentioned that many substances retain the power of phosphorescing at a high temperature, especially if they are in a very fine state of division or not quite pure.) Most of the limes were made from organic salts of calcium, and as the organic matter burnt away, a thin and scarcely visible flame played over the surface of the lime at the top of the crucible in which the calcination was carried out. It was frequently quite possible to predict by watching the glow which was developed in the lime what colour would be given when the phosphorescence was brought about by oscillations from the other sources, such as the jar-spark or the discharge in vacuo.

No one who has spent much time in experimenting with various substitutes for lime in lantern work can have failed to be struck by the very different appearances of the light on the screen given by such bodies as magnesia and zirconia in comparison with lime; but, perhaps, the best examples are the two mantles in use at the present day for incandescent gas lights. One of them, the Welsbach mantle, gives a light of almost a white colour. The other, or Sunlight mantle, shows a much pinker colour to the eye.

Experiments with many substances used in a similar way to the mantles seem to indicate that, in addition to the ordinary heating effect of the gas flame, there is another and a phosphorescent effect which probably, so far as observation can tell, precedes the ordinary hot stage. It is not usual to find any pure substances capable of showing this phenomenon to any marked extent unless, as mentioned just now, they are in an extremely fine state of division; a condition which, like the presence of impurities, may be considered to be unfavourable to the too rapid discharge of the strained particles; thus giving them the opportunity of becoming fully enough charged to make their oscillations, when they are discharged, of sufficient vigour to be sensibly visible.

If either of the mantles mentioned be introduced into a tube and treated with an electric discharge in a high vacuum, the phosphorescent glow can be studied either with or without the heating effect. The glow of the Welsbach mantle is a greenish white, but not very marked. The Sunlight mantle gives a fine red glow. It is interesting to note that the glow shows great persistence even when the temperature of the substance has been raised very considerably by the vigour of the bombardment.

Having now dealt with the last source of oscillation which it was proposed to consider, it may be as well to summarise the conclusions which for the present seem to be the least open to objection so far as experimental evidence goes. The attempt has been made to connect together all the phenomena of phosphorescence with a view of showing between them a likeness in kind. Any theoretical suggestions should be taken only as hypotheses for assisting this attempt and for pointing the direction of further experiments. It is believed, then, that the following typical examples of the various phenomena which are described as phosphorescent phenomena are similar in kind and can be related to one another by the application of slight modifications of the same general principle—the glow of phosphorus, the fluorescence of quinine, the sparkling of heated chlorophane, the luminosity of Balmain's paint, the light from lime in a vacuum tube, and the glowing of barium platinocyanide under the influence of X-rays. To these it is proposed to add coloured flames and the spectral light of glowing gases. It is suggested that all these phenomena may be looked upon as outward evidences of response on the part of the substances to rapid oscillations, whether these oscillations have their origin in chemical combination in what is commonly spoken of as light, or in electrical discharge. The nature of that response may in some cases be of a direct character; but, when account is taken of the many degrees of persistence of phosphorescence and of potential phosphorescence, it seems in many cases first to assume the form of something which, to avoid circumlocution, may be called a statical charge. The release of this condition of strain is accompanied by oscillations which give rise to the visible undulations of the phosphorescent light.

One final suggestion may perhaps be made, though it is mentioned with diffidence, as many may consider it outside of the subject.

If it be accepted that the light of the sun has its immediate origin mainly in the masses of luminous clouds floating in the photosphere, and if these clouds be considered as condensations into material of greater molecular complexity than that from which they were condensed, then it may be not altogether out of place in the present lecture to speculate on the relation between the actual light from the glowing clouds and possible oscillations of the particles of the medium in which they exist. There is no need to emphasise the idea that the oscillations of very simple molecular systems give rise to undulations which can only be perceived when, by their action upon something more complex than themselves, they cause either a distinct chemical change or set up undulations within the range of the visible spectrum.

May it be that there are similar oscillations in the sun, that the simpler materials out of which the photospheric clouds are condensed vibrate too quickly to give out visible light, but that their oscillations are rendered visible when they are absorbed and responded to by the more complex groupings of the condensed masses? A sun-spot, looked upon as a partial absence of clouds, would mean that the conditions which serve to screen us to a great extent from the rapid undulations have been somewhat modified.

Is it too much to suppose, in view of the close resemblances between many of the actions of light and electricity, and of the well-known electrical effects of ultra-violet light and of X-rays, that the breaking down of a dielectric which they can accomplish may, on a vastly larger scale, accompany an unusual exposure of the earth to similarly rapid undulations? Should there be anything in this suggestion, it may help to remove a part of the difficulty in relating the presence of sun-spots to those casual electrical disturbances with which they undoubtedly coincide in point of time.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A NEW technical institute was opened at Wellingborough on Thursday last, by Sir Philip Magnus. The building has been erected by the Urban District Council at a cost of 3000*l.*, exclusive of the site, and it will be maintained out of the free library rate.

THE following donations are announced in *Science*:—Colonel Oliver W. Payne has given 1,500,000 dollars to the Cornell University Medical College; the late Mr. Rowland Hazard has bequeathed 100,000 dollars to Brown University; Mr. George A. Gardner has given 20,000 dollars to the Massachusetts Institute of Technology, to be added to the general endowment fund; Dr. D. K. Pearsons, of Chicago, has offered 50,000 dollars to Fairmount College, Wichita, Kans., on condition that 150,000 dollars can be raised; in connection with the Maryland Agricultural Experiment Station, the State Legislature has granted 14,000 dollars for the erection of a science hall, to be used jointly by the college and station. 10,000 dollars have also been granted for inaugurating State work in entomology and vegetable pathology, and an annual grant of 8000 dollars for maintenance has been made.

THE new Technical Institute and Public Library, erected by the West Ham Corporation, will be opened to-day by Mr. J. Passmore Edwards. The foundation-stone of a natural history museum, which will be built close by, will also be laid. The Technical Institute, the principal of which is Mr. A. E. Briscoe, will be wholly under the control of the municipality, and will be financed from municipal sources. Every department is well equipped, special attention being paid to the chemical laboratories and the engineering workshops. The buildings have cost 450,000*l.*, and a further 15,000*l.* has been spent on equipment and fittings. The money for the working has been created by the accumulation of the Excise duties grants, but the corporation have secured sanction to raise 35,000*l.*, and have power to levy a 1*d.* rate (which will produce about 3800*l.*) for technical instruction purposes. The new central library is wholly on the ground floor, and is fitted with all the modern appliances of such institutions. Towards the cost of the natural history museum Mr. Passmore Edwards has contributed 2500*l.* The Essex Field Club, who will have the scientific control of the museum, will house their large collection here.

IN the course of an address upon "Science and Education," delivered at Mason College on Tuesday, Sir Archibald Geikie remarked that there is no more pernicious doctrine than that which measures the commercial value of science by its immediate practical usefulness, and restricts its place in education to those only of its subdivisions which are of service to the industries of the present time. By all means let artisans know as much as could be taught them regarding the nature and laws of the scientific processes in which they are engaged. But it is not by mere technical instruction that the industrial and commercial greatness of the country will be maintained and extended. If we are not only to hold our own, but to widen the boundaries of applied science, to perfect our manufactures, and to bring new departments of nature into the service of man, it is by broad, thorough, untrammelled scientific research that the success must be achieved. The continued development of the faculty of prompt and accurate observation is a task on which students cannot bestow too much attention. Amongst the mental habits which education in science helps to foster are a few which specially deserve attention as worthy of most sedulous care all through life. In the first place should be put accuracy; in the next thoroughness, which is closely akin to accuracy; then breadth; then the habit of wide reading in scientific literature; and then patience. It is by failures as well as by successes that the true ideal of the man of science is reached.

THE following entrance and other scholarships have been awarded at London Medical Schools:—London Hospital Medical College: Price Scholarship, value 120*l.*, Mr. F. W. Jones; Epsom Scholarship, value 126*l.*, Mr. Colmer; Price University Scholarship, value 60*l.*, Mr. Bousfield; Science Scholarship, value 60*l.*, Mr. J. W. Fox; Science Scholarship, value 30*l.*, Mr. Rainforth.—Charing-cross Hospital Medical School: Livingstone Scholarship (100 guineas) to Mr. G. E. Bellamy; Huxley Scholarship (55 guineas) to Mr. B. R. Bickford; Universities Scholarships (each 60 guineas) to Mr. H. G. Gabb and Mr. B. G. Fiddian. Entrance scholarships have also been awarded to Mr. R. H. Cooper (60 guineas), Mr. D. M. Davies (40 guineas), and Mr. T. Law (30 guineas); and exhibitions of 30 guineas each to Mr. A. C. Ingram, Mr. G. O. Lambert, and Mr. B. R. Lloyd.—Guy's Hospital Medical School: Scholarships for University students: H. S. French, Christ Church, Oxford, 50*l.*; Open Science Scholarship, E. H. B. Milsom, Guy's Hospital Medical School, 150*l.*; F. Rogerson, Guy's Hospital Medical School, and N. J. Spriggs, private study (equal), 30*l.* each.—St. Thomas's Hospital Medical School: Entrance Scholarships in Natural Sciences: 150*l.*, Chas. Michael Roberts; 60*l.*, Harry Mellor Woodcock; 20*l.*, Charles Hugh Latham.—University College, London, Medical Entrance Scholarships: 131 guineas, Mr. H. A. Haig; 55 guineas, Mr. M. Stewart Smith; 55 guineas, Mr. W. M. Sadler.—The first and second entrance scholarships of the Middlesex Hospital Medical School have been awarded to Mr. W. Cameron Macaulay and Mr. William Gordon Taylor, respectively.

THE Secondary Education Bill introduced into the House of Commons by Colonel Lockwood, proposes to separate technical from secondary education. For this and other reasons the Council of the Association of Technical Institutions has entered a protest against the Bill. It is pointed out that the proposed separation of technical and secondary education is an entire reversal of previous educational policy, and if it were carried into effect it would be detrimental to the education of this country. The power which Colonel Lockwood's Bill gives for the creation of a new local authority to deal specially with secondary education is also objected to, the multiplication of local authorities for the purposes of education beyond the elementary stage being regarded as a retrograde step. Other defects which the Bill possesses are: (1) The proposal to provide for the financial needs of secondary education by taking away from technical education part of the money assigned for instruction in science and art, and of the money available under the Local Taxation Act. (2) The proposal that the limits of secondary and technical education shall be settled on the basis of the opinions expressed by an advisory Council on which secondary schools and teachers shall be very largely represented, but which shall not contain a single representative of technical institutions. (3) No provision is made for the registration of teachers in technical institutions. (4) The proposal that a local secondary education authority shall not provide or have the management of any secondary school. The Council desires that steps should speedily be taken to organise secondary education in this country, and is willing to aid any statesmanlike attempt to accomplish this, but Colonel Lockwood's Bill would, it is pointed out, do mischief by creating a distinction between technical and secondary education, and setting up a purely artificial barrier between the two. It is not expected that the Bill will pass, but as the manner in which it is received may influence the Government to incorporate the proposals contained in it in the Secondary Education Bill to be produced next session, it behoves those interested in technical education to show unmistakably that such provisions as those in Colonel Lockwood's Bill are not generally acceptable.

AT a Congregation of Cambridge University held on Saturday, Dr. Hill, the retiring Vice-Chancellor, delivered a valedictory address, in the course of which he made the following remarks:—"The admirable and central sites which have been purchased by the University during the last three years are still entirely unoccupied, although many departments of the University are either overcrowded or most inadequately housed; but, at the desire of our Chancellor, steps have been taken which may, it is hoped, bring in the funds necessary for the erection of the buildings which are so urgently required. A very influential committee of University men has been formed for the purpose of organising a 'Cambridge University Association,' the members of which will be kept informed of, and will be pledged to make known, the needs of the University. It is hoped that through the influence of this association the University may be placed in possession of the means of maintaining her position in the ever-widening and ever-changing educational life of the nation. The legal and medical schools, feeling that it is impossible to wait until the general resources of the University allow of the provision of new buildings, have opened subscription lists on their own account, and it is significant of their sense of the pressing need for such accommodation that of the 6000*l.* already subscribed a large proportion has been given by the teachers of law and medicine and other residents in the University. Among gifts to the University during the past year were a very valuable collection of minerals given by the Rev. T. Wiltshire, Professor of Geology and Mineralogy in King's College, London, a collection of polyzoa given by Miss E. C. Jelly, a skeleton of the elephant seal given by Sir W. L Buller, K.C.M.G., a MS. of *de proprietatibus rerum* of Bartholomaeus Anglicus given by Lieut. Archibald Stirling, and a collection of Malay native objects given by W. W. Skeat. The University has also received a bequest of 10,000*l.* under the will of the late A. W. G. Allen for the establishment of a scholarship or prize in memory of the Right Rev. Joseph Allen, formerly Bishop of Ely, and grandfather of the donor. Not a few gifts for the foundation of scholarships and prizes have been received by the University during recent years. Such gifts are always acceptable; but at the present time there is a greater need for the endowment of teaching posts and the provision of buildings for University purposes than for the encouragement and stimulation of students." Dr. Hill was re-elected Vice-Chancellor for the ensuing year.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 26.—M. van Tieghem in the chair.—On the changes occurring in the large nebula in the belt of Andromeda, by M. G. Rayet. The brilliant point announced by M. Seraphimoff is probably the central point of the nebula, the brightness of which is variable, and is now temporarily increased. The position of the point does not coincide with that of the temporary star whose position was measured by M. Bigourdan in 1885.—On a geometrical theory of the marine compass, by M. S. L. Ravier.—On the convergence of some *réduites* of the exponential function, by M. H. Padé. The term *réduite* is applied to a function (regular in the neighbourhood of the origin) of the rational fractions which, near this point, represent this function with close approximation.—Action of lime and chalk upon certain natural humic materials, by M. G. André. The earths were heated at 100° for fifteen hours with lime, chalk, or water, and determinations made of the nitrogen volatilised as ammonia, the nitrogen rendered soluble, and the ammonia present in the filtrate.—On the composition of œolosomine, by M. A. B. Griffiths. Œolosomine is the name given to a colouring matter, green in acid, purple in alkaline solutions, found in *Œolosoma tenebrarum.*—Chlorophyll assimilation in plants growing by the sea-shore, by M. Ed. Griffon. The leaves of maritime plants under the influence of sea-salt undergo a reduction of chlorophyll, acquiring by way of compensation a greater thickness and a more marked development of the assimilating tissues. But this modification of structure, although having a tendency to compensate the injurious action of the salt, is insufficient, since the assimilation per unit of surface is always less for the leaves of a maritime species than for comparable leaves of the same species growing inland.—Observations of an aurora borealis at Göttingen (Hanover) on September 9, by M. B. Violle.—On an observation of the green ray at sunrise, by M. H. de Maubeuge: The phenomenon was noticed from the steamer *Ernest Simons*, by several people simultaneously, over Mt. Sinai.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Arithmetical Chemistry: C. J. Woodward, Part 1. new edition (Simpkin).—The Campaign in Tirah: Colonel H. D. Hutchinson (Macmillan).—The Telephone: Prof. W. J. Hopkins (Longmans).—An Introduction to Practical Quantitative Analysis: H. P. Highton (Rivingtons).—Diet and Food: Dr. A. Haig (Churchill).—Beiträge zur Physiologie des Centralnervensystems: Prof. Max Verworn, Erster Theil (Jena, Fischer).—The Living Organism: A. Earl (Macmillan).—Catalogue of Chemical and Physical Apparatus and Chemicals (Leeds, Reynolds and Branson).—Eclipses of the Moon in India: R. Sewell (Sonnenschein).—Cape of Good Hope: Report of the Marine Biologist, 1897 (Cape Town, Richards).—The Gold Coast, Past and Present: G. Macdonald (Longmans).—Psychology in the Schoolroom: T. F. G. Dexter and A. H. Garlick (Longmans).

PAMPHLETS.—The Witness of Science to Linguistic Anarchy: Lady Welby (Grantham, Clarke).—Glasgow and West of Scotland Technical College: Reports on Experiments on the Manuring of Oats, Hay, and Turnips and Potatoes (Glasgow).—The Wanton Mutilation of Animals: Dr. G. Fleming (Bell).

SERIALS.—Chambers's Journal, October (Chambers).—Good Words, October (Isbister).—Sunday Magazine, October (Isbister).—Longman's Magazine, October (Longmans).—Monthly Weather Review, June (Washington).—National Geographic Magazine, September (Washington).—Century Magazine, October (Macmillan).—Humanitarian, October (Duckworth).—Contemporary Review, October (Isbister).—Fortnightly Review, October (Chapman).—Reliquary, &c., October (Bemrose).—Himmel und Erde, September (Berlin, Paetel).—Janus, July-August (Williams).—Journal of the Royal Agricultural Society of England, Vol. 9, Part 3 (Murray).—Proceedings of the Geologists' Association, August (Stanford).—National Review, October (Arnold).—Knowledge, October (Holborn).—Observatory, October (Taylor).

CONTENTS.

THURSDAY, OCTOBER 13, 1898.

THE NATIONAL PHYSICAL LABORATORY.

THOSE who remember the address by Prof. Lodge at Cardiff, in which he advocated the establishment of a National Physical Laboratory, and the feeling of hopelessness with which the suggestion was received, will be confirmed in the view that the world moves by the fact that a Treasury Commission has now reported in favour of the scheme. Sir Douglas Galton dealt with the question in his presidential address at Ipswich, and, on the following day, read a paper on the Reichsanstalt before Section A. That body then took the matter up in earnest and, even in its so-called decadence, was strong enough to start a movement which was before long supported, with practical unanimity, by all British physicists and chemists. A deputation to Lord Salisbury followed, and a Committee, with Lord Rayleigh as Chairman, was appointed—

"To consider and report upon the desirability of establishing a National Physical Laboratory for the testing and verification of instruments for physical investigation: for the construction and preservation of standards of measurement: and for the systematic determination of physical constants and numerical data useful for scientific and industrial purposes—and to report whether the work of such an institution, if established, could be associated with any testing or standardising work already performed wholly or partly at the public cost."

The Committee asked various scientific and technical institutions to nominate witnesses, and the evidence thus collected was very interesting and almost entirely in favour of the scheme. The views of those who approached the subject primarily as students of pure science are well known to the readers of NATURE; but it is satisfactory to note that they were warmly supported from the practical point of view by such men as Sir Bernhard Samuelson, Sir William Anderson, Sir Lowthian Bell, Mr. Crompton, Mr. Preece and others directly connected with industry and technology. The number of questions suggested as those on which useful work might be done was indeed almost overwhelming, and the Committee lay stress on the fact that one of the chief functions of the Governing Body would be to select the most important of the various problems with which they might deal. We agree with the opinion of the Committee that a strong Governing Body would arrive at a solution of this difficulty.

The Committee had further to consider the relations between the proposed institution, the Standards Department, and the Electrical Standardising Laboratory of the Board of Trade. They wisely decided that the new institution ought not to be under a Government Department, and as the Board of Trade has statutory powers with respect to the standards, this decision precludes a fusion between the Standards Department and the new Laboratory. It is, however, suggested that the relations between the two should be very close, that the Permanent Secretary of the Board of Trade should be *ex officio* a member of the Governing Body, which "should be consulted by the Standards Office and the Electrical Standardising Department of the Board of Trade upon difficult questions that may arise from time to time or as to proposed modifications or developments."

It is not, however, proposed to found a brand new institution. "In the opinion of the Committee the principles which underlie the proposal for the establishment of a National Physical Laboratory have been tested on a comparatively small scale at the Kew Observatory with the most satisfactory results."

The Committee therefore propose the extension of the Kew Observatory, and as that institution is controlled by the Royal Society it naturally follows that its management when enlarged and developed should remain in the same hands. A considerable change is, however, contemplated in the constitution of the Governing Body. Representatives of industry are to be added, and it is stipulated particularly that these should not necessarily be selected from among the Fellows of the Royal Society.

The plan thus sketched out seems reasonable and practical, and it is to be hoped that the Government will give effect to it.

If it does, and if the Royal Society consent to play the part assigned to it in the Report, the Council will undertake a grave responsibility and enjoy a great opportunity. Much will depend upon the start.

Nothing is said in the report of the Committee as to the funds which would be wanted to carry out the scheme they propose. The form which it ultimately assumes must depend upon whether the Government subvention is large or small. It is, we suppose, improbable that the new institution, if founded, will at first be on the same scale as the Reichsanstalt at Berlin. The question as to whether that institution is not too magnificent has in fact occurred to many of those who have seen it.

No one has ever accused the Kew Observatory of too lordly buildings or too lavish an equipment. As the central thermometric station, it has been hampered by the fact that it has not possessed the apparatus or the means to establish direct comparisons with the gas thermometer. We believe that this difficulty is about to be overcome by the generosity of Sir Andrew Noble who is presenting the necessary installation to the Observatory. But though in this and in other respects it has failed in the past to reach the level of its modern rivals, Kew has been useful both to industry and science. This is proved by its financial success. With a modest endowment of 470*l*. a year and the use of a Government building, the Committee make about 2000*l*. a year in fees, and the average receipts increased in the last five years about 25 per cent. over those in the earlier half of the decade. If a specific example of its operations be needed, it is sufficient to cite the fact that, unsolicited by the trade, Kew established a system of trials for watches, in which the leading makers now eagerly compete, and which they confess has improved the standard of their work.

The more scientific side of the functions of the Observatory is illustrated both by its magnetic work and by the fact that the Committee is now employing a gentleman to compare the platinum thermometer over a wide range with the gas thermometer at the Bureau des Poids et Mesures at Paris. What is wanted is the multiplication of operations

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such as these, together with the systematic determination of selected physical constants. With larger funds such results could be obtained, and there is no reason to fear that with a carefully chosen Committee, a good organisation, and the best Director that can be secured, the National Physical Laboratory would in due time take its place among the great scientific institutions of Europe, and would forge another link in the chain which binds science and industry together.

EXPERIMENTAL PHYSICS.

Lehrbuch der Experimental-Physik. Von Eduard Riecke. Zweiter Band, Magnetismus, Elektrizität, Wärme. (Leipzig: Verlag von Veit und Comp., 1896.)

IN NATURE for August 20, 1896, we reviewed the first volume of this work, and there stated what seemed to us to be its most notable features. The second volume strikes us as being even better than the first: the author, at any rate, seems to move in the subjects here treated with still more grace and freedom.

The treatment of the subjects is clear, and, so far as we have seen, always accurate, though the methods adopted are not always the newest. Perhaps, it may be argued, they are none the worse for that. However, in one or two places, there are described at some length various pieces of apparatus which hardly deserve a place in a modern book on electricity. An electrician may, for example, know nothing of the "unit jar," and not be a whit the worse. Yet Prof. Riecke gives "Ein vollständiges Bild von der Konstruktion der Massflasche"!

Dielectric action is illustrated by well-chosen and instructive diagrams. The theory described is one precisely analogous to that of magnetic induction and magnetic force, in which the medium is supposed to be made up of polarised molecules, the opposite charges of which act at a distance like other electric charges; while the electric induction is defined as the electrostatic force in a crevasse at right angles to the polarisation, and the electric force as the electrostatic force in a cylindrical hollow along the lines of polarisation. Thus we have in electricity, as in magnetism, the equation

$$\mathfrak{B} = \mathfrak{F} + 4\pi\mathfrak{J}.$$

Here a distinction is drawn between the true and the free distribution on the plate of a condenser, a mode of discussing the external action of the condenser which is supplemented by an all too short account of the Maxwellian view of the subject.

Prof. Riecke gives at p. 23 a simple construction for finding the direction of a magnetic line of force at any point P. Draw to the point a line CP from the centre C of the magnet, and find a point Q such that CQ = $\frac{1}{3}$ CP. Draw from Q a perpendicular QR to CP, meeting the magnetic axis in R. RP is the direction of the line of force at P. It ought to be stated in the text that this construction, which is easily derivable from the polar equation $r = c \sin^2\theta$ of the line of force, is only applicable to the case of an infinitely short magnet; that is, it can only be applied for an ordinary bar magnet when the distance CP is very great in comparison with the length of the magnet.

The subject of electromagnetism is fully dealt with so far as the magnetic action of a current element, and the mutual force between two current elements are concerned. The law of Laplace (which was also given by Savary and by Ampère) that the magnetic force produced by a current γ in an element C of a circuit of length ds at a point P at distance r from the element and making an angle θ with CP is $\gamma ds \sin\theta / r^2$, and acts at right angles to the plane of the element and P, is first stated and used for the ordinary applications. Then from that, by the principle of action and reaction, is obtained the electromagnetic force on a current element γds in a field of intensity H, making an angle θ with the element is $\gamma H\, ds \sin\theta$. It is not noticed here, however, that taking the magnetic *action* of an element of current to be as stated in Laplace's formula, the *reaction* must exist in the same line as the action, and hence to get the electromagnetic force on each element the reaction must, after the method of Poinsot, be reduced to a force on the element and a couple.

All these laws of action of elements however are, it should be more emphasised, incapable of absolute demonstration. It is impossible to experiment with elements, and so settle the question, and no confirmation obtained by arriving at the observed actions of complete currents is proved in the least, inasmuch as the addition to the action of an element of any term, which integrated round the circuit gave a zero result would give another law, equally valid so far as the evidence goes. The same point requires mention again later when Ampère's law of the mutual action of two currents is discussed. It seems therefore to be demonstrably certain that in the ordinary theory of circuits it is impossible to arrive at a unique law of the mutual action of elements. Yet time is still wasted on the search for it.

Notwithstanding the narrow limits of the book as compared with many other Lehrbücher, Prof. Riecke has succeeded in compressing an immense amount of valuable matter into his chapters on electricity and magnetism. Of course the pages are large and well filled, and there is far more than would be contained in an English book of the same number of pages, but the author has succeeded wonderfully in contriving to give an account in so much detail of electro-optics, including the electromagnetic theory of light, and of dynamo-electric machinery.

The final chapter, Elektrochemie, Electrolyse, contains a fair discussion of the motion of ions, of electrolytic dissociation, winding up with a sketch of the energy theory of the voltaic cell.

The final part of the second volume deals with heat, and here again, in 130 pages, the author effects quite a marvel of condensation. Temperature, expansion, the air thermometer, all are soundly and clearly treated, and there is an absence of the terrible confusion about scales of the mercury and air thermometers which is so common. For example, we came across again the other day the statement that air is an excellent thermometric substance because its expansion is so *uniform*. The same thing is generally claimed in the same books for mercury, and the authors never seem to think that this uniformity is not absolute, but must be relative to some standard. They do not perceive that the standard they set up is really the expansion of the mercury itself in the thermometer. Here, however, there is no such nonsense.

The third book of this part deals with thermodynamics, and we must enter our protest once more against the mode of treatment adopted for absolute temperature. As is usual in German and French treatises temperature is first defined by the so-called law of gases, and then based on the hypothetical something called a perfect gas. Then that notion of temperature is carried into the discussion of the indicator diagrams given by Carnot's engine. Of course if a perfect gas is properly and clearly defined the discussion *can* be made logically consistent, though in what seems a forced and unnatural way; and Prof. Riecke is careful to state, though not quite all at one place, what the properties of his perfect gas are.

The true method is to define absolute temperature by means of a perfect engine, so as to get a scale independent of the properties of any known substance, and then Joule and Thomson's experiment becomes a comparison of the scales of different gas thermometers with the absolute scale, that is a test of the perfection of the gases. So far as we have been able to see, the name of Thomson is not mentioned in this section of the work!

In taking leave of this treatise we wish to say that students owe much to Prof. Riecke for giving them a readable, not too abstruse, and yet thoroughly sound and fairly full discussion of the elements of physics. To many German students who have not time to struggle through the larger treatises this book must be very welcome. A. GRAY.

A NEW DEPARTURE BY THE RAY SOCIETY.

The Tailless Batrachians of Europe. Part II. By G. A. Boulenger, F.R.S. (London: The Ray Society, 1898.)

WE recently reviewed under the above heading the first part of the above-mentioned work, which will become classical among popular treatises upon zoology, and the second part, following so close upon it, calls for nought but the highest admiration. In the 131 pages which compose its body, the Bufonidæ, Hylidæ, and Ranidæ, are treated in a manner uniform with the contents of the first volume, with which it is serially paged. There are 14 plates, of which 10 are coloured, 4 maps, and 44 text illustrations, all of the same excellence as in the first part; and the whole work well-nigh challenges criticism, it being praise sufficient to remark that it is its author's. Although the pages deal professedly with European animals, their value is materially enhanced by the recognition of the world-wide distribution of these, with especial reference to local varieties—as, for example, the Japanese and Chinese Bufones. The difficult topic of the racial varieties of the Ranidæ is for the first time handled in popular terms, the author giving the results of his ripe experience in a concise tabular form which will be of the greatest use to both the wayside and professed naturalist. Nor is the experimental aspect of the study neglected, and concerning this, in his disproof of the Fischer-Sigwart hypothesis (p. 311), the author once again displays a commendable enthusiasm and love of science for its own sake which cannot fail to exercise the healthiest influence upon the reader's mind. Equally encouraging is his frequent allusion to the work of the dillettanti, not a few among his critical observations and records as to geographical distribution and breeding period being culled from the pages of journals and the publications of local Natural History Societies, which the too academic critic might be apt to ignore. Under this head the incorporation of observations like those of Mr. Norman Douglass is deserving especial comment, as furnishing encouragement to the mere lover of nature and those content to seek our familiar creatures in localities in which they are unknown, and as bringing to these persons a full assurance that their efforts do not pass unnoticed by the leading masters of their craft. To the popular mind, the record of a toad's attempt to swallow a viper, and of the edible frog's more regular habit of snake capture, will especially appeal, as an interesting fact concerning the balance of nature.

The book concludes with an appendix of 16 pages; a bibliographical index of 13 pages; and an alphabetical index to the two parts. The appendix embraces a list of the specimens preserved in our National Museum at South Kensington, and to peruse this is to realise that the work is a popular commentary upon a collection unparalleled by that of any other museum in the world—a glorious possession of the British race. With this at his command the author could not have achieved other than a great result, but still by no means the least conspicuous feature about it is the stamp of his own individuality and personal influence which it bears. His book is worthy this unique material, and the best endeavours of all concerned in its accumulation; and while congratulating the Ray Society upon the success of their new departure, we earnestly hope that its executive will forthwith consider the advisability of making corresponding and ample provision for a companion work on the Batrachia Caudata, regarding that as at present the object most deserving their support, and most worthy their old-established reputation as pioneers in the popularisation of biology.

There are a few trivial matters of terminology in the present volume, such as the usage of the words "hand," "sternum," and "anus," and one or two expressions of orientation, to which exception might be taken; but these are altogether trivial where all else has been so nobly done.

OUR BOOK SHELF.

Morality independent of Obligation or Sanction. By M. Guyau. Translated from the French (second edition) by Gertrude Kapteyn. Pp. xii + 215. (London: Watts and Co., 1898.)

IN the twilight of gods and systems has naturalism any word as to the conduct of life? The author of "The Irreligion of the Future" feels that the scientific spirit in its revolt can rest in no optimism theological or teleological, while, discounting pessimism of temperament as simply the symptom of unfitness of life, the pessimism put forward as a general solution can be shown to be bound up with psychological illusion and is negatived by the will to live. If the systems afford us no certitude, and we cannot accept the anodyne of faith, what shall a spirit which doubts all that it may, and finds its chief probabilities in the indifference of nature and the relativity of knowledge, maintain as to the problems of that life which still goes on? Is it possible, upon the positive basis of facts which we cannot doubt, to found "a small house at the foot of the Tower of Babel," leaving the latter to rear itself to heaven, if it can, and not knowing whether in the end the new structure may not need its shelter?

As the conception of duty crumbles before analysis, its equivalents are to be found in the impulse to maintain and expand life in its productive fecundity, and in life the unconscious forces are as little negligible as the conscious. I can, therefore I must, overflow creatively into and upon other life, and in the spending is my gain. The ideas of expanding action are in themselves forces tending to realisation. Such expansion is necessarily social and even self-sacrificing. The struggle for existence, if it takes a purely egoistic direction, as in the case of violence, results in outward limitation and inner loss of equilibrium; while, supposing it to take the risk and, what the plain man means by, the responsibility of speculation or action, it realises the actual ideal of the moment, the hope which has not despaired of the commonweal. Thus morality without obligation is the outcome of naturalism. The so-called sanctions of morality are in part illusory, and are never wholly sanctions. The physical and physiological have no regard to intention. Remorse is not necessarily in the direction of morality. Punishment is justified only from the point of view of social defence, defence being the reaction upon attack which alone of our instincts does not lose force under the solvent of conscious analysis. We cannot substitute sanctions for obligation. The practical conclusion is a gospel of work and social fecundity: the theoretical that we stand, as it were, on the deck of some great ship lost between sky and water, and left to make what port it can; rudder there never was. But here the practical intervenes again. We will risk our all on our hopes. The rudder is still to make. "This is a great task; and it is our task." H. W. B.

Th. Thoroddsen, Geschichte der Isländischen Geographie. Vorstellungen von Island und seines Natur, und Untersuchungen darüber in alter und neuer Zeit. Autorisierte Uebersetzung von August Gebhardt. Vol. I., 1897; vol. II., 1898. Pp. xvi + 238, and xvi + 384. (Leipzig: B. G. Teubner.)

THESE volumes deal with the intellectual and social history of Iceland from the earliest times to the middle of the eighteenth century, and are by no means restricted to the geographical conditions of the island. Dr. Thoroddsen wrote in Icelandic and designed his book for his own countrymen, who remain in many ways one of the most cultured, at any rate of the most reading, peoples of Europe. He has spent most of his life in the detailed study of the geology of Iceland, on which he has written many monographs of great value, and now he is publishing the results of researches in a different direction, which have involved much searching of the archives of Iceland and Copenhagen; a great part of the text being derived from MSS. which have never before been printed.

The translator appears to have done his work with care and discrimination, but it must have been an unusually arduous task, as the old documents cited were in archaic Icelandic very difficult to render into modern German; and Dr. Gebhardt has endeavoured to preserve their flavour by imitating the contemporary German style and spelling when translating them.

The work is arranged chronologically, beginning with a discussion of the first reference to Iceland in classical writings, and proceeding to the first colonisation by Irish monks, the second by Norse exiles, the Golden Age of Icelandic discovery which followed, and the subsequent development of the most learned literary society in Europe. The mediæval accounts of Iceland are then discussed; but here the foreign reader is at a disadvantage, as he does not occupy the standpoint of the Icelander for whom the book was written, and loses much of the humour of the various misrepresentations of fact. The story of the narrow escape which Iceland made from becoming an English colony in the fifteenth century, when it was the great fishing ground for Bristol and Scarborough smacks, and the manner in which German commercial interests triumphed, has special interest for English readers. An account of the renaissance in Icelandic literature after the Reformation completes the first volume. The second volume deals largely with superstitions and witchcraft in the sixteenth and seventeenth centuries; and gives details of the first native descriptions of the country and the first surveys of Iceland, as well as recounting the services of Icelanders to science in general. These were, however, of no very great moment, and by no means so interesting to read of as the highly developed system of magic and witchcraft for which Iceland was famous in the preceding century.

An island of any sort is a fascinating thing to explore and to describe. It presents possibilities of completeness denied to countries which form part of a continent, and Dr. Thoroddsen has given his countrymen a book to study and to think over. For the sake of the foreign reader we hope that on the completion of the work he will himself retell the story in one handy volume, written with the object of making outsiders acquainted with Iceland and its people. H. R. M.

The Telephone. Outlines of the Development of Transmitters and Receivers. By Prof. William J. Hopkins. Pp. ix + 83. (New York and London: Longmans, Green, and Co., 1898.)

A CLEAR and connected explanation of the principles underlying the action and the design of telephone transmitters and receivers is given by Prof. Hopkins in this volume. The work is by no means exhaustive; indeed, men engaged in practical telephone construction may object that it is not full enough to be of real service. But as a general survey, for the instruction of students of telephony, the book contains a distinct view of the subject, into which details can be worked later on. The book begins with a chapter on the analysis of vibrations of sounding bodies. Following this is a short account of Reis's and Bell's telephones; and then come chapters on the development of transmitters, early successful types of transmitter, the results of systematic investigations upon transmitters of various types, granular transmitters, magneto instruments, and the design of receivers. This outline is sufficient to show that the volume provides students of practical electricity with a good view of telephone construction. The text is elementary enough to be read with interest by the general public.

Mathematical Examination Papers for Use in Navy Classes in Schools. By the Rev. J. L. Robinson, M.A. Pp. vii + 143. (London: Rivingtons, 1898.)

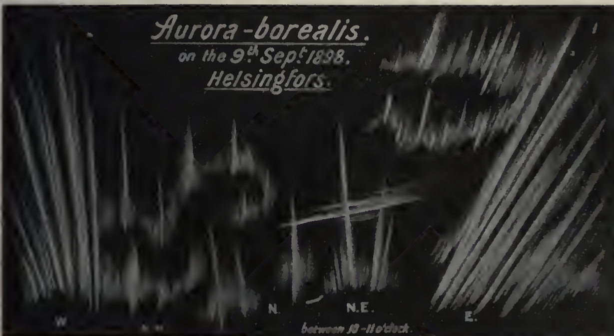
THIS collection of examination questions in arithmetic, algebra, geometry, mixed mathematics (including elementary trigonometry), and mechanics, and geometrical riders, will be found of real service by teachers preparing candidates for admission to naval cadetships of the Royal Navy. The student who works through the questions will be able to sit for the examination with an easy mind.

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 Aurora Borealis of September 9.

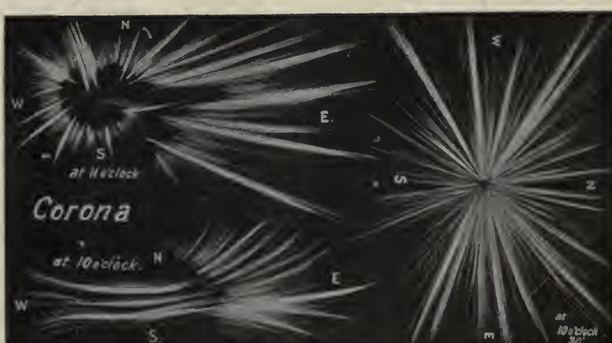
I HAVE read, with much interest, in NATURE of September 15, the article concerning the aurora borealis of September 9, and it may be of interest to your readers to know that this beautiful phenomenon displayed its splendours the same evening in all parts of Finland territory.



On that day I had the good fortune to see it in Helsingfors, from its earliest beginning to its end, in a clear, perfectly cloudless sky, and a calm and transparent air. These favourable conditions enabled me to sketch the principal movements of it, and I send you herewith a copy of the drawing I made.

The aurora was not only one of the most splendid that has been seen, but also that has appeared in our latitude for a long series of years. It began a little before 9 o'clock, and at 10 arrived at its maximum brilliancy, a state in which it, ever changing, remained till 11 o'clock, displaying the whole time an exceedingly beautiful brightness in all its parts.

The display began with a very bright arc in the north, but this very soon disappeared, while at the same moment exceedingly brilliant streamers extended at once up from the western and eastern horizons, sending immense columns to the zenith, and taking the shape of a colossal arc arching the whole sky from horizon to horizon. Masses of light flowed from both sides to the zenith, where they seemed to disappear. At 10 o'clock the great arc was interrupted on both sides by a dark region, the bright streamers remaining only on opposite horizons; but in the same moment a corona of the highest splendour appeared in the zenith, consisting of three nearly parallel streamers, stretching from west to east, and ending towards the west in the dark space, and towards the east in a beautiful fan of light. Half an hour later the corona took the shape of an immense dome, the ribs and columns of which stood around all parts of the horizon. The whole visible sky at that moment presented one single enormous dome of indescribable beauty. The brightest columns of this dome were to the west and to the east, those to the north were much less bright, and the columns to the south were scarcely visible. From every part of this dome streamers of light, without interruption, flowed up to the zenith.



At 11 o'clock, when the dome suddenly disappeared, the corona took the shape of a luminous spiral-ring, sending short but very bright streamers in all directions, especially to the east. This latter formation was surrounded by quite black spaces of sky, which made the luminous phenomena look more beautiful.

Meanwhile, in the northern part of the sky, the aurora took the shape of ever-changing columns, and long, sometimes spiral and undulating bands, which twice, in the north-west and in the north-east, doubled, resembling curtains hanging one over the other.

A little after eleven I saw in the north a very strange formation of aurora; three vertical columns in their upper part were crossed by a bright horizontal streamer, extending nearly from north-west to north-east.

Soon after 11.30 the aurora began to vanish everywhere, and, in a very marked manner, took more and more the aspect of some luminous shapeless cloud. After 12 o'clock all traces of columns and streamers disappeared, and at 1 o'clock nothing more of the phenomenon was to be seen.

N. KAULBARS.

Helsingfors, September 28.

Fourier's Series.

IN a letter to NATURE of October 6, Prof. Michelson, referring to the statement that a Fourier's series can represent a discontinuous function, describes "the idea that a real discontinuity can replace a sum of continuous curves" as "utterly at variance with the physicists' notions of quantity." If, as this seems to imply, there are physicists who hold "notions of quantity" opposed to the mathematical result that the sum of an infinite series of continuous functions may itself be discontinuous, they would be likely to profit by reading some standard treatise dealing with the theory of infinite series, such, for example, as Hobson's "Trigonometry," and the paper by Sir G. Stokes quoted on p. 251 of that work.

Prof. Michelson takes a particular case. He appears to find a difficulty in the result that the sum of the series

$$y = 2[\sin x - \tfrac{1}{2}\sin 2x + \tfrac{1}{3}\sin 3x - \ldots]$$

is equal to x when x lies between $-\pi$ and π, is equal to $-2\pi + x$ when x lies between π and 3π, and so on, and further is equal to zero when x is $-\pi$, or π, or 3π, and so on.

With the view of stating his difficulty simply, he has tried to sum this series, and the series obtained from it by differentiating its terms, for values of x of the form $\pi + \epsilon$, where it appears to be meant that ϵ is positive and less than 2π.

The series (thus obtained) for y and dy/dx are given by the equations

$$-\tfrac{1}{2}y = \sin\epsilon + \tfrac{1}{2}\sin 2\epsilon + \tfrac{1}{3}\sin 3\epsilon + \ldots + \frac{1}{n}\sin n\epsilon + \ldots$$

$$-\tfrac{1}{2}\frac{dy}{dx} = \cos\epsilon + \cos 2\epsilon + \cos 3\epsilon + \ldots + \cos n\epsilon + \ldots$$

Of the first series Prof. Michelson says: "This series increases with n until $n\epsilon = \pi$. Suppose therefore $\epsilon = k\pi/n$, where k is a small fraction. The series will now be nearly equal to $n\epsilon = k\pi$, a finite quantity even if $n = \infty$.

"Hence the value of y in the immediate vicinity of $x = \pi$ is not an isolated point $y = 0$, but a straight line $-y = nx$."

Of the second series he says that it "is nearly equal to n for values of $n\epsilon$ less than $k\pi$."

Neither of these statements is correct. The sum of the first series can be proved to be $\frac{1}{2}(\pi - \epsilon)$ when ϵ lies between 0 and 2π, and $-\frac{1}{2}(\pi + \epsilon)$ when ϵ lies between 0 and -2π, and it is zero when $\epsilon = 0$. The sum of n terms of the second series does not approach to any definite limit, as n is increased indefinitely; nor does the difference between the sum of this second series to n terms and the number n tend to zero or any finite limit, but the ratio of the sum to n terms and the number n tends to the definite limit zero as n is increased indefinitely.

The processes employed are invalid. It is not the case that the sum of an infinite series is the same as the sum of its first n terms, however great n is taken. It is not legitimate to sum an infinite series by stopping at some convenient nth term. It is not legitimate to evaluate an expression for a particular value of x, *e.g.* $x = \pi$, by putting $x = \pi + \epsilon$ and passing to a limit; to do so is to assume that the expression represents a continuous function. It is not legitimate to equate the differential coefficient of the sum of an infinite series to the sum of the differential coefficients of its terms; in particular the series given as representing dy/dx in the example is not convergent.

Lastly, Prof. Michelson says "it is difficult to see the meaning of the tangent if y were an isolated point." The tangent, at a point, to a curve, representing a function, has of course no meaning, unless the function has a differential coefficient, for the value corresponding to the point; and a function which has a differential coefficient, for any value of a variable, is continuous in the neighbourhood of that value.

St. John's College, Cambridge, A. E. H. LOVE.
October 7.

Helium in the Atmosphere.

THE letter of Mr. Baly in your issue of last week, corroborating the statement of Friedländer and Kayser that helium is a constituent of the atmosphere, induces me to put on record a further confirmation of the accuracy of this observation. Having had the opportunity, on June 20 last, of examining samples of the more volatile portions from liquid air, which had been handed to me by Prof. Dewar, I had no difficulty in seeing the lines of helium in them. Further, a sample of the helium separated by Prof. Dewar from Bath gas (following the discovery of Lord Rayleigh) undoubtedly contained the substance called neon.

In giving these facts I am only confirming the observations of Prof. Dewar given to me in letters accompanying the samples of gas. WILLIAM CROOKES.
October 11.

Triplet Lightning Flash.

AT the suggestion of Lord Kelvin, I send you the enclosed photograph of a triplet lightning flash which was taken during a recent thunderstorm at Whitby, and under the following conditions.

The flash must have been about two miles distant (out at sea). The focus of the camera lens was 8 inches; the aperture, f/64; the plate, Ilford Empress. The camera was not stationary, but was purposely oscillated by hand. It was intended that its axis should describe a circular cone, but from the photograph the path appears to have been rather elliptical. Each revolution occupied about 1/80 minute. From these rough data I estimate that the three flashes followed each other with a frequency of about 30 to 35 per second. They are identical in shape, but the top part of the lowest (left-hand) one is missing, and the bottom is screened. On the negative the centre flash is rather weaker than the other two. Each flash is sharply defined on the left edge and somewhat hazy on the right edge, due probably to the gradual cooling of the glowing gases, and showing that the lowest (left-hand) flash is the first of the three. The photograph also contains a faint image of a single flash. During this thunderstorm two other plates were exposed under the same conditions as the above, but no images were found on them. Possibly the lightning was too far off, and the aperture too small.

In view of the importance of obtaining more definite information about lightning, I would suggest that in the presence of a thunderstorm photographs similar to the above should be taken. Greater accuracy than was possible under the above conditions could be attained by rigging up the following simple contrivance. An ordinary bedroom looking-glass should be placed on a table in front of an open window facing the storm. The mirror should be inclined at any angle of 45°. The camera tripod, with its legs spread as wide apart as possible, should be placed on the table so that its centre is over the looking-glass. The camera, with its objective downwards, should be suspended from this centre by means of three strings, and should be made to swing in a circle by a gentle finger pressure close to the point of suspension. The period of revolution should be noted. Should any multiple flash imprint itself on the negative, it will now be possible to accurately measure the intervals of time, except

under the following conditions. If there are only two flashes, the radius of the circle described by the camera can only be guessed at. If the camera has described an ellipse, at least four lightning images are required to find its elements. A camera revolving on an axis passing through the objective would in some respects be more convenient to work with, but unless it is revolved by clock-work the time measurements would not be trustworthy. The aperture used by me, f/64, is probably too small except for very brilliant flashes; but if it is intended to allow several discharges to imprint themselves on one negative, a very large aperture will be found inconvenient because of the illumination of the landscape. The size of the aperture, rapidity of plate, and distance of each lightning flash should be noted to assist at forming some idea as to the heat generated.

C. E. STROMEYER.
Lancefield, West Didsbury, October 3.

The Centipede-Whale.

THE "Scolopendrous Millipede," which forms the subject for the epigrams of Theodoridas and Antipater, and to which Mr. W. F. Sinclair kindly called my attention (NATURE, vol. lvi. p. 470), seems to mean a being quite different from the "Centipede-Whale" which Ælian and Kaibara describe (see my letter, *ibid.*, p. 445); for the former apparently points to a huge skeleton of some marine animal, while the latter is an erroneous but vivid portrait of an animal actively swimming with numerous fins.

Major R. G. Macgregor, in his translation of the Greek Anthology (1864, p 265), remarks upon the "Scolopendrous Millipede" that the "word *millipede* must be understood rather in reference to the extreme length of the monster than to the number of its feet." However, it would appear more likely that, in this similitude of the animal remains to the Myriapod, the numerous articulations of the vertebral column as well as its length played a principal part, should we take for comparison the following description of an analogous case from a Chinese work (Li Shih, "Süh-poh-wuh-chi," written thirteenth century, Jap. ed., 1683, tom. x. fol. 6, *b*.):—"Li Mien, a high officer (ninth century), during his stay in Pien-Chau, came in possession of one joint of a monstrous bone, capable of the use as ink-stone (*Yen*). A foreign tradesman who brought it from the South Sea stated it to be the vertebra of a centipede." Seeing that its use here alluded to is nowadays often repeated, we do not hesitate to conclude that this "vertebra of a centipede" was nothing other than the vertebra of a whale. A long series of the cetacean vertebræ, especially when it is separate from the skull yet remaining adhered with the fragments of the ribs, would, to the imagination of those crude folks, naturally furnish a ready sketch of a gigantic, marine centipede.

The "Centipede-Whale" of Ælian's and Kaibara's descriptions are very probably certain species of sharks with the habit of swimming one following another. The reason is that while the fantastic figure of a six-legged sea-serpent, that was cast up on the Orkney in 1808 and subsequently proved to be the shark *Selache maxima* (*Memoirs* of the Wernerian Nat. Hist. Soc., Edin., vol. i., Plate XI., 1811), forcibly reminds us of the "Centipede-Whale," pictured in Gesner's "Historia Animalium" (see my letter, *l.c.*) and in a Japanese work (Hirazumi, "Morokoshi Kimmôdzui," 1719, tom. xiv. fol. 6, *a*.), Tanigawa Shisei, the Japanese glossarist (1707–1776), mentions in his "Wakun-no-Shiori" (ed. 1887, 3rd ser., tom. xvi. fol. 8, *a*.) the "Centipede-Shark" (*Mukadezame*), which is doubtless identical with the "Centipede-Whale." That the manner of the natatory movements of some sharks—to which are attributable the words of Ælian, "idque conferri posse cum triremi instae magnitudinis, atque per multis pedibus utrinque ordine sitis, tanquam ex scalmis appensis, natare"—should suggest to the mind the active representation of a terrestrial centipede, is well evinced by the Japanese word *Mukadebune* (*i.e.* Centipede-Boat), signifying a slender boat with many oars in pairs that have to be moved like the legs of a running centipede (mentioned in Yuasa, "Jôzan Kidan," 1739, tom. xv. fol. 12, *a*.).

An older description of such a fabulous creature in the Far East, occurs in the Chinese "History of the Sui Dynasty" (written seventh century, A.D.), and reads thus: "Chin-Lah (Cambodja) produces a fish named *Fu-Hu*, which resembles Mud-Eel (*Monopterus javanensis*, Lacépède, according to Möllendorff), but with the bill shaped like the parrot's, and has eight legs"

When we set apart the more or less allied stories of the Dragon (Chinese, *Lung*, and Japanese, *Tatsu*), which very probably originates in the phenomena of waterspout and whirlpool,[1] we hardly know from the Far Eastern sources anything like the Sea-Serpent stories so much in circulation in the West. In the Far East, indeed, the Sea-Serpent seems to have totally given place to the Sea-Centipede, both having the identical, diverse origins—the back-bone of a whale, the sharks, and some Cephalopods (*cf.* "Encyc. Brit.," ninth ed., vol. xxi. pp. 608–610, and my letter, *l.c.*). Thus, in China, there prevails a long-established belief in the existence of huge centipedes in the South Sea, very valuable for their flesh and skin, the former tasting like prawn and much superior to beef, and the latter being useful for making drum.[2]

Turning to Japan, we read in the "Konjaku Monogatari" (written by Minamoto-no-Takakuni in the eleventh century, ed. Izawa, tom. xv. fol. 2–7), a narrative of the seven anglers, who killed a centipede about 10 feet long, that came from amidst a wide sea to combat with a huge serpent, the master of an island. This story of the "Sea-Centipede" is perhaps a prototype of the later but far more popularised legend of Tawara Tôda's slaughter of a monstrous Myriapod, which, the tradition says, used to molest a dragon in Lake Biwa.[3]

Kumagusu Minakata.

7 Effie Road, Walham Green, September 17.

1 For similar misconceptions current among the Arabs, *vide* "Encyc. Brit.," *l.c.*, p. 610.

2 The first description of such a gigantic centipede occurs in a poem by Koh Hung (*circa*. 254–334 A.D.). In the year 745 a centipede was found drowned by sea-tide on a coast of Kwang-Chau, and a man was fortunate enough to secure 120 *kin* weight of edible flesh by opening its "claws" ("Yuen-kien-lui-han," 1701, tom. cdxlix. fol. 11, *a*.). Here, the said "claw" would seem no other than the shark's fin, which in recent times has become the article of commercial importance with the Chinese. Even in the Imperial Geography ("Ta-Tsing-i-tung-chi," tom. cccliv. fol. 19, *b*.), compiled so lately as the eighteenth century, a similar centipede is described as native to Anam, which Tanigawa (*l.c.*) happily identifies with his "Centipede-Shark."

3 The latter story is first recorded in "Taiheiki" (written fourteenth century, lib. xv. ch. 3), although its hero flourished in the tenth century (for its brief account see Mr. E. Gilbertson's article in the *Trans. and Proc. Jap. Soc.*, London, 1898, vol. iv., part ii., p. 115). Kyokutei Bakin, in his "Shichiya-no-Kura" (1810, ch. v.), gives an exhaustive account of this tradition, but does not refer to the "Sea-Centipede" story quoted above.

The Moon's Course.

The moon's unique course was not known, in J. Fergusson's time, to be so peculiar as it now appears; for only five other satellites were then known, but now we know twenty, and still no other that has a path always concave to the sun.

It arises, of course, from her being more pulled by the sun than by the earth. All the others are more pulled by their primaries than by the sun. The distance from our earth where she balances the sun is but 1/569th of the sun's. But the moon's mean distance is fully a 386th of the sun's. The distance from Jupiter where he balances the sun is a 33rd of his own. That from Saturn is over a 60th of his own distance. That from Uranus a 155th; from Neptune a 140th; but from Mars only a 1760th; and in every case their furthest satellites are much nearer. Our moon's form of path is quite unique in the universe, so far as known.

E. L. Garbett.

25 Claremont Square, London, N., October 10.

A Simple Method of Making Light Mirrors.

The following description of a simple and inexpensive method of making optically perfect mirrors for galvanometers and similar instruments will, I think, be of interest to many of your readers.

Strips of French plate-glass, about 5 mm. thick and 20 mm. long, are well silvered and carefully polished with rouge. The silvered strip is placed upon edge on a flat stone or other firm support, and a light blow is struck with the edge of a hammer a little distance back from the silvered face. If the blow is well directed, a chip of glass of circular or elliptical form will be broken out. The nearer the edge the blow is struck the thinner the mirror will be. Of course not every blow will produce a good mirror, but with a little practice a strip 10 centimetres long should yield a dozen good mirrors, of assorted weights and sizes, which may be cemented to a card and put away in a box for use as occasion requires. Since the silver surface is exposed, it will tarnish in time; but as the expense and trouble involved in making the mirrors is so slight, and the definition given by them when new is so perfect, one can afford to renew them once a year if necessary. The method of silvering mirrors given in the "Encyclopædia Britannica" gives a surface well adapted to this purpose.

Charles B. Thwing.

Knox College, Galesburg, Illinois, September 17.

Animals and Poisonous Plants.

When visiting lately the herbaceous department in the Royal Botanic Gardens, Regent's Park, I noticed that nearly all the berries had disappeared from the deadly nightshade, *Atropa belladonna*, the calyx being left untouched. The foreman of the herbaceous department told me that he believed they had been eaten by blackbirds, which are very active in the bushes; also that the seeds of *Datura stramonium* are eagerly devoured by mice. Can any of your readers confirm this statement of animals feeding on poisonous plants? In *Nature Notes* for October, I notice a statement of a report that wild rabbits feed on the leaves of the belladonna.

Alfred W. Bennett.

Crannoges in Estuaries.

Referring to the notices on this subject in Nature of September 15 and 29, I beg to say that, in 1879, I discovered a crannoge constructed on a bed of peat, below high-water mark, in Ardmore Bay, Co. Waterford. It was at the mouth of a small stream.

The diameter of the enclosure was about 100 feet. It was surrounded by a double fence of massive piles, apparently sharpened with the stone axe. The interior contained mortised beams and cleft panels of the dwelling, and portions of the wattled partitions, traces of which covered the enclosed area in the form of pointed stakes whose ends remained in the peat.

The kitchen midden contained bones of horse, ox, goat, pig, and red deer, the usual bill of fare found in the raths of the country.

A paper on this crannoge was published in the *Proceedings* of the Royal Irish Academy, December 1880, and the site has been visited by Prof. Boyd Dawkins. It is covered by every tide, and the crannoge is now almost obliterated.

Cappagh, Fermoy, October 1.

R. J. Ussher.

A SHORT HISTORY OF SCIENTIFIC INSTRUCTION.[1]

I.

THE two addresses by my colleagues Profs. Judd and Roberts-Austen have drawn attention to the general history of our College and the details of one part of our organisation. I propose to deal with another part, the consideration of which is of very great importance at the present time, for we are in one of those educational movements which spring up from time to time and mould the progress of civilisation. The question of a Teaching University in the largest city in the world, Secondary Education, and so-called Technical Education are now occupying men's minds.

At the beginning it is imperative that I should call your attention to the fact that the stern necessities of the human race have been the origin of all branches of science and learning; that all so-called educational movements have been based upon the actual requirements of the time. There has never been an educational movement for learning's sake; but of course there have always been studies and students apart from any of those general movements to which I am calling attention; still we have to come down to the times of Louis Quatorze before the study of the useless, the *même inutile*, was recognised as a matter of national concern.

It is perhaps the more necessary to insist upon stern necessity as being the origin of learning, because it is so difficult for us now to put ourselves in the place of those early representatives of our race that had to face the problems of life among conditionings of which they were profoundly ignorant: when night meant death; when there was no certainty that the sun would rise on the morrow; when the growth of a plant from seed was unrecognised; when a yearly return of seasons might as well be a miracle as a proof of a settled order of phenomena; when, finally, neither cause nor effect had been traced in the operations of nature.

It is doubtless in consequence of this difficulty that some of the early races have been credited by some authors with a special love of abstract science, of science for its own sake; so that this, and not stern necessity, was the motive of their inquiries. Thus we have been told that the Chaldæans differed from the other early races in having a predilection for astronomy, another determining factor being that the vast plains in that country provided them with a perfect horizon.

The first historic glimpses of the study of astronomy we find among the peoples occupying the Nile Valley and Chaldæa, say 6000 B.C.

But this study had to do with the fixing of the length of the year, and the determination of those times in it in which the various agricultural operations had to be performed. These were related strictly to the rise of the Nile in one country and of the Euphrates in the other. All human activity was in fact tied up with the movements of the sun, moon and stars. These, then, became the gods of those early peoples, and the astronomers, the seers, were the first priests; revered by the people because as interpreters of the celestial powers they were the custodians of the knowledge which was the most necessary for the purposes of life.

Eudemus of Rhodes, one of the principal pupils of Aristotle, in his History of Geometry, attributes the origin of geometry to the Egyptians, "who were obliged to invent it in order to restore the landmarks which had been destroyed by the inundation of the Nile," and observes "that it is by no means strange that the invention of the Sciences should have originated in practical needs."[2] The new geometry was brought from Egypt to Greece by Thales three hundred years before Aristotle was born.

[1] An address delivered at the Royal College of Science by Sir Norman Lockyer, K.C.B., F.R.S., on October 6.
[2] "Greek Geometry from Thales to Euclid," p. 2. (Allman.)

When to astronomy and geometry we add the elements of medicine and surgery, which it is known were familiar to the ancient Egyptians, it will be conceded that we are, in those early times, face to face with the cultivation of the most useful branches of science.

Now, although the evidence is increasing day by day that Greek science was Egyptian in its origin, there is no doubt that its cultivation in Greece was more extended, and that it was largely developed there. One of the most useful and prolific writers on philosophy and science who has ever lived, Aristotle, was born in the fourth century B.C. From him, it may be said, dates a general conception of science based on *observation* as differing from experiment. If you wish to get an idea of the science of those times, read his writings on Physics and on the Classification of Animals. All sought in Aristotle the basis of knowledge, but they only read his philosophy; Dante calls him "the Master of those who know."[1]

Why was Aristotle so careful to treat science as well as philosophy, with which his master, Plato, had dealt almost exclusively?

The answer to this question is of great interest to our present subject. The late Lord Playfair[2] in a pregnant passage, suggests the reason, and the later history of Europe shows, I think, that he is right.

"We find that just as early nations became rich and prosperous, so did philosophy arise among them, and it declined with the decadence of material prosperity. In those splendid days of Greece, when Plato, Aristotle, and Zeno were the representatives of great schools of thought, which still exercise their influence on mankind, *Greece was a great manufacturing and mercantile community*; Corinth was the seat of the manufacture of hardware; Athens that of jewellery, shipbuilding and pottery. The rich men of Greece and all its free citizens were actively engaged in trade and commerce. The learned class were the sons of those citizens, and were in possession of their accumulated experience derived through industry and foreign relations. Thales was an oil merchant; Aristotle inherited wealth from his father, who was a physician, but, spending it, is believed to have supported himself as a druggist till Philip appointed him tutor to Alexander. Plato's wealth was largely derived from commerce, and his master, Socrates, is said to have been a sculptor. Zeno, too, was a travelling merchant. Archimedes is perhaps an exception, for he is said to have been closely related to a prince; but if so, he is the only princely discoverer of science on record."

In ancient Greece we see the flood of the first great intellectual tide. Alas! it never touched the shores of Western Europe, but it undoubtedly reached to Rome, and there must have been very much more observational science taught in the Roman studia than we generally imagine, otherwise how account for Pliny, the vast public works, their civilising influence carried over sea and land from beyond Bab-el-Mandeb to Scotland? In some directions their applications of science are as yet unsurpassed.

With the fall of the Roman Empire both science and philosophy disappeared for a while. The first wave had come and gone; its last feebler ripples seem to have been represented at this time by the gradual change of the Roman secular studia wherever they existed into clerical schools, the more important of which were in time attached to the chief cathedrals and monasteries; and it is not difficult to understand why the secular (or scientific) instruction was gradually replaced by one more fitted for the training of priests.

It is not to be wondered at that the ceaseless strife in the centre of Europe had driven what little learning there was to the Western and Southern extremities where

[1] "Inferno," c. iv. 130 *et seq.*
[2] "Subjects of Social Welfare," p. 206

the turmoil was less—I refer to Britain and South Italy—while the exiled Nestorians carried Hellenic science and philosophy out of Europe altogether to Mesopotamia and Arabia.

The next wave, it was but a small one, had its origin in our own country. In the eighth century England was at its greatest height, relatively, in educational matters; chiefly owing to the labours of two men. Beda, generally called the Venerable Bede, the most eminent writer of his age, was born near Monkwearmouth in 673, and passed his life in the monastery there. He not only wrote the history of our island and nation, but treatises on the nature of things, astronomy, chronology, arithmetic, medicine, philosophy, grammar, rhetoric, poetry, music; basing his work on that of Pliny. He died in 735, in which year his great follower was born in Yorkshire. I refer to Alcuin. He was educated at the Cathedral School at York under Archbishop Egbert, and having imbibed everything he could learn from the writings of Bede and others, was soon recognised as one of the greatest scholars of the time. On returning from Rome, whither he had been sent by Eaubald to receive the pallium, he met Karl the Great, King of the Franks and Lombards, who eventually induced him to take up his residence at his Court, to become his instructor in the sciences. Karl (or Charlemagne) then was the greatest figure in the world, and although as King of the Franks and Lombards, and subsequently Emperor of the Holy Roman Empire, his Court was generally at Aachen, he was constantly travelling throughout his dominions. He was induced, in consequence of Alcuin's influence, not only to have a school always about him on his journeys, but to establish, or foster, such schools wherever he went. Hence it has been affirmed that "France is indebted to Alcuin for all the polite learning it boasted of in that and the following ages." The Universities of Paris, Tours, Fulden, Soissons and others were not actually founded in his day, but the monastic and cathedral schools out of which they eventually sprung were strengthened, and indeed a considerable scheme of education for priests was established; that is, an education free from all sciences, and in which philosophy alone was considered.

Karl the Great died in 814, and after his death the eastward travelling wave, thus started by Bede and Alcuin, slightly but very gradually increased in height. Two centuries later, however, the conditions were changed. We find ourselves in presence of interference phenomena, for then there was a meeting with another wave travelling westwards, and this meeting was the origin of the European Universities. The wave now manifested travelling westerly, spread outward from Arab centres first and finally from Constantinople, when its vast stores of Greek lore were opened by the conquest of the city.

The first wavelet justified Eudemus' generalisation that "the invention of the Sciences originated in practical needs," and that knowledge for its own sake was not the determining factor. The year had been determined, stone circles erected almost everywhere, and fires signalled from them, giving notice of the longest and shortest days, so that agriculture was provided for, even away from churches and the Festivals of the Church. The original user of geometry was not required away from the valleys of the Nile, Tigris and Euphrates, and, therefore, it is now Medicine and Surgery that come to the front for the alleviation of human ills. In the eleventh century we find Salerno, soon to be famed throughout Europe as the great Medical School, forming itself into the first University. And Medicine did not exhaust all the science taught, for Adelard listened there to a lecture on "the nature of things," the cause of magnetic attraction being one of the "things" in question.

This teaching at Salerno preceded by many years the study of the law at Bologna and of theology at Paris.

The full flood came from the disturbance of the Arab wave-centre by the Crusades, about the beginning of the twelfth century. After the Pope had declared the "Holy War," William of Malmesbury tells us, "The most distant islands and savage countries were inspired with this ardent passion. The Welshman left his hunting, the Scotchman his fellowship with vermin, the Dane his drinking party, the Norwegian his raw fish." Report has it that in 1096 no less than six millions were in motion along many roads to Palestine. This, no doubt, is an exaggeration, but it reflects the excitement of the time, and prepares us for what happened when the Crusaders returned; as Green puts it,[1] "the western nations, including our own, 'were quickened with a new life and throbbing with a new energy.' . . . A new fervour of study sprang up in the West from its contact with the more cultured East. Travellers like Adelard, of Bath, brought back the first rudiments of physical and mathematical science from the schools of Cordova or Bagdad. . . . The long mental inactivity of feudal Europe broke up like ice before a summer's sun. Wandering teachers, such as Lanfranc or Anselm, crossed sea and land to spread the new power of knowledge. The same spirit of restlessness, of inquiry, of impatience with the older traditions of mankind, either local or intellectual, that drove half Christendom to the tomb of its Lord, crowded the roads with thousands of young scholars hurrying to the chosen seats where teachers were gathered together."

Studium generale was the term first applied to a large educational centre where there was a guild of masters, and whither students flocked from all parts. At the beginning of the thirteenth century the three principal studia were Paris, Bologna and Salerno, where theology and arts, law and medicine, and medicine almost by itself, were taught respectively; these eventually developed into the first universities.[2]

English scholars gathered in thousands at Paris round the chairs of William of Champeaux or Abelard, where they took their place as one of the "nations" of which the great Middle Age University of Paris was composed.

We have only to do with the Arts faculty of this University. We find that the subject-matter of the liberal education of the Middle Age there dealt with varied very little from that taught in the schools of ancient Rome.

The so-called "artiens," students of the Arts faculty, which was the glory of the University and the one most numerously attended, studied the seven arts of the trivium and quadrivium—that is, grammar, rhetoric, dialectic and arithmetic, geometry, music, astronomy.[3]

This at first looks well for scientific study, but the mathematics taught had much to do with magic; arithmetic dealt with epacts, golden numbers, and the like. There was no algebra, and no mechanics. Astronomy dealt with the system of the seven heavens.

Science, indeed, was the last thing to be considered in the theological and legal studia, and it would appear that it was kept alive more in the medical schools than in the Arts faculties. Aristotle's writings on physics, biology, and astronomy were not known till about 1230, and then in the shape of Arab-Latin translations. Still it must not be forgotten that Dante learned some of his astronomy, at all events, at Paris.

Oxford was an offshoot of Paris, and therefore a theological studium, in all probability founded about 1167,[4] and Cambridge came later.

Not till the Reformation (sixteenth century) do we see

[1] "History of the English People," I. 198.
[2] See "Historie de l'Université de Paris." Crévier, 1791, *passim*.
[3] Enumerated in the following Middle Age Latin verse:
"Lingua, tropus, ratio, numerus, tonus, angulus, astra."
[4] "Universities of Europe in the Middle Ages," Rashdall, vol. ii. p. 347.

any sign of a new educational wave, and then we find the two which have had the greatest influence upon the history of the world—one of them depending upon the Reformation itself, the other depending upon the birth of experimental inquiry.

Before the Reformation the Universities were priestly institutions, and derived their authority from the Popes.

The Universities were for the few; the education of the people, except in the various crafts, was unprovided for.

The idea of a general education in secular subjects at the expense of the State or of communities is coeval with the Reformation. In Germany, even before the time of Luther, it was undreamt of, or rather, perhaps, one should say, the question was decided in the negative. In his day, however, his zeal first made itself heard in favour of education, as many are now making themselves heard in favour of a better education, and in 1524 he addressed a letter to the Councils of all the towns in Germany, begging them to vote money not merely for roads, dikes, guns, and the like, but for schoolmasters, so that all children might be taught; and he states his opinion that if it be the duty of a State to compel the able-bodied to carry arms, it is *à fortiori* its duty to compel its subjects to send their children to school, and to provide schools for those who without such aid would remain uninstructed.

Here we have the germ of Germany's position at the present day, not only in scientific instruction but in everything which that instruction brings with it.

With the Reformation this idea spread to France. In 1560 we find the States General of Orleans suggesting to Francis II. a "levée d'une contribution sur les bénéfices ecclésiastiques pour raisonablement stipendier des pédagogues et gens lettrés, en toutes villes et villages, pour l'instruction de la pauvre jeunesse du plat pays, et soient tenus les pères et mères, à peine d'amende, à envoyer les dits enfants à l'école, et à ce faire soient contraints par les segnieurs et les juges ordinaires."

Two years after this suggestion, however, the religious wars broke out; the material interests of the clerical party had predominated, the new spirit was crushed under the iron heel of priestcraft, and the French, in consequence, had to wait for three centuries and a revolution before they could get comparatively free.

In the Universities, or at all events alongside them, we find next the introduction, not so much yet of science, as we now know it, with its experimental side, as of the scientific spirit.

The history of the Collége de France, founded in 1531 by Francis the First, is of extreme interest. In the fifteenth century, the studies were chiefly literary, and except in the case of a few minds they were confined merely to scholastic subtleties, taught (I have it on the authority of the Statistique de l'Enseignement Supérieur) in barbarous Latin. This was the result of the teaching of the faculties; but even then, outside the faculties, which were immutable, a small number of distinguished men still occupied themselves in a less rigid way in investigation; but still these studies were chiefly literary. Among those men may be mentioned Danès, Postel, Dole, Guillaume Budé, Lefèvre d'Étaples, and others, who edited with notes and commentaries Greek and Latin authors whom the University scarcely knew by name. Hence the renaissance of the sixteenth century, which gave birth to the Collége de France, the function of which, at the commencement, was to teach those things which were not in the ordinary curriculum of the faculties. It was called the *Collége des Deux Langues*, the languages being Hebrew and Greek. It then became the *Collége des Trois Langues*, when the king, notwithstanding the opposition of the University, created in 1534 a chair of Latin. There was another objection made by the University to the new creation: from the commencement the courses were free; and this feeling was not decreased by the fact that around the celebrated masters of the Trois Langues a crowd of students was soon congregated.

The idea in the mind of Francis the First in creating this Royal College may be gathered from the following Edict, dated in 1545: "François, &c., savoir faisons à tous présents et à venir que Nous, considérant que le sçavoir des langues, qui est un des dons du Saint-Esprit, fait ouverture et donne le moyen de plus entière connaissance et plus parfaite intelligence de toutes bonnes, honnêtes, saintes et salutaires sciences. . . . Avons fait faire pleinement entendre à ceux qui, y voudraient vacquer, les trois langues principales, Hébraïque, Grecque, et Latine, *et les Livres esquels les bonnes sciences* sont le mieux et le plus profondément traitées. A laquelle fin, et en suivant le décret du concile de Vienne, nous avons piéça ordonné et establi en nôtre bonne ville de Paris, un bonne nombre de personnages de sçavoir excellent, qui lisent et enseignent publiquement et ordinairement les dites langues et sciences, maintenant florissant autant ou plus qu'elles ne firent de bien longtemps. . . . auxquels nos lecteurs avons donné honnêtes gages et salaires, et iceux fait pourvoir de plusieurs beaux bénéfices pour les entretenir et donner occasion de mieux et plus continuellement entendre au fait de leur charge. . . . &c."

The Statistique, which I am following in this account, thus sums up the founder's intention:—"Le Collége Royal avait pour mission de propager les nouvelles connaissances, les nouvelles découvertes. Il n'enseignait pas la science faite, il la faisait."

It was on account of this, more than on account of anything else, that it found its greatest enemy in the University. The founding of this new College, and the great excitement its success occasioned in Paris, were, there can be little doubt, among the factors which induced Gresham to found his College in London in 1574.

These two institutions played a great part in their time. Gresham College, it is true, was subsequently strangled, but not before its influence had been such as to permit the Royal Society to rise phœnix-like from its ashes, for it is on record that the first step in the forming of this Society was taken after a lecture on astronomy by Sir Christopher Wren at the College. All connected with them felt in time the stupendous change of thought in the century which saw the birth of Bacon, Galileo, Gilbert, Hervey, Tycho Brahe, Descartes and many others that might be named; and of these, it is well to remark, Gilbert,[1] Hervey and Galileo were educated in medical schools abroad.

Bacon was not only the first to lay down *regulæ philosophandi*, but he insisted upon the far-reaching results of research, not forgetting to point out that "*lucifera experimenta, non fructifera quærenda*,"[2] as a caution to the investigator, though he had no doubt as to the revolution about to be brought about by the ultimate application of the results of physical inquiry.

As early as 1560 the Academia Secretorum Naturæ was founded at Naples, to be followed by the Lincei in 1609, the Royal Society in 1645, the Cimento in 1657, and the Paris Academy in 1666.

From that time the world may be said to have belonged to science, now no longer based merely on observation but on experiment. But, alas! how slowly has it percolated into our Universities.

The first organised endeavour to teach science in schools was naturally made in Germany (Prussia), where, in 1747 (nearly a century and a half ago), Realschulen were first started; they were taken over by the Government in 1832, and completely reorganised in 1859, this step being demanded by the growth of industry and the spread of the modern spirit. Eleven hours a week were given to natural science in these schools forty years ago.

1 "William Gilbert, of Colchester, on the Magnet." Mittelag, p. x.
2 "Nov. Org.," l. 70. Fowler's Edition, p. 255.

Teaching the Teachers.

Until the year 1762 the Jesuits had the education of France almost entirely in their hands, and when, therefore, their expulsion was decreed in that year, it was only a necessary step to create an institution to teach the future teachers of France. Here, then, we had the École Normale in theory; but it was a long time before this theory was carried into practice, and very probably it would never have been had not Rolland d'Erceville made it his duty, for more than twenty years, by numerous publications, amongst which is especially to be mentioned his "Plan d'Education," printed in 1783, to point out, not merely the utility, but the absolute necessity for some institution of the kind. As generally happens in such cases, this exertion was not lost, for, in 1794, it was decreed that an *École Normale* should be opened at Paris, "ou seront appelés de toutes les parties de la République, des citoyens déjà instruits dans les sciences utiles, pour apprendre, sous les professeurs les plus habiles dans tous les genres, l'art d'enseigner."

To follow these courses in the art of teaching, one potential schoolmaster was to be sent to Paris by every district containing 20,000 inhabitants. 1400 or 1500 young men, therefore, arrived in Paris, and in 1795 the courses of the school were opened first of all in the amphitheatre of the Museum of Natural History. The professors were chosen from among the most celebrated men of France, the sciences being represented by Lagrange, Laplace, Haüy, Monge, Daubenton, and Berthollet.

While there was this enormous progress abroad, represented especially by the teaching of science in Germany and the teaching of the teachers in France, things slumbered and slept in Britain. We had our coal and our iron, our material capital, and no one troubled about our mental capital—least of all the universities, which had become, according to Matthew Arnold (who was not likely to overstate matters), mere *hauts lycées*, and "had lost the very idea of a real university,"[1] and since our political leaders generally came from the universities little more was to be expected from them.

Many who have attempted to deal with the history of education have failed to give sufficient prominence to the tremendous difference there must necessarily have been in scientific requirements before and after the introduction of steam power.

It is to the discredit of our country that we, who gave the perfected steam engine, the iron ship, and the locomotive to the world, should have been the last to feel the next wave of intellectual progress.

All we did at the beginning of the century was to found mechanics' institutions. They knew better in Prussia, "a bleeding and lacerated mass,"[2] after Jena (1806), King Frederic William III. and his councillors, disciples of Kant, founded the University of Berlin, "to supply the loss of territory by intellectual effort." Among the universal poverty money was found for the Universities of Kœnigsberg and Breslau, and Bonn was founded in 1818. As a result of this policy, carried on persistently and continuously by successive Ministers, aided by wise councillors, many of them the products of this policy, such a state of things was brought about that not many years ago M. Ferdinand Lot, one of the most distinguished educationists of France, accorded to Germany "a supremacy in Science comparable to the supremacy of England at sea."

But this position has not been obtained merely by founding new universities. To Germany we owe the perfecting of the methods of teaching Science.

I have shown that it was in Germany that we find the first organised science teaching in schools. About the year 1825 that country made another tremendous stride. Liebig demonstrated that science teaching, to be of value, whether in the school or the university, must consist to a greater or less extent in practical work, and the more the better; that book work was next to useless.

Liebig, when appointed to Giessen, smarting still under the difficulties he had had in learning chemistry without proper appliances, induced the Darmstadt Government to build a chemical laboratory in which the students could receive a thorough practical training.

It will have been gathered from this reference to Liebig's system of teaching chemistry, that still another branch of applied science had been created, which has since had a stupendous effect upon industry; and while Liebig was working at Giessen, another important industry was being created in England. I refer to the electric telegraph and all its developments, foreshadowed by Galileo in his reference to the "sympathy of magnetic needles."

Not only then in chemistry, but in all branches of science which can be applied to the wants of man, the teaching must be practical—that is, the student must experiment and observe for himself, and he must himself seek new truths.

It was at last recognised that a student could no more learn Science effectively by seeing some one else perform an experiment than he could learn to draw effectively by seeing some one else make a sketch. Hence in the German Universities the Doctor's degree is based upon a research.

Liebig's was the *fons et origo* of all our laboratories—mechanical, metallurgical, chemical, physical, geological, astronomical, and biological. J. NORMAN LOCKYER.

(*To be continued.*)

[1] "Schools and Universities on the Continent," p. 291.

[2] "University Education in England, France and Germany," Sir Rowland Blennerhassett, p. 25.

OPENING OF THE THOMPSON-YATES LABORATORIES AT UNIVERSITY COLLEGE, LIVERPOOL.

THE latest addition to the noble series of buildings now fast surrounding the old lunatic asylum in which University College, Liverpool, started work seventeen years ago is devoted to the Schools of Physiology and Pathology. The professorships in these subjects were endowed and equipped by the late Mr. George Holt some years ago; and now suitable laboratories, on a magnificent scale, have been erected by the generosity of the Rev. S. A. Thompson-Yates at a cost of nearly 30,000*l*.

The building is of Liverpool grey brick and Ruabon terra-cotta in the renaissance Gothic style. It is L-shaped, one wing extending towards the north, where it joins the pathological museum of the old medical school buildings, and the other towards the east, the entrance being at the angle where the wings join. There are three floors and a basement. The two upper floors are occupied by physiology, under Prof. Sherrington; and the ground floor and basement by pathology, under Prof. Boyce. A large lecture theatre, the fine staircase and halls, and a few other apartments for the use of students are common to the two departments. Simplicity of plan has been the aim of the architects (Messrs. A. Waterhouse and Son), and there has been little or no expenditure of space in corridors and passages. As some of the rooms are to accommodate large numbers of workers, and so require to be lofty, while others are the private studies of individuals where a high ceiling would mean waste of space, a free use has been made of the expedient of mezzanines, by which the smaller rooms have been interpolated between the floors. The lecture theatre is very completely fitted for lantern illustration, including the projection microscope, the chromoscope, the animatograph, the episcope and skiopticon, and also very perfect arrangements for the projection of the spectrum. The Physiological Department contains, in addition, large rooms for:—Chemical physiology with separate work-places for over fifty students, and fuller accommodation for about six research workers; physical physiology enabling a class of more than thirty to carry out exercises on muscle and nerve at one time, each student's place being provided with electric light, water, gas, electric wire for supply of current, induction coil, electric battery, recording drum driven by fixed pulleys from the shafting running above the table, electric keys, and heliostat apparatus, &c.; histology with accommodation for about eighty students, with adjoining preparation and store rooms; also smaller chemical rooms, professor's private and photographic rooms, room for experiments in electro-physiology, and a smaller theatre for the demonstration of experiments. The Pathological Department has large rooms for:—Morbid histology with work-places for sixty students; bacteriological work with suction and force pumps for filtering, a bacterial mill for pulverising bacteria, and a plentiful supply of steam at high pressure to conduct the various boiling operations. There are also rooms for chemical pathology, museum preparator's work, incubators at constant temperature, private experimental work, pathological diagnosis society, bacteriological work of the city, gas analysis, and the professors' private rooms. Briefly stated the special features of the pathological laboratories are the impervious opaline slabs covering the tops of the work-benches, and diminishing the risk of contamination and facilitating cleaning, the use of steam for boiling operations, a plentiful electric supply working the lamps and the numerous motors, and a specially high-pressure water supply, and lastly the refrigerator chamber. Throughout the Thompson-Yates laboratories are fitted up in the most complete and perfect manner, both for teaching and research; and the favourable opinions which have been so freely expressed by the distinguished scientific visitors during the opening and following days may be briefly summed up in the quotation from Prof. Michael Foster's happy and stimulating speech at the banquet, that "they (the laboratories) produced two physiological effects—they took one's breath away, and they made one's mouth water."

The invitation from the Council and Senate of University College to the opening function was accepted by a large number of distinguished men of science and representatives of universities and medical schools from all parts of the country, including Lord Lister and Lord Kelvin, Earl Spencer and the Earl of Derby, the Bishops of Ripon, Carlisle, Chester and Liverpool, Prof. Virchow, Sir S. Wilks (President of the College of Physicians), the Vice-Chancellor of Cambridge University, Prof. M. Foster and Prof. Burdon Sanderson, the Presidents of the Royal College of Physicians and Surgeons of Edinburgh, Sir W. Turner, Sir W. Gairdner, Sir Douglas Galton, Sir A. Geikie, Sir J. Crichton Browne, Mr. R. B. Haldane, M.P., Mr. Justice Kennedy, Sir James Russell, Prof. Rutherford, Dr. Lauder Brunton, Captain Abney, Prof. Rücker, Prof. Poulton, Prof. Gotch, Prof. Kanthack, Sir R. Thorne Thorne, Prof. Schäfer, and many others. These guests, for the most part in their academic robes, walked in procession with the civic authorities, the University and College staff, forming a ceremonial that for stateliness, brilliance, and interest has probably never been equalled before in Liverpool.

The scientific and medical guests arrived in Liverpool on Friday, and that day and Sunday were given up to private hospitality and informal meetings at the College and elsewhere; while Saturday, October 8, was the date of the University Degree ceremony and the formal opening of the new laboratories.

The University function was arranged to take place in St. George's Hall; and there, in the presence of the Lord Mayor and Corporation, the staff, graduates and students of the University, the distinguished guests, and a large concourse of citizens of Liverpool, the honorary degree of Doctor of Science was conferred upon Lord Lister by Earl Spencer, the Chancellor of the Victoria University.

Lord Lister was presented for the degree by Dr. Richard Caton, Chairman of the Medical Faculty, and formerly Professor of Physiology in University College; and both the Chancellor and Dr. Caton in their speeches drew attention to Lister's immortal life-work in the antiseptic methods of surgery, and to the benefits conferred thereby upon humanity and the lower animals.

After Lord Lister had been admitted to the degree by the Chancellor, and had signed the roll of graduates, the Principal of University College (Mr. R. T. Glazebrook, F.R.S.) made a statement as to the history of the medical school and of the erection of the new laboratories by Mr. Thompson-Yates. The generous donor himself was unable to be present, but a letter from him was read expressing good wishes.

Lord Lister then delivered a short address, for which a vote of thanks was proposed by the Lord Mayor of Liverpool, and seconded (in the absence of Lord Derby) by Mr. W. Rathbone, Vice-President of the College.

Lord Lister pointed out in eloquently simple language the necessity for such laboratories in medical education, their importance both in teaching and research, and the benefits they were calculated to confer upon the College, upon Liverpool, and upon the neighbourhood. Lord Lister then, with a boldness and wisdom which compelled admiration, made a dignified statement as to the utility and humanity of experiments upon animals, which coming from such a man on such an occasion cannot but have a most beneficial effect. He concluded this part of his address with the sentence, "While I deeply respect the humane feelings of those who object to this class of inquiry, I assure them that, if they knew the truth, they would commend and not condemn them."

After the function in St. George's Hall, the company proceeded to University College, where the brief ceremony of declaring the laboratories open was performed by Lord Lister, after the presentation of a key in a silver casket had been made by the Chairman of the College Council. A similar key was retained for presentation to Mr. Thompson-Yates. Lord Lister and the large assembly of invited guests were then conducted in parties through the laboratories; other parts of the College were also visited. Tea and refreshments were served in the Victoria building; and, finally, the Lord Mayor's banquet at the Town Hall in the evening brought to a conclusion the formal proceedings of what stands out as the first great University function in Liverpool.

College functions have been frequent; noble buildings and new laboratories belonging to University College have been opened before; but now for the first time the professors and students appeared not merely as members of the College, but of the Victoria University. Liverpool is to be congratulated not only upon the splendid new laboratories, not only upon the impressive ceremonial of their inauguration, but also upon the fact that the first honorary degree conferred by her University, in the City, has been bestowed upon such a man as Lord Lister.

THE OPENING ADDRESSES AT THE MEDICAL SCHOOLS.

IN respect of an opening address there seems at the medical schools no fixed rule; in some cases the first year's student plunges *in medias res*, and the first word he receives from his teachers is actually work; in others a more or less philosophical discourse, often, it must be admitted, more suited to the practitioner or advanced student, forms the prelude to a medical curriculum. The actual need for an opening address on medical education is really somewhat less than would be thought, since the "Student's Numbers" of the *Lancet* or *British Medical Journal* contain usually all that can possibly be said in the way of general advice to the student, and these every student or his parents read. This fact, doubtless well known to those giving the addresses, is perhaps one explanation of the varied subject-matter which October after October gets worked up and delivered as introductory addresses. What is in a name? Whether the introductory address benefits the first year's student or not, it at any rate forms an excuse for a batch of interesting dissertations, which have at this season of the year, when returning from holiday and bent on work, an effect both stimulating and refreshing. Stimulating, because from these addresses we get glimpses of the varied character and enormous extent of the undiscovered country, which lies open to the scientific explorer; refreshing, because we get a few tastes, as it were, of the fruit of the promised land.

The address of addresses this year was Prof. Virchow's, which was printed fully in these columns last week. The Mason College, Birmingham, was fortunate in having Prof. Michael Foster as lecturer. The subject chosen was the nature and function of a university. Prof. Foster has a high ideal of what a university ought to be, and, in view of the formation of a Midland University, indicated at Birmingham, what should be the aims of those entrusted with the foundation of this University. It is a relief to-day, when universities are rather apt to be regarded as examination-framing and degree-giving machines, to hear an eloquent voice raised which emphasises the value to the medical student of research and individual laboratory supervision, as being not only the best but in the long run the quickest way of teaching him the way to think, and thus attack the problems which the future practice of his profession will present to him.

Mr. Turner, in his inaugural address at St. George's Hospital, directed the attention of his audience to, perhaps, a less ideal, but nevertheless an important subject. Mr. Turner contends, as many have done before, that the profession of medicine is not rewarded proportionally to its merits. Distinctions are *cæteris paribus* conferred less readily on medical men than on members of the legal or clerical profession. Further, authors have done a wrong to the medical profession on many occasions by distorting in fiction and elsewhere its characteristics. This, no doubt, is very true; but one is thankful that it is fast disappearing. That those in authority are not, or rather were not entirely to blame for these grievances is also equally true. The emergence of medical practice from crude empiricism to its present-day condition, demanding on the part of the medical unit higher intellectual faculties, as opposed to mere memory, which bring in their train an increased appreciation of the æsthetic, will certainly remedy the social position of the rank and file of the profession. The effect of this is already seen in the increasing numbers of medical *litterateurs* of the type of Oliver Wendell Holmes, and medical authors. Mr. Turner rightly not only indicated the disease, but suggested a remedy. While deprecating any attempt at organisation allied to trade unionism, he exhorted his hearers "to make by force their merit known," and cultivate amongst themselves an *esprit de corps* which would essentially overcome whatever obstacles it encountered.

A practical medical subject was the text of Dr. Caley's address at St. Mary's Hospital—prevention in medicine. Dr. Caley contended that to whatever extent the science of hygiene might develop, the actual prevention of disease will also depend upon the rank and file of the medical profession and the public. Some interesting points were brought out in this address with regard to some of Dr. Sidney Martin's researches on the effect of organically polluted soil on the retention of vitality by the typhoid bacillus. In the case of virgin soil inoculated with the bacillus, no signs of vitality were found after fourteen, twenty, or twenty-three days; in the case of polluted soil, the bacillus was thriving at the end of seven months. Dr. Caley emphasised the importance to Great Britain as a colonising power of the prevention of malarial fevers, and noted with satisfaction that, thanks to the new army medical regulations, a better class of army medical officer will be forthcoming. The lecturer further considered the application of prevention to tuberculous disease, and in this connection referred to the results of the Royal Commission on Tuberculosis and the recent French Tuberculosis Congress.

An important point in Dr. Voelcker's address at the Middlesex was the caution which he gave to students as to how they spoke of medical matters in lay circles. This might have been extended, as there can be no doubt of the incalculable harm that may be done by a student or doctor who is not possessed of tact. The public as a rule lose no time or spares no pains in making the most of what has the material in it of a medical scandal. Incautious students have before now doubtless unwittingly been sources of great mischief.

At the Royal Free Hospital, Dr. Walter Carr discoursed upon "Fashion in Medicine." Bleeding naturally found a place amongst the historic medical fashions, as also did the administration of calomel. Two present fashions in medicine were, according to Dr. Carr, the anti-toxine treatment and the treatment by animal extracts. At the close of the address he touched, appropriately to his audience, upon the future of the medical woman. He rightly urged the necessity of keeping up the standard of the medical woman, and gave a note of warning with regard to the possibility of the success, which had finally attended the movement, producing a less valuable individual.

The Pharmaceutical Society of Great Britain had the fortune to be addressed by Sir James Crichton Browne. Sir James pointed out that the examination of chemists and druggists ought to proceed on different lines to that of medical students in that the former were, as a rule, earning their livelihood by more or less manual service all the time they were in *statu pupillari*. Sir James discussed the sale of poisons and the possibility of new legislation upon this subject in the immediate future. The average poisoner, according to the lecturer, takes but little advantage of the recent discoveries of science. In this connection he pointed out the popularity of arsenic, which was used by Wonderton in his attempt, in 1384, to poison Charles VI. of France and the Dukes of Valois, Berri, Burgundy, and Bourbon. This drug was also the basis of the "manna" of St. Nicholas of Bari, and Toffania of Naples, which caused the deaths of 600 persons. In Sir James' experience no medical poisoner has ever used a drug outside Schedule A of the Poisons Act. From this circumstance the lecturer drew an interesting inference—viz. that medical poisoners, so far from being intellectual villains, were as a rule dull and stupid to a degree, since much more deadly and much less easily detectable substances lay to their hand, if only they would take the trouble to find them and be original. They are, in fact, another instance of intellectual incapacity being associated with moral debasement. The lecturer then entered upon the subject of disease toxines and allied bodies, and pointed out how in all probability the poisoner of the future would avail himself of this class of poison. In conclusion, the effect of anti-toxines in the prevention of the sequelæ of the infective diseases was pointed out; and basing his observations upon the dictum of Sir William Gull, that a patient took ten years to recover from an attack of typhoid fever, Sir James emphasised the benefit which would accrue to mankind from the use of these remedies.

Dr. Robert Saunby delivered an opening address at the Medical School of University College, Cardiff, on modern universities. The lecturer deplored the condition of university education in England so far as concerns medicine, and pointed to what was done by the State in Germany and France. This theme has been often dwelt upon, and not without effect. England is now waking up to the value of technical education, of creating places where men can pursue those studies which are to form their stock-in-trade for life.

The address at the Yorkshire College, Leeds, was given by Dr. Cullingworth upon the importance of personal character in the profession of medicine. The author referred to an interesting article by Sir James Paget on the result of an inquiry of what became of 1000 of his pupils fifteen years after their entry at St. Bartholomew's. This showed that 9 per cent. died within twelve years of their commencing practice, and forty-one, or about 4·5 per cent., during their pupilage, fifty-six failed entirely, the remainder were successful in all degrees varying from distinguished success to very limited success. This, on the whole, is not a bad average, and if it was possible to the medical student of 1870, more is possible and probable to the medical student of to-day.

From the above brief extracts it will be seen with what varied advice and dissertations the recruits of the medical profession have been introduced to their life study. The practitioner and advanced student, rendered more cynical, perhaps, by contact with his fellows, will be inclined, and possibly not altogether wrongly, to recall the words of Mephistopheles to the would-be medical student in *Faust*, and abide by them :—

> The trade of medicine's easiest of all.
> 'Tis but to study all things—everywhere
> Nature and man—the great world and the small.
> Then leave them at haphazard still to fare.

F. W. Tunnicliffe.

SURGEON-MAJOR J. E. T. AITCHISON, M.D., C.I.E., F.R.S.

BOTANY has lost another of its devotees. Dr. Aitchison died at Kew on the 30th ult., at the age of sixty-three, after two or three years of bad health, consequent on a weak heart and other complications. He was a man of fine physique, and of a genial and happy disposition. The son of Major J. Aitchison, H.E.I.C.S., he was born in India in 1835. After successfully studying medicine and surgery at Edinburgh, he entered the Bengal medical service in 1858, and remained in it for thirty years. But it was as a botanical explorer and an investigator of the vegetable products of the various countries he visited that he was known in the scientific world. Enthusiastic, enterprising, and persevering in no ordinary degree, he succeeded in forming valuable botanical collections under difficulties that would have discouraged and prevented many men. Science is primarily indebted to him for collecting plants and their products and local information concerning them. In these investigations he was indefatigable; and he had a rich field for his labours in North-west India, Afghanistan, Baluchistan, Persia, and Russian Turkestan. He seems to have been led to botanical pursuits by the study of Indian drugs, as in tracing their origin he became familiar with vegetable organography, and acquired a love for plants which he retained to the last. Indeed, he settled at Kew in order to be able to continue his studies. His first contribution (1863) to botanical literature was an enumeration of the plants of the Jhelum district of the Punjab, with notes on their products and distribution. It was in this paper that he published the only new species, I believe, that he ever described independently. For the many novelties he subsequently discovered he always called in professional aid, being too modest and too anxious for accuracy to attempt it alone.

Subsequently, in 1869, he published a catalogue of the plants of the Punjab and Sindh, which, however, was a good deal more than a catalogue. This was followed by a lengthy paper on the flora and vegetable products of Lahul, a "Handbook" on the trade products of Leh, and a number of smaller contributions to botanical literature. But his great harvest was made in Afghanistan and the surrounding countries. In the winter of 1878, he accompanied the troops under General (now Sir Frederick) Roberts into the Kuram Valley, and the following year was appointed botanist to the expedition. A collection of some 15,000 specimens of dried plants was made between Thal and Peiwarkotal, at elevations of 2500 to 15,000 feet. A further collection was made in 1880 in the same country; and in 1884 he was appointed naturalist to the Afghan Delimitation Commission. This was even more fruitful than the previous expeditions, yielding about 800 species, represented by 10,000 specimens. But Dr. Aitchison not only collected specimens; he also collected a large amount of local information concerning them. These immense collections were worked out at Kew, and the results published in the *Journal* and *Transactions* of the Linnean Society. The papers are prefaced by admirable descriptions of the vegetation and local conditions of the districts traversed. Apart from the plants collected by William Griffith during the first Afghan war (1839-40), Kew possessed very little from this interesting region; hence Aitchison greatly enriched the herbarium and museum. In addition to the papers mentioned, he wrote a number of articles on the medicinal and other vegetable products of commercial value. I had almost forgotten to mention that he also collected zoological specimens.

Personally Dr. Aitchison was of a most amiable and kind-hearted disposition, and this, combined with his fine presence, tact and medical knowledge, enabled him to mix with the natives with impunity, and obtain information that others could not. One of the first things he did on arriving at a place was to treat the sick, and his reputation preceded him, so that he was often approached and besought for aid. In 1883 he was created a Companion of the Order of the Indian Empire, and in the same year he was elected a Fellow of the Royal Society of London. Unfortunately the last year of his life was saddened by the loss of his wife, to whom he had been deeply attached.

He was occupied during the last two years in preparing a *Flora Indiæ Desertæ*, to include the plants of North-western India, Baluchistan, and Afghanistan, but his ailments prevented him from doing more than collect materials. It is not possible to find at once an equally qualified person to carry this idea into effect.

Though Aitchison was little in society during the last four or five years, there are many who will feel the loss of one who was such a cheerful companion and warm friend.

W. Botting Hemsley.

CONFERENCE ON THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

AT the Royal Society on Monday evening, the President and Council held a reception to meet the delegates attending the international conference upon an international catalogue of scientific literature. The conference began on Monday, and practically all countries actively engaged in scientific work are represented. The following is a list of delegates appointed to attend the conference :—

Austria.—Prof. L. Boltzmann (Kaiserliche Akademie der Wissenschaften, Vienna); Prof. E. Weiss (Kaiserliche Akademie der Wissenschaften, Vienna).

Belgium.—Chevalier Descamps (President de l'Institut International de Bibliographie, Brussels); M. Paul Otlet (Secretaire-General de l'Institut International de Bibliographie, Brussels); M. H. Lafontaine (Directeur de l'Institut International de Bibliographie, Brussels).

France.—Prof. G. Darboux (Membre de l'Institut de France); Dr. J. Deniker (Bibliothécaire du Museum d'Histoire Naturelle); M. E. Mascart (Membre de l'Institut de France).

Germany.—Prof. Dr. Klein, Geheimer Regierungs-Rath (University of Göttingen).

Hungary.—Dr. August Heller (Librarian, Ungarische Akademie, Buda-Pesth); Dr. Theodore Duka (in London).

Japan.—Prof. Einosuke Yamaguchi (Imperial University of Kioto).

Mexico.—Señor Don Francisco del Paso y Troncoso.

Netherlands.—Prof. D. J. Korteweg (Universiteit, Amsterdam).

Norway.—Dr. Jörgen Brunchorst (Secretary, Bergenske Museum).

Sweden.—Dr. E. W. Dahlgren (Librarian, Kongl. Svenska Vetenskaps Akademie, Stockholm).

Switzerland.—Dr. Jean Henri Graf (President, Commission de la Bibliotheque Nationale Suisse); Dr. Jean Bernoulli (Librarian, Commission de la Bibliotheque Nationale Suisse).

United Kingdom.—Representing the Government: The Right Hon. Sir John E. Gorst, Q.C., M.P., F.R.S. (Vice-President of the Committee of Council on Education). Representing the Royal Society of London: Prof. Michael Foster, Sec.R.S.; Prof. Arthur W. Rücker, Sec.R.S.; Prof. H. E. Armstrong, F.R.S.; Sir J. Norman Lockyer, K.C.B., F.R.S.; Dr. Ludwig Mond, F.R.S.

United States.—Dr. Cyrus Adler (Librarian, Smithsonian Institution, Washington).

Cape Colony.—Roland Trimen, Esq., F.R.S.

India.—Lieut.-General Sir R. Strachey, G.C.S.I., F.R.S.; Dr. W. T. Blanford, F.R.S.

Natal.—Sir Walter Peace, K.C.M.G. (Agent-General for Natal).

New Zealand.—The Hon. W. P. Reeves (Agent-General for New Zealand).

Queensland.—The Hon. Sir Horace Tozer, K.C.M.G. (Agent-General for Queensland).

On Tuesday evening the Royal Society gave a dinner to the delegates at the Hôtel Métropole. Lord Lister occupied the chair, and many Fellows of the Society were present, in addition to the foreign representatives of science. The *Times* gives the following report of the speeches at the dinner:—

Prof. Rücker, in proposing "Science in all Lands," said that science had become the most cosmopolitan of all the professions. In his own case he had this year taken part, more or less, in four international meetings; and he did not think there was any body of men or any other profession in which such cordial arrangements were made for the recognition of merit, foreign or otherwise, as the Royal Society. They had a regular organisation for recognising merit outside the geographical boundaries of the nation to which men belonged. They recognised great scientific triumphs as being triumphs, not for one nation, but for the world. Names like those of Pasteur, Helmholtz, and Maxwell were recognised as names of which the whole world was proud. Science was gradually forming a permanent international conference of scientific men, all communicating with each other by writings, if not by speech, and they were drawn together not only by the bonds of intellectual sympathy but by scientific friendship.

Prof. Darboux, of the University of Paris, acknowledging the toast in French, said that the ideas to which Prof. Rücker had given expression would receive the unreserved adhesion of all those who cultivated science for its own sake. The most illustrious scientific men always retained some trace of their origin and of their race, as might be seen in the differences between the genius of a Descartes, a Newton, a Cuvier, a Darwin, or a Lagrange. German science was characterised by depth and power; French science by greater clearness and better method; while English science, though frequently beset with difficulties and dangers, had by a bold and timely policy rescued free inquiry from being overwhelmed. Whenever men of science met one another face to face, notwithstanding the differences that might separate them, they felt drawn to each other by the bonds of common interests. Every man of science recognised in another seeker after truth, wherever he might be met, a friend; and, though he did not cease to uphold the love for his Fatherland, he was proud to participate, as the delegates were participating now, in a work of peace, concord, and civilisation.

Prof. Weiss, director of the Imperial Observatory, Vienna, in proposing "Success to the Conference," said he had spent a few years in England in early childhood, and had learnt to love the English people; and in declining age he had occasion to admire the scientific men of England—their earnestness and the skilful perseverance with which they carried out their researches. He trusted that the conference would be a success, and that it would form the foundation of an international catalogue of scientific literature which would redound to the benefit of science and to the glory of England.

Sir John Gorst, in acknowledging the toast, said that the conference, as far as his experience had gone, seemed to be an admirable instrument for forwarding the scientific purpose for which it had assembled. In the first place, its wisdom was derived from every part of the world. Amid all this diversity of knowledge, surely it was reasonable to expect that some progress might be made in the work which the conference had in hand. According to the different way in which the question struck the peculiar idiosyncrasy of the different nationalities, they were much more likely to arrive at the truth than if left to blunder it out in their own British fashion without the assistance of minds very diverse from their own. He was not sure that the concert of Europe was in political affairs always a very brilliant success, but he thought that the concert of Europe in scientific affairs, free as it was from the drawbacks which accompanied political action—all the members of a conference of this kind being animated by only one desire, and that was the attainment of truth, having no personal and no national interest to serve outside the attainment of truth—a concert of that kind was one of the most valuable methods which the comity of modern nations had discovered for the propagation of all kinds of science and knowledge.

Prof. Korteweg proposed "The Royal Society."

Lord Lister, in acknowledging the toast, said it had been a great satisfaction to hear from delegates the very cordial feelings expressed towards the society. He confessed that he had sometimes entertained fears that the task undertaken by the conference was too gigantic to be satisfactorily completed, but he felt encouraged that evening when he heard that the work seemed to be going forward satisfactorily, and that there was a fair prospect that it would be completed in such a way as would tend to cement even more firmly than at present the union of international science.

Prof. Armstrong proposed "Our Guests."

Le Chevalier Descamps, delegate from the Belgian Government, expressed the gratitude which the delegates from foreign Governments felt at the kind reception accorded by the members of the Royal Society, and pointed out that their labours all tended in the direction of cementing still more closely the bonds of international scientific brotherhood. Their work in the conference, though being carried on modestly, was bound to be fruitful of good results, for bibliography had no pretensions to reform the world.

Prof. Klein proposed "The Secretaries," which was responded to by Prof. Michael Foster. Among the other speakers were Prof. Boltzmann, Sir Norman Lockyer, M. Mascart, Sir William Crookes, Dr. Graf, and Dr. Cyrus Adler.

NOTES.

WE understand that the vacancy in the Assistant-Directorship of Kew Gardens, caused by the appointment of Mr. D. Morris as Commissioner of Agriculture for the West Indies, will not be filled up. Mr. S. T. Dunn has been appointed Secretary to the Director.

THE *Botanisches Centralblatt* states that Prof. P. Knuth, of Kiel, is starting this month on a scientific expedition round the world, extending over from eight to ten months. He proposes a considerable stay in Buitenzorg, Java, visiting India on his way, and afterwards China and Japan, Honolulu and North America. Prof. K. Goebel, of Munich, is also starting, this autumn, on a botanical journey to Australia and New Zealand.

THE banquet of the Chemical Society to those of its past-Presidents who have completed fifty years' fellowship of the Society, which was postponed last June owing to the lamented death of the senior past-President, Lord Playfair, is now arranged to take place on Friday, November 11, at the Hôtel Métropole. The past-Presidents who will then be entertained are:—Sir J. H. Gilbert, F.R.S., Sir Edward Frankland, F.R.S., Prof. Odling, F.R.S., Sir F. A. Abel, Bart., F.R.S., Dr. A. W. Williamson, F.R.S., and Dr. J. H. Gladstone, F.R.S.

PROF. S. SCHWENDENER, of the University of Berlin, has been made a Knight of the Order *pour le mérite* in the class of science and art. We learn, from the *Botanical Gazette*, that the Order was founded by Frederick the Great, as a mark of distinction for military service; but the statute was revised in 1842 by Frederick William the Fourth, to include scientific men and artists of distinction. The latter class is limited to thirty Germans and thirty foreigners. The order is practically conferred by vote of the members. Prof. Schwendener is the only botanist who has been elected.

UPON the nomination of the Director of Kew Gardens, Mr. C. A. Barber has been appointed Government Botanist at Madras, in succession to the late Mr. M. A. Lawson.

THE Welby Prize of 50*l.*, offered for the best essay on "The causes of the present obscurity and confusion in psychological and philosophical terminology, and the directions in which we may hope for efficient practical remedy," has been awarded to Dr. Ferdinand Tönnies, of Hamburg.

AT the national observatory upon the Pic du Midi, a few days ago, two busts of General Champion de Nansouty and the engineer, M. Vaussenat, the founders of this useful meteorological establishment, were unveiled. M. Mascart, to whose suggestion the erection of the busts is due, and M. Baillaud, director of the Toulouse Observatory, delivered addresses to an audience of about five hundred persons who had assembled in the observatory.

THE handsome amphitheatre at the new Sorbonne has inscribed on the ceiling (says the *Chemist and Druggist*) the names of forty-five illustrious chemists. England is well represented by Cavendish, Priestley, Wollaston, Dalton, Davy, Faraday, Graham, and Griess—eight in all. The twenty-six French names are Lavoisier, Berthollet, Leblanc, Proust, Vauquelin, Thénard, Gay Lussac, Dulong, Chevreul, J. B. Dumas, Dessaignes, Balard, Boussingault, Pélouze, Laurent, Gerhardt, Regnault, Péligot, Cahours, Ebelmen, Fremy, Wurtz, Henri St. Clair Deville, Debray, and Pasteur. Sweden is represented by Scheele and Berzelius, Russia by Zinin and Butlerow, Belgium by Stas, Switzerland by De Marignac, and Germany by Mitscherlich, Wöhler, Liebig, Kolbe, and Kekulé.

SIR WILLIAM MACCORMAC, BART., and Sir Francis Laking have been appointed Knights Commander of the Royal Victorian Order, and Mr. A. D. Fripp and Fleet-Surgeon A. G. Delmege have been appointed Members of the Fourth Class of the same Order, in recognition of their services in connection with the recent accident met with by H.R.H. the Prince of Wales. The Royal Victorian Order is bestowed upon "such persons, being subjects of the British Crown, as may have rendered extraordinary, important, or personal service to Her Majesty, her heirs and successors, and who have merited Her Majesty's royal favour."

THE Harveian Oration will be delivered by Sir Dyce Duckworth on Tuesday next, at the Royal College of Physicians. The Bradshaw Lecture will be delivered by Dr. W. M. Ord on Thursday, November 10. The Goulstonian Lectures will be given next year by Dr. G. R. Murray, who has taken for his subject the Pathology of the Thyroid Gland. The Lumleian Lectures for next year will be given by Dr. Samuel Gee. The Croonian Lecturer for 1899 is Prof. Bradbury, and for 1900 Dr. F. W. Mott, F.R.S.

A MEETING of the Institution of Mechanical Engineers will be held on Wednesday and Thursday evenings, October 26 and 27, at the Institution of Civil Engineers, Great George Street, Westminster. The chair will be taken by the president, Mr. Samuel W. Johnson, at half-past seven p.m. on each evening. The following papers will be read and discussed, as far as time permits:—"Electric installations for lighting and power on the Midland Railway, with notes on power absorbed by shafting and belting," by W. E. Langdon; "Results of recent practical experience with express locomotive engines," by Mr. Walter M. Smith; "Mechanical testing of materials at the locomotive works of the Midland Railway, Derby," by Mr. W. Gadsby Peet.

A CIRCULAR informs us of a proposal to place in Corsock Parish Church, by half-guinea subscriptions, a suitable memorial to the memory of Prof. James Clerk Maxwell. There is already in the church a memorial to the memory of his father, John Clerk Maxwell, by whose influence and exertions the church was originally built. "This church," we read, "is chosen for the memorial, as the Professor's connection with it through life was very close. He was led to it as a child by his father; taught in its Sabbath School; was ordained an elder within its walls, and acted as such up to the time of his death; gave liberally towards its endowment, and the first and largest subscription towards the manse; was a trustee of the church and properties; and otherwise interested himself in its behalf." Subscriptions for the memorial may be sent to the Rev. George Sturrock, The Manse, Corsock, by Dalbeattie, N.B.

THE fifth International Congress of Hydrology, Climatology and Medical Geology, was held during last and part of the present week at Liège, Belgium, under the patronage of H.R.H. the Crown Prince of Belgium, and the Presidency of the Minister of Agriculture. The Congress was well attended by representatives of various nationalities. Many important communications were read and discussed in the various Sections, but the most interesting was an address given before the whole Congress by Prof. Walthere Spring, Professor of Chemistry at the University of Liège, on the colours of natural waters. Prof. Spring showed experimentally that the true colour of pure water is blue as in the Lake of Geneva, and that this colour is the colour proper to the water, and is not due to a mere reflection from the surface, nor from suspended particles in the water. When pure water has a very slight cloudiness, due to the presence of finely divided nearly white or colourless particles in suspension, even if these are absolutely colourless, as in the case of very finely divided rock crystal, a yellow tint is given to the water, which, together with the natural blue proper to the water itself produces a green colour, as in the cases of the Lakes of Neuchatel and of Constance. He remarked that it had been noted by various observers that the water of certain lakes usually green becomes occasionally absolutely colourless, and this he showed was due to the washing into the lakes of a fine mud of a reddish tint due to oxide of iron, which neutralises the green colour of the water, rendering it for the time being perfectly colourless. In connection with the Congress, interesting excursions were made to visit the bathing establishments, and to inspect the sanitary arrangements of Ostend and Middlekerke, Spa, Chandfontaine, and Aix-le-Bains. The Sanitary Institute was represented by Dr. Corfield, the Professor of Hygiene and Public Health at University College, London, who was elected an Honorary Vice-President of the Congress, and was also appointed the English Member of an International Committee which was formed for the purpose of inquiring into the means to be adopted for the preservation of the purity of the sources of natural mineral waters.

A COMPLIMENTARY dinner was given to Prof. Virchow at the Hôtel Métropole on Wednesday in last week. The chair was occupied by Lord Lister, and more than two hundred representatives of medical science and practice were present. Lord Lister, in proposing the toast of the evening, dwelt upon the versatility of the genius of the distinguished guest, his eminence as a pathologist being equalled by his reputation as an anthropologist and antiquarian. He referred particularly to Virchow's "Cellularpathologie," which work, he remarked, "swept away the false and barren theory of a structureless blastema, and established the true and fertile doctrine that every morbid structure consists of cells which have been derived from pre. existing cells as a progeny. Cellular pathology is now universally recognised as a truth. Even those morbid structures which deviate most from the normal structure are known to be derived as a progeny from normal tissue—from normal cells, driven to abnormal development by injurious agencies." In acknowledging the toast, Prof. Virchow made allusion to Huxley and his work in these words: "I have been touched by the confidence you have placed in me in choosing me to renew the remembrance of the great investigator whose commemoration we have just been celebrating. My task the other day demanded that I should demonstrate Huxley's influence upon the development of medical science. To-day I wish to emphasise that his merits in anthropological and ethnological respects are so great in the eyes of German investigators that they alone would suffice to procure immortal reverence for his name. We shall not cease to follow in his footsteps and to defend the place which he has assigned to man in nature. Together with you we will try to clear up in every direction the biological history of man. May this task still further confirm and strengthen the solid union of English and German science. May the corporations of Great Britain and Ireland, which form a bulwark of medical science and practice that has remained unshaken for centuries, continue to give the world by teaching and example a guarantee that the results of our science may benefit mankind in an ever increasing degree."

INOCULATION against plague has been accomplished on a very large scale at Hubli. The present population of Hubli is about 40,000, and a correspondent of the *Times of India* reports that up to September 7, 35,000 had been inoculated as a protection against plague, while about two-thirds of this number had been inoculated twice. Out of the whole proportion, therefore, there only remained about 5000 people who had not been inoculated at all; and by far the greater number of deaths which occurred were amongst these people. The returns for the first week in September show amongst 32,000 inoculated persons 69 attacks, and amongst 8500 uninoculated 417 attacks, which facts speak for themselves. The chief medical officer, Dr. Leumann, is writing a report on the results which he has obtained from inoculation, and this ought to prove most interesting not only to those who are connected with plague, but to all the races who live in India. It is to be hoped that the report will be widely distributed, in order that the practical proofs which have been obtained may become the means of giving confidence to the wavering, and to those who at present regard the system of inoculation with fear, and are disposed to treat it with resistance.

A TRIBUTE to the genius of Lord Kelvin is paid by Prof. Oliver Lodge in the form of an article in the *Liverpool Daily Post* (October 4). After describing some of the ingenious devices and instruments which have made Lord Kelvin's name known to the public, Prof. Lodge refers to his more purely scientific work in the following terms:—"The modern theory of electricity, developed so brilliantly by Clerk Maxwell, was begun by him. The science of thermodynamics owes much to him; the theoretical laws of thermoelectricity were wholly worked out by him; and to him long ago is due the theory of those electric oscillations which were elaborated practically by Hertz, and have recently been exciting some popular interest as affording a method of wireless telegraphy. In the higher regions of optics also he has worked much, and in his Baltimore Lectures and elsewhere has striven to unveil the mystery of the connection between ether and matter, as revealed in the facts of radiation, fluorescence, phosphorescence, selective absorption, and dispersion. The definition and the experimental determination of the absolute zero of temperature are both due to him. The vortex theory of matter constitutes one of his most brilliant but incompletely worked out speculations. The kinetic theory of its elasticity and rigidity is a definite contribution to that view of the physical universe which seeks to resolve the whole of merely material existence into the two fundamental entities—ether and motion. Let any one ask what is the size of an atom, and he is referred to Lord Kelvin. Let him ask what is the age of the earth, and if he mean anything definite by this question—if he mean, for instance, what time has elapsed since the earth was a molten mass beginning to cool, it is again to Lord Kelvin that he must go. And then the tides; all the higher mathematical work on the tides, with their various causes and perturbations, is based on Kelvin's pioneering work, and to him all writers on this abstruse subject look up and defer as their master." The words in which Prof. Lodge concludes his article glow with appreciation. They are:—"Happy in the circumstances of his education, pertinacious in his unwearying industry, and undistracted by other interests from a constant devotion to definite dynamical science, narrow perhaps in some of its aspects, but all the more intense for that, he stands before us now a monument of human power and influence, one of the benefactors of the human species, one who has been happily preserved with hardly diminished energy for nearly sixty years of peaceful epoch-making work, one on whom posterity will heap high honours, and will regard with feelings of envy us of the present generation who are still illuminated by his living presence."

ON account of its practical importance, the influence of the chemical composition of a glass upon its coefficient of expansion has attracted the attention of several workers, more especially Fizeau, Schott, Châtenet, and Grenet. In the current number of the *Moniteur Scientifique* is an interesting *résumé*, by M. A. Granger, of the results obtained up to the present in this very complicated field. The simple rule tentatively proposed by Schott, that the expansion follows an additive law, is only approximately followed in a few cases, as quite a considerable number of substances, such as the oxides of lead, calcium, manganese, aluminium, and boron, possess the property of lowering the dilatation when added in small quantities, and raising it when the proportion is increased. The addition of either potash, soda, lithia, fluorspar, lime, or calcium phosphate raises the coefficient of expansion of a glass, but with the exception of the last, which may be added up to 20 per cent., not more than 8 per cent. can be used. For proportions higher than this, the glass either refuses to take up any more, or else becomes devitrified and opaque. Calcium borate, oxide of iron, alumina, and silica have the effect of lowering the coefficient of expansion, alumina being especially active in this respect.

THE following neat result in the dynamics of impact is proved by Ingegnere D. De Francesco in the *Rendiconto* of the Naples Academy for July :—In the impact of two perfectly smooth solid bodies, the kinetic energy due to the velocities lost is a minimum compatibly with the final value of the difference of normal velocity of the points of contact. It is to be observed that the function which De Francesco proves to be a minimum is not the actual kinetic energy lost by impact, but a quadratic function of the differences of velocities before and after impact of the same form as the kinetic energy. The theorem is somewhat analogous to several of the "minimum" theorems given in the chapter on "Vis Viva" in Dr. Routh's familiar "Elementary Rigid Dynamics," and, to use a common way of speaking among mathematicians, the result "comes out in about a line."

WE have received from Major-General Schaw a copy of papers read before the Wellington Philosophical Society, on Australasian weather charts and New Zealand storms. Charts were exhibited illustrating types of summer and winter storms, and showing their progress eastward from the Great Australian Bight to New Zealand. The author urges that the phenomena exhibited in these charts of horizontal motion and atmospheric pressure, need for their elucidation a knowledge of the vertical circulation. With this object he has constructed a wind vane showing the wind direction both vertically and horizontally, and has made careful observations during several months. The observations showed that at times the upward or downward inclination prevails for hours, while at other times there may be for hours no regular deviation from the horizontal. The author refers to similar experiments by Prof. A. Klossovski at Odessa, which have been noticed in our columns, but makes no mention of those made by the Rev. M. Dechevrens at Zi-ka-wei Observatory.

THE Report of the Meteorological Commission of the Cape of Good Hope for the year 1897 has been published. Barometric and thermometric observations are recorded from forty-six stations, and observations of rainfall from 336 stations. As an encouragement to continuous observations, the Commission presents to observers the instruments with which they have made a series of satisfactory observations for a period of not less than five years. Among the contents of the Report, in addition to the meteorological statistics and summaries, are useful notes for the guidance of observers, prepared by Mr. C. M. Stewart, Secretary of the Commission, and a short paper by Mr. A. Struben, upon the rainfall maps of South Africa, prepared by Dr. A. Buchan. The Report is illustrated by a map showing the distribution of summer and winter rainfall in percentages of the mean annual fall over the whole of South Africa, and by diagrams showing the mean monthly rainfall in each division, and the departures from the means of 1885–94. Another report of meteorological observations lately received contains the results of observations made during 1897 in the four Government observatories at Bangalore, Mysore, Hassan, and Chitaldrug, under the direction of Mr. J. Cook. A comparison is made between the results for 1897 and the means of the weather elements at these places during the last five years.

A NOVEL plan has recently been carried out at the Avonmouth Dock, at Bristol, for increasing the capacity of the lock so as to adapt it for the use of the larger vessels which have for the last few years been coming into use. The length between the gates of the lock, as originally constructed, is sufficient to dock a vessel 425 feet in length; but the vessels now trading between Bristol and Canada are 465 feet long, and could therefore only enter and leave the dock at spring tides. To provide for their entering at all tides, the useful length of the dock has been increased by the adoption of a floating steel caisson which fits into grooves cut in the masonry of the lock walls beyond the outer gates, and which serves the same purpose as the gates, only giving an increased length to the space available for locking of 40 feet. This caisson is 70 feet long, 30 feet wide, and 46 feet high. When the vessel has entered the lock, the caisson is floated from its berth and placed in the grooves; the tanks are then filled with water sufficiently to sink it on to its sill. When the locking is completed, the water is pumped out, and the caisson floated back to its berth. The steamer *Montrose*, which arrived from Canada a few days since with a large cargo of provisions, on a neap tide, and which is 465 feet in length, was the first vessel to be docked by the aid of the caisson.

THE Report of Dr. D. Prain, the Director of the Botanical Survey of India, for the year 1897–98, is largely occupied by a continuation of Prof. Woodrow's Flora of Western India. He records the botanical explorations which have been made during the year of portions of Assam and Burma; in the latter of which great assistance was rendered by Lieut. E. Pottinger, R.A.

A NEW edition of Mr. C. J. Woodward's "Arithmetical Chemistry," Part i., has been published by Messrs. Simpkin, Marshall, Hamilton, Kent, and Co., Ltd. The book has been rewritten, with additions in the form of hints and suggestions for experimental work as a basis for the lessons. Elementary students of chemistry are thus instructed in laboratory methods, as well as given numerous arithmetical problems which will help to make them understand the value of quantitative work.

VOL. I. No. 2 of the *Records of the Botanical Survey of India* is entitled a "Note on the Botany of the Kachin Hills north-east of Myitkyina." It is, however, more than a "note," consisting of a record of the results of Lieut. E. Pottinger's journey through this district of Burma. After some preliminary general notes on the Botany of the Kachin Hills by Lieut. Pottinger and Dr. D. Prain, a complete list is given of the Flowering Plants and Vascular Cryptogams collected, the district proving especially rich in Orchideæ. A small map is appended.

MR. STANFORD has now concluded the arrangements for the completion of the re-issue of his "Compendium of Geography and Travel." The Europe volumes are in the hands of Mr. George G. Chisholm, who has finished Volume i., comprising the countries of the mainland (excluding the north-west), and has Volume ii., covering the British Isles, Scandinavia, Denmark, and the Low Countries, in hand. The volumes on Central and South America have been entrusted to Sir Clements Markham and Mr. A. H. Keane, and they will be furnished with the usual maps and illustrations. Mr. Stanford hopes to complete the issue of the series in the course of 1899.

FROM the United States we have the following botanical publications of taxonomic interest:—Revision of the Mexican and Central American species of *Galium* and *Relbunium*; and Diagnoses of New and Critical Mexican Phanerogams, by J. M. Greenman (Contributions from the Gray Herbarium of Harvard University); also Onagraceæ of Kansas, by Prof. A. S. Hitchcock, with sketch-maps of the distribution of each species (in French and English, published at Le Mans). And from Australia:—Contributions to the Flora of New Guinea; Contributions to the Flora of Queensland (Fungi); and Edible Fruits indigenous to Queensland; all by F. M. Bailey.

AN elaborate illustrated catalogue of chemical and physical apparatus has been issued by Messrs. Reynolds and Branson, Ltd., Leeds. No less than three thousand separate pieces of apparatus are numbered in the catalogue, and very many of them are illustrated. The large number of physical appliances and instruments included in the catalogue is an indication of the important part which instruction in physics now takes in science schools. Teachers of practical science, more especially those working in connection with the Department of Science and Art, will find the catalogue serviceable when considering the purchase of apparatus.

M. C. SCHUYTEN publishes in the *Bulletin* of the Belgian Academy a continuation of his researches on the double salicylates of certain metals and antipyrin. He now finds that the salicylates of magnesium, of manganese and of lead, as well as certain others previously investigated, give rise to compounds with antipyrin, while he has found it impossible to realise, under the same conditions, the formation of double salicylates of aluminium, of chromium, and of uranium and antipyrin. The case of bismuth is reserved for future consideration. M. Schuyten calls attention to the instability of these compounds in which water easily promotes dissociation.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*, ♀) from West Africa, presented by Mrs. Henry Lloyd; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Mrs. Snowden; an Indian Wild Dog (*Cyon aukhunensis*, ♂) from India, presented by Surgeon-Lieut.-Colonel J. Duke; an Egyptian Jerboa (*Dipus ægyptius*) from North Africa, presented by Mr. David Devant; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mrs. Molteno; a Golden Eagle (*Aquila chrysætus*), British, presented by the Rev. F. Foxhambert; a Black-headed Caique (*Caica melanocephala*) from Demerara, presented by Master Bertie Standing; a Common Squirrel (*Sciurus vulgaris*) from Austria, presented by Mr. A. M. Wigram; a Puma (*Felis concolor*) from America, a Reticulated Python (*Python reticulatus*) from the East Indies, deposited.

OUR ASTRONOMICAL COLUMN.

VARIABLE STARS IN CLUSTERS.—American astronomers have, during the last few years, made great advance in increasing our knowledge relating to variable stars. Nor have they limited themselves to photographic surveys of variable stars of the ordinary type, but have been examining clusters of stars to detect variability. Prof. Bailey, who has been very successful in this direction, has just undertaken a systematic search which has led him to some most interesting results (*Harvard College Observatory Circular*, No. 33). This *Circular* informs us that the whole number of stars examined in the photographs was 19,050, of which 500 were found to be variable, thus representing a variability of about 3 per cent. This at first does not seem a very high percentage, but, as Prof. Pickering points out, "it does not follow, however, that clusters in general contain more variable stars than occur elsewhere, for, if we except the four clusters ω Centauri, Messier 3, Messier 5, and Messier 15, which contain 393 variables, an average of 7 per cent., the remaining 19 clusters have 116 variables among 13,350 stars, or less than 1 per cent." Even clusters which are equally rich in stars show great differences in this respect: thus the great cluster in Hercules (Messier 13) has only two variables out of 1000 stars, while in Messier 3, of 900 stars, 132 are variable. Not only have variables in these clusters been detected, but their periods and light curves are being carefully determined. In the case of the cluster ω Centauri, which up to the present has received most attention, 150 photographs have been taken with the 13-inch, and already 10,000 measures have been made. Of the 3000 stars used in this cluster for comparison, 125 have been recorded as variable. The periods of 106 have been determined, and 98 of these have periods less than 24 hours, the largest range in variation being about 5 magnitudes; no star is included which varies less than half a magnitude. Prof. Pickering has divided these 98 variables into four classes, namely, those which have a very rapid rise to maximum, those like η Aquilæ with a secondary maximum, those whose times of increase and decrease are about equal, and lastly those which drop very suddenly from maximum to minimum: attention is called also to the marked regularity in the periods. In referring to the kind of clusters in which variables have been detected, he says that up to the present time only such dense globular clusters as Messier 3, Messier 5, and the great cluster in Hercules have been found to contain them.

LARGE METEORS IN 1897 AND 1898.—Mr. W. F. Denning in the *Observatory* for the present month brings together a number of notes concerning fireballs and bright meteors which have been observed in England during the last year and a half. In many cases sufficient and accurate information was available to enable their real paths to be determined. The radiant-points which have been derived from these observations are in most cases, as he says, very interesting, as they suggest evidence of new showers or corroboration of others previously observed.

As we have on several occasions in this column pointed out the great necessity of obtaining accurate and complete information of the path of these roving bodies through our atmosphere, so that observations may be comparable with one another, it is encouraging to read, and Mr. Denning himself is the writer, that "it is clear . . . that this department is receiving more attention than formerly. It is hoped that this interest will continue to increase, and that the fortunate spectators of fireballs will never forget to record those all-important features, viz. the direction and position of the flight amongst the stars and the duration of visibility."

REMINISCENCES OF AN ASTRONOMER.—Prof. Simon Newcomb continues in *The Atlantic Monthly* for September his reminiscences, from which we make the following few extracts. In one of his journeys to observe a total eclipse of the sun he went to Gibraltar, and one of the first things he did the morning after his arrival was to choose "a convenient point on one of the stone parapets for 'taking the sun,' in order to test the running of my chronometer. I had some suspicion as to the result, but was willing to be amused. A sentinel speedily informed me that no sights were allowed to be taken on the fortification. I told him I was taking sights on the sun, not on the fortification. But he was inexorable; the rule was that no sights of any sort could be taken without a permit." Needless to say Prof. Newcomb soon obtained the required permit, and was allowed to continue his sights without interruption.

Having some important work to do with regard to the motion of the moon, and the Franco-Prussian war being on at the time, Prof. Newcomb went to Berlin, *viâ* Naples to pass the winter, and to wait till the war was over, until he could visit Paris. Having arranged his luggage so that on landing at Naples the Custom House officer should find anything that was subject to duty at the top of his trunk, the officer contemptuously threw the top things aside, and devoted himself to a search at the bottom. "The only unusual object he stumbled upon was a spy-glass enclosed in a shield of morocco. Perhaps a gesture or a remark on my side aroused his suspicions. He opened the glass, tried to take it to pieces, inspected it inside and out, and was so disgusted with his failure to find anything contraband in it that he returned everything to the trunk, and let us off."

Speaking of Prof. Auwers, who "stands at the head of German astronomy," he says, "in him is seen the highest type of the scientific investigator of our time, one perhaps better developed in Germany than in any other country. The work of men of this type is marked by minute and careful research, untiring industry in the accumulation of facts, caution in propounding new theories or explanations, and, above all, the absence of effort to gain recognition by being the first to make a discovery." Journeying to Pulkova to visit Otto Struve, Prof. Newcomb relates many interesting reminiscences. After mentioning that the instruments which Struve designed sixty years ago still do the finest work of any in the world, he tells us that the air there "is remarkably clear; the entrance to St. Petersburg, ten or twelve miles north, is distinctly visible; and Struve told me that during the Crimean war he could see, through the great telescope, the men ou the decks of the British ships besieging Kronstradt, thirty miles away." Towards the latter part of these reminiscences, Prof. Newcomb mentions his meeting with Hansen, "who was at odds with him on a scientific question," the question being that Hansen was the author of a theory that the further side of the moon is composed of denser materials than the side turned towards us. We must, however, leave our readers here to study this article for themselves for further details, as we have already extended this note beyond the usual limit.

THE CAPE OBSERVATORY REPORT.—Dr. Gill's report to the Secretary of the Admiralty of the work done at the Cape Observatory during the year 1897, shows the great state of activity which has pervaded the whole atmosphere of the observatory during the past twelve months. It will be remembered that Mr. McClean last year made a stay at the Cape to complete his spectroscopic survey of all stars down to 3·5 magnitude, his 20-degree prism being fitted on to the 12-inch astrophotographic telescope. Unfortunately Mr. McClean's magnificent gift to the observatory did not arrive from Dublin during his stay, as was expected, so that he was deprived of the pleasure of witnessing its erection. The observatory for this instrument is completed as far as possible, and is only now waiting for the arrival of the heavy portions of the telescope. The rising floor and its hydraulic machinery have been set up, and, as Dr. Gill says, "the whole has been admirably designed by Mr. McClean and Mr. Osbert Chadwick, ... it was erected here under my personal supervision by Cape workmen, and acts to perfection." The plans for the new transit circle and observatory have been settled in complete detail, and both will be executed with as little delay as possible. The transit circle has been employed chiefly for observations of standard stars required for the reduction of measures of the Catalogue photographic plates. A system of double watches with this instrument was organised so that the observers would be ready to take up the fundamental meridian work with the new transit circle in 1900. Both the equatorials have been employed, and the 7-inch was chiefly used by Mr. Innes for observing the stars in four lists forwarded by Prof. J. C. Kapteyn. In this work a star of the eighth magnitude was discovered "having an annual proper motion amounting to nearly 9″ of arc on the great circle, *the largest proper motion yet known.*" Besides several uncatalogued nebulæ, Mr. Innes has found no less than 128 new double stars. Many of our readers may not be aware that Mr. Innes is secretary, librarian, and accountant to the establishment, but "has applied himself to the revision of the Durchmusterung and other extra-meridian work (which he has performed as a labour of love), in addition to the thorough discharge of his official clerical duties." To refer to the work accomplished and proposed for the heliometer, the observations of the zenith telescope, the state of current reductions, publications, time service, would make this note too long, so we will only confine ourselves, in conclusion, to the fact that proposals have been sent forward for erecting a suitable building for a physical laboratory and accommodation for records and astrographic work.

ZOOLOGY AT THE BRITISH ASSOCIATION.

ALTHOUGH the foreign zoologists who had attended the International Congress at Cambridge a week before did not stay on for the British Association meeting, as had been expected, still the attendance at Section D was good, and many of the papers were of an interesting character. The number of papers was not large, so the Section did not meet on Saturday and Wednesday.

Prof. Weldon's presidential address gave a useful popular discussion of some of the principal objections which are urged against the theory of Natural Selection, and showed (1) that the law of chance enables one to express easily the frequency of variations among animals; (2) that the action of Natural Selection upon such fortuitous variations can be experimentally measured; and (3) that the process of evolution is sometimes so rapid that it can be observed in the space of a few years.

The Section did not sit in the afternoon, but a Biological Exhibition at the Clifton Zoological Gardens was opened at three o'clock by Sir John Lubbock.

Friday, September 9.—The following papers were taken:—Prof. E. B. Poulton, on the proof obtained by Marshall that *Precis octavia-natalensis* and *P. sesamus* are seasonal forms of the same species. The specimens were exhibited.

Mr. F. Galton, on photographic records of pedigree stock. This was for the purpose of urging the systematic collection of photographs and information as to pedigree stock. Galton's ancestral law proves the importance of a much more comprehensive system of records than now exists. A breeder ought to be in a position to compare the records of all the near ancestry of the animals he proposes to mate together in respect to the qualities in which he is interested. More especially he ought to have access to photographs, which indicate form and general attitude far more vividly than verbal descriptions. Mr. Galton considers that every important stallion or bull should have a pamphlet all to himself, with photographs of his ancestry and with appropriate particulars about each of them. Mr. Galton, finally, proposes a scheme for the consideration of societies which publish stud books.

Mr. W. Garstang, on the races and migrations of the mackerel. From the examination of a large number of mackerel Mr. Garstang is able to distinguish the following three races:—(1) American, (2) Irish or Atlantic, and (3) North Sea and Channel. Each of these races, he considers, does not wander far from its own coast in winter, and does not mix with the other races, but merely moves out into deeper water. Mr. Garstang also gave, along with Mr. H. N. Dickson, an account of the connection between the appearance of mackerel and the changes of sea temperature in spring and autumn. Whether the movements of the mackerel are determined directly by the temperature or indirectly through food was left unsettled; but the authors proposed a more detailed biological and physical investigation of the English Channel.

Prof. A. B. Macallum gave a short paper calling attention to points in the microchemistry of cells. A report was presented by the Committee on Zoological Bibliography and Publication, and also one by the Index Animalium Committee, giving an account of Mr. Sherborn's work at the Natural History Museum. The Canadian Biological Station Committee, appointed last year at Toronto, reported in favour of a floating station to be established in the Gulf of St. Lawrence for five years. Their application to the Dominion Government for an appropriation for construction and maintenance has been granted.

The report from the Plymouth Marine Biological Laboratory contained an account by Mr. G. Brebner of his algological work, by Mr. F. W. Gamble on his investigation of the nerves of Arenicola, Nereis, and other Polychæts by the methylene blue method; and by Prof. Hickson on the embryos of Alcyonium collected by Mr. Wadsworth.

The Committee on the Zoology of the Sandwich Islands stated that work was in progress, and that they hope to be able soon, with the aid of the Royal Society and the Bishop Museum in Honolulu, to publish a volume of investigations.

Dr. Arthur Willey's paper "On the phylogeny of the Arthropod amnion" stated that the importance of the problem lies in the fact that the principle which will account for the amnion of insect embryos is the same as that which has been applied by Prof. Hubrecht to the mammalian amnion. The insect amnion is not cenogenetic and is not due to mechanical causes, as is the prevailing impression, but it is of palingenetic significance. The material which supplied the necessary data for coping with this problem consisted of the embryos of a species of *Peripatus* (*P. novæ britanniæ*) which Dr. Willey found in New Britain last year. These embryos possess a remarkable trophic organ, the epidermal layer of which is called the trophoblast, and the latter is the forerunner of the serosa of insect embryos—the serosa being the essential structure in connection with the embryonic membranes of insects, the amnion being accessory or incidental to the serosa.

The report from the Naples Zoological Station, in addition to the usual statistical information as to the progress of the station, contained accounts by the three naturalists who have occupied the British Association table during the year as to their special work. Mr. J. F. Gemmill investigated the pseudobranch and the intestinal canal of Teleosteans. Mr. H. M. Vernon writes on the relations between marine animal and vegetable life in aquaria; and on the relations between the hybrid and parent forms of echinoid larvæ. Mr. J. Parkinson worked at the variation of species of *Cardium*, *Donax*, and *Tellina*. The object of Mr. Vernon's interesting work was to determine how the nitrogenous matter excreted by marine animals into the water is removed, and what parts the various forms of vegetable life and other agencies play in the process. Bacteria are of importance. It was found that the pipes conducting the water from the reservoirs to the rooms were coated internally with a layer of bacterial slime, and that in its passage along these pipes the water underwent considerable purification. Probably in marine aquaria a more powerful purifying influence than the bacterial is exerted by the diatoms and minute algæ.

An interim report was presented by the Committee on Bird Migration in Great Britain; and the Rev. T. R. R. Stebbing discussed the report of the International Zoological Congress on Nomenclature.

The final report of the Oyster Committee was presented by Prof. W. A. Herdman, who gave an account, illustrated by lantern slides, of the chief conclusions arrived at. The report ends with the following recommendations:—

(*a*) That the necessary steps should be taken to induce the oyster trade to remove any possible suspicion of sewage contamination from the beds and layings from which oysters are supplied to the market. This could obviously be effected in one of two ways, either (1) by restrictive legislation and the licensing of beds only after due inspection by the officials of a Government Department, or (2) by the formation of an association amongst the oyster-growers and dealers themselves, which should provide for the due periodic examination of the grounds, stores and stock, by independent properly qualified inspectors. Scientific assistance and advice given by such independent inspectors would go far to improve the condition of the oyster beds and layings, to reassure the public, and to elevate the oyster industry to the important position which it deserves to occupy.

(*b*) Oysters imported from abroad (Holland, France, or America) should be consigned to a member of the Oyster Association, who should be compelled by the regulations to have his foreign oysters as carefully inspected and certificated as those from his home layings. A large proportion of the imported oysters are, however, deposited in our waters for such a period before going to market that the fact of their having originally come from abroad may be ignored. If this period of quarantine were imposed upon all foreign oysters, a great part of the difficulty as to inspection and certification would be removed.

(*c*) The grounds from which mussels, cockles and periwinkles are gathered should be periodically examined by scientific inspectors in the same manner as the oyster beds. The duty of providing for this inspection might well, we should suggest, be assumed by the various Sea Fisheries Committees around the coast.

Dr. H. Lyster Jameson exhibited examples of a race of protectively coloured mice that inhabit a sandy island in the Bay of Dublin, known as the North Bull. A considerable percentage of these mice are distinctly lighter in colour than the ancestral type (*Mus musculus*, Linn.). Every possible intergradation, however, occurs between the typical house mouse and the palest examples. Mr. Jameson considers the marked predominance ot sand-coloured examples as due to the action of natural selection. The hawks and owls, which frequent the island and hunt by "sight," are the only enemies the mice have to compete against, and they most easily capture the darkest mice; that is to say, the mice that contrast most strikingly with the colour of the sand; and thus by the weeding out of the dark-coloured examples a protectively coloured race is becoming established, which, however, has not yet settled down into the comparative stability which usually characterises species.

A reference to old charts and Parliamentary papers has shown that this island first came into existence about a century ago; consequently it is in this case possible to fix a time limit within which the race in question has been evolved.

Monday, September 12.—The Section opened with an interesting account, by Prof. Poulton and Miss C. B. Sanders, of an experimental inquiry into the struggle for existence in certain common insects. A large number of lepidopterous pupæ were exposed under various conditions at Oxford, in Switzerland, and in the Isle of Wight, in order to test by experiment the amount of destruction by birds and other enemies, and also to determine what amount of protection was afforded by coloration. The results showed that there is a heavy death-rate in the pupal condition, and apparently that there is a greater destruction of pupæ at Oxford than in Switzerland. An interesting discussion followed, in which Sir John Lubbock, Prof. Lankester and Prof. Meldola took part. Miss Sanders described and demonstrated with specimens the actual details of the experiments and observations.

Prof. Lloyd Morgan followed with a paper on animal intelligence as an experimental study, which dealt largely with the results of Mr. Thorndike's experiments in America with cats. It was shown that the cats, in opening the doors of ingeniously devised cages, learned gradually by experience, and were not able to profit by imitation. This performance of purposive acts, learned as the result of chance experience, was characterised as intelligent in contradistinction to rational. Prof. Morgan expressed the opinion that without the record of the genesis of an intelligent action observation and anecdote of animal intelligence are of little importance; and in answer to Sir John Lubbock, and others who spoke in the discussion, he stated that the advantage of simple experiments, such as those of Thorndike, over observations, is that the results can be readily expressed in curves.

Dr. A. J. Harrison read a paper on his own observations in the Clifton Zoological Gardens, on the so-called fascination of snakes. The animals dealt with were pythons, both adult and young; and it was shown that in captivity, at least, there was no evidence that they possessed the power of fascinating their living prey, such as hens, ducks and rabbits.

Prof. O. C. Marsh gave a paper on those families of the Dinosauria, which he has called Sauropoda—such as Ceteosaurus and its allies—upon which he has a memoir ready for publication.

Dr. Masterman read a paper by Prof. McIntosh on the scientific experiments to test the effects of trawling in the waters of Scotland from 1886 to 1897. The areas dealt with were St. Andrews Bay, the Firth of Forth, and the Moray Firth, and Prof. McIntosh gave his reasons for dissenting from the conclusion drawn from the work of the Fishery Board for Scotland, that the closure of areas against trawlers had led to an increase in the fish population.

The remaining papers were:—A new theory of retrogression, by Mr. G. A. Reid; the structure of nerve cells, by Dr. G. Mann; and a circulating apparatus for use in researches on colour physiology and other purposes, by Messrs. F. W. Gamble and W. F. Keeble.

Tuesday, September 13.—The following papers were taken:— Mr. R. I. Pocock, on musical organs in spiders; Dr. A. T. Masterman, on the origin of the vertebrate notochord and pharyngeal clefts; Prof. Ch. Julin, on "Le développement du cœur chez les Tuniciers—quelques considérations sur la phylogénie des Ascidies simples"; Mr. W. E. Hoyle, on Dr. Field's card-catalogue of zoological literature; Mr. F. A. Bather, on the classification of the Pelmatozoa; Prof. A. B. Macallum, on the detection of phosphorus in tissues; and two reports of Committees, one on the physiological effects of peptone and its precursors when introduced into the circulation, and the other on the exploration of caves in the Malay Peninsula.

Prof. Julin in his paper dealt with the formation of the heart from the epicardium and its homology with the stolon. He showed reasons for regarding *Distaplia* as a central form linking the other compound ascidians to the simple ascidians through the Clavelinidæ.

The Peptone Committee report that their experiments make it appear probable that peptones and albumenoses are not wholly foreign substances to the circulating blood. It is, however, uncertain to what extent any given substance introduced into the circulation is again recoverable from the urine, and how long such substances can retain their identity after being so introduced. Anti-peptone seems to remain in the system to a much greater extent than any of the other substances employed.

As Section I did not meet this year, but was supposed to be incorporated with D, several of the papers and reports—such as the one last mentioned—were of a physiological nature.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE Geographical Section at Bristol was as a rule well attended, and on one occasion crowded; but, as happens too frequently, the audience had a tendency to vary inversely as the scientific value of the communications submitted to it. Yet on the whole the twenty-five papers read were of high quality, and some of them represented original work in research as well as in travel. The President, Colonel George Earl

Church, formerly of the United States Army, gave an address full of original observations on the central parts of South America, in the course of which he traced the origin of the main features of that continent. This address as printed is enriched with a series of maps and diagrams.

Seven important papers were read on various branches of physical geography, most of them being illustrated by lantern slides. Mr. Vaughan Cornish discussed wave-forms, giving the preliminary results of a research in which he is engaged on the phenomena of waves in water, air, and drifted sand. The results were made clear by a large number of carefully selected photographs and diagrams.

Mr. H. N. Dickson gave a brief account of his work on the salinity and temperature of the North Atlantic, which promises to produce results of great value. His paper described the first results of a discussion of observations of surface temperature made in the North Atlantic, during the two complete years 1895 and 1896, by the captains and officers of merchant ships. The captains of a number of the vessels also collected daily samples of surface water, and the densities of these, numbering about 5000 in all, have been determined by chlorine titration. The material has been found sufficient to allow of the construction of charts showing the distribution of temperature and salinity over a large part of the area during each of the twenty-four consecutive months. The series, which is the first of its kind, shows the progressive changes in the manner of synoptic charts, and provides the data necessary for extending the work recently done in and around the North Sea, in connection with sea-fisheries and long-period weather forecasting. Specimens of the maps were shown on the screen.

Dr. K. Natterer, of Vienna, submitted the oceanographical results of the Austro-Hungarian Deep-Sea Expeditions in the Eastern Mediterranean, Sea of Marmora, and Red Sea. He referred especially to his own chemical observations and the deductions made from them. Of these the most striking was the presumption that the salt-deposits of arid regions surrounding a deep sea were due to the evaporation of sea-water raised by capillarity through the substance of the rocks.

A report by Mr. E. G. Ravenstein was presented on behalf of the Committee for the investigation of the climatology of Africa. The efforts of this Committee during the last seven years have resulted in inducing a number of the African colonial governments to institute regular meteorological observations, and the Committee feels that it is no longer necessary to supply instruments to unofficial observers, although several of the sets supplied to missionaries and others have led to the compilation of important records.

Dr. J. W. Gregory discussed the theory of the arrangement of oceans and continents on the earth's surface in the light of geological and physical observations, He pointed out that Elie de Beaumont's famous scheme attached undue importance to linear symmetry and was too artificial. It led, however, to the tetrahedral theory of Lowthian Green, which regards the world, not as shaped like a simple tetrahedron, but as a spheroid slightly flattened on four faces. Such flattenings occur on hollow, spherical shells, when they are deformed by uniformly distributed external pressure. The oceans would occupy the four depressions thus produced, and the land masses occur at the angles and along the edges. The existing geographical arrangement is in general agreement with this scheme; for as the tetrahedron is hemihedral the assumption that the lithosphere is tetrahedral explains the antipodal position of land and water, the excess of water in the southern hemisphere, and the southward tapering of the land masses. The main lines of the existing system of fold-mountains have a general agreement with the arrangement of the edges of a tetrahedron. Some striking deviations occur, but are explicable by the variations in the composition of the lithosphere, and the existence of impassive blocks of old strata which have moulded the later movements. The lines of the old fold-mountains of the Hercynian system may have been tetrahedrally arranged, with the axes occupying different positions from those of the great Cainozoic mountain system. So far, however, there is no completely satisfactory theory of geomorphology, for which we must wait for further information as to the distribution of land and water in successive epochs of the world's history.

Two important papers on earthquake phenomena were read—one by Prof. J. Milne, F.R.S., on the methods and utility of seismological research; the other by Mr. R. D. Oldham, on the great Indian earthquake of June 12, 1897, which was the largest and, with a few possible exceptions, the most violent of which there is any record. The area over which the shock was sensible was not less than 1,750,000 square miles, while the focus occupied an area of 200 miles in length and 50 miles in width. Landslips on an unprecedented scale were produced in the Garo and Khasia hills, and in the Himalayas north of Lower Assam. A number of lakes have been produced by changes of level due to the earth-movements by which the earthquake was caused, and the mountain peaks have been moved both vertically and horizontally. Monuments of solid stone and forest trees have been broken across by the violence of the shaking they have received. Communications of all kinds were interrupted; bridges were overthrown, displaced, and in some cases thrust bodily upwards to a height of as much as 20 feet, while the rails on the railways were twisted and bent. Earth fissures were formed over an area larger than the United Kingdom, and sand rents, from which sand and water were forced in solid streams to a height of 3 to 5 feet above the ground, were opened in incalculable numbers.

Dr. J. Scott Keltie in a short paper on "political geography" laid stress on the way in which natural conditions determined the manner of the relations between land and people, and showed how changing economic conditions produced corresponding changes in political geography, *e.g.* the formation of such forms as spheres of influence and leased territories. A paper by Mr. G. G. Chisholm, on the impending economic revolution in China, enforced by a concrete instance of great practical importance some of the theoretical considerations brought forward by Dr. Keltie.

Mr. H. T. Crook, of Manchester, criticised the methods of selecting place-names for the Ordnance Survey Map, and brought forward several errors in the sheets of the new one-inch map of the Manchester district. The paper gave rise to a lively discussion, in which Mr. G. F. Deacon supported the contention of the author; while Colonel Farquharson and Sir Charles Wilson, the present and late Directors-General of the Survey, fully explained the methods employed and showed the enormous difficulties with which the whole question of place-names is surrounded. They stated that the Survey always welcomed criticism, and that corrections were frequently made on the plates as the result of information sent by people in the localities when mistakes occurred. It was suggested that the public could aid in the production of good maps more effectually by communicating with the Survey Office than by writing critical articles in the press.

A group of papers submitted to the Section dealt with geographical developments of the future. Prof. Reclus brought forward his scheme for a great terrestrial globe on the scale of 1 : 500,000, or about 84 feet in diameter. The surface of this globe should exhibit the relief of the lithosphere on a true scale, and separate plates of it would be available for use as relief maps upon a surface showing the natural curvature. M. Reclus spoke with great eloquence of the scientific and educational advantages of his scheme, the initial cost of which, however, could not fall far short of 50,000*l.* In the discussion Sir Richard Temple spoke in support of the work being carried out, and a Committee of Section E was appointed by the General Committee to consider and report upon the scientific value of the proposal.

Prof. Patrick Geddes described an interesting experiment in the practical teaching of geography about to be tried in Edinburgh, where he is fitting up an "outlook tower" or geographical museum of a novel character. Thus the exhibition of the ground-floor centres round a globe with an outline survey of the main concepts of world geography—*e.g.* an incipient collection of maps and illustrative landscapes, an outline of the progress of geographical discovery and of map-making, &c. The first floor is devoted to the geography and history of Europe in correspondingly fuller treatment; the second is set apart for an outline geography and history of the English-speaking world, the United States having a room on the same level as the British Empire. On the third story is preparing a corresponding survey of Scotland, viewed at once as an historic and social entity and as an element of greater nationality; while the fourth story, naturally as yet in the most advanced state of preparation, is a museum of Edinburgh, though again not without comparison with Scottish and other cities. The flat roof bears a turret of culminating outlook with a *camera obscura*. Descending from the roof to the upppermost story, this succession and unity of the physical, organic and social conditions is better understood.

Thus the relief model of the site of Edinburgh brings indispensable light on the interpretation of the antique and the modern city, its military history or its industrial present, its medical eminence or its picturesque interest. Similar regional towers should be erected in all large towns. A tower as a memorial to Cabot was recently opened in Bristol, presenting some features which might be developed on the lines of Prof. Geddes' conceptions, but no reference was made to it at the meeting of Section E, nor was the Section invited to visit the tower.

Ballooning as an aid to geographical exploration was discussed by Captain B. Baden-Powell, of the Scots Guards, who outlined a well-considered scheme for an experimental balloon voyage up the Nile valley, where the meteorological conditions are more favourable than those of the Arctic regions, and the chances of disaster more remote. Mr. Eric Stuart Bruce exhibited a method of flash signalling by means of an electric lamp enclosed in a transparent balloon, which he believes to be of special value in polar exploration.

Dr. H. R. Mill discussed the prospects of Antarctic research, tracing the historical changes of the Antarctic problem, and pointing out that the purely scientific importance of south polar exploration demands co-operation amongst simultaneous expeditions rather than consecutive work. He hoped that the definite refusal of Government to take up the work would now leave the way clear for the immediate organisation of a great expedition by the British nation to co-operate with the German expedition which has been planned for 1900.

While the characteristic of this meeting was undoubtedly the solid value and good discussion of the general papers, it in no way fell short of the meetings of preceding years in the interest and value of the records of personal exploration. Mrs. Bishop gave a remarkable paper describing her recent journey in the Yangtze valley, and summarising the geography of that important region. It was illustrated by a series of unique photographs taken by Mrs. Bishop herself. Mrs. Theodore Bent also contributed a paper describing her visit to Sokotra, in the course of which she made valuable observations. A Committee, with a small grant in aid of the further exploration of Sokotra by Dr. H. O. Forbes, was appointed by the Association.

Sir Charles Wilson gave an address on the Upper Nile region with reference to the re-conquest of the Sudan; and, in the absence through illness of the author, he also read a paper, by Sir T. H. Holdich, on Tirah, which was splendidly illustrated by slides. Mr. C. W. Andrews, of the Natural History Museum, gave a preliminary account of Christmas Island in the Indian Ocean, where he has recently spent the greater part of a year. He found it to be an upraised coral island, the coral limestone resting on a hard foraminiferal limestone, which in turn is based on basalt. The whole island is so densely jungle-clad that it could only be traversed at the rate of one mile per day, every yard having to be cut through the dense undergrowth. Captain G. E. H. Barrett-Hamilton described a recent visit he had made to Karaginski Island and the mainland of northern Kamchatka, and Mr. O. H. Howarth added another to his important series of papers on the exploration of Mexico, dealing on this occasion with a journey from Mazatlan to Durango across the Sierra Madre.

It may be pointed out as a disappointing feature at the meeting, that no effort appears to have been made to place before the Section any account of the remarkable geographical position of Bristol with respect to site, immediate surroundings, or commercial position in the world.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Mr. W. Beckit Burnie has been appointed to the vacant Senior Demonstratorship in Electrical Engineering at the South-Western Polytechnic, Chelsea. Mr. Burnie has studied at the Nottingham University College; under Prof. Ayrton, at the Central Technical College; and under Prof. Weber, of Zürich.

Dr. M. C. Schuyten, rue van Luppen 31, Anvers, invites teachers who are daily engaged in instructing children to make notes upon the characteristics of the minds of their pupils, and send them to him for incorporation in a work to be published by a special commission upon the psychology of the child from a pedagogic point of view.

The foundation-stone of a new Science and Art School for Deptford was laid in New Cross Road on Saturday. The new school is the result of an amalgamation by the Charity Commissioners of two ancient charities—the Addey and the Stanhope—and the joint school is to be known as the Addey and Stanhope Foundation. The new building will cost for erection 10,000*l*., and for furniture and fittings about 4000*l*.

A course of twenty-four lectures and practical demonstrations on the theory and practice of photography, by Mr. W. J. Pope and Mr. A. A. Donald, commenced on Friday last at the Goldsmiths' Institute, New Cross. Mr. Pope is giving a course of twenty-eight lectures on metallurgy, and a course of laboratory instruction on methods of water analysis commenced on Wednesday, October 5. The course will extend over twelve evenings, and the students will obtain practice in the chemical methods ordinarily used to ascertain the degree of purity of water and its suitability for various manufacturing and domestic purposes.

In an address delivered to the members of the London School Board on Thursday last, Lord Reay, the Chairman of the Board, remarked: Training in physics is found to be preferable to chemistry, and the laboratories now in construction are, as a rule, so fitted as to be adapted to the teaching of physics rather than for specialised instruction of chemistry. Geography in the past has been taught too mechanically. Map-drawing has been revived and greatly improved, but more attention should be given to physical geography, to the great phenomena of nature, to the laws influencing climate, productiveness of soil, &c. History should be connected with geography, and the lessons should be given in such a manner as to make history and geography illustrate each other.

The Directors of Nobel's Explosives Company, Limited, after consultation with Dr. G. G. Henderson, Freeland Professor of Chemistry in the Glasgow and West of Scotland Technical College, have decided to give a prize tenable under the following conditions: (1) The prize to be 30*l*. and to be known as the "Nobel Company Prize." (2) The prize to be awarded annually, until further notice, to a student in the chemical laboratory of the Technical College, who has passed through the usual course of training in that laboratory, and who, in the opinion of the Professor of Chemistry for the time being, is qualified to prosecute research. (3) The holder of the prize to engage in research work in the chemical laboratory of the Technical College, under the direction of the Professor of Chemistry for the time being, for the period of one academical year. (4) The prize to be awarded by the Professor of Chemistry for the time being. In accepting the gift, the Governors of the College further resolved to grant a free studentship for one year in the laboratory to the Nobel Company's prizeman, thus raising the money value of the prize to about 50*l*. The example of Nobel's Company might profitably be followed by other chemical manufacturers.

The Scotch Education Department has issued a circular in further explanation of the scheme of organised science instruction in various classes of schools recently proposed (see p. 408). The schemes proposed in aid of systematic instruction based upon the teaching of science, or in which science is a predominant element, are two—viz. (1) the scheme for higher grade (science) schools, and (2) the scheme for schools of science defined in the Science and Art Directory. The former is especially designed to apply to secondary departments, which, while possessing a distinct organisation, are connected with schools aided under the Education Code, which possesses the necessary equipment for giving practical instruction in science, and in which the predominant aim is intended to be scientific. It is thought that the scheme provides a course of instruction specially suitable for pupils leaving school at the age of fifteen or sixteen, who will in after life for the most part follow industrial or commercial pursuits. Having regard to the increasing importance of a thorough training in science, especially in large industrial centres, the circular points out that schools of science should by preference be absolutely independent institutions, having their own premises, equipment, and staff, in which instruction in science can be carried to a much higher point than obtains at present; and it is hoped that such schools of science, in the proper sense of the term, will be before long established in the large towns. But for the present, on good cause being shown, the existing practice of recognising, as schools of science, the science sides or departments of secondary schools, will not be departed from. The science side must, however, be clearly separated from the classical or language side of such schools. In view of the presumably greater age of pupils in a secondary school, it will be required, as a condition of the continued recognition of a school of science, that a considerable proportion of the pupils shall proceed to the advanced course; and the inspectors will be directed to make strict inquiry into the reasons which prevent pupils who have enteted upon the course, and are still in attendance at the school, from completing the curriculum.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 3.—M. Van Tieghem in the chair.—The analysis of some commercial specimens of calcium carbide, by M. Henri Moissan. If calcium carbide is prepared from impure materials, it is liable to contain calcium phosphide and aluminium sulphide, both decomposable by water, giving hydrogen phosphide and sulphide respectively. In the residue left after treatment with water, besides lime, there is found calcium, iron, and carbon silicides, calcium sulphide, and sometimes graphite. Crystals of silica are also present, but a careful search for diamonds gave negative results in all the samples examined. The acetylene produced by the action of water upon the carbide contains traces of sulphur compounds other than sulphuretted hydrogen.—Increase of weight of the body, and the transformation of fat into glycerine, by M. Ch. Bouchard. In the course of some observations upon the changes of weight in a man placed under such conditions that the only *ingesta* conld be atmospheric air and the only *excreta* moisture and carbonic dioxide, a distinct gain of weight was observed. Repetitions were made confirming this, the gain being on one occasion as much as 40 grams per hour. After a discussion of the possible ways of accounting for this increase, the conclusion is drawn that the only probable explanation is to be sought in the conversion of fat into glycogen, according to the equation

$$C_{55}H_{104}O_6 + 30O_2 = 12H_2O + 7CO_2 + 8C_6H_{10}O_5.$$

Experiments made on animals fed with fatty diet confirmed this view.—On the distribution of farm manure, by M. P. P. Dehérain. An experimental study of the losses of ammonia and carbonic acid by farm manure exposed to intermittent currents of air.—Observations of the planet DQ Witt (August 13), made with the large equatorial of the Observatory of Bordeaux, by MM. Rayet, L. Picart, and F. Courty.—On interscapulo-thoracic amputation in the treatment of malignant tumours of the upper extremity of the humerus, by M. Paul Berger. In both the cases operated on by the author a radical cure was effected, the recovery being very rapid. Out of forty-six cases of this operation on record, only two were attended with fatal results.—Observations of comets made at the Observatory of Rio de Janeiro, by M. L. Cruls.—Observations of the 1898 Comet (Perrine-Chofardet), made at the Observatory of Besançon, by M. L. J. Gruey.—On a class of contact transformations, by M. E. O. Lovett.—On the preparation and properties of the double carbides of iron and chromium, and of iron and tungsten, by M. Percy Williams. A mixture of chromium oxide (200 gr.), iron (200 gr.), and carbon (70 gr.) is heated in the electric furnace for five minutes with a current of 900 amperes and 45 volts. The carbide can be isolated from the fused mass in metallic needles, having the colour of nickel. A double carbide of iron and molybdenum is obtained in a similar manner. The formulæ of these compounds are $3Fe_3C.2Cr_3C_2$ and $Fe_3C.Mo_2C$.—New combinations of phenylhydrazine with certain metallic salts, by M. Pastureau. Combinations of phenylhydrazine with $BiCl_3$, $Bi(NO_3)_3$, $ZnSO_3$, and $MnSO_3$ are described.—On the vivipary in an annelid (*Dodecaceria concharum*), by MM. Félix Mesnil and Maurice Caullery.—On the tactile impression due to the contact of a succession of reliefs representing a mobile object in its different positions. With practice it is possible to rapidly recognise a relief by touch, and if a series of reliefs follow each other at a certain rate, the effect of movement is obtained. Thus the motion of the flight of a bird may in this way be imparted to the blind.

BOOKS, PAMPHLET, SERIALS, &c., RECEIVED.

BOOKS.—Skiagraphic Atlas: J. Poland (Smith, Elder).—Seismology: J. Milne (K. Paul).—A Treatise on Dynamics of a Particle: Dr. E. J. Routh (Cambridge University Press).—L'Année Biologique, 1896 (Paris, Reinwald).—In the Forbidden Land: A. H. S. Landor, 2 Vols. (Heinemann).—Reliquary, Vol. iv. (Bemrose).—Qualitative Chemical Analysis Chapman Jones (Macmillan).—A History of Chemistry: Prof. E. Von Meyer, 2nd edition, translated by Dr. G. McGowan (Macmillan).—The Illustrated Annual of Microscopy (Lund).—Uber die Theorie des Kreisels: F. Klein und A. Sommerfeld, Heft 2 (Leipzig, Teubner).

PAMPHLET.—Report on the San Jose Scale in Maryland: W. G. Johnson (College Park, Md.).

SERIALS.—Kew Bulletin, October (London).—Reale Istituto Lombardo, Rendiconti, Serie 2, Vol. xxxi Fasc. 15 and 16 (Milano).—Imperial University, College of Agriculture, Bulletin, Vol. 3, No. 4 (Komaba, Tokyo).—Mind, October (Williams).—Journal of the Royal Statistical Society, September (Stanford).—Engineering Magazine, October (Strand).—Geographical Journal, October (Stanford).—Atlantic Monthly, October (Gay).

Philip's Celestial Globe (Philip).—Philip's Popular Globe (Philip).

CONTENTS.

THURSDAY, OCTOBER 20, 1898.

PEARY'S "NORTHWARD OVER THE GREAT ICE."

Northward over the "Great Ice." A narrative of life and work along the shores and upon the interior ice-cap of Northern Greenland in the years 1886 *and* 1891–1897. *With a description of the little tribe of Smith Sound Eskimos, the most northerly human beings in the world, and an account of the discovery and bringing home of the "Saviksue" or great Cape York meteorites.* By Robert E. Peary, Civil Engineer, U.S.N. With Maps, Diagrams, and about eight hundred Illustrations. In two volumes. Pp. lxxx + 522 and xiv + 626. (London: Methuen and Co., 1898.)

IT may safely be said that the title-page is the dreariest in this book. It lacks the quaintness which enlivened the gossipy titles of the sixteenth century, and it does not altogether dispense with the necessity for a table of contents. The maps also are extremely disappointing, and it is to be regretted that the English edition at least was not provided with a well-executed map of part of the polar regions on a fair scale, especially as Mr. Peary repeatedly found errors in the existing charts which his observations enabled him to correct. The new work, however, has probably been postponed until the expedition on which Mr. Peary is now engaged—the survey of the Arctic archipelago, north of Greenland—has been carried out. We are promised a full discussion by specialists of the various branches of science studied by the members of the various expeditions, the record of which fills these volumes. They profess only to give a popular account of the work accomplished, and they do this in a full and satisfactory manner. The almost innumerable illustrations differ in quality, but many of them are remarkably clear and some have an artistic beauty that is unusual.

The outward form of the book is like that of most books of popular travel, but within there are marked differences. The amounts of time occupied and of space covered were so large that the narrative had to be compressed (to the detriment of the printing towards the end), in order to get it into two volumes. Hence, as the author states, there was no room for padding. An excellent device is that of following each section describing an expedition with a summary of the objects and results. One result not mentioned is that Mr. Peary has obtained more experience of long-distance sledge-travelling with dogs, and of life at extremely low temperatures, than any other living man.

With regard to these Arctic journeys it is desirable to point out that they are the work of one man, an enthusiast determined to persevere in the attempt to accomplish his plans, but absolutely unfettered by the instructions or advice of others. The United States Government have done no more for him than to renew his leave with increasing reluctance, the scientific societies have supported him, but could only give very small money grants, a few private friends have done something to help forward the expeditions; but in every case the greater part of the funds has been provided by the efforts of Mr. and Mrs. Peary themselves. All they have been able to make they have put into the equipment of the new expedition, and from a pecuniary point of view it is impossible that the labours of so many years of effort can meet with an adequate reward.

Mr. Peary is very frank in expressing his opinion about himself, he bases his passion for Arctic travel mainly on sentiment, but the sentiment bears fruit in sober plans, laborious scientific researches, and a terse manly narrative of occurrences.

The object of the first journey in 1886 was "to gain a practical knowledge of the obstacles and ice conditions of the interior of Greenland, to put to the test of actual use certain methods and details of equipment, to make such scientific observations as may be practicable, and to push into the interior as far as possible."

The results were the attainment of a greater distance inland and a higher elevation on the inland ice than had been previously done by any white man, and a great deal of valuable experience as to equipment and methods. Mr. Peary, on his return, drew attention to three lines along which the crossing of Greenland from west to east should be attempted, and he demonstrated that the attempt was practicable.

In 1888 Dr. Nansen succeeded in crossing the south of Greenland from east to west; and accordingly Peary concentrated his attention on the northern routes, although it was not until the summer of 1891 that he was able to escape from official routine and resume exploration.

The objects of the 1891–92 expedition were the determination of the northern limit of Greenland overland the possible discovery of the most practicable route to the pole, the study of the Smith Sound Eskimos, and the securing of geographical and meteorological data.

The results were highly satisfactory. The conditions of travel over the smooth elevated surface of the inland ice were worked out, one of the most interesting details being the use of an odometer or measuring wheel attached to a sledge, in order to give distances by dead reckoning; another was to demonstrate the possibility of sleeping at the lowest recorded temperatures in the open air without either tent or sleeping bag. The inland ice was found to have the same shield shape in the extreme north as Nansen showed it to have in the south, and the surface was smooth and unbroken, except near the edges and where the glacier basins dipped to the north. The insularity of Greenland was determined to Mr. Peary's satisfaction, grass was found growing, and musk-oxen feeding north of the ice-cap; and still further north, beyond a narrow strait, low land was discovered free from ice. In addition, comprehensive meteorological and tidal observations were made at the base station on Inglefield Gulf, the shores of which were surveyed, and the tribe of Arctic Highlanders were exhaustively studied and photographed as no tribe of Eskimos had been before.

The expedition of 1893–94 set out with an ambitious programme. A large party was to cross the ice-cap to Independence Bay on the north-east coast, and there to divide: part going north in an attempt on the pole, part turning south to trace the unknown east coast of Greenland. It was a failure. Mr. Peary points out that the efforts he was obliged to make to raise funds prevented him from exercising sufficient care in selecting his companions. He broke one of his own rules by taking too many, and the majority of them turned out totally unfit for the work. The climatic conditions, too, were very unfavourable, a succession of furious gales was encountered with temperatures down to – 60° F., but before acknowledging defeat a magnificent effort was made to cross the ice-cap.

In 1894-95 Mr. Peary remained in Greenland, whilst his wife, their little daughter, and the majority of his party returned to the United States. One white companion, Lee, and the negro servant, Henson, alone remained faithful, and in the spring of 1895 Peary and Henson, provided with insufficient supplies, once more made the long tramp across the inland ice, rising to over 8000 feet, and back again, 1200 miles in all, reaching the base with one surviving dog and no food. The hardships were severe, and it was impossible to extend the observations at Independence Bay beyond those made in 1892, but the effort was heroic. A visit to Cape York before returning was rewarded by the discovery of the sources of native iron which Sir John Ross heard of in 1818. They were found to be three large meteorites, and the summer trips of 1896 and 1897 were successful in bringing them back (see NATURE, vol. lvii. p. 132.)

During these expeditions the knowledge of the Arctic regions had been greatly advanced by other explorers, and the drift of the *Fram* convinced Mr. Peary that the only reasonable chance of reaching the pole was from the north of Greenland. To this purpose he now intends to devote himself, and his plan is to become for the time practically an Eskimo, living in snow igloos, and accompanied by a few picked families of the Smith Sound tribe, every individual of which he has come to know well. Experiments during his three winters in the far north have convinced him that it is quite practicable in good weather to travel with sledges during the Arctic night, although of course the greater part of his journeys will be done in summer.

Apart from the direct work of the Peary expeditions, great scientific advantages have accrued from the summer parties he has taken up in successive years. These included Prof. Chamberlin of Chicago, Prof. Heilprin of Philadelphia, Prof. Tarr of New York, and a large number of other specialists; and already some important monographs, such as those of Prof. Chamberlin on Glacial Phenomena, have been published.

In meteorology there is one fact of great importance clearly demonstrated, which Nansen refers to as probably true in the account of his crossing of Greenland. It is that the wind always blows strongly outward from the interior. Once arrived at the summit level of the ice-cap, whether going east or west, Peary always found a strong favourable wind, enabling him to use sails on the sledges. The condensation of air by the extreme cold of the high plateau would naturally give rise to outflowing winds, and the question arises how far this area of permanent low temperature, producing a permanent anticyclonic condition at an altitude of from 5000 to 10,000 feet, may not be responsible for the existence of the low-pressure area south-east of Greenland, which exercises so large an influence on the climate of north-western Europe. The influence of the constant down-draught carrying air from high regions of the atmosphere to sea-level has probably not been hitherto sufficiently considered by meteorologists, and the observations in Greenland suggest what the condition of things on the Antarctic ice-sheet must be. Föhn effects of a very remarkable kind were observed by Peary giving rise on one occasion to deluges of rain, which were instantly afterwards converted into solid ice. HUGH ROBERT MILL.

MODERN MYCOLOGICAL METHODS.

Mykologische Untersuchungen aus den Tropen (*Mycological Researches in the Tropics*). By Dr. Carl Holtermann. Pp. viii + 122, and Plates. (Berlin: Gebrüder Borntraeger, 1898.)

THE exceedingly important and original investigations prosecuted during a sojourn of fourteen months in Ceylon, Java, Borneo, and the Straits Settlements, by Dr. Holtermann, can only be compared with the admirable work done by Dr. Möller in Brazil, inasmuch as both authors adopted the Brefeldian method of research by means of pure cultures, and both paid special attention to the simpler forms belonging respectively to the Ascomycetes and the Basidiomycetes. Dr. Holtermann commences by creating a new genus belonging to the Hemiasci, and utilises it as a means of perpetuating for all time the full name of the talented author of "Unters. aus dem Gesamm. der Mykologie" by calling it *Oscarbrefeldia*.

Failing a terse generic diagnosis, the salient features of the genus cannot be ascertained morphologically. The species is *O. pellucida*, bearing remarkably large conidia. The asci are terminal or rarely intercalary, and at maturity contain four 1-septate spores. A second new genus appertaining to the Hemiasci is *Conidiascus*, which, like the preceding, occurs in "Schleimfluss" on trunks of trees in company with various Anguillideæ, Bacteria, Oidium, &c. The feature of this species is that the apparent asci are in reality conidia, the protoplasm of which becomes differentiated into spores; if a structure develops, the protoplasm of which remains unsegmented, it has been considered as a conidium; if the contents divide into several bodies, each capable of germination, it has been considered as an ascus containing spores; in the present species the two are considered as conidia exhibiting a difference of degree only as to division, or not, of the protoplasm. Coming to the Basidiomycetes, we find a new species of *Lentinus* described as *L. variabilis*. Under certain conditions of culture the germinating spores produced a fertile structure resembling the genus *Hypochnus*, considered as a very primitive type of the Basidiomycetes. Under a different set of conditions, spores of the same *Lentinus* gave origin to structures resembling *Clavaria*, a type much higher than *Hypochnus*. Hence the author says:—

"Hier liegt ein Fall vor, der sich mit einigem Recht zu phylogenetischen Speculationen verwenden lässt. Den der Pilz durchläuft Entwickelungsstadien, die selbständigen Formen in der freien Natur entsprechen. Das erste Stadium findet in *Hypochnus*, das andere in *Clavaria* fast einen Doppelgänger."

It has been known for a long time that species of *Lentinus*, when developing on wood in dark places, as pits, cellars, &c., assumes very grotesque forms in which the pileus is suppressed, and the stems consequently more or less resemble species of *Clavaria*, but hitherto every one considered these productions simply as monstrosities due to an exceptional environment. Whether these antiquated views, or the later one propounded by Dr. Holtermann prove to be correct, we consider yet remains to be proved.

Polyporus polymorphous, as found in nature, resembles a bracket in form attached by one edge to the matrix, from which it projects at right angles. The spores of this species in cultures produce a thin crust attached by its entire under surface to the substratum, its upper surface being covered with pores bearing the hymenium, a *Poria* in fact. In this case again, systematists have long known that the higher forms included under *Polyporus*, *Fomes*, and *Polystictus*, not unfrequently develop the resupinate or *Poria* form, often showing every transition from one to the other; but this was included under the presumed elasticity of the species, as such forms are developed more especially when the fungus occurs in conditions different from those under which it appears in its normal or highest known stage of development. Every departure from the normal form of a species cannot surely be considered as a retrogression towards a phase lower in the evolution of the species, even if the exceptional development bears a resemblance to some genus lower in the scale of organisation, and through which phase the species under consideration may presumably be supposed to have passed. Pure cultures in various nutritive media grown on a slip of glass come under the category of things grown under conditions that may be termed as exceptional, to say the least, and the fact that such developments represent phases in the normal life-history of the species investigated, or indicate its phylogeny, has yet to be proved.

Another new genus is named *Van Romburghia*, the one species stands as *V. R. silvestris*.

In the introduction the author states that as his principal object is to elucidate the life-history of forms, he has not attempted pedantic diagnoses of forms. Having been sufficiently pedantic to establish five new genera, and above a score of new species, the amount of pedantry would not have been much accentuated by the addition of diagnoses of each of these. Apart from interpretations bearing on the cultures, every mycologist will welcome the work done by Dr. Holtermann, which is a model of exactness, and bears on its face the stamp of accuracy. The twelve plates add much to the value of the work.

G. MASSEE.

OUR BOOK SHELF.

Applied Magnetism: an Introduction to the Design of Electromagnetic Apparatus. By J. A. Kingdon, B.A. Pp. 292. (London: H. Alabaster, Gatehouse, and Co.)

MR. KINGDON commences his book with the magnetic flux, and his readers are evidently expected to bring their equipment of dynamics, elementary information as to units and electrical phenomena, with them. Ohm's law is introduced apparently for the purpose of bringing in its magnetic equivalent, and the fact that the coincidence is rather one of form than substance ought, we think, to have been pointed out. Reluctance and permeability are defined and shortly treated, and tables of magnetic force, induction, and permeability are given for various kinds of iron. Then follow specimens of elementary calculations regarding magnetic circuits.

The next chapter is entitled Magneto-motive Force of Current. The magnetic fields of different simple arrangements of conductors are first discussed, thus the force at the centre of a circular coil is worked out, and the field intensity—Biot and Savart's result—for a straight current is calculated from the simple law of magnetic force due to an element of a current. This law, as a matter of fact, was derived by Laplace from Biot and Savart's result for a straight current, and the recovery of the experimental result is interesting only as showing how the inverse square of the distance law for an element leads to the law of the inverse distance for a long straight conductor. The exact directions of the magnetic forces produced by the currents in elements of conductors seem not to be always quite clearly given, and some amplification of this part of the book seems desirable. We may say that we do not like the name "mags" any more than we liked the names "hens" and "millihens," which were once proposed for other units. Abbreviations which have any flavour of extraneous association should not be tolerated.

We come next to Tractive Force of Magnets and Current Reactions, with the pereameter method of testing iron, and some results thereby obtained for Krupp steel and Lowmoor iron.

Next we have a rapid account of the Generation of Electromotive Force by variation of magnetic flux through a circuit, or across a moving conductor, and the idea of self-induction is introduced. What exactly the self-induction or self-inductance of a coil is does not seem to be defined, though several things have their definitions given which certainly do not more deserve attention.

Alternators and other forms of direct current generator are described, and specimens of various calculations given. But we have looked in vain for the characteristic curves by which Hopkinson did so much for the practical working out of the dynamo. Surely in a book the object of which is to deal with practical calculations regarding magnetic circuits, this matter of all others ought to have received attention. Yet it is not even mentioned!

The book will be found to give information of considerable service on many points, but it is not homogeneous and consistent enough in its treatment. The chances are about even that if it is consulted on some important point the matter will not be found treated. With some rewriting and additions its usefulness will be much increased.

Biomechanik erschlossen aus dem Principe der Organogenese. By Dr. E. Mehnert. Pp. viii + 177. (Jena: Fischer, 1898.)

AT a time when "vitalism" is rife, and the disbelief in Natural Selection is almost a disease, an attempt to explain the phenomena of development on mechanical grounds is very welcome.

In this treatise Mehnert has examined very thoroughly the groundwork of organogeny, and has had little difficulty in showing, by reference to the development of such organs as the heart and blood-vessels, the pineal eye, the neurenteric canal, and so on, that the exceedingly loose interpretation commonly given to the law of recapitulation, namely that embryogeny is, *pure and simple*, a repetition of phylogeny, is absolutely incorrect; in fact, the ontogenetic is frequently the very reverse of the phylogenetic order—in all cases the order of development has become changed.

By a careful consideration of very numerous facts Mehnert shows that the principal factors in this alteration have been on the one hand Abbreviation, or the early arrest of development, and Retardation, or the late appearance of the first signs of an organ, acting, together or separately, on regressive organs; while on the other hand Acceleration, or the early appearance and rapid development of an organ, and Prolongation, or gradual increase in the length of life, are influences to which progressive organs are subject.

These four factors then, separately or combined, condition ontogeny, and hence is formulated the "fundamental law of organogeny," that the rate of development of an organ is proportional to the degree, at the time, of its phyletic development; so that ontogeny is a very much modified recapitulation of phylogeny.

In the development of an individual it is therefore possible to discern two influences at work: (1) the hereditary, recapitulating, phylogenetic influence, and (2) functional epigenesis, due to the direct action of inner and outer causes, such as surrounding organs, food, temperature, gravity, and so on. Mehnert is, perhaps, not as clear as he might be, when he comes to deal with the exact way in which these environmental changes have become inherited; but (without mentioning Natural Selection) he seems to tend towards a Lamarckian inheritance of acquired characters. He discards, however, a chemical pangenesis, and explains the influence of the soma on the germ by a physical theory—analogous to magnetisation—which has at least the merit of being novel.

At the end of the book are some remarks on the specific variations in embryogeny, and in length of life, and on involution.

The epigenetic modifications of the phylogenetic order, perhaps the most valuable part of this work, are graphically illustrated by numerous diagrams.

Practical Plant Physiology. By Dr. W. Detmer. Translated from the second German edition by S. A. Moor, M.A. (Camb.), F.L.S. (London: Sonnenschein and Co., Ltd., 1898.)

A translation of Detmer's "Pflanzenphysiologische Practicum" will doubtless be very acceptable to students of vegetable physiology in English-speaking countries. Since its publication Detmer's work has always been a standard one, and its second edition was in many ways a great improvement on the first. However, notwithstanding the high reputation of the German edition, it seems a pity that the translator should decide that "no sufficient reason has been found for addition or alteration"; for, with but little extra trouble, a very complete English text-book could have been made of the translation. By including physiological work published since 1895, and by the addition of more complete references to older researches, the usefulness of the book would have been largely increased.

The German edition has already been reviewed in a previous number of Nature, so that little need be said of the translation. The translator's style is good, and he reproduces faithfully the sketchy and note-book-like form of the original. It may be added that the English edition is well printed, and the illustrations have hardly suffered in their reproduction. H. H. D.

A Chemical Laboratory Course. By A. F. Hogg, M.A., F.C.S. Pp. 24. (Darlington: James Dodds, 1898.)

A series of experiments, arranged to illustrate elementary chemical analysis, are briefly described in this pamphlet. The experiments are arranged to accompany lectures on water, air, combustion, &c., and they form a course of work for the elementary and advanced stages of inorganic chemistry of the Department of Science and Art. Little information is given in addition to instructions for carrying out the 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.*]

Stereo-chemistry and Vitalism.

Before commenting on the argument for Vitalism urged in the opening address of Prof. Japp to the Chemical Section of the British Association, it will be best to quote from the report published in Nature such passages as clearly present his position. He said:—

"Pasteur's point is, that whereas living nature can make a *single* optically active compound, these laboratory reactions, to which we resort in synthesising such compounds, always produce, simultaneously, at least *two*, of equal and opposite optical activity; the result being intermolecular compensation and consequent optical inactivity. . . .

"If these conclusions are correct, as I believe they are, then the *absolute origin* of the compounds of one-sided asymmetry to be found in the living world is a mystery as profound as the absolute origin of life itself. The two phenomena are intimately connected for, as we have seen, these symmetric [? asymmetric] compounds make their appearance with life, and are inseparable from it.

"How, for example, could lævo-rotatory protein (or whatever the first asymmetric compound may have been) be spontaneously generated in a world of symmetric matter and of forces which are either symmetric or, if asymmetric, are asymmetric in two opposite senses? What mechanism could account for such selective production? Or if, on the other hand, we suppose that dextro- and lævo-protein were simultaneously formed, what conditions of environment existing in such a world could account for the survival of the one form and the disappearance of the other?"

The last sentence implies the assumption that in the absence of some special unknown cause, the mixed right-handed and left-handed molecules which neutralise each other's optical activities would remain mixed. But is this a valid assumption? Is there not, contrariwise, a general cause for the separation of them? Prof. Japp appears to have taken no account of a universal law displayed throughout that continuous redistribution of matter and motion which constitutes Evolution. In the second part of "First Principles" will be found a chapter entitled "Segregation," in which this law and its results are set forth. After illustrations of the process of segregation as it everywhere goes on in astronomic changes, geologic changes, changes in organisms considered individually and as an aggregate, changes throughout mental evolution and social evolution, there come at the close of the chapter the following paragraphs:—

"The abstract propositions involved are these:—First, that like units, subject to a uniform force capable of producing motion in them, will be moved to like degrees in the same direction. Second, that like units if exposed to unlike forces capable of producing motion in them, will be differently moved—moved either in different directions or to different degrees in the same direction. Third, that unlike units if acted on by a uniform force capable of producing motion in them, will be differently moved—moved either in different directions or to different degrees in the same direction."

A subsequent paragraph argues that by resolution of forces it is demonstrable that any difference between the acting forces, or between the units on which they act, implies the presence of some force, active or reactive, in the one not present in the other; and that supposing the conditions are such as to permit motion, this differential force must, in virtue of the law of the persistence of force (conservation of energy) produce a differential motion. Hence the corollary is that—

"Any unlikeness in the incident forces, where the things acted on are alike, must generate a difference between the effects; since otherwise, the differential force produces no effect, and force is not persistent. Any unlikeness in the things acted on, where the incident forces are alike, must generate a difference between the effects; since otherwise, the differential force whereby these things are made unlike, produces no effect, and force is not persistent." [1]

[1] This passage was written in 1862 at a time when the nomenclature now current was not established. Hence the use of the word force instead of energy. I still, however, adhere to the use of the word persistence, for the

Now from this process of segregation it must have happened that when "dextro- and lævo-protein were simultaneously formed" the two kinds of molecules, differently related to environing actions (say ethereal undulations alike in nature and direction), separated themselves into groups of their respective kinds. It is true that in virtue of the small differences between the two classes of molecules, the minute differential actions of forces upon them might be long in producing their effects; and, further, that the segregation might be impeded by restraining forces. But when we remember that segregations take place in long periods of time even where the restraining forces are very great, as instance the formation of hematite nodules and flints in chalk-formations or of siliceous concretions in limestone, the implication is that the segregation would slowly, if not quickly, take place. And then the molecules of either group would exhibit just that optical activity which Prof. Japp, following Pasteur, alleges can result only from molecules formed by vital action.

I do not draw attention to this truth for the purpose of showing the adequacy of the physico-chemical interpretation of life, but for the purpose of showing the inadequacy of Prof. Japp's argument against it. My own belief is that neither interpretation is adequate. A recently-issued revised and enlarged edition of the first volume of the "Principles of Biology" contains a chapter on "The Dynamical Element in Life," in which I have contended that the theory of a vital principle fails and that the physico-chemical theory also fails: the corollary being that in its ultimate nature Life is incomprehensible.

Brighton, October 12. HERBERT SPENCER.

Organic Variations and their Interpretation.

I SHOULD like, if you will kindly afford me a little space, to offer a few remarks on Prof. Weldon's presidential address to Section D of the British Association.

The first part of that address deals with the question whether individual variations are fortuitous, *i.e.* occur by chance. It contains a very able and lucid exposition of the fact that the distribution of individual variations is of a similar kind, and is open to the same mathematical treatment, as events which happen by chance. I do not think that any one has denied this. It does not admit of dispute. But it is no answer whatever to the reasoning of those who oppose the theory of Natural Selection. The question is whether a given modification, the degrees of which are distributed among individuals according to what may be called the law of chance, originated accidentally, or as the result of a definite ascertainable cause. To give an illustration. If I plant a hundred or a thousand sunflower seeds in good soil in a market garden, at about equal distances from one another, I get a number of sunflower plants which will not all be of the same size. If I measure their heights, or take their weights, I shall find that these magnitudes are so distributed as to form one of Prof. Weldon's curves. If I take another hundred or thousand seeds from the same sack, and plant them in flower-pots, each 6 inches in diameter and of exactly the same capacity, placing the flower-pots in the same garden, I shall get a number of sunflower plants whose heights or weights will form a curve of the same kind. *But* the mean height or weight of the second lot of plants will be very much less than that of the first lot. This I know to be true because I have tried it. The distribution of the magnitudes has nothing whatever to do with the cause of the difference in the two cases. That cause is limited nourishment in the second case. Similarly in the progressive modification of animals and plants under natural conditions, the distribution among individuals of the degrees of a character has nothing whatever to do with the question of the cause of the character. When selection takes place, by breeding from the larger or the smaller variations, the mean of a character may be raised or lowered, but the question is whether this can be done without regard to conditions of life or not. In numbers of cases there is reason to believe that it cannot. And there is reason to believe that in numbers of cases the mean of a character can be raised or lowered by the application of definite conditions without any selective breeding at all. I will not attempt to prove this here; all I wish to point out is, that Prof. Weldon's argument does not touch the question.

Still more serious objections must be made to Prof. Weldon's evidence concerning the actual operation of selection with regard to the frontal breadth of *Carcinus mænas*. I do not dispute his measurements, but his interpretation of them, which seems to me obviously and demonstrably unsound. He finds that the mean frontal breadth of the crabs at Plymouth was less in 1895 than in 1893, and less in 1898 than in 1895. I have always held that he courted failure by taking for investigation a character which is known to be undergoing progressive change in the individual during growth. We know that change in the proportions of a crab occur only at the ecdysis. It is, I think, certain that the number of ecdyses depend on age, not on size. Prof. Weldon himself remarks that the estimate of age by size is a dangerous proceeding. Yet for individual variations he compares crabs of the same size, not of the same age. Now the results he finds with regard to the diminution in frontal breadth in terms of total length would be exactly the same, if the growth of the crabs had been less in 1895 and 1898 than in 1893; in other words, if the crabs of the same size had been in these years, on the average older, had on the average passed through more moults; for the older crab has a relatively smaller frontal breadth. Now have I any reason for supposing that the crabs grew more rapidly in 1893, and do I suppose that the increased muddiness of the water in Plymouth Sound caused a diminution in the rate of growth? I do not suppose that mud had anything to do with it, but I have good reason for holding that crabs, like oysters, grow faster and larger when the water is warmer. Here is what Mr. Garstang wrote in 1894 concerning the summer of 1893: "Under the influence of the great heat the temperature of the Channel waters rose continuously, until in August it attained a point unprecedented for a quarter of a century; and it was of the highest interest to observe the effect of this high temperature, and of the prolonged calmness of the sea, upon the floating population of the neighbouring portion of the Channel. Numbers of semi-oceanic forms which rarely reach our shores arrived in remarkable profusion. In June the tow-nets were crowded with Salps, while towards the latter end of August they were almost choked by masses of living Radiolaria." The beginning of the year 1895, on the other hand, was exceedingly cold, and in the summer the water temperature was less than in 1893. It is not certain, as so few crabs were measured in 1898, whether their mean frontal breadth was really less than in 1895. But it is a fact that although last winter was unusually mild, the water temperature off Looe in May and June was lower than in the same months in 1895.

It is remarkable that Prof. Weldon found the change in female crabs was less than in males, and it is difficult to understand why the sexes should be affected in different degrees by an increase in the muddiness of the water. On the other hand, as the males in crabs generally are larger than the females, the former would necessarily be more affected in their growth by temperature.

Next as to the experiment which is adduced to show that the increase of sediment is the cause of the selective destruction of the crabs with greater frontal breadth. The survivors of crabs placed in water with china clay had narrower foreheads. But this merely means that they were on the average older, and the younger specimens were killed first, which is what might be expected. Prof. Weldon believes that the cause of death was the entrance of the sediment into the gill chamber, but it appears that the dead crabs had been in the muddy water, while the living were killed after removal. There is no evidence that the clay entered before death, and any dead crab which had been some time in muddy water constantly stirred would probably have mud on its gills.

Lastly there is the experiment of keeping crabs in bottles for a period including a single moult. At first the crabs with broader foreheads died, and in this case the death is attributed to the putridity of the water. In this case there was no sediment, and putrefaction in the water has the same effect as sediment, a fact perfectly in agreement with the view that under unfavourable conditions the younger die first, but inconsistent with the view that death is due to the greater filtering power of the branchial apparatus in the narrower-fronted crabs. The mean frontal breadth having been decreased by selective deaths before the moult, was found, after the moult, to be greater than that of crabs from the sea of the same size. This again is easily explained by increased growth. The crabs in the bottles were

reason that the word conservation is doubly inappropriate. Conservation connotes a conserver and an act of conserving—conceptions utterly at variance with the doctrine asserted; and it also implies that in the absence of a conserver and an act of conserving, the energy would disappear, which is also a conception utterly at variance with the doctrine asserted.

in warmer water and better fed than those in the sea, and therefore on the average were younger after the moult than a number from the sea of the same size. In fact the diminution of frontal breadth depends not on the size of the crab, but on the number of moults it has passed through, while the size depends on the increase at each moult. A crab which has moulted seven times may be smaller than one which has only moulted five or six times.

Another case is on record which seems to me to afford an exact parallel to Prof. Weldon's. In Darwin's "Descent of Man" is quoted the evidence of a hunter who asserted that in a certain district male deer with a single unbranched antler were becoming gradually more numerous and taking the place of those with normal branched antlers. The district referred to was that of the Adirondack Hills in North America. As the witness in question had hunted deer for twenty-one years, Darwin considered his evidence important. J. D. Caton, however, who for many years made the Cervidæ his special study in Canada, particularly investigated this case. He satisfied himself that there was no truth whatever in the evidence above mentioned. *The spike-horn bucks seen and killed in the Adirondacks were all yearling bucks with their first antlers.* In all species of Cervus the horns which first grow are simple pointed unbranched spikes; and to prove the existence of spike-horned bucks as a variety, it would be necessary to show that when they cast their horns they developed simple spikes every year throughout life. No attempt was made to prove this, and Caton describes cases which he observed himself, in which spike-horned bucks of unusually large size, which might have been supposed to be full grown, developed branched horns in the following year.

A final objection to Prof. Weldon's argument may be mentioned. All the crabs on whose measurements he bases the conclusion that the relative frontal breadth of the species in Plymouth Sound has actually decreased within a few years, are small specimens 10 to 15 mm., or about half an inch in length of carapace. He makes no attempt to show that the decrease has occurred in adult crabs. The efficiency of filtration would necessarily depend on the absolute size of the filtering mechanism, not on the relative size, since the size of the particles of mud to be excluded remains the same. A crab therefore which survived in consequence of its narrow frontal region at the size of half an inch, would have no advantage when it was 2 or 3 inches long, as the frontal region would then be absolutely much greater. If the mud then kills the small crabs with a broad frontal region, it ought to kill all the adult crabs without exception.

A simple method of testing the soundness of Prof. Weldon's conclusion, with regard to the crabs in Plymouth Sound, would be to compare the mean frontal breadth of adult crabs from that locality, with that of others collected outside the Sound, *e.g.* at the mouth of the Yealm, where the water is pure, and at Saltash, where the water is much more turbid. If the sediment in the Sound is really decreasing the mean frontal breadth by a process of selection, that dimension must be greater in clean water, and less where there is still more sediment.

J. T. CUNNINGHAM.

Penzance, September 24.

I SHOULD like to be allowed to make a few remarks upon Prof. Weldon's address to the Zoological Section of the British Association; for it seems to me—very interesting as it is—that it is entirely outside the real question of the evolution of varieties and species of animals.

My contention is that *individual differences*—with which Prof. Weldon is solely concerned—*do not afford the materials for new varieties or species* (I would refer the reader to my paper on "Individual Variations," *Natural Science*, vol. vi. p. 385).

A systematist has to consider differences of "form" as well as, and indeed, he regards it as much more important than, "size" or "number." Prof. Weldon, however, refers only to *size* in crabs and recruits, and to *number* in pigs' glands and petals of the buttercup.

If I understand Darwin's theory of "The origin of species by *means* of natural selection," an individual has some slight variation or *new* feature, which is beneficial to it in the struggle for life among other organisms, more especially of the same kind —as a "large population" of the same sort is what Darwin and Dr. Wallace demand—then, such an individual may prove itself best fitted to survive and ultimately establish a new variety, the others dying out in the struggle.

But, for one or more crabs to have a frontal breadth a little less than that of others in a group of the same kind of crab is *no new feature*. It is only an "individual difference," such as *all* organisms are subject to.

"Number" and "size," to be included in varietal characters must be more pronounced than in the case with the crabs. The extreme lengths of the carapace are given as 10·1 and 14·9 millimetres—*i.e.* two-fifths and three-fifths of an inch; but between those killed by suffocation and the smaller survivors, the greatest difference lies between 816·17 and 787·36, these numbers being the highest "mean frontal breadths in terms of carapace length = 1000"; so that the difference is 28·81, not 3 per cent.

Upon such insignificant differences the life or death of the crabs is supposed to hang!

But the contention presumably is that the smaller crabs will form a new variety. Will any zoological systematist accept this?

But is it not obvious that if natural selection has been always constantly at work in this supposed way with individual differences among plants and animals, *some* varieties might be looked for among buttercups and *Carcinus mænas*? Take *Ranunculus Ficaria*, which furnished Mr. Burkill with materials for like observations (NATURE, February 7, p. 359, 1895), the petals of which vary much more in number than do those of buttercups. If natural selection has been busy over this species for centuries, how is it that *R. Fic.* remains *R. Fic.* still? for it grows in all sorts of places, favourable and unfavourable. It would be easy to make curves for individual differences for the number of petals, stamens, size of leaves, tubercles, &c., but it would all be a waste of energy as far as advancing any illustrations of evolution. Individual differences come up every year, in spite of natural selection and all its imaginary doings. Moreover similar individual differences occur in the leaves all over one and the same tree and of every kind; what can natural selection do among them?

In fact, no one has ever yet shown that a new species has ever arisen out of individual differences "observed in the individuals of the same species inhabiting the same confined area" ("Origin of Species," 6th ed., p. 34).

The utmost that Prof. Weldon has shown is that, *under abnormal and dangerous circumstances*, which have killed off other kinds of marine animals from the Sound at Plymouth, crabs are dying out too; but that the larger ones (older?) are killed off a little faster, perhaps, than the smaller (Is the orifice to the gills a little larger, so as to allow an easier passage for the mud?). We may compare this with the London fogs in winter, which raise the death-rate of older members of the community.

Prof. Weldon says: "I will show you that in those crabs small changes in size of the frontal breadth do, under certain circumstances, affect the death-rate."

As this is the very kernel of the whole matter—for he quotes Darwin as saying, "the theory asserts the smallest observable variation" (observe Darwin requires a "variation"; but there is *none* at all in any of Prof. Weldon's four examples) "may affect an animal's chance of survival," one anxiously looked out, on reading the address through, for the fulfilment of this promise; but near the end, all he says is, that the immediate cause of death was suffocation by mud clogging the gills, and adds: "I think it can be shown that a narrow frontal breadth renders one part of the process of filtration of water more efficient than it is in crabs of greater frontal breadth."

This opinion is unfortunately no scientific proof; and it is much to be regretted that he did not give us the grounds for his so thinking.

He only measured the carapaces and frontal breadths, but it is presumable that the legs were proportionally longer in the deceased crabs. The question therefore arises, were they, too, concerned in causing the increased death-rate of those with the bigger carapaces?

Once more, what has all this got to do with evolution? No one will dispute these interesting illustrations of chance—a name for all cases where one cannot trace actual causes, or inductive evidence—and its application to individual differences; which, by the way, Dr. Wallace now regards as "non-specific or developmental characters" (*Fortnightly Review*, March 1895, p. 444), and *not* leading to new varieties; as he did in his work on "Natural Selection" in 1871.

Natural selection determines what shall survive and what shall die in the universal struggle for life; but it has yet to be shown, that the origin of species has anything to do with it.

Prof. Weldon concludes with the observation that "numerical knowledge of this kind is the only ultimate test of the theory of natural selection; or of any other theory of any natural process whatever."

It has tested natural selection, and shown that nothing of the nature of a *true variety* has been established by it. There is no *evolution* in the process described at all.

Does he not speak a little too confidently as to there being no other means of investigation into the procedure of evolution?

The true method of establishing this doctrine, as in all other matters of science, I take to be by *inductive evidence* and *experimental verification*. By these it has been proved that true varietal changes are produced by what Darwin called "the definite action of changed conditions of life," and he added that when this was the case "a new sub-variety would be produced without the aid of natural selection" ("Animals and Plants under Domestication," vol. ii. pp. 271, 272).

In support of this contention of Darwin's I shall be happy to supply Prof. Weldon with an abundance of facts collected in my book, "The Origin of Plant-Structures," if he will promise to read it, entirely unbiassed by his established belief in the efficacy of natural selection. GEORGE HENSLOW.

80 Holland Park, W.

THE points raised by Mr. Cunningham are numerous, and I trust that he will not think me wanting in courtesy if I make my answer to each of them as short as possible.

(1) I am glad Mr. Cunningham now believes that the fortuitous character of animal variation is in many cases indisputable, so that he no longer holds the view of chance adopted by Eimer and others (*cf.* Eimer, "Organic Evolution," translated by J. T. Cunningham. Macmillan, 1890).

(2) I cannot agree that the question, which the theory of natural selection attempts to answer, is the question "whether a given modification . . . originated accidentally, or as the result of a definite ascertainable cause." Without discussing the conception of an "accident" implied in this phase, I fail to see that the theory of natural selection involves a theory of the origin of variation: all it asserts is that the variation which is known to occur does affect the death-rate.

(3) The well-known fact, that a change in surrounding conditions often produces a change in the character of a race by methods other than that of selective destruction, does not disprove the co-existence of selective destruction. For example, Mr. Cunningham has not shown that the adaptation of sunflowers to life in six-inch flower-pots is effected without selective destruction; he has only shown that a portion of the change, associated with life in pots is effected without such destruction. By dividing a sample of seed of known origin into two portions, sowing seeds of one portion in a market garden, seeds of the other portion singly in a series of flower-pots, Mr. Cunningham has produced two different series of sunflowers, which differ in stature and in other characters. I fully accept Mr. Cunningham's statement that the plants in the flower-pots were modified without selective destruction. But these plants were not all alike; and unless it can be shown that each of them produced an equal number of seeds, of equal germinating power, so that if life in flower-pots had been continued each plant, whatever its stature, would have contributed an equal number of equally fertile offspring to the next generation,—unless this can be shown, the action of natural selection is by no means disproved. If among the sunflowers of different stature growing in similar flower-pots, plants of one stature produced more seed than plants of different stature, the plants of that stature were better "adapted" to life in flower-pots than the others, and in a struggle to occupy a world filled with six-inch flower-pots, the offspring of the more fertile plants would very probably win; so that a process of natural selection would occur. So far as Mr. Cunningham has described his observations, they do not exclude the possibility that this and other kinds of selection operate. All I am anxious to know, in those cases of organic evolution which I try to understand, is how much of the observed change is due to a process of selective destruction, how much to other causes.

(4) I heartily agree with the view that it is not possible for selection, under fixed conditions, to modify a species in every direction. It is only possible for natural selection to act so as to produce a race with a minimum death-rate. For example, since muddy water of a certain salinity kills broad-fronted crabs more quickly than narrow-fronted crabs, it is probably impossible for natural selection to increase the frontal breadth of crabs which live in such water.

(5) In the second part of his letter, Mr. Cunningham attempts an explanation of the evolution observed in Plymouth crabs, which does not involve any selective destruction. For this purpose he makes two hypotheses, one about the growth of crabs, one about the temperature of the sea-shore at Plymouth. Neither of these hypotheses seems to me to fit the facts. If I understand the hypothesis about growth, it is this: that the frontal breadth of a crab depends on its age, while the length of a crab depends not only upon age, but upon temperature and other circumstances affecting it during growth. From this it is deduced that in a group of crabs of the same length, those with narrower fronts are older, those with broader fronts are younger, and I suppose that those with equal fronts are assumed to be of the same age. Therefore, when I say that under certain conditions the crabs with the broadest fronts die first, Mr. Cunningham assumes that under those conditions the youngest crabs die first. I do not know of any published account of the growth of crabs which supports this hypothesis, and the following facts seem to disprove it:—If we take a group of crabs, of the same length and the same frontal breadth, they are, on this view, nearly of an age: if we keep these crabs till they moult, they will grow at different rates during the moult; now those which increase abnormally much in length during the moult, will be younger than average crabs of their new length; those which show abnormally little increase in length, will be older than the majority of crabs of their new length. Mr. Cunningham says that in crabs of a given length, the youngest are the broadest; therefore those crabs which grew abnormally much ought to have broader fronts than their fellows of their new length, those crabs which grew abnormally little ought to be narrower than their fellows. I have worked out the relation between growth-rate and frontal breadth abnormality in more than 500 cases, and the relation which ought to hold, if Mr. Cunningham's hypothesis were true, does not hold.

A further disproof of the contention that the youngest crabs died first in my experiments is this: in most of the experiments about equal numbers of crabs of all lengths from 10 to 15 mm. were treated together; and all crabs used in an experiment were gathered on one day. It will hardly be contended that irregularity of growth goes so far as to produce in the same season crabs between 10 and 11 mm. long which are of the same age as crabs between 14 and 15 mm long. If the younger crabs died first in my experiments, a mortality of 70 or 80 per cent. might be expected to kill all, or nearly all the shorter crabs, the survivors being derived almost entirely from the longer crabs. This was not the case. For example, in one experiment 200 crabs, between 10 and 15 mm. long, were treated with mud until only four were left alive. These four were respectively 10·67 mm., 11·67 mm., 11·43 mm., and 12·11 mm. long.

(6) Mr. Cunningham further supposes, and no doubt rightly, that crabs grow faster, within certain limits, the warmer the water in which they are; so that crabs 10 mm. long, grown in warm water, are probably younger than crabs 10 mm. long grown in colder water. From observations made on the temperature of the Channel water, he thinks it probable that the crabs measured in 1893 were on the whole younger than those measured in 1895, and those measured this year were oldest of all,—all the crabs being of the same length. The reason for this is that the water in the Channel was exceptionally hot in 1893, and for some time exceptionally cool this year. But the stony beach where these crabs were collected looks due south, and is uncovered for hours daily, when it is often exposed to the direct rays of the sun. I am most unwilling to believe that the temperature on such a beach was lower during the past summer than in 1893. A further point is that crabs gathered in January ought, if Mr. Cunningham's hypothesis were true, to be distinctly narrower than crabs of the same length gathered in August. Crabs gathered last January were narrower than crabs gathered in August 1893, but they were not narrower than crabs gathered last August. So that all Mr. Cunningham's ingenious hypotheses fail to fit the facts.

(7) Mr. Cunningham says that there is no evidence of the entrance of fine mud into the gill-chambers of crabs during life. If he will watch a crab breathing in muddy water, or if he will consult the works of Mr. Garstang and other students of the subject, he will see that he is mistaken. I thought the entrance of such particles into the gill-chamber so well known that I need

not describe experiments (of which I have made plenty) in proof of its occurrence.

(8) I quite agree with Mr. Cunningham and Mr. Henslow, that it is my duty to describe the effect I believe fine mud to have upon the respiratory apparatus, and I am preparing such a description as quickly as I can. I hope also to be able before long to answer Mr. Cunningham's last and very pertinent question, whether crabs of given length, from the clear water outside Plymouth Sound, are broader or narrower than crabs of the same length from muddy waters within the Sound.

(9) I altogether fail to understand Mr. Henslow's letter, and I fear that my imperfect exposition has led him to misunderstand me as completely as he has misunderstood one of the clearest passages in the "Origin of Species." Mr. Henslow suggests that a variation, fit to afford material for natural selection, must be a *new* character, differing in some mysterious and undefined way from those individual differences which he refuses to call variations; and he further attributes the same view to Mr. Darwin. If Mr. Henslow will read once more the section of the fourth chapter of the "Origin of Species" headed "Illustrations of the Action of Natural Selection, &c.," he will see that Mr. Darwin does not express this opinion. The important thing to determine is not what any man, however eminent, has said about the importance of differences between individual animals, but what that importance can be shown to be. The crabs at Plymouth have not, during the past five years, exhibited any changes in the magnitude of their frontal breadth which Mr. Henslow would rank as a variation, but they have exhibited individual differences. During these five years the mean frontal breadth ratio has changed nearly 2 per cent., so that the change now going on would produce, if it were to continue at the same rate for fifty years, a change big enough to constitute a difference which most men would rank as specific. I have endeavoured to show that this change has been accompanied by a destruction which has acted selectively upon individual differences. Mr. Henslow has not seriously discussed this attempt of mine, but ridicules the idea that so small a change can be of importance in relation to evolution. If the mean stature of Englishmen were to diminish by an inch in a few years, I presume Mr. Henslow would regard such change as rapid and important; but the percentage change would be less than that which Mr. Thompson and I have demonstrated during the past five years in crabs.

W. F. R. WELDON.

Mirage on City Pavements.

DURING my summer visits to San Francisco, I have been so frequently struck with the beautiful miniature mirages that can be seen on the flagstone sidewalks whenever the sun shines, that I determined to secure, if possible, a photograph of the phenomenon on a scale suitable for reproduction. One or two previous attempts in past years having been partial failures owing to the smallness of the image, I secured, through the kindness of a friend, the use of a very fine tele-objective capable of giving an image six or eight times as large as an ordinary objective of 12 inches focus. The streets over some of the hills are so laid out that it is possible, on nearing the brow, to bring the eye on the level of the side-walk, and look along a perfectly level stretch of one hundred yards or more. Standing in this position it is almost impossible to resist the conviction that the walk is flooded with a perfectly smooth sheet of water, in which the reflections of pedestrians can be seen as distinctly as in a mirror.

In order to observe the phenomenon it is necessary that a considerable stretch of level pavement be foreshortened into a very narrow strip. This is the condition in the photograph: the camera stood just below the brow of the hill, and the distance in the photograph from the X to where the children and the toy cart are standing, is an entire block (135 yards). The position of the camera and section of the hill-top are shown in the diagram. The apparent reflections, due to the

bending upward of the rays by the thin layer of heated air, come out very clearly in the picture, but the camera fails to give a correct reproduction of the extreme brilliancy of the reflecting layer of air.

On taking a few steps up the hill, decreasing the foreshortening, the glaze vanishes, and we see only the dull grey of the flagstones. Extremely hot sunshine is not necessary. I have observed the phenomenon early in the morning after a cold night, before the sun had reached the pavement, the slight warmth from the ground being sufficient. Under these conditions, however, the pavement must be more foreshortened than when in the full sunshine. The refracting layer is probably only a thin skin of warm air, which adheres as it were to the surface of the flagstones, for the mirage is unaffected by the strong winds which frequently sweep the top of the hill.

Probably these mirages can be seen on any level pavement where the eye can be brought into the proper position.

Physical Department of the University, Madison, Wisconsin, September 20. R. W. WOOD.

Transference of Heat in Cooled Metal.

MY attention has just been called to two communications to your journal, entitled "Transference of Heat in Cooled Metal." The first, by M. Henry Bourget, appears in the issue of June 30, and the second, by Mr. Albert T. Bartlett, in the issue of September 1.

About the year 1880 I had occasion to heat one end of an iron bar to a bright red heat whilst holding the cooler end in my hand. Upon plunging the heated end into a bucket of water the cooler end became suddenly so hot that I was obliged to release my hold on it.

This phenomenon interested me very much, as I could find no explanation for the apparent reflection of heat to the cooler end of the bar; and in 1888, whilst working in the physical laboratory at Johns Hopkins University, I further investigated the matter.

To one end of an iron or steel bar was soldered a thermo-electric couple, the circuit of which was closed through a very sensitive, high resistance, Rowland, reflecting, galvanometer. The bar was passed through two pasteboard screens, and was supported in a horizontal position, the screens serving to intercept any heat which might be conveyed by radiation or convection through the air from one end of the bar to the other. Under the end of the bar, remote from that to which the thermo-electric couple was soldered, was placed a compound bunsen burner, by which the end of the bar was raised to a dull red heat. The spot of light on the galvanometric scale moved off to the right very gradually as the cooler end of the bar became heated, but was brought back to a convenient point on the scale by means of a controlling magnet. When the state of steady flow was reached, the bunsen flame was removed, and water was immediately poured over the heated end of the bar. The spot of light on the galvanometer scale immediately moved off to the right, indicating an immediate rise of temperature at the cooler end of the bar.

The rapidity of the action was a second source of surprise to me, as it far exceeded the velocity of propagation of heat along the bar by conduction. I was obliged to discontinue this line of work for a time, and did not return to it till 1895, when I repeated the experiments described above, this time, however, using brass rods of various dimensions. In the case of the brass rods I failed to observe the same phenomenon, and concluded that the effect was due, as I had supposed in 1888, to much the same cause as recalescence.

I should judge from my results that if the effect exists at all in brass, it is yet much more pronounced in iron or steel.

At the time I made my experiments at Johns Hopkins University, I drew the attention of Prof. Henry A. Rowland and Dr. Louis Duncan to the matter, the latter witnessing the experiments, and later I discussed it with Prof. Ogden N. Rood, of Columbia University, New York City. Prof. Rowland pointed out that theoretically there should be a very slight instantaneous effect, but that it should be a reduction and not an increase of temperature.

That the effect just described is altogether unaccounted for by the present mathematical theory of the propagation of heat in conductors is not very surprising in view of the fact that that theory postulates the constancy of the specific heat and thermal conductivity of the medium, whereas at high temperatures these properties vary considerably with the temperature, and particularly in the case of iron, the physical state undergoes a complete change of what Hopkinson termed the *critical temperature*, which varies in different specimens from 690° C. to 870° C.

In attempting an explanation of the phenomenon which we have been discussing, it seems to me fair to assume that the heat producing the sudden rise of temperature observed, is not transmitted along the rod with the great velocity observed in the tests, but that it exists at the cooler end of the rod before the rise of temperature occurs. When iron or steel which has been heated to redness is suddenly plunged into water a marked change takes place in the properties of the metal, and if this change of character in the metal is in part transmitted from particle to particle to the other end of the rod, and results in a lowering of the heat capacity of the material, a rise of temperature will result as observed. JOHN STONE STONE.

20 Newbury Street, Boston, Mass., U.S.A., September 19.

Animals and Poisonous Plants.

FROM repeated observations in my own garden, I know that song-thrushes will eat ripe mezereon berries greedily. In the winter of 1896 they cleared a small bush containing, perhaps, two hundred berries, in the course of a week or two, returning at once when driven away, and becoming half-stupefied; so that they might, apparently, have been caught with the hand.

Dr. Withering states ("British Plants," ed. 1812) that six berries of this shrub (*Daphne mezereum*) will kill a wolf.

According to the same authority, *Cicuta virosa* is a certain poison to cows; while goats devour it eagerly, and it is not injurious to sheep and horses. As to *Atropa belladonna*, a case which received much attention at the time may be found in the daily papers of some twenty years ago. A family were poisoned by eating rabbit-pie, the symptoms being those of atropine poisoning; and the inquiry, which followed, showed that rabbits do often eat deadly nightshade berries. J. C.

Loughton, Essex.

WITH reference to Mr. Bennett's inquiry as to the consumption of poisonous berries by birds, I remember a young blackbird, some years back, who used to frequent the garden of the house in which I was staying, and who eagerly swallowed the berries of the *Daphne mezereum*. He was rather tame and would take them when I threw them to him, following them as they rolled along the ground, as a chicken would go after peas. I see that Sowerby confirms the ordinary opinion as to the poisonous nature of these berries: "The whole plant is a powerful irritant, both bark, leaves and *fruit* acting poisonously if taken in large quantities. *A few of the berries have been known to cause death when swallowed.*" The blackbird did not seem the worse for them. EDWARD M. LANGLEY.

16 Adelaide Square, Bedford, October 15.

An Osteometric Index-Calculator.

I SHOULD feel obliged if any of your readers could inform me whether there is in use among anthropologists any mechanical appliance by which indices can be determined without loss of time and the possible inaccuracy attending an arithmetical calculation.

I am anxious to obtain information on this subject in order to find out if there is any simpler or possibly better instrument than one I have constructed. It consists of a graduated quadrant and a movable arm, and it is very helpful in doing the purely arithmetic work, as it shows accurately, at a glance, the index required from any two figures, and does not work by logarithms, as does the slide rule of engineers, which might be used for the purpose. DAVID WATERSTON.

Anatomical Department, University of Edinburgh, October 11.

Capture of Curious Crustaceans.

Two living specimens of that very curious Crustacean *Stenorynchus phalangium* were taken in a net, off this coast, yesterday. E. L. J. RIDSDALE.

The Dene, Rottingdean, October 14.

A SHORT HISTORY OF SCIENTIFIC INSTRUCTION.[1]

II.

I MUST come back from this excursion to call your attention to the year 1845, in which one of the germs of our College first saw the light.

What was the condition of England in 1845? Her universities had degenerated into *hauts lycées*. With regard to the University teaching, I may state that even as late as the late fifties a senior wrangler—I had the story from himself—came to London from Cambridge expressly to walk about the streets to study crystals, prisms, and the like in the optician's windows. Of laboratories in the universities there were none; of science teaching in the schools there was none; there was no organisation for training science teachers.

If an artisan wished to improve his knowledge he had only the moribund Mechanics' Institutes to fall back upon.

The nation which then was renowned for its utilisation of waste material products allowed its mental products to remain undeveloped.

There was no Minister of Instruction, no councillors with a knowledge of the national scientific needs, no organised secondary or primary instruction. We lacked then everything that Germany had equipped herself with in the matter of scientific industries.

Did this matter? Was it more than a mere abstract question of a want of perfection?

It mattered very much! From all quarters came the cry that the national industries were being undermined in consequence of the more complete application of scientific methods to those of other countries.

The chemical industries were the first to feel this, and because England was then the seat of most of the large chemical works.[1]

Very few chemists were employed in these chemical works. There were in cases some so-called chemists at about bricklayers' wages—not much of an inducement to study chemistry; even if there had been practical laboratories, where it could have been properly learnt. Hence when efficient men were wanted they were got from

[1] An address delivered at the Royal College of Science by Sir Norman Lockyer, K.C.B., F.R.S., on October 6. (Continued from page 575.)

[1] Perkin, NATURE, xxxii. 334.

abroad—*i.e.* from Germany, or the richer English had to go abroad themselves.

At this time we had, fortunately for us, in England, in very high place, a German fully educated by all that could be learned at one of the best equipped modern German Universities, where he studied both science and the fine arts. I refer to the Prince Consort. From that year to his death he was the fountain of our English educational renaissance, drawing to himself men like Playfair, Clark and De la Beche; knowing what we lacked, he threw himself into the breach. This College is one of the many things the nation owes to him. His service to his adopted country, and the value of the institutions he helped to inaugurate, are by no means even yet fully recognised, because those from whom national recognition full and ample should have come, were, and to a great extent still are, the products of the old system of middle age scholasticism which his clear vision recognised was incapable by itself of coping with the conditions of modern civilised communities.

It was in the year 1845 that the influence of the Prince Consort began to be felt. Those who know most of the conditions of Science and Art then and now, know best how beneficial that influence was in both directions; my present purpose, however, has only reference to Science.

The College of Chemistry was founded in 1845, first as a private institution; the School of Mines was established by the Government in 1851.

In the next year, in the speech from the Throne at the opening of Parliament, Her Majesty spoke as follows:—"The advancement of the Fine Arts and of practical Science will be readily recognised by you as worthy the attention of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you having in view the promotion of these objects, towards which I invite your aid and co-operation."

Strange words these from the lips of an English sovereign!

The Government of this country was made at last to recognise the great factors of a peaceful nation's prosperity, and to reverse a policy which has been as disastrous to us as if they had insisted upon our naval needs being supplied by local effort as they were in Queen Elizabeth's time.

England has practically lost a century; one need not be a prophet to foresee that in another century's time our education and our scientific establishments will be as strongly organised by the British Government as the navy itself.

As a part of the comprehensive scheme referred to by Her Majesty, the Department of Science and Art was organised in 1853, and in the amalgamation of the College of Chemistry and the School of Mines we have the germ of our present institution.

But this was not the only science school founded by the Government. The Royal School of Naval Architecture and Marine Engineering was established by the Department at the request of the Lords Commissioners of the Admiralty "with a view of providing especially for the education of shipbuilding officers for Her Majesty's Service, and promoting the general study of the Science of Ship Building and Naval Engineering." It was not limited to persons in the Queen's Service, and it was opened on November 1, 1864. The present Royal College of Science was built for it and the College of Chemistry. In 1873 the School was transferred to the Royal Naval College, Greenwich, and this accident enabled the teaching from Jermyn Street to be transferred and proper practical instruction to be given at South Kensington. The Lords of the Admiralty expressed their entire satisfaction with the manner in which the instruction had been carried on at South Kensington; and well they might, for in a memorandum submitted to the Lord President in 1887, the President and Council of the Institute of Naval Architects state:—"When the Department dealt with the highest class of education in Naval Architecture by assisting in founding and by carrying on the School of Naval Architecture at South Kensington, the success which attended their efforts was phenomenal, the great majority of the rising men in the profession having been educated at that Institution."

Here I again point out, both with regard to the School of Mines, the School of Naval Architecture, and the later Normal School, that it was stern need that was in question, as in Egypt in old times.

Of the early history of the College I need say nothing after the addresses of my colleagues, Profs. Judd and Roberts-Austen, but I am anxious to refer to some parts of its present organisation and their effect on our national educational growth in some directions.

It was after 1870 that our institution gradually began to take its place as a Normal School—that is, that the teaching of teachers formed an important part of its organisation, because in that year the newly-established Departments having found that the great national want then was teachers of Science, began to take steps to secure them. Examinations had been inaugurated in 1859, but they were for outsiders, conferring certificates and a money reward on the most competent teachers tested in this way. These examinations were really controlled by our School, for Tyndall, Hofmann, Ramsay, Huxley, and Warington Smyth, the first professors, were also the first examiners.

Very interesting is it to look back at that first year's work, the first cast of the new educational net. After what I have said about the condition of Chemistry and the establishment of the College of Chemistry in 1845, you will not be surprised to hear that Dr. Hofmann was the most favoured—he had forty-four students.

Prof. Huxley found one student to tackle his questions, and he failed.

Profs. Ramsay and Warington Smyth had three each, but the two threes only made five; for both lists were headed by the name of

Judd, John W.,
Wesleyan Training College,
Westminster.

Our present Dean was caught in the first haul.

These examinations were continued till 1866, and upwards of 600 teachers obtained certificates, some of them in several subjects.

Having secured the teachers, the next thing the Department did was to utilise them. This was done in 1859 by the establishment of the Science Classes throughout the country which are, I think, the only part of our educational system which even the Germans envy us. The teaching might go on in schools, attics or cellars, there was neither age-limit nor distinction of sex or creed.

Let me insist upon the fact that from the outset practical work was encouraged by payments for apparatus, and that latterly the examinations themselves, in some of the subjects, have been practical.

The number of students under instruction in Science Classes under the department in the first year in which these classes were held, was 442; the number in 1897 was 202,496. The number of candidates examined in the first year in which local examinations were held, was 650, who worked 1000 papers; in 1897 the number was 106,185, who worked 159,724 papers, chemistry alone sending in 28,891 papers, mathematics 24,764, and physiography 16,879.

The total number of individual students under instruction in Science Classes under the Department from 1859 to 1897 inclusive has been, approximately, 2,000,000. Of these about 900,000 came forward for examination, the total number of papers worked by them being 3,195,170.

Now why have I brought these statistics before you?

Because from 1861 onwards the chief rewards of the successful students have been scholarships and exhibitions held in this College; a system adopted in the hope that in this way the numbers of perfectly trained Science Teachers might be increased, so that the Science Classes throughout the country might go on from strength to strength.

The Royal Exhibitions date from 1863, the National Scholars from 1884. The Free Studentships were added later.

The strict connection between the Science Classes throughout the country and our College will be gathered from the following statement, which refers to the present time:—

Twenty-one Royal Exhibitions—seven open each year—four to the Royal College of Science, London, and three to the Royal College of Science, Dublin.

Sixty-six National Scholarships—twenty-two open each year—tenable, at the option of the holder, at either the Royal College of Science, London, or the Royal College of Science, Dublin.

Eighteen Free Studentships—six open each year—to the Royal College of Science, London.

A Royal Exhibition entitles the holder to free admission to lectures and laboratories, and to instruction during the course for the Associateship—about three years—in the Royal College of Science, London, or the Royal College of Science, Dublin, with maintenance and travelling allowances.

A National Scholarship entitles the holder to free admission to lectures and laboratories and to instruction during the course of the Associateship—about three years—at either the Royal College of Science, London, or the Royal College of Science, Dublin, at the option of the holder, with maintenance and travelling allowances.

A Free Studentship entitles the holder to free admission to the lectures and laboratories and to instruction during the course for the Associateship—about three years—in the Royal College of Science, London, but not to any maintenance or travelling allowance.

Besides the above students who have been successful in the examinations of the Science Classes, a limited number (usually about 60) of teachers, and of students in science classes who intend to become science teachers, are admitted free for a term or session to the courses of instruction. They may be called upon to pass an entrance examination. Of these, there are two categories—those who come to learn and those who remain to teach; some of the latter may be associates.

Besides all these, those holding Whitworth Scholarships—the award of which is decided by the Science examinations—can, and some do, spend the year covered by the exhibition at the College.

In this way, then, is the École Normale side of our institution built up.

The number of Government students in the College in 1872 was 25; in 1886 it was 113, and in 1897 it was 186.

The total number of students who passed through the College from 1882–3 to 1896–97 inclusive was 4145. Of these 1966 were Government students. The number who obtained the Associateship of the Royal School of Mines from 1851 to 1881 was 198, of whom 39 were Government students, and of the Royal College of Science and Royal School of Mines from 1882 to 1897 the number was 525, of whom 323 were Government students. Of this total of 362 Government students 94 were Science teachers in training.

With regard to the Whitworth Scholarships, which, like the Exhibitions, depend upon success at the yearly examinations throughout the country, I may state that six have held their scholarships at the College for at least a part of the scholarship period, and three others were already associates.

So much for the prizemen we have with us. I next come to the teachers in training who come to us. The number of teachers in training who have passed through the College from 1872 to 1897 inclusive is about 600; on an average they attended about two years each. The number in the session 1872–73, when they were first admitted, was 16, the number in 1885–86 was 50, and in 1896–97 60. These have not as a rule taught Science Classes previously, but before admission they give an undertaking that they intend to teach. In the earlier years some did not carry out this undertaking, doubtless because of the small demand for teachers of Science at that time. But we have changed all that. With but very few exceptions, all the teachers so trained now at once begin teaching, and not necessarily in classes under the Department. It is worthy of note, too, that many Royal Exhibitioners and National Scholars, although under no obligation to do so, also take up Science teaching. It is probable that of all the Government students now who pass out of the College each year not less than three-fourths become teachers. The total number of teachers of Science engaged in classes under the Department alone at the present time is about 6000.

I have not yet exhausted what our College does for the national efforts in aiding the teaching of Science.

When you, gentlemen, leave us about the end of June for your well-earned holidays, a new task falls upon your professors in the shape of summer courses to teachers of Science Classes brought up by the Department from all parts of the four kingdoms to profit by the wealth of apparatus in the College and Museum, and the practical work which it alone renders possible.

The number of Science teachers who have thus attended the summer courses reaches 6200, but as many of these have attended more than one course the number of separate persons is not so large.

Research.

From time to time balances arise in the Scholarship fund owing to some of the National Scholarships or Royal Exhibitions being vacated before the full time for which they are tenable has expired. Scholarships are formed from these balances and awarded among those students who, having completed the full course of training for the Associateship, desire to study for another year at the College. *It is understood that the fourth year is to be employed in research in the subject of the Associateship.*

The gaining of one of the Remanet Scholarships, not more than two on the average annually, referred to, furnishes really the only means by which deserving students are enabled to pursue research in the College; as, although a professor has the power to nominate a student to a free place in his laboratory, very few of the most deserving students are able to avail themselves of the privilege owing to want of means.

The Department only very rarely sends students up as teachers in training for research work, but only those who intend making teaching their profession are eligible for these studentships.

I trust that at some future day, when we get our new buildings—it is impossible to do more than we do till we get them—more facilities for research may be provided, and even an extension of time allowed for it if necessary. I see no reason why some of the 1851 Exhibition Scholarships should not be awarded to students of this College, but to be eligible they must have published a research. Research should naturally form part of the work of the teachers in training who are not brought up here merely to effect an economy in the teaching staff.

Such, then, in brief, are some of our Normal School attributes. I think any one who knows the facts must acknowledge that the organisation has justified itself not only by what it has done, but also by the outside activities it has set in motion. It is true that with regard to the system of examining school candidates by means of papers sent down from London, the Department was anticipated by the College of Preceptors in 1853, and by Oxford and Cambridge in 1858; but the action of 1861, when Science Classes open to everybody, was copied by Oxford and Cambridge in 1869. The Department's teachers got to work in 1860, but the so-called "University Extension Movement" dates only from 1873, and only quite recently have summer courses been started at Oxford and Cambridge.

The Chemical and Physical Laboratories, small though they were in the Department's schools, were in operation long before any practical work in these subjects was done either at Oxford or Cambridge. When the College laboratories began about 1853, they existed practically alone. From one point of view we should rejoice that they are now third rate. I think it would be wrong of me not to call your attention to the tenacity, the foresight, the skill, the unswerving patience, exhibited by those upon whom has fallen the duty of sailing the good ship "Scientific Instruction," launched as I have stated, out upon a sea which was certain from the history I have brought before you to be full of opposing currents.

I have had a statement prepared showing what the most distinguished of our old students and of those who have succeeded in the Department's examinations are now doing. The statement shows that those who have been responsible for our share in the progress of scientific instruction have no cause to be ashamed.

Conclusion.

I have referred previously to the questions of Secondary Education and of a true London University, soon, let us hope, to be realised.

Our College will be the first institution to gain from a proper system of Secondary Education, for the reason that scientific studies gain enormously by the results of literary culture, without which we can neither learn so thoroughly nor teach so effectively as one could wish.

To keep a proper mind-balance, engaged as we are here continuously in scientific thought, literature is essential, as essential as bodily exercise, and if I may be permitted to give you a little advice, I should say organise your athletics as students of the College, and organise your literature as individuals. I do not think you will gain so much by studying scientific books when away from here as you will by reading English and foreign classics, including a large number of works of imagination; and study French and German also in your holidays by taking short trips abroad.

With regard to the University. If it be properly organised, in the light of the latest German experience, with complete Science and Technical Faculties of the highest order, it should certainly insist upon annexing the School of Mines portion of our Institution; the past history of the School is so creditable that the new University for its own sake should insist upon such a course. It would be absurd, in the case of a nation which depends so much on mining and metallurgy, if these subjects were not taught in the chief national university, as the University of London must become.

But the London University, like the Paris University, if the little history of Science teaching I have given you is of any value, must leave our Normal College alone, at all events till we have more than trebled our present supply of Science teachers.

But while it would be madness to abolish such an institution as our Normal School, and undesirable if not impossible to graft it on the New University, our School, like its elder sister in Paris, should be enabled to gain by each increase in the teaching power of the University. The students on the scientific side of the Paris School, in spite of the fact that their studies and researches are looked after by fourteen professors entitled Maîtres de Conférences, attend certain of the courses at the Sorbonne and the Collége de France, and this is one of the reasons why many of the men and researches which have enriched French science, hail from the École Normale.

One word more. As I have pointed out, the French École Normale was the result of a revolution, I may now add that France since Sedan has been doing, and in a tremendous fashion, what, as I have told you, Prussia did after Jena. Let us not wait for disastrous defeats, either on the field of battle or of industry, to develop to the utmost our scientific establishments and so take our proper and complete place among the nations.

J. NORMAN LOCKYER.

FELLOWSHIPS FOR RESEARCH.

THE foundation of Research Fellowships by the Commissioners of the Exhibition of 1851 was in this country of the nature of an experiment. Many people more or less enamoured of the system in vogue at the universities, whereby a man is carried on from one examination grind to another, until his freshness and originality of mind are in great measure lost, looked at the scheme for Research Fellowships with distrust, and an inclination to foretell their failure. There might, it was said, be an able man here and there who is benefited by holding a Research Fellowship and who does good work while holding it, but, in general, maturity of mind and knowledge, and an accumulated fund of experience are necessary for the success of a scientific or literary investigator. There is truth in this, of course, but the scholastic training of the best men is frequently carried so far that all enthusiasm is killed out by examinations, or the mind has become too critical and fastidious for the work of original production or continuous investigation.

These prophecies have been falsified in the most conclusive way by the report of the Commissioners. They say that they have received from academic institutions all over the country unanimous testimony to the success of their system of Research Scholarships, and an analysis of the work done by the Research Scholars and their after careers shows that the success has been full and complete. A number of able young men, fairly well trained in theoretical and practical science, have been chosen from the best students of our provincial colleges and given the means of pursuing research, and therefore also higher study of the best kind, for two or three years at approved institutions at home and abroad. The Commissioners most wisely determine that the whole time of the scholars should be given to the research work undertaken, and have steadfastly refused to sanction the employment of their funds to enable students to prepare for University degrees. The scheme and its conditions were the subject of much criticism. It was objected that by spending time in research the prospects in life of such men would be injured, that it would be difficult for them after to find congenial employment. This fear has also proved groundless. Of the large number of young men who have been sent out by the Royal Commissioners nearly all have obtained appointments in which the knowledge, skill, and, above all, resource and self-dependence they have acquired will be of the utmost value. Many have returned to their old colleges to teach, and to encourage among the students rising among them that zeal for the advancement of science they have themselves imbibed, to be an example ever before the eyes of still younger men, and by their association with rising students to create an interest in scientific progress which the studies of the class-room often fail to arouse. Some have been appointed to important educational posts at home and in the Colonies; others have gone to direct scientific industries and engineering achievements. In spite of the vaticinations of the doubters, the scheme of the Commissioners has succeeded far beyond the expectation of even those who most believed in it, and its remarkable record ought to be widely studied by all interested in the higher education of the country, and especially by those who have the privilege of guiding the policy of our universities.

A similar movement has been started by the youngest of our universities. The University of Wales has now got its curricula into full swing, and has already begun to form its roll of graduates. The question of post-graduate work, and especially of Fellowships for literary and scientific research, was raised at an early period in the discussion of regulations for degrees. There has been no matter before the senate or the court of greater or even approximately equal importance. For upon the decision of the authorities as to whether promising students should after taking their degrees go on to real post-graduate work, or, as is the case at too many places, be encouraged to enter again as undergraduates at some other university, generally either Oxford or Cambridge, rests the whole future of the newer universities as regards the higher learning. If it is regarded as the natural course for a graduate to enter again as a freshman at another university, an important stimulus towards providing the necessary staff and machinery for imparting the best and completest teaching in all subjects will be withdrawn from the colleges. The new universities may do some good to their localities by giving the ordinary education of a professional man, but, under such a policy, they will never become homes of learning and research. In fact these colleges, however well manned, will, as regards the higher work only, take the place of feeding schools for the old universities, and the time and energies of their professors will be occupied with the ignoble task, which might surely be left to the schools and the cramming shops, of striving for the credit of their colleges in the race for a good place in the record of scholarships won or in the list of examinational successes. Already one Oxford college has proposed to give scholarships to be confined to the best Welsh graduates, a plan well calculated to increase the number of First Classes in the schools obtained by that college, but certain, so far as it operates in this direction, to degrade the University of Wales. It is to be hoped that this proposal will receive no official countenance from the University itself.

It will be said that the degrees of the University of Wales have as yet little or no market value, and that the best students must go elsewhere to obtain degrees which have. This may be true; a university, like everything else, must begin; but the question arises, how is the university to form its reputation, and to confer a value on its degrees? Surely not by itself sending its best men to colleges on which their home academic training will only help to shed lustre, and to which not only their academic success, but all the credit of their after life will be attributed. The duty of the university is to itself, and relates not to the present merely, but also to the future. It has no right to imperil or delay any credit or renown there may be a possibility of its attaining; and if there is any lesson to be learned from the history of universities, it is that learning will refuse to grow within academic walls if aims are not high, and if teachers are content to see others doing their highest work.

Also, a new university should pursue this policy of high aims and resolute determination to do all that a university can do for learning and science, from the very beginning. It has a unique opportunity. It is free from the trammels of custom and prejudice, and the claims of vested interests. It can be guided by older institutions, but the guidance to be obtained from these is almost more often of the nature of warning than of example.

The contention that has been put forward, that this kind of migration to undergraduate work in honours schools elsewhere should be encouraged by the newer, and even some of the older universities of the country, and that they should aid it by the foundation of scholarships and prizes, rests on a confusion of ideas. It may sometimes be a good thing for students who are already graduates to go to Oxford or Cambridge, but the interests served are not those of the parent university, and it is not a thing for the university as such to assist. Funds for such a purpose should be provided by persons interested in the older universities, or in the students to be sent there.

The foundation of Research Fellowships has been undertaken by universities in America with great success. Witness the youthful vigour of Johns Hopkins, and the great and growing vigour of Harvard and Yale, and others in the United States. The plan has been several times proposed in this country, but never until in the scheme of the Commissioners for the Exhibition of 1851 has it had a practical trial. An important pronouncement in its favour was given a few days ago by Mr. Simon at Manchester, and there is reason to hope that it may be followed by some practical action at Owens College or in the Victoria University. A fund for five years has been subscribed chiefly in the court of the University of Wales, and at a forthcoming meeting an election of a Fellow will probably be made, and we trust that he will prove the first of a long succession of literary and scientific scholars of native growth. In spite of the proverb, there is much in a name, and it seems to us that no better name than Fellow could have been devised. By rigidly refusing to allow undergraduate work to be undertaken, and giving the style of a Research Fellow to the graduate appointed, the university assures three things: that he shall throughout his tenure of the Fellowship at home or abroad be identified with the parent university, that his status shall be clear, and that no one shall be appointed whose merit is not clear and unmistakable. The advantage to the colleges of having a number of young men aspiring to obtain these Fellowships will be immense, especially if, like the Exhibition of 1851 Commissioners, the authorities, where possible, take the successful prosecution of a research as the best evidence of his fitness to hold a Fellowship. Nothing encourages higher work or stimulates a teacher like the presence of young men looking eagerly forward to doing something for the advancement of knowledge. Nothing kills research among teachers like confinement to mere preparation for examinational tests, or is more soul destroying for both teacher and taught than the competition which goes on for the longest list of examination successes.

It has been said that men would be encouraged to begin too soon to do original work. This is surely a strange thing to say in the face of the history of learning and science. Some of the greatest discoverers have had little or no training of the ordinary scholastic kind, and it is doubtful if they would have been so successful if they had spent years in grinding for successive examinations. Surely, when a man has taken his B.A. or B.Sc. degree with, say, first class honours in the subject or subjects he has chosen to specialise in, he ought to be ready to make a beginning of research. It does not follow that his work will be unfruitful because his experience has been brief, or his knowledge lacks the width and depth it will subsequently acquire, and acquire all the more surely and truly, if his mind is fixed on discovery or the advancement of learning instead of on the attainment of merely another first class. Training long continued for examinations has killed much intellect; it has created none. Yet, like many another fetish, the examination system lingers on, and yearly claims its victims.

The University of Wales is to be congratulated in that so far it has recognised no examinational post-graduate work at other universities as fit work for the graduates sent out to represent it in the academic world. If higher degrees than that of B.A., M.A., or B.Sc. are required by these, there are the degrees of D.Litt., and D.Sc. of their own university, which it is to be hoped will be given solely as a reward for meritorious research.

It is essential for success in research that the man should be started when his mind is fresh, and he has not had time to acquire that morbidly critical habit of mind which residence at some of the universities seems to encourage so much, and which has been so fatal to the performance of real work by many highly gifted men.

Research will encourage resource, and the application of knowledge to real problems will foster a dependence on self which cannot but be of the greatest value to the possessor. Going out into the world of learning in a self-respecting way, received with due recognition of the position he has attained by the university to which he goes to reside, he will gain experience of the world, and be less apt to show that limitation of mental horizon, and that superciliousness of intellect, so characteristic of many, though happily by no means of all, who have taken high honours at the old universities.

But the best answer to the contention that a long and arduous preparation beyond the Bachelor's degree is necessary for successful research is to be found in the fact that already the contrary has been demonstrated at the Welsh colleges. One young man of great promise did most excellent work in Germany in the difficult field of the study of old Celtic manuscripts, another has made his name known in physical research. Both have returned to their college to teach, and their presence has proved a stimulus and inspiration to others. If the example thus set is followed by others in the Welsh University, and the Fellowship system is allowed a patient and fair trial, the results cannot fail to be of the greatest benefit to all concerned. Knowledge will be increased, the University by respecting itself and its students will be respected and its work will be recognised, and its *alumni* will have no cause to complain of the estimation in which the public hold the credentials they have received from their *Alma Mater*.

A. Gray.

NOTES.

The meetings of the International Conference on Scientific Literature, held last week at the Royal Society, came to an end on Thursday. A list of the delegates appointed to attend the Conference appeared in last week's Nature, with an account of the dinner given by the Royal Society in their honour. We hope shortly to give a report of the questions discussed and the resolutions adopted.

The annual general meeting of the London Mathematical Society will be held on Thursday, November 10. Lord Kelvin has acceded to the request of the Council, and will be nominated for the office of President. Prof. H. Lamb, F.R.S., will be nominated for a Vice-Presidentship. The retiring members are Messrs. Jenkins and G. B. Mathews, F.R.S. The former thus severs his long connection of more than thirty years—he being almost an original member. Prof. Elliott, F.R.S., has chosen for the subject of his address, "Some secondary needs and opportunities of English mathematicians."

With the object of comparing systems of electric traction suitable for use in London, the London County Council have consented to permit the London United Tramways Company to re-construct one section of their lines in the neighbourhood of Hammersmith on the overhead trolley system of electric traction, on condition that two other sections are laid down on the underground conduit plan.

In his opening lecture to the engineering students at Cambridge on Friday last, October 14, Prof. Ewing intimated that the crowded state of their lecture-rooms and laboratories would soon be relieved. A gift of 5000*l.* had just been made for the addition of a new wing to the engineering laboratory in memory of the late Dr. John Hopkinson and of his son, John Gustave Hopkinson, who recently lost their lives in the Alps. Dr. Hopkinson's son was to have begun work at this time as a student of engineering at Cambridge. This splendid and welcome gift was made by Mrs. Hopkinson jointly with her son Bertram and her surviving daughter.

The Harveian Oration was delivered at the Royal College of Physicians on Tuesday by Sir Dyce Duckworth, who, after urging the claims of the college to the consideration of generous benefactors, pointed out that Harvey had definitely charged them to encourage research. The lecturer is reported by the *Times* to have said that what were greatly needed now in England were research laboratories attached to hospital wards and *post-mortem* theatres, and also a select staff of fully trained investigators available for service throughout the Empire. It was surely humiliating that researches were permitted to be made for the public benefit in various parts of British territory by foreigners, while many of their countrymen and countrywomen, owing to ignorance and mawkish sentimentality, were doing their best to debar the training of such men in England. After alluding to the results of recent pathological research in regard to the preventive treatment of tuberculosis, Sir Dyce Duckworth observed that the Röntgen rays had as yet yielded little new information, and their therapeutic influence was not determined, but, according to Rieder, of Munich, the rays emitted from "hard," vacuum tubes killed bacteria. The influence of glycerine in destroying some of the most noxious microbes which gained access to ordinary vaccine lymph was very noteworthy, and he could not but imagine that this agent might yet be found of more extended usefulness as a bactericide. Expressing his private opinion, though he believed it to be shared by the majority of those he addressed, he did not hesitate to stigmatise the recent Vaccination Act as a piece of panic legislation, a lamentable concession to ignorance, fraught with serious peril to the whole community, and unworthy of the duty and dignity of any British Government. He closed with a brief appreciation of Harvey's chief scientific achievements, and of his great guiding principle, devotion to truth.

Mr. W. H. Preece, C.B., F.R.S., will deliver the inaugural address at the new session of the Institution of Civil Engineers, on Tuesday, November 1. The Council of the Institution have made the following awards out of the trust funds at their disposal for the purpose for original papers dealt with during the year 1897–98. The formal presentation will take place on November 1:—Telford medals and premiums—A. H. Preece (London) and H. C. Stanley (Brisbane, Queensland); Watt medals and premiums—H. L. Callendar, F.R.S. (London), and J. T. Nicolson (Montreal, Canada); George Stephenson medals and premiums—Whately Eliot (Plymouth), W. O. E. Meade-King (London), and W. P. Marshall (Birmingham); the Crampton prize—E. W. Anderson (Erith); Telford premiums—L. B. Atkinson (Cardiff), Henry Fowler (Horwich), W. L. Strange (Bombay), F. J. Waring (London), D. W. Brunton (Denver, U.S.), Wilfred Airy (London), E. M. Bryant (Newcastle-on-Tyne), D. B. Butler (London), and H. V. Champion (Victoria); the James Forrest medal—W. L. Brown (London); Miller prizes—C. E. Wolff (Derby), A. D.

Keigwin (Ashford), Harold Williams (Kingston), J. T. Morris (London), H. C. Adams (Birmingham), H. O. Eurich (Bradford), B. K. Adams (Colombo), A. B. E. Blackburn (Wednesbury), Thomas Carter (Newcastle), P. F. Story (Manchester), D. E. Lloyd-Davies (Bewdley), and Wilfred Hall (Corbridge-on-Tyne).

THE Hayden Memorial Award of the Philadelphia Academy of Natural Sciences has been made to Prof. Otto Martin Torell, formerly professor of zoology and geology at the University of Sweden, and late Chief of the Geological Survey of Sweden. Of his works, those which treat of the ice period are the most important. To these belong "Contribution to the molluscan fauna, with a general view of the natural state of the Arctic regions," "Investigations of the Ice Period," and "On the causes of glacial phenomena in the north-eastern portion of North America." Partly by these works and partly by lectures Torell has, in Sweden as abroad, actively assisted in making known the theory that the territory of northern Europe, where great blocks of Scandinavian rocks have been found, was formerly covered by land ice, extending from Scandinavia, like the ice in Greenland at the present time, and not, as had been formerly supposed, by a frozen sea (Eismeer). Dr. Torell is a member of the Royal Society of Sciences of Sweden (1870), of the Agricultural Academy (1872), and of many other scientific societies in Sweden and abroad. He is Commander of the Swedish "North Star," Grand Officer of the Italian Order of the Crown, Knight of the second class of the Russian Order of St. Anna, Commander of the Danish Dannébrog, Officer of Public Instruction, and Officier de la Legion d'honneur.

FROM the report of the Laboratories Committee, presented at the quarterly meeting of the Council of the Royal College of Surgeons of England, held on Tuesday, it appears that since June 3 last 7050 doses of antitoxin, each containing 2000 units, and 2325 doses, each containing 4000 units, for the treatment of diphtheria in the hospitals of the Metropolitan Asylums Board, have been supplied, and all demands fully met. In deference to the researches in connection with the grant from the Goldsmiths' Company, Dr. T. G. Brodie and Dr. Cartwright Wood have continued their investigations and have planned out a further series of experiments for the coming winter. The Committee has awarded to each of them a further sum of 50*l*. from the research grant, as a recognition of their valuable work. Dr. T. G. Brodie is at present engaged on the chemistry of diphtheria antitoxin, and Dr. Cartwright on diphtheria toxins and antitoxins, and a method of examining water bacteriologically. The demand for antitoxin supplied to general and children's hospitals in London, in accordance with the conditions of the grant from the Goldsmiths' Company for use among the poorer classes of the community, is steadily increasing.

THE death is announced of Prof. Andreas Arzruni, professor of mineralogy and petrography in the Technical High School at Aachen, and of Dr. C. G. Gibeli, professor o botany and director of the Botanical Institute at Turin.

A MEETING of the Physical Society will be held on Friday, October 28. The papers down for reading are: An influence machine, by Mr. W. R. Pidgeon; the repetition of an experiment on the magneto-optic phenomenon discovered by Righi, by Prof. Silvanus P. Thompson, F.R.S.; the magnetic fluxes in meters and other electrical instruments, by Mr. Albert Campbell.

THE following meetings of the Royal Photographic Society are announced:—Technical meeting, Tuesday, October 25, "On the alleged discovery of photography in 1727," by R. B. Litchfield; "On the grain of photographic negatives," by E. Duncan Stoney. On Monday, October 31, slides will be shown by members of affiliated societies at the exhibition of the Royal Photographic Society.

THE *Athenæum* states that the Vienna Academy of Sciences has chartered the Swedish steamship *Gottfried* for its projected scientific expedition to South Arabia. The ship is expected to arrive in a few days at Trieste, where the members of the expedition will go on board. The leader of the party is Count Carl Landberg, the Bavarian Orientalist, who has already spent several winters in the district. Dr. H. Müller proposes to devote his researches to the Sabæan inscriptions and the pre-Arabic archæology. Prof. Simony will accompany the expedition as botanist, Dr. Cossmat as geologist, and Mr. Bury will be the leader of the caravan. Dr. Jahn will take as his speciality the study of the Mahra language. Dr. Layn goes as physician to the expedition.

WE learn from *Science* that, through the generosity of Mr. Cornelius Vanderbilt, the New York Botanical Garden is about to undertake a botanical exploration of the island of Porto Rico. The expedition, which is now being organised, will leave for the new Colony within a few weeks, and will be occupied in collecting museum and herbarium specimens and living plants for at least six months. Inasmuch as very little is yet known concerning the natural flora of the island, it is confidently expected that much of value and interest will be secured, and the collections will furnish the basis of a report on the botany and vegetable productions of our newly-acquired territory.—During the past summer much progress has been made in the New York Botanical Garden, in Bronx Park. The construction of the museum building has proceeded rapidly, three-fourths of its steel frame being in place, the walls being completed as far as the second story. The warm and wet summer has been favourable to the plants. Much progress has been made in planting the border, which will be completed during the autumn. It will be about two miles in length, and will contain some three hundred and fifty varieties of trees and shrubs.

AN instructive and interesting account of the cultivation of plants yielding Parà rubber, the collection and preparation of the rubber, and other aspects of the industry, is given in the *Kew Bulletin* for October. With regard to future prospects of the rubber from the vast region drained by the Amazon, Mr. Consul W. A. Churchill is quoted to have remarked as follows, in a recent report to the Foreign Office:—"Some people suppose that the supply of Amazonian rubber may become exhausted in the near future. The most competent authorities are not at all of this opinion, but maintain that the supply is inexhaustible, because the *Hevea* is continually being reproduced by nature. Certainly some areas become exhausted when overworked, but when left alone for some time they recover. . . . The area that is known to produce Pará rubber amounts to at least 1,000,000 square miles. Further exploration will, no doubt, show that this area is under-estimated." The introduction of the rubber-yielding trees of tropical America to British Possessions in the East was an enterprise in which, more than twenty years ago, Kew took an active part, the expense being borne by the Government of India. A survey of the results of experiments carried out in various places in which the cultivation of rubber has been attempted, is given in the present number of the *Bulletin*.

IN a recent paper on "The accepted altitude of the Aurora Borealis," read by Prof. Cleveland Abbe before the American Philosophical Society, he stated that some observers have seen the light in such positions between themselves and neighbouring objects as to demonstrate that the aurora, like the lightning, may be entirely confined to the lowest stratum. Others have seen it so located among the clouds that its origin must be placed at or below their level, and, therefore, within a few thousand feet of the earth's surface. On the other hand, those who have calculated the altitudes of specific beams by trigonometrical or equivalent methods have deduced heights of twenty to a hundred miles; Dr. Boller has even quoted an altitude of 1243 miles. Prof. Abbe remarks that, after reviewing the literature of the subject since the time of Halley, he finds that all methods agree in one fundamental assumption that the observed beams and arches have an individual existence and a definite *locus*. But this assumption is negatived by the equal frequency of negative and positive parallaxes wherever the parallax method is applied. The only conclusion possible is that the observers do not see the same object, partly because the aurora is too low down, and partly because there are optical illusions due to alignment.

During the present year, Dr. Doberck, Director of the Hong Kong Observatory, published a useful pamphlet on "The law of storms in the Eastern seas," the first part of which was issued in 1886. The work is illustrated by plates showing the different classes of typhoons, and their average tracks and rate of progress, based upon 244 storms registered during the past thirteen years. A translation of the pamphlet by Dr. P. Bergholz, of Bremen, appeared in the *Meteorologische Zeitschrift* for September, thus testifying to the value of Dr. Doberck's investigations to the sea-faring community, and to maritime meteorology generally.

The special Antarctic number of the *Scottish Geographical Magazine* ought to be widely distributed and read, in order to excite a little more practical sympathy with scientific Antarctic exploration than has yet been shown by the general public. Sir John Murray pleads strongly for a British Antarctic Expedition. At the present moment, he points out, scientific men in Germany are making arrangements, with the approval and support of their Government, for the exploration of the Antarctic in the year 1900. We have been asked to co-operate, at the same time, in this exploration, but our Government has expressed itself unable to support the undertaking, and there is little hope of the necessary funds being procured from private sources. The outlook is thus not at all promising so far as British science is concerned; and unless the unexpected happens, we shall have to stand aside while other countries carry through the great work of examining the south polar area, and reap the results of their enterprise. Sir John Murray suggests that a rich man, or several rich men, should place in the hands of the President of the Royal Society at least 100,000*l*. for the purpose of organising an Antarctic expedition to co-operate with the other expeditions that are preparing to set out in the year 1900. Here is a splendid opportunity for wealth to assist most usefully in the development of knowledge, and earn renown for British science. May the desire to place our country in the fore-front in scientific research, and especially in oceanic explorations, move some generous benefactor to provide means for equipping and sustaining an expedition which will be a credit to the nation and to science. The whole history of Antarctic exploration, including complete reports of the discussion of the subject at the Royal Society on February 24 (see Nature, vol. lvii. pp. 420-427), and an excellent map of the south polar regions, is given in the *Scottish Geographical Magazine*, and we trust its publication will produce a practical result.

The August number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (Paris) is occupied almost entirely by an article by M. L. de Chasseloup-Laubat, on the steamboat service of this country, the United States, Germany and France. The development of steam navigation is traced, and full descriptions given of all the principal steamers which have been engaged in the passenger service of the world, and of some cargo boats. The article contains detailed particulars of the dimensions of the boats, mode of construction, engines and fittings, speed and draught. In some of the more modern boats, such as the *Campania*, particulars are given of the staff and crew engaged in working the boats, and the quantity of coal and provisions used. From the tables given it appears that for the number of cabin passengers carried the American Line stands first, followed in order by the Cunard, White Star, Hamburg-American and Norddeutscher Lloyd. The German boats carry the greatest number of emigrants. The article is very fully illustrated, and contains several tables as to the time occupied in the different voyages, details of dimensions, horse-power and other matters.

A magnificent meteor was observed at numerous points in Ontario, at 8.50 standard time of July 5, and many descriptions of it appeared in the newspapers at the time. Mr. F.F. Payne gives a few particulars of the meteor in the July number of the Canadian *Monthly Weather Review*, which has just reached this country. The meteor was described by observers as a ball of lurid light, apparently about ten inches in diameter, exploding with a loud rumbling noise like thunder, and leaving a long sinuous trail of white vapour, which was visible for at least six minutes afterwards. As is usual there was some apparent disagreement between observers as to the meteor's flight, the popular opinion prevailing that its course must be parallel to the earth's surface, its vertical motion scarcely being considered. From data received, Mr. Payne thinks that the meteor became visible at a height of 125 miles above the earth's surface at a point somewhat to the eastward of Collingwood, over which place it passed near the zenith, its path being inclined a little to the north of west. It apparently exploded over the Georgian Bay in latitude 44° 50′, longitude 80° 30′, and the observer at Collingwood states that "a loud rumbling noise was heard."

The question of the determination of the neutral elements of involutions presents considerable difficulties to the mathematician. An important contribution to the solution of this problem is given by M. F. Deruyts, of the University of Liége, in the *Bulletin* of the Belgian Academy. The same mathematician also considers certain properties of gauche curves, his conclusions including amongst others the following interesting result:—"Through $9 - k$ points of space there can be drawn

$$2(k - p + 1)\binom{2n - k + 1}{p}\binom{2n - k}{p - 2},$$

gauche curves of the fourth order having contact of order $(k - p + 1)$ with a given gauche curve of order n, and meeting this curve in $2p - 3$ points."

The installation of a storage battery of ten thousand cells has enabled Prof. John Trowbridge to undertake an inquiry into the nature of electrical discharges in air and gases under conditions which render the investigation practically an incursion into a new region of research. The results of his investigations have on several occasions been referred to in these columns; nevertheless the following *résumé* of certain conclusions, from his paper in the *Proceedings* of the American Academy of Arts and Sciences, vol. xxxiii. No. 21, is of interest:—Beyond 1,000,000 volts the initial resistance of atmospheric air to electric discharge decreases, and may become as low as 1000 ohms between terminals 2 or 3 inches apart. When the initial resistance of highly rarefied air is broken down by x-rays, it exhibits less resistance than it does at 2 mm. pressure when its conductivity is generally considered to be greatest. There are anode as well as kathode x-rays, and these rays exhibit all the peculiarities of the kathode rays. The x-rays can be distinctly produced with an electromotive force of 10,000 volts, and there are indications of them at 5000 volts. Electrostatic induction is an important phenomenon in that of x-rays; experiments indicate that these rays are evidence of an electromagnetic disturbance, which therefore travels with the velocity of light, and is accompanied by molecular excitation. The mechanism of the production of x-rays appears to be a setting-up of electrostatic lines of induction, and a production of an electromagnetic wave or impulse; the stress in the medium reduces its resistance, and the x-radiations become less and less energetic after a certain interval the longer the Crookes' tube is excited. The behaviour of rarefied media to powerful electric stress is analogous to that of elastic solids to mechanical stresses; a so-called vacuum, which acts as an insulator for electromotive forces giving a spark of 8 inches in air (about 200,000 volts), breaks down under 3,000,000 volts. A single discharge with this voltage through highly rarefied media produces x-rays powerful enough to give a photograph of the bones of the hand in one-millionth of a second. During the discharge the apparent resistance of the medium is only a few ohms. In this case the medium seems completely to lose its elasticity, so to speak, and is ruptured, and the elastic solid analogy thus seems to elucidate the question of the electrical conductivity of the ether.

MR. D. E. HUTCHINS, Conservator of Forests at the Cape, recently read before the Cape Town Philosophical Society a paper showing the need and value of extending the area in the Colony at present under forest. Cape Colony stands far below other countries in its proportion of forest, though the climate of the country is such that it ought to have a percentage under forest at least equal to Germany. The following table shows the area under forest in the Colony compared with that in some other countries:—

Countries.	Area under forest in acres.	Percentage under forest of total area of country.
Russia in Europe	...527,427,000	42
Sweden	... 42,366,000	42
Austria	... 46,856,000	31
Germany	... 34,350,000	26
Norway	... 18,920,000	25
India	...140,000,000	25
France	... 20,750,000	16
Portugal	... 1,666,000	5
Great Britain and Ireland	... 2,790,000	4
Cape Colony	.. 353,280	0·29

Mr. Hutchins suggests that plantations should be formed in districts within minimum rainfall limits of 15 or 20 inches per annum. The argument which will perhaps appeal most forcibly to Cape agriculturists is that while the total value of the fruit produced in Cape Colony is 100,000*l*., no less than 269,349*l*. have been paid for wood imported into the Colony during the last two years, nearly the whole of which would be produced in national forests covering an area of about 50,000 acres. That forests can thrive where agriculture is difficult or impossible, is shown by the steep richly-wooded slopes of the lofty Amatolas, the similarly beautiful forest with its gigantic yellow-wood trees in the barren Knysna country, and, perhaps most striking of all, the cedar trees of Clanwilliam, growing on the absolutely bare rocks of the stupendous Cedarberg Range; while at Genadendal an introduced tree, the cluster pine, hardier than any of the indigenous trees, is spreading itself self-sown up the rocky mountain-side, in spite of fires, drought, hot winds and climatic vicissitudes, that are too often the despair of the agriculturist.

A PAPER on the "Wanton Mutilation of Animals," contributed by Dr. George Fleming to the *Nineteenth Century* for March 1895, has been issued in separate form by the Royal Society for the Prevention of Cruelty to Animals. The paper shows that many mutilations of this kind can boast of a venerable antiquity, and are practised in many countries. The practice of removing a portion of the tails of certain breeds of dogs appears to have been instituted as a means for the prevention of rabies, the belief being that the sinew which followed the piece bitten off was a worm which produced madness. "Worming," which was performed upon dogs for the same purpose, consisted in the excision of the frænum of the dog's tongue, under the impression that it had something to do with madness. Ear-cropping of dogs has been carried on for two or three centuries. Horses are subjected to tail-docking, ear-cropping, nostril-slitting, and other unnecessary mutilations. The fashion of mutilating horses appears to have prevailed at a very early date in England, and may have been introduced from Germany or Scandinavia. Dr. Fleming's descriptions will assist in suppressing these cruel and useless practices.

MESSRS. WILLIAMS AND NORGATE'S Book Circular for October, and their latest list of second-hand books (No. 10), contain the titles of a number of volumes on scientific subjects. —A more elaborate catalogue, occupying 686 pp., is the new volume of "Naturae Novitates" just issued by Messrs. R. Friedländer and Son, Berlin. This publication not only contains classified lists of books in many languages on all branches of science, but the works named in it are indexed according to subjects and authors.

THE following official publications from our foreign possessions have reached us:—*The Central Africa British Gazette* (published at Zomba) for July 9, containing an interesting report on the cultivation of coffee, compiled by the Commissioner of Agriculture to the Hawaian Government; Report on the Botanic Gardens and Domains, New South Wales, for the year 1897, by the Director, Mr. J. H. Maiden; Annual Report of the Royal Botanic Garden, Calcutta, for the year 1897–98, by the Superintendent, Dr. D. Prain, chiefly occupied by a list of exchanges; *Bulletin* (No. 15) of Miscellaneous Information from the Royal Botanic Gardens, Trinidad, edited by the Superintendent, Mr. J. H. Hart, and consisting of a conspectus of the genera of Ferns and Fern-allies of the Colony, and a monograph of the Cyatheaceæ, comprising the genera *Alsophila* (14 sp.), *Hemitelia* (15 sp.), and *Cyathea* (25 sp.); *Circular*, Nos. 4–7, of the Royal Botanic Gardens, Ceylon, issued by the Director, Mr. J. C. Willis, in which the extension of the rubber cultivation in the island is advocated, especially that of the Parà rubber, *Hevea brasiliensis*, which is stated to be well suited to the climate of the low country in the south-west of Ceylon.

THE additions to the Zoological Society's Gardens during the past week include a Tantalus Monkey (*Cercopithecus tantalus*, ♂) from Lagos, presented by Mr. Arthur T. Warren; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. H. W. Mote; two American Flying Squirrels (*Sciuropterus volucella*) from North America, presented by Mrs. Nias; a Bengalese Cat (*Felis bengalensis*) from the East Indies, presented by Mr. David J. Munro; a Ruddy Ichneumon (*Herpestes smithi*) from India, presented by Mr. J. Lyons; a Black-headed Lemur (*Lemur brunneus*) from Madagascar, deposited; an Eland (*Orias canna*, ♂), bred in France purchased.

OUR ASTRONOMICAL COLUMN.

THE ANDROMEDA NEBULA.—In this column (September 22, p. 515) we have previously referred to the telegram which informed us that M. Seraphimoff had discovered, near the centre of the nebula of Andromeda, a stellar-like condensation. Writing to the *Astr. Nachr.* (No. 3523), he states that the central condensation is no nebulous nucleus, but is quite a distinct star of magnitude 10–11. Measurements with a star of magnitude 11 in the neighbourhood showed that the observed object is exactly identical in position with that of the old nucleus.

M. Seraphimoff also mentions that an examination of all photographs, drawings and descriptions of this nebula shows that the central part was very seldom referred to as a small star. In the year 1885 numerous observations (*Astr. Nachr.*, vol. cxii.-cxv.) showed that the central portion had a different appearance to what it now has; at the present time the two small stars appear equally bright and sharp, and this has been corroborated by Profs. Backlund, Belopolsky and Morin.

That the central portion of this great nebula is variable there can be little doubt, but up to the present time only very small differences of intensities have been recorded.

Prof. Pickering, in a Harvard College *Circular*, No. 34, states that a comparison of photographs of the nebula taken with the 8-inch and 11-inch Draper telescopes on September 20 and 21, 1898, with similar photographs taken in 1893–96, fails to show the new stellated appearance.

Atlas of Variable Stars.—In a recent number of the *Astr. Nachr.* (No. 3523), Dr. J. G. Hagen describes the arrangement of a new atlas of variable stars, which we hope will soon be published, as it promises to be a very useful addition to an astronomical observatory. When completed the chart will consist of five series, the first three showing, on separate sheets, the positions and neighbouring stars of variables with faint minima; the fourth series of charts is for variables observable with small instruments; and the fifth, for naked eye variables. The sample chart accompanying Dr. Hagen's notice gives one an idea of the completeness of the work undertaken. The zones included in the first three series are $-25°$ to $0°$, $0°$ to $+25°$, and $+25°$ to $90°$, and will cover altogether 150 charts. These charts include a field of one square degree, with an inner square of half the sides. On the outer side of the small square only stars of the BD are inserted. In the inner square all stars are inserted which appear in a 12-inch with a magnifier of 45 and a measurable field of $0°\cdot75$.

The variable, with one exception, on each chart is situated in the middle, so that the observer will be able directly to recognise in his field of view which of the stars is the variable in question.

Each chart, further, gives the coordinates of the variable for 1900, with the annual movements, and, in addition, the colour, type of spectrum according to Secchi's classification, and the magnitudes at maximum and minimum. We may mention that each chart will be mounted on good stiff cardboard, and being of a handy size can be held by or placed close to the observer at the eye end of the telescope.

In conclusion, it must be remembered that the publication of this fine series of working charts is a very costly affair, and would probably not have been accomplished had not the benevolent Miss Catherine Bruce taken her usual interest in the progress of astronomical science, and tendered considerable financial help to further the printing of them.

Reminiscences of an Astronomer.—Prof. Simon Newcomb continues his reminiscences in the third of a series of articles to the October number of the *Atlantic Monthly*. He commences in this number with his visit to Paris to search among the old manuscripts of the Paris Observatory for early observations of occultations which had never been published. We may here point out how important it is to keep a record of every observation that is made, no matter whether at the time it be considered useful or not. The study of what may now seem apparently useless may, for all we know, in years to come, become of vital importance. Such was the case with the old observations of occultations made at the Paris Observatory. "The astronomers had no idea of the possible usefulness and value of what they were recording. So far as we can infer from their work, they made the observations merely because an occultation was an interesting thing to see; and they were men of sufficient scientific experience and training to have acquired the excellent habit of noting the time at which a phenomenon was observed." By means of these old observations "seventy-five years were added, at a single step, to the period during which the history of the moon's motion could be written. Previously this history was supposed to commence with the observations of Bradley, at Greenwich, about 1750; now it was extended back to 1675, and with a less degree of accuracy, thirty years further still."

Referring to a meeting of the Academy of Sciences which he attended four years later, he says: "In the course of the session a rustle of attention spread over the room, as all eyes were turned upon a member who was entering rather late. Looking towards the door, I saw a man of sixty, a decided blond, with light chestnut hair turning grey, a slender form, a shaven face, rather pale and thin, but very attractive and extremely intelligent features. As he passed to his seat hands were stretched out on all sides to greet him, and not until he sat down did the bustle caused by his entrance subside. He was evidently a notable.

"Who is that?" I said to my neighbour.

"'Leverrier.'"

Prof. Newcomb found Delaunay one of the most kindly and most attractive of men. "His investigation of the moon's motion is one of the most extraordinary pieces of mathematical work ever turned out by a single person. It fills two quarto volumes, and the reader who attempts to go through any part of the calculations will wonder how one man could do the work in a life-time."

After the death of Delaunay, who was drowned when out for a sail in a small boat, Leverrier was reappointed to his old place at the Paris Observatory, and to him, as Prof. Newcomb says, "belongs the credit of having been the real organiser of the Paris Observatory. His work there was not dissimilar to that of Airy at Greenwich; but he had a much more difficult task before him, and was less fitted to grapple with it."

LORD LISTER ON EXPERIMENTAL MEDICINE.

THE address delivered by Lord Lister at Liverpool on October 8, on the occasion of the opening of the Thompson-Yates Laboratories at the University College in that city, was briefly referred to in our report of the ceremony last week. The complete address is printed in the *British Medical Journal* of October 15, and is reproduced below. It is a statement as to the nature and value of the work to be carried on in the new laboratories, and a dignified vindication of the experimental method in medicine. The facts concerning experiments upon animals are so often presented to the public in a distorted form, that a calm exposition of the true ethical policy of vivisection, such as Lord Lister gives in his address, should have a most beneficial effect.

Lord Lister's Address.

My Lord Chancellor, my Lord Mayor, my lords, ladies, and gentlemen,—When I was honoured by the authorities of the Liverpool College with the request that I would open the Thompson-Yates Laboratories I little imagined that I was asked to take part in so imposing a ceremonial as the present. That it should have assumed such a character, that it should have attracted so large and brilliant a company, including not only many men from various and often distant parts of the country distinguished in medicine and other branches of science, but also noblemen, Church dignitaries, and persons eminent in literature and in politics, seems to me a matter of great importance, full of good augury for the future of the scientific practice of the healing art—in other words, treatment based on real knowledge as contrasted with the blind gropings of empiricism. We seem to have before us to-day clear evidence that the more cultured sections of the British public are becoming alive to the necessity for providing adequate means for the practical study of the sciences which are of the very essence of the knowledge that confers the power to recognise and treat disease. It an engineer is to qualify himself for detecting and correcting anything wrong in a machine of human construction, no verbal description or drawings will give him the requisite information; he must see and handle the details of the mechanism, and watch them at work. And it might seem the veriest common sense that the more practically familiar a man is with the structure and working of that marvellously complicated mechanism, the human body, the better fitted will he be to deal with its disorders. Yet obvious as such a consideration may seem, it is only in comparatively recent periods that its truth has been generally recognised. I am old enough to remember the years before the passing of the Anatomy Act, and I recollect being told as a child of the fiendish deeds of Burke and Hare, horrors which it would appear were needed to arouse a prejudiced and apathetic public to the imperious necessity of making it legally permissible for the intending surgeon to become acquainted in the only possible way, by dissection, with the sacred structures which he would be called upon to invade with his knife in the living body. A dissecting room well provided with the needful material for study has since been an essential equipment of every medical school, and a thorough course of dissection is demanded of every medical student. Meanwhile another kind of anatomy than that which the scalpel displays has come into being—the anatomy which the microscope has revealed and is constantly further revealing. This microscopic anatomy both of healthy and of diseased structures has assumed the greatest importance, and like naked-eye anatomy it requires special provision for its successful study. The materials to be studied cannot well be obtained by the student in his lodgings, and the processes employed for the elucidation of their minute structure are often of a complicated character which he cannot learn unaided, and require costly apparatus which he cannot provide. The requisite facilities for this work will be amply supplied by the laboratories which are to be opened to-day. The necessity for special pathological institutions has long been recognised on the continent, and nowhere has such an establishment been conducted with more signal success than in the Pathologisches Institut of Berlin, presided over for many long years by the illustrious man whom Liverpool is, I am sure, as glad to welcome with reverence as London has been. Many present to-day have sat at the feet of Prof. Virchow, but we may fairly anticipate that Liverpool students at all events will for the future be able to dispense with these pilgrimages to Germany. While the minute anatomy of normal and morbid structures will be thus effectively taught in the new laboratories, much may also be done in them to demonstrate and explain the actions of the living organism. I well remember the effect produced upon me as a member of Dr. Sharpey's class in London, by the repetition before us of Bernard's great experiment on the local circulation, and the converse experiment of Waller. The sympathetic nerve in the neck of an animal being divided, the ear of that side instantly became red and hot, and the blood vessels turgid; while on the application of galvanism to the severed nerve the opposite effect immediately followed, the ear becoming white and cool, and the vessels less conspicuous than those of the other side. Thus was impressed upon us, as mere oral teaching could hardly have done, the immensely important fact that the contractions of the arteries are as much under the control of the nervous system as are those of the muscles of a limb. I need, perhaps, hardly add that the animal being completely under an anæsthetic during such a demonstration no pain whatever is inflicted. In the study of the new science of bacteriology the pathological laboratory will render most important service. The student will see with his own eyes by aid of the microscope the minute living beings which we now know to constitute the essential cause of many infectious diseases, and he will be put through a course of the cultivation of these microbes, which, while it will impress upon him the reality of their existence, and the characters by which the various species may be recognised, will be invaluable as an exercise of the habits of accurate observation and manipulative skill. The new laboratories will also serve as a centre to which practitioners of a wide surrounding district may refer for the authoritative determination of the nature of doubtful specimens of diseased material, which they have neither the needful equipment, time, nor special knowledge to decide for themselves. As important as the services which the laboratories will render to education and medical practice will be the opportunities which they will afford for research. I had occasion, in the address which I gave two years ago in this city, to refer to some of the benefits which have been secured to mankind by recent biological investigation, and I need not say more on the subject at present; but I would remark that every step in advance in science only opens up wider fields for exploring the infinite resources of nature; and these laboratories will afford ample means for the further prosecution of such beneficent inquiries. Some, perhaps, may be disposed to object to such researches because they involve the sacrifice of animal life. This, however, I need hardly remark, is as nothing compared to what occurs for the supply of food to man. Of animal suffering I need hardly speak, because, in truth, the actual pain involved in these investigations is commonly of the most trifling description. Anæsthesia has come to the aid of experiment on animals, as the electric telegraph did for railways. Anæsthesia enables needful operations to be done without disturbance from the struggles of the animal, while it affords to the operator the unspeakable comfort of knowing that he inflicts no pain. I am bound to add that antiseptic treatment of the wounds has had a similar doubly beneficial influence. By preventing inflammation it renders healing painless, while it leaves the parts uncomplicated by inflammatory changes, and allows the results of operative procedure to be rightly estimated. I greatly surprised a former Chancellor of the Exchequer when, on a deputation to him on this subject, I explained to him that operations for the removal of parts of the brain of monkeys, which he had imagined to be attended with horrible torture, had, thanks to anæsthetics and antiseptics, been probably from the first to last unattended with a twinge of pain. Such operations thus painlessly conducted have, by indicating the precise functions of different parts of the organ, and thus guiding the surgeon in his operations, already led to the saving of many human lives. While I deeply respect the humane feelings of those who object to this class of inquiry, I would assure them that, if they knew the truth, they would commend and not condemn them. The laboratories, though they will be formally opened to-day, have for some time past been in practical operation; with the result that the Biological and Pathological School of Liverpool is already ranking very high among similar institutions in other parts of the world. As an illustration I may mention the fact that a committee of the Royal Society, with the approval of the Secretary of State for the Colonies, has lately selected a pupil of this school as one of two men specially qualified to undertake investigations in Africa on the deadly malaria of those regions. I cannot conclude these remarks without congratulating the Liverpool College on the mighty addition which these laboratories afford to their powers for usefulness. I believe they may be pronounced, both in structure and equipment, equal to any in existence. I must also congratulate you on having so nobly generous a benefactor as Mr. Thompson-Yates. I trust he will be rewarded by the deep satisfaction of knowing that he is doing incalculable good to mankind. If I may make one more observation, it is that while the laboratories have been so nobly constructed and equipped, there is yet much to be desired as regards the means for maintaining them in efficiency; and if any wealthy inhabitant of Liverpool is anxious to bestow his wealth in some manner calculated to do good to his fellow-men, he could hardly do better than by devoting a portion of his resources to the permanent maintenance of these fine institutions.

MECHANICS AT THE BRITISH ASSOCIATION.

Though an admirable President had been secured in Sir John Wolfe Barry, the proceedings in this Section were not up to the usual standard either in interest or importance to the profession. The fact of the matter is that, as in other Sections, too many papers are accepted, involving inordinately long sittings and often tending to hinder due discussion of really valuable papers. Unless the communications are mere notes of some scientific discovery or fact, the programme should be so arranged that not more than four papers are put down for any one day. The organising committee should insist that at least half a dozen copies of any paper intended for reading should be in the hands of the recorder a month before the opening of the meeting: the recorder could then circulate these copies, with a note of the day on which the paper would be taken, amongst those engineers most capable of discussing satisfactorily the facts and conclusions of the author, with a request from the organising committee that they should attend and take part in the discussion. The President would thus have a list of those he could call upon to speak on any paper, and the speakers having had an opportunity of preparing their remarks beforehand, a really valuable discussion would be secured. Few men are able to get up and discuss off-hand a scientific paper, which they have had no opportunity of studying, especially when it has been read often at great speed in an almost inaudible tone; the result is that we have the poor discussions which so often take all the life out of the proceedings in Section G.

At the Institution of Civil Engineers printed copies of the papers are always circulated a week or two beforehand, and no effort is spared to secure the attendance of every one capable of throwing any light upon the subject under consideration. As a result discussions often extend over two successive meetings of the Institution. Perhaps the organising committee may be able to do something in this line before the next meeting, and renewed efforts should be made to secure papers from the workers in the engineering laboratories which are such a feature now of all our universities and university colleges. All attempts to secure such help during the past few years have met with most disheartening refusals.

The most important point raised by the President in his valuable address was the suggestion that in order to enable funds to be cheaply raised to carry out the deepening and enlarging of our docks, the great railway companies should practically take over the control of the harbours and docks which they respectively serve. It was pointed out that every year saw an increase in the over-all dimensions not only of ocean liners, but of the ordinary cargo boats; this means that most of the dock authorities will within the next few years have to face very heavy expenditure in enlarging and deepening locks and their water approaches. Sir John doubted if this increased capital would be able to earn a fair interest, and claimed that if they were administered by the railway companies there was more chance of both diminishing establishment charges and of securing a sufficient inducement for the public to invest, on the faith of this new security. He indicated ways of preventing the growth of a dangerous monopoly, but it is very doubtful whether the public would willingly see such an amalgamation; there is already an indictment against the railways of strangling many industries by their excessive charges for carriage of goods, and curiously enough Mr. Forster Brown, in a thoughtful paper on "The economic and mechanical features of the coal question," advocated strongly the State purchase of railways in order to bring about a reduction of freight charges, and thus to make good the ever growing cost of production owing to deeper and thinner seams having to be worked. In the discussion on Mr. Brown's paper several of the speakers reluctantly confessed they were gradually drifting to State purchase as a necessity sooner or later, but the President opposed the proposal very strongly.

The outstanding feature in the proceedings of the Section was the constant cropping up of this all-important question of facilitating the carriage from the sea-board to the factory of the raw products of our great manufactures, and the return transit of the manufactured goods. The extraordinary growth of the manufactures and commerce of Germany during the last twenty years, the still more rapid strides which have been made in the United States during the same period, are forcing us to realise that our supremacy is being challenged in every quarter of the globe; this is the justification of the feverish haste with which schemes are being pressed forward to enlarge our dock facilities, to increase their equipment, and to connect our great inland manufacturing centres to the sea-board by canals suitable for sea-going vessels. The cost of carriage must at all hazards be reduced, hence the papers by Mr. R. C. H. Davison on the new works at Barry Docks (visited by the Section on the Saturday), by Prof. Ryan on Welsh methods of shipping coal, by Mr. Marten on a scheme for the improvement of the waterway between the Bristol Channel and the Birmingham district, and by Mr. Allen on electric canal haulage, and also the paper by Mr. Brown, already alluded to. It was not so much the mechanical and engineering details described in these papers, important though they were, which interested the audiences and gave rise to discussion, but the economic features of the one problem common to them all—the cheapening of the carriage of our raw products and our manufactures. Industrial legislation during recent years, and the upward tendency of wages of skilled labour render inevitable a reduction in some other direction to counterbalance the increased cost of production brought about by the above two tendencies. The two directions in which this reduction can be obtained most readily are in the increase of labour-saving appliances in the process of manufacture, and a lessening the cost of the raw product by facilitating and cheapening its carriage; this latter saving again coming to the help of the manufacturer in the diminishing of the carriage charges on the manufactured goods as they are distributed to our customers. Mr. Brown drew attention to one other direction in which expenses might be cut down, namely in the charge for rates and taxes, but here he was in reality advocating something which would be of benefit to the next generation and not to ours; his claim that local loans should be repaid within a shorter interval of time than is now necessary would in fact place, perhaps rightly, a heavier burden on our shoulders. It must in this connection be remembered that much of the great increase in local indebtedness which has begun to alarm some of our statesmen, is due to the borrowing of money for remunerative undertakings, and that as long as the general prosperity of the nation lasts, such municipal undertakings as electric lighting works, waterworks, gasworks, tram-lines, &c., are not likely to become a burden to the community. The money sunk in them is in a similar condition to that invested in ordinary commercial undertakings; the rate-payer pays no increased rates in consequence of them, but in reality obtains many absolute necessities of modern life cheaper than he would were these undertakings in private hands.

The visit to Barry, mentioned above, was a most enjoyable and instructive one; the extraordinary change in the district since the Association met in Bath, when a similar visit was made, was a striking object-lesson in the growth of the Welsh coal trade. The new dock was actually opened at this visit, since the three launches in which the party were taken round were the first vessels to steam from the old dock through the connecting cut (the dam closing this was only partly removed) into the new dock. The splendid caisson for closing this cut, which was worked with the utmost ease and perfect truth, and the extensive equipment of cranes and appliances for shipping coal were the objects of much admiration on the part of the visitors. Mr. Davison's paper, well illustrated by lantern slides, in which all the difficulties met with in the construction (and so well overcome) were clearly described, had prepared the members of the Section for this visit, which also made Prof. Ryan's somewhat technical paper on the coal-tips in use in South Wales a much more valuable and interesting contribution.

Monday, as usual, was devoted to electrical engineering, when three papers on the application of the electric motor to the engineering workshop, by Mr. A. Siemens, Mr. H. H. Gibbings and Mr. W. Geipel, were read and jointly discussed. The best discussion in the Section at this meeting rose over these three papers, Prof. Silvanus Thompson arguing that in England, by adhering to the continuous current so rigidly, we were dropping behind continental and American engineers, who found no difficulty in their alternating current systems; he claimed that all the difficulties could be easily met and solved, if we only faced them and made use of the experiences of other workers in the field. This contention was hotly denied by Mr. Parker and other speakers, and in the end the matter was left where it began; but, at any rate, it gave an opportunity of publicly thrashing out once more this vexed question. The novel plan adopted at Bradford of hiring out motors to small customers, with the object of increasing the day load at the central station, and also of stimulating small industries will, perhaps, be widely adopted; but it is very questionable whether the charge made for loan of the motor is in any way sufficient to cover depreciation of these somewhat delicate machines. Mr. Proctor, electrical engineer to the city of Bristol, gave some valuable figures as to the comparative cost of working steam and electric pumps for boiler feeding, &c., in central stations; the economy of the electric pump was very distinctly shown, especially at light loads; the experiments have, however, hardly been of a sufficiently extensive character to justify absolute conclusions in all cases.

Prof. Silvanus Thompson and Mr. Walker contributed a joint paper on electric traction by surface contacts, in which most of the schemes so far brought forward were described; the experiments conducted by the authors on an experimental line at Willesden were explained, and many of the details described by the help of lantern slides. There was a very scanty discussion, turning chiefly on the possible danger of such studs giving electric shocks (the author explained in reply this was impossible), and on the question of the cost of fitting up such apparatus.

There were two papers descriptive of new instruments—one by Mr. Coker describing a very ingenious instrument for attachment to test bars under torsional stresses in order to measure the small strains or twists, while the material was still in the elastic stage. The instrument had been tried in the mechanical engineering laboratory at University College, London, and found to work well and with complete freedom from all back-lash; it is, however, too delicate and complex to place in the hands of students. The other paper was by Prof. Hele-Shaw on a new instrument for drawing envelopes, and its application to the teeth of wheels and for other purposes. This communication and also Mr. Forster Brown's are to be printed *in extenso* in the *Proceedings* of the Association. The instrument was a very beautiful one, and the difficult problem it solved had been most carefully worked out; but here again a very poor discussion followed, because no one felt able to criticise the instrument or discuss the advantages or disadvantages of such a piece of apparatus after merely hearing the author's short account; a description with sufficient diagrams ought to have been weeks before in the hands of those anxious to become acquainted with it, and to discuss it.

Amongst other papers dealt with was Mr. Dibdin's paper on the treatment of sewage by bacteria, which in the discussion elicited from Sir Alex Binnie the statement that the experiments he was carrying out for the London County Council led him to believe we were on the eve of most important changes in the treatment of town sewage.

SCIENCE IN RELATION TO TRADE.

DURING the last few years numerous references have appeared in the various reports made to the Foreign Office by Her Majesty's diplomatic and consular officers on the methods adopted by the principal trade rivals of the United Kingdom in their competition in foreign trade abroad, and on the apparent supineness of British traders in meeting this competition. Besides calling attention to this, the Consuls suggest the adoption of certain measures which they consider would be advisable for British traders to take with a view of retaining the pre-eminence of this country on foreign markets.

A selection has been made of the views expressed in some of these reports issued during the period comprised between January 1896 and the present time, and has just been published in a Blue Book.

From the 171 extracts in this publication it appears that the following are some of the causes which are considered as tending to place British trade at a disadvantage in those districts where, especially of late years, foreign competition has been more than usually keen:—

I. The disinclination of British traders—
- (*a*) To supply a cheaper class of goods.
- (*b*) To be content with a small order at first.
- (*c*) To study a customer's wishes.
- (*d*) To adopt the metric system in calculations of weight, cost, &c.
- (*e*) To grant credit facilities.

II. The scarcity of British commercial travellers, in comparison with those of other nationalities, their ignorance of the language of the countries they visit, and the endeavour to supply their place by a lavish distribution of catalogues and other matter printed in English only.

III. The inferiority of the British to the German and American methods of packing.

IV. The additional cost of goods caused by the high rates of freight on British lines of steamers.

V. The frequency of strikes in the United Kingdom tending to cause uncertainty in the delivery of orders.

VI. The development of technical education in Germany and the greater attention paid in schools to modern languages, added to the system of sending young Germans all over the world to acquire a practical knowledge of the language, business habits, &c., of other countries, by means of which they are afterwards able to compete with those countries with a greater chance of success.

The two causes which concern us refer to the use of the metric system and the development of technical education in Germany. On these matters the Blue Book contains the following summary of the views expressed in the reports:—

METRIC SYSTEM.

The Consuls all lay stress upon the uselessness and expense of British exporters forwarding trade circulars and catalogues more or less well-prepared in English, and with English weights and measures calculated in our own currency. British weights and measures are not liked abroad, and are in many cases either not understood at all, or very imperfectly so, and the preference is given to those who accommodate themselves to the metric and decimal systems. On this point the Consul at Naples expresses himself as follows:—"It seems absurd that the first commercial nation in the world should measure their horses by hands and their dogs by inches, their cloth by ells and their calico by yards; that such impossible numbers should come into their square measure as 30¼ and 4840, and in their measure of solidity as 1728. And the weights are worse still. It can never be too much impressed upon British traders that all goods for sale on the continent should be marked in metres and kilogs, and all catalogues sent to the continent should be in a language which is understood by the people of the country."

TECHNICAL EDUCATION.

Much has been written respecting the superiority of the German technical education to that of Great Britain, and to this has been attributed the success which is said to have attended German commercial enterprise within the last twenty-five years That the technical education is better than that in England is denied by many Germans who are competent to express an opinion, having studied the question in both lands; but what they do admit is that the application of this education in Germany is carried out to a more practical and useful conclusion than in England. "Thus," says the Consul at Stettin, "in Great Britain there are numerous public and private schools having a modern side in their curriculum which is an excellent adaptation of what is termed in Germany the "real gymnasium"; but in how many English schools is the modern side looked down upon by the head master and consequently by the boys themselves; and the classic side held up as the education which befits a gentleman! . . . Undoubtedly the far greater majority of British lads, on the completion of their education, become what is vaguely termed men of business, and at the present day it is an absolute necessity for the carrying on of that business against the keen competition which, owing to European peace, has manifested itself in foreign lands during the last twenty-five years, that we, as a nation of merchants, should be able to deal with our customers in their own tongues; and for this purpose it is of the utmost importance that the youth of Great Britain should be instructed for the most part in living languages."

Again, attention is called in the reports to the fact that Germans have been gradually paving their way to their present position by quiet individual persistence backed up by special education. It is stated that they are in the habit of going as clerks into British houses at home and abroad and gradually obtaining a thorough knowledge of the British way of doing business, of the centres of production, &c., which they subsequently turn to good account; but some doubts are expressed as to whether any German houses would receive an Englishman in the same way even if he possessed the necessary qualifications. On this point the British Vice-Consul at Porto Alegre says: "Germans can generally speak English and French practically and usefully, and were taken into English houses at first because they were content with little, and sometimes even no salary, in order to pick up business. On the other hand, the English clerk usually understands no language but his own, and this deficiency alone would be enough to prevent his being taken on as a clerk in a German house. Twenty or thirty years ago the important export trade of this State was almost exclusively in the hands of British merchants; now it is in German hands."

THE DEVELOPMENT OF THE TUATARA LIZARD.

PROF. A. DENDY, professor of biology in Canterbury College, New Zealand, has been engaged for the past two years in investigating the development of the Tuatara Lizard, perhaps the most remarkable animal now living in New Zealand, and the oldest existing type of reptile. A short summary of the principal scientific results obtained was sent to London just in time to be laid before the Royal Society at its final meeting for the session in June last. The memoir itself, containing a detailed account of the general development, with numerous illustrations, has now arrived in England, and will shortly be published. Meanwhile, the following particulars, published in the *Christchurch Press*, will be of interest to naturalists:—The development of the Tuatara presents several remarkable features. The eggs are laid in November, and on Stephen's Island take about thirteen months to hatch, the embryos passing the winter in a state of hybernation, unknown in any other vertebrate embryos. Before entering upon their winter sleep the nostrils of the embryo become completely plugged up by a growth of cellular tissue. The embryos obtained have been classified in sixteen stages. The early stages of development are singularly like the corresponding stages in the Chelonia, especially as regards the fœtal membranes; there being a long canal behind the embryo leading to the exterior, and known as the posterior amniotic canal, which has hitherto been found only in Chelonians, in which it was discovered a few years ago by Prof. Mitsukuri, of Tokyo. Prof. Dendy's results thus strongly confirm the views of those naturalists who regard the Tuatara as being at least as closely related to the turtles as it is to the lizards. In the later stages of the development the young animal has a strongly developed pattern of longitudinal and transverse stripes, which disappear before hatching, the adult animal being usually spotted. This observation is a striking confirmation of the general laws of coloration observed in young birds and mammals, which are commonly striped. The eggs which Prof. Dendy investigated were collected for him by Mr. P. Henaghan, principal keeper on Stephen's Island, who showed indefatigable zeal in the pursuit, and made many valuable observations on the habits of the Tuatara. Permission was granted to Prof. Dendy by the Government to collect both eggs and specimens for scientific investigation, and the result of Mr. Henaghan's observations has been to show that eggs can be obtained all the year round by those who know where to look for them. Fortunately for the Tuatara Mr. Henaghan appears to be the only collector who does know at present, and it is to be hoped that before his knowledge is made public the Government will take steps to prohibit the taking of eggs as well as of adults, for we believe the wording of the Act leaves the eggs unprotected. We believe that two German collectors have lately made vigorous, but as yet unsuccessful, efforts to collect the eggs.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. E. W. Barnes, bracketed Second Wrangler 1896, Class I., first division Mathematical Tripos, Part II, 1897, has been elected to a fellowship at Trinity College.

Prof. Liveing has been appointed a University Governor of the South-eastern Agricultural College, Wye, for five years.

Prof. Flinders Petrie has presented to the Museum of Anatomy and Anthropology nineteen cases of skulls and bones from his excavations at Hierakonopolis, including remains of the prehistoric and earliest dynastic races in Egypt. Prof. Macalister remarks that with this addition the University collections in Egyptian anthropology are probably the largest in Europe; it consists of specimens representing all periods of Egyptian history from prehistoric times down to the battle of Tel-el-Kebir.

Prof. Foster will this term give a weekly lecture on the history of Physiology. The first lecture, on Monday, October 24, will be on Claude Bernard.

The Reader in Geography, Mr. Yule Oldham, lectures this term on the geography of Europe and on physical geography.

The University of Sydney is to become affiliated to the University of Cambridge, and students in arts or in science who have pursued a certain course at Sydney will be entitled to the privileges of affiliated students.

MR. JOHN CORBETT, formerly M.P. for Mid-Worcestershire, has offered to give 50,000*l.* for founding and endowing a school of agriculture for sons of tenant farmers for the county of Worcester and district.

ONE of the most recent of the many educational conferences held in the United States during the past ten years, was that of a Committee on Physical Geography appointed under the National Educational Association. As is usual in such cases, the members of the Committee were selected from a wide range of educational institutions, including universities, colleges, endowed schools, and public schools (in the American sense of the term); the expert in the scientific aspects of the subject being thus associated with the practised teacher, who is familiar with the capacities and limitations of young scholars. The preliminary report of the Committee is published in the *Journal of School Geography* for September. It is strongly urged that the physical environment of man should constitute the leading theme of the subject, and that irrelevant items from astronomy, principles of physics, topics from historical geology, and the classification of animals and plants should be carefully excluded, in order to give time for the proper development of physical geography itself.

THREE members of a series, to be known as the Harvard geographical models, constructed by Mr. G. C. Curtis from designs by Prof. W. M. Davis, have been reproduced in a durable composition by Messrs. Ginn and Co., educational publishers, Boston, Mass., as aids in systematic geographical teaching. The models, 25 by 19 inches in size, may be used in elementary classes in illustration of type forms, such as mountains, peaks, ridges, glaciers, valleys, plains, volcanoes, capes, islands, rivers, lakes, deltas, bays, &c. They also serve for more advanced instruction in rational or explanatory physical geography. The second model is derived from the first by elevation, whereby a low and flat coastal plain is added to the mountainous background. The third is derived from the first by depression, whereby the valleys among the mountains are transformed into bays, and the ridges stand forth as promontories, the coast-line being changed from a simple to a very irregular outline. Many applications of the principles thus taught may be made in all grades of geographical teaching.

THE annual meeting of the governors of University College, Liverpool, was held on Saturday last. The Earl of Derby, president of the college, occupied the chair, and, in moving the adoption of Principal Glazebrook's report, which was of a very satisfactory character, he said that though much had been done, much yet remained to be accomplished. A pressing need was a proper building for the department of physics, and another very pressing need was a suitable building for the school of human anatomy. Prof. Oliver Lodge deserved to be furnished with adequate means for the important work in which he was engaged. That, however, might be postponed so that the more pressing equipment of a building for the school of human anatomy might be provided. The cost would be about 20,000*l.*, and he would contribute a quarter of this sum if other benefactors were forthcoming. It was announced by the treasurer that besides the 5000*l.* from Lord Derby, he had that day received a cheque for 2000*l.* from Mr. Ralph Brocklebank, for the school of anatomy. Incidentally it was mentioned that the land, buildings, and endowments of University College represented a total value of 400,000*l.*, though the college was founded only in October 1880.

COPIES of the prospectuses of the Day and Evening Classes held at the South-Western Polytechnic have been received. This Polytechnic has been built and equipped at a cost of nearly 55,000*l.*, the greater part of which has been raised by voluntary subscriptions. The institute at present possesses a fixed endowment of 1500*l.* annually from the Charity Commissioners. The London County Council will also contribute to the institute an annual sum, depending upon the amount of educational work carried on; and it is anticipated that this contribution will average about 3500*l.* annually. The Principal is Prof. Herbert Tomlinson, F.R.S., and from the prospectuses referred to we see that the operations of the institute are of a kind which will benefit industry and encourage scientific study. The Day College comprises two departments, viz. the technical department, in which students are instructed in the principles of applied science, and the general department, which aims at giving a general education, or special training in science, art, literature, or commerce. The evening classes and lectures are designed to supplement, and not to supersede, the training of the workshop. Among the subjects taught in the mathematical classes we notice the calculus and its application to electrical and other engineering problems. The subjects taught at the Polytechnic cover a wide range, as they also do in other London polytechnics; and they provide all who wish to learn with facilities for doing so.

THE trustees of the late Sir Edwin Chadwick have founded in memory of the great sanitarian a course of lectures and demonstrations in municipal hygiene at University College, London, and have devoted a sum of 700*l.* a year to the endowment of a chair of municipal engineering and a lectureship of municipal hygiene. They have given the further sum of 1000*l.* for the purpose of instruments and appliances, and for the amplification of existing laboratories. The *British Medical Journal* reports that, on Wednesday, October 12, Prof. Osbert Chadwick, son of Sir Edwin Chadwick, delivered an inaugural address opening the first course. After giving a sketch of the history of the foundation, he observed that relatively little practical instruction can be obtained from lectures alone, and that their utility is greatly increased by a course of practical work. The drawing office is an essential adjunct to academic instruction; engineering is a high art, the art of applying the great sources of power in nature to the use of man, and it is only to be acquired by experience, practice, and observation. The course to be given in municipal engineering will comprise lectures by Mr. R. Middleton, on water works, sewage works, and the like. The lectures on municipal hygiene will give elementary instruction as to the cause of disease, methods of disinfection and bacteriology, and other matters which strictly belong to medicine, but as to which the engineer ought to have information in order that he may be able to design municipal works with intelligence. The Chadwick Laboratory will afford opportunities to the students for practical work in the analysis of air, gas, water, and in other branches of practical chemistry. The trustees have also founded a Chadwick Scholarship, under which the sum of 100*l.* will be paid as an honorarium to a practising engineer taking the student as pupil, or as an alternative the sum will be paid to the student to augment the small salary he may receive as an improver.

A PLEA for increased instruction in geology is put forward by Prof. Logan Lobley in the volume of *Transactions* of the South-Eastern Union of Scientific Societies for 1898. He points out that an elementary knowledge of geology could be given in our secondary schools in part of the time usually allotted for geography, a subject over which much time is worse than wasted in burdening the youthful memory with names and statistics that really mean nothing to the average pupil. At present the place of geology in the early education of the people of this country, whether it be that of the school, the technical college, or the university, is an insignificant one, and unworthy of the general educational importance of the subject. As a remedy, Prof. Lobley proposes that geology should be made an obligatory subject for university pass degrees. He remarks: The great cause of the general absence of scientific teaching in England is the example set by our two ancient Universities in not requiring some knowledge of what are called the natural sciences for the ordinary pass degree. A graduate of either of these two world-renowned seats of learning may leave his Alma Mater, and with honours, and yet be without even an elementary acquaintance with any of these sciences. The consequence is that the great public schools omit science from their obligatory curriculum, and devote their attention to those subjects which are alone required to fit their pupils for obtaining, when at the universities, the pass degree. The practice and the curricula of the public schools again are followed by less important schools, and by the preparatory schools, and the standard of education so set up and made fashionable dominates the teaching of schools generally. Hence it is, in a great measure, that in England education in science is so far behind that of Germany, and we look in vain for geology in the curriculum of an ordinary middle-class school—Prof. Lobley is justified in pleading for increased attention to be paid to geology, but considering that in this country the elementary principles of the subject included under physical geography, which should form the basis of all geographical teaching, are almost entirely neglected in the average middle-class school, there seems little hope at present that geology will find a place in the school curriculum.

ON Friday last Mr. Long, M.P., President of the Board of Agriculture, performed the ceremony of opening the experimental farm of Lledwigan, Anglesey, which is rented and managed by the Agricultural Department of the University College of North Wales, Bangor. This college was the first in the kingdom to apply for and to make use of the grant voted by Parliament for the promotion of agricultural education. The area of the farm taken is 358 acres, and the farm is considered one of the best in the county. The aim of the Agricultural Department is to illustrate experimentally the theoretical teaching given at the college. The farm will, therefore, be used as a practising school for the in-college students, as a permanent experimental station where experiments extending for a series of years can be made, and also as a dairy school for the counties of Anglesey and Carnarvonshire. The Professor of Agriculture at the Bangor University College will reside at the farm as the head and manager. He will be assisted by a small committee of practical farmers, who will be entrusted with the equipping, stocking, and cropping of the farm, and with the control of the finances. The Board of Agriculture make a special grant of 200*l.* towards the maintenance of the farm as an experimental and educational centre. A capital sum of 4000*l.* was required for the stocking of the farm. The Drapers' Company have generously made a conditional grant of 1000*l.*, and the college hope to secure the remainder in due time. In formally opening the experimental farm Mr. Long remarked that for a long time practical agriculturists had looked with suspicious apprehension, even with something akin to contempt, upon scientific method and procedure, but that feeling had to a large extent disappeared, and farmers began to realise that, after all, science meant nothing more than accurate knowledge of the causes which produced certain results, and that such knowledge could not fail to be of use to those who had to produce the results as a means of earning their living. In 1888, excepting three agricultural colleges, certain scattered science and art classes, and two local schools in Cumberland and Cheshire, nothing was done for agricultural education. In 1889 Parliament gave a grant of 1630*l.*, and of that Bangor College received 200*l.* In 1889 the grant was increased to 2610*l.*, out of which Bangor received 400*l.* In 1890 Parliament voted 750,000*l.* to the County Councils to be spent on technical education. The Board of Agriculture thereupon took a new departure and applied the Parliamentary grant to general as distinguished from local projects. The amount of the grant has been increased from 2610*l.* to 6800*l.*, and of this sum 5900*l.* is paid to collegiate centres.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 5.—Mr. R. Trimen, F.R.S., President, in the chair.—The President announced that the late Mrs. Stainton had bequeathed to the Society such entomological works from her husband's library as were not already in its possession. This bequest was of great importance, and would add to the library a large number of works, many of which, formerly in the library of J. F. Stephens, were old and now scarce.—Mr. J. J. Walker exibited a black form of *Clytus mysticus*, L. (var. *hieroglyphicus*), taken by Mr. Newstead at Chester, where about 1 per cent. of the specimens were of that variety; also a black variety of *Leiopus nebulosus*, L., from the New Forest.—Mr. Tutt exhibited an example of *Euchloe cardamines*, irregularly suffused with black markings, and a series of local varieties of Lepidoptera from Wigtonshire.—Mr. S. Image exhibited a specimen of *Acidalia herbariata*, taken in Southampton Row.—Prof. Poulton showed and made remarks on specimens of *Precis octavia-natalensis* and *Precis sesamus*. These strikingly dissimilar insects had been shown by Mr. G. A. K. Marshall to be seasonal forms of the same species; from two eggs laid by a female of the first-mentioned (summer) form he had bred one imago resembling the parent, and one which was of the blue *sesamus* form.—On behalf of Dr. Knaggs, Mr. South exhibited a series of *Dicrorhampha*, the synonymy of which was discussed by him and Mr. Barrett, *D. flavidorsana*, Knaggs, being shown to be a good species.—Mr. Barrett exhibited and made remarks on specimens of *Lozopera beatricella*, Wals., from Folkestone, and the allied species.—Mr. Porritt showed examples of *Arctia lubricipeda*, obtained by continued selection of the parents, and probably the darkest ever bred in this country.—Mr. Adkin exhibited a long series of *Tæniocampa gothica*, to show the results of breeding by continued selection, and some remarkable forms of *Abraxas grossulariata* from Pitcaple.—Mr. F. Merrifield read a paper, illustrated by a large number of specimens, on the colouring of pupæ of *P. machaon* and *P. napi* caused by exposing the pupæ to coloured surroundings. The pupæ of both species were found to be modified by the surroundings of the larva, the effect being extremely marked in the case of *P. napi*. When the larvæ of the latter species were kept in a cage half orange-coloured and half black, all but four of the pupæ on the roof of the orange-coloured side were green with very little dark spotting, and all the pupæ on the roof of the black side were bone-coloured with numerous dark-brown spots. He regarded the phenomenon as protective. The exhibit was discussed by Prof. Poulton, who showed a similar series of specimens, and observed that he found the rays near the D line of the spectrum had the greatest influence upon the incipient pupæ, the effect diminishing towards either the red or the violet ends. The effect, therefore, appeared to be one of luminosity. Mr. Bateson stated that his own experience fully confirmed Mr. Merrifield's results, but was unable to see how the green coloration of the pupæ could be protective, at least in the winter brood. Mr. G. H. Verrall read a paper on Syrphidæ collected by Colonel Yerbury at Aden, the specimens, together with some rare British diptera, being exhibited by Colonel Yerbury. Papers were communicated by Mr. G. C. Champion on the Clavicorn Coleoptera of St. Vincent, Grenada, and the Grenadines; and by the Rev. T. A. Marshall on the British Braconidæ, Part viii.

Paris.

Academy of Sciences, October 10.—M. van Tieghem in the chair.—Observations on the supposed transformation of fat into glycogen, by M. Berthelot. Comments upon the paper on this subject of M. Bouchard. The fact of the fixation of oxygen is undoubted, but the author regards the interpretation given to the facts observed as doubtful. It is probable that albuminoids may play a part in this temporary increase of weight. For a man to gain 40 grams of oxygen in an hour, means that nearly all the oxygen respired during that time must remain in the body. The respiratory coefficient under these conditions should be considerably reduced, and further experiments in this direction are very desirable.—Preparation and properties of calcium nitride, by M. Henri Moissan. Starting with pure crystallised calcium, prepared in the manner previously described, it is easy to prepare calcium nitride by the direct combination of the two elements. In the cold, nitrogen has no action upon calcium, but on gently heating a slow absorption takes place; the white metal becoming a bronze-yellow colour, the yellow colour attributed to calcium by previous workers being undoubtedly due to the presence of this nitride. At a low red heat the calcium catches fire and burns in the nitrogen, the absorption of the gas being very rapid. The reaction is best carried out in a nickel tube. At the temperature of the electric furnace the nitride is completely decomposed by carbon, calcium carbide remaining in the tube. Water decomposes it with violence, ammonia and calcium hydrate being formed. The suggestion is made that this substance may find a commercial application in the formation of ammonia from atmospheric nitrogen. On the results of Russian geodesic work in Manchuria, by M. Venukoff.—Remarks on the 50th volume of the "Mémoires de la Section topographique de l'État-Major général de Russie."—Observations of Perseid meteors made at Athens, by M. D. Eginitis.—On the integration of the problem of three bodies, limited to the first power of the disturbing mass, by MM. J. Perchot and W. Ebert.—On the energy of a magnetic field, by M. H. Pellat. It has been shown in a previous paper that the expression for the energy of an electrified system undergoes certain modifications if the quantity of heat is taken into account, that the medium gives to or takes from the exterior necessary to maintain its temperature constant during the change. In the present paper a similar expression is developed for the case of a magnetic field.—On a new iodide of tungsten, by M. Ed. Defacqz. By the reaction between aqueous hydrogen iodide and tungsten hexachloride a tungsten tetraiodide is produced, WI_4. The iodide is infusible, cannot be volatilised without decomposition, and is slowly altered by exposure to the air.—On a crystallised tungsten dioxide, and on a tungsto-lithium tungstate, by M. L. A. Hallopeau. By heating lithium paratungstate with hydrogen at a temperature near the fusing point of hard glass, crystallised tungsten dioxide WO_2 is formed.—Thermal study of the sub-oxide and dioxide of sodium, by M. de Forcrand.—On the combinations of lithium chloride with methylamine, by M. J. Bonnefoi. Pure anhydrous lithium chloride rapidly absorbs methylamine, and a study of the heats of formation and dissociation pressures shows that three distinct compounds are formed, $LiCl,CH_3.NH_2$; $LiCl,2CH_3NH_2$; and $LiCl.3CH_3NH_2$. The application of Clapyron's formula to the calculation of the heats of dissociation gives results closely agreeing with the experimental determinations.—On a diodo-quinoline, by M. C. Istrati. The introduction of the iodine is affected in the warm, in the presence of sulphuric acid. The iodo-quinoline isolated had the composition $C_9NH_5I_2$.—On phenyl-phosphoric and phenylene phosphoric acids, by M. P. Genvresse. These are obtained by the action of phosphorus pentoxide upon phenols.—The volumetric estimation of acetaldehyde, by M. X. Rocques. Rieter's method of titrating with alcoholic sulphurous acid is modified in such a manner as to increase the accuracy when strong solutions of aldehyde are under examination.—Thermal data relating to isoamylmaloric acid. Comparison with its isomer, suberic acid, by M. G. Massol.—Embryos without a maternal nucleous, by M. Yves Delage.—Air and water as factors in the food of certain Batrachians, by M. S. Jourdain. Under certain conditions the eggs of some frogs, during the period of embryonic development, borrow the constituent elements of the young animal from the stock of food materials which it contains, and from the air and water vapour of the surrounding medium.—On the composition and alimentary value of haricots, by M. Balland.—Remarks on an *aurora borealis*, observed at Guingamp, September 9, by M. V. Desjardins.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—La Fonderie: Prof. Le Verrier (Paris, Gauthier-Villars).—Notes on Water Supply: J. T. Rodda (King).—The Structure and Classification of Birds: F. E. Beddard (Longmans).—A Text-Book of Mineralogy: Prof. E. S. Dana, new edition (Chapman).—The Tides and Kindred Phenomena in the Solar System: Prof. G. H. Darwin (Murray).—The Story of Marco Polo (Murray).—Kepler's Traum vom Mond: L. Günther (Leipzig, Teubner).—The Story of the Farm: J. Long (*Rural World* Publishing Company).—Indiana, Department of Geology and Natural Resources: Twenty-second Annual Report (Indianapolis).—Les Ballons-Sondes et les Ascensions Internationales: W. de Fonvielle, deux édition (Paris, Gauthier-Villars).—Manual de l'Explorateur: E. Blim and M. Rollet de L'Isle (Paris, Gauthier-Villars).—How to Work Arithmetic: L. Norman (Rugby, Over).

Pamphlets.—Report and Transactions of the South-Eastern Union of Scientific Societies for 1898 (Taylor).—A Chemical Laboratory Course: A. F. Hogg (Darlington, Dodds).—Untersuchungen über die Theorie des Magnetismus, &c.: Prof. E. Dreher and Dr. K. F. Jordan (Berlin, Springer).—The School Cookery Book: M. Harrison (Macmillan).

Serials.—American Journal of Science, October (New Haven).—American Naturalist, September (Ginn).—Notes from the Leyden Museum, April and July (Leiden, Brill).—Himmel und Erde, October (Berlin, Paetel).

CONTENTS.

THURSDAY, OCTOBER 27, 1898.

THE FIRST VOLUME OF HUXLEY'S MEMOIRS.

The Scientific Memoirs of Thomas Henry Huxley. Edited by Profs. M. Foster, Sec.R.S., and E. Ray Lankester, F.R.S. Vol. i. Pp. xv + 606. (London: Macmillan and Co., Ltd., 1898.)

THE editor, whose commands it has long ceased to be possible for an old contributor to gainsay, has desired me to write some notice of the first of these volumes. That his choice should have fallen upon a botanist is perhaps singular: for though there was no branch of biological science to which Huxley was not sympathetic, the bulk of his work is entirely beyond my powers of criticism. Other hands, I understand, will do justice to it as the successive volumes appear.

My task, at any rate, is merely introductory. And in that sense I gladly undertake it. For the appearance of this stately volume is to me a matter of peculiar satisfaction. I think it cannot be doubted that Huxley stood in the public eye as something other than a great man of science. The outside world saw that he had the scientific world at his back when it made him first Secretary and then President of the Royal Society. But why it was so, it may be confidently stated that the vast majority of persons had not the vaguest idea. They knew that he had a great literary gift: "at least," said Mr. Balfour at the Memorial meeting, "he will go down to posterity as a great master of English prose"; they knew that he had a singularly lucid and impressive power of oral exposition; they saw that he spent no small part of his life and of his strength in public work and the service of the State: most marvelled at the dexterity with which he wielded the perilous weapon of controversy; a necessarily smaller number delighted in the charm with which he played the part of the brilliant man of society; and perhaps some, fewer still, recognised his place amongst the great thinkers of his time.

The splendid gifts which led to success in so many and such varied fields threw the real Huxley which science will hand down to posterity somewhat in the background. I was one of those who were extremely anxious that this side of him should be brought into due prominence by the collection of his scientific work. The project was beset with many difficulties, and it would never probably have been achieved but for the chivalrous loyalty with which the publishers of this journal came to the rescue.

I have stated one reason why, personally, I desired it done. From the point of view of establishing Huxley's place in scientific history, it will be no unworthy *apologia pro vitâ suâ*. But there are others about which a few words may be said.

Not long ago Mr. Lionel Tollemache quoted Mr. Gladstone as saying that while he allowed genius to Romanes he could not concede it to Huxley. The dictum is of no critical or, indeed, of any other value, except as giving an insight into Mr. Gladstone's own ways of thought. For what do we mean by genius? I take it that it is the power of seeing further into the nature of things than is possible with the ordinary insight possessed at the time by a man's contemporaries. Genius, then, is essentially prophetic. And being so, the validity of its utterances can only be judged by posterity. When one walks in a wood, how can one judge the relative height of the trees; viewed from a distance it jumps to the eyes. For my part, then, I regard it as at once polite and politic to allow genius to all my friends.

But the juxtaposition of Romanes with Huxley suggests some interesting considerations of quite another kind. I knew both pretty intimately; both are dead, and I would not utter a word of criticism which would be unkind to the memory of either. Romanes was peculiarly interesting to talk to; his writing gave me less satisfaction. The bent of his mind was essentially deductive; his mental processes pursued an abstract course aloof from facts, and if he ever descended to them, it was from a sort of condescension to the weaker brethren amongst us. When he arrived at a conclusion, he looked about for facts to verify it. The method was quite logical and correct. Only unfortunately, in common with others who have followed the same line, he never really grasped the fact that biological science is very far indeed from admitting at present of deductive treatment at all.

Huxley, on the other hand, was supremely objective. Animated throughout his life by the most intense "curiosity" in the higher sense, the establishment of accurate observations was a positive passion with him. If facts came into collision with theory, with Romanes it was so much the worse for the facts; with Huxley, so much the worse for the theory. Even I, in turning over the pages of this handsome volume, can trace the dissipation of the mists of hazy transcendentalism in the middle third of the century as Huxley's ardent sun rose stronger and stronger above the horizon. I suppose, but I speak with all diffidence in such a matter, that it was in its full fervour when he wrote the classical paper with which this volume concludes, "On the theory of the vertebrate skull." I myself was too early to come under Huxley's influence in this direction, but I can yet remember the dreary Okenism with which the Comparative Anatomy Lecture-room was pervaded before Huxley's teaching had sunk to the level of the schools.

But the insatiate pursuit of fact, by which I mean the achievement of accurate objective knowledge without prepossession of any kind, was not Huxley's only scientific characteristic. It was accompanied by extraordinary powers of generalisation. He was not a mere compiler of observations. Sparing no pains to see the phenomena accurately, he was equally keen to make them tell their hidden story. Perhaps sometimes he was too keen; but if the story, as Huxley read it, would not always bear subsequent examination, at any rate the original documents on which it was based were always available to test it by.

But there is a curious fascination in turning over the collected work of a man such as Huxley, and tracing the mental paths by which his own ideas shaped themselves. It is not the habit now to study anything but the last and most fashionable text-book. Yet I am persuaded that any biologist who wishes to cultivate accurate habits of thought might profit exceedingly by a careful study of these pages. The method of research of a great master of the art is laid bare for us; and the acquisition of a right method is a greater thing than a mere knowledge of the results: πλέον ἥμισυ παντός.

Take as an illustration the interesting indications of the way in which Huxley's mind was feeling its way towards a grasp of evolution. The comparison of the results of philology and embryology in the lecture "On the common plan of animal forms" is curiously suggestive (p. 283). It throws light on what some of us thought a hard saying in his last (as I suppose) public speech made at Oxford, when he said that whether the Darwinian theory remained or fell, the fact of evolution would survive.

It has been said that Huxley made a "stalking-horse" of Darwin, and there is just the amount of truth in this as in every jest. It is evident that Huxley's morphological studies had brought him to the precise point where the "Origin of species" gave him the illumination of which he stood in need. And he seized it with characteristic ardour and enthusiasm. In the case of the cell-theory his mind was not so receptive because not so prepared. "Its value," he says, "is purely anatomical" (p. 220). He could not foresee, and perhaps would not have been justified in foreseeing, that it would supply the future key of our physiology.

And here I must acquit myself of the task which I have reluctantly undertaken. To do any adequate justice to the wealth of accomplished work included in this volume alone is, as I began by saying, wholly beyond my powers. But no intelligent student can turn over these records of Huxley's work without realising the truth of the remark of the editors, that "the progress of biology during the present century was largely due to labours of his of which the public knew nothing." And whatever else such a student may take away from their study, he cannot at least fail to learn how to treat of the most technical matters with the extremity of pregnant and lucid expression. W. T. THISELTON-DYER.

THE SCIENCE OF APPLIED ELECTRICITY.

Magnets and Electric Currents. By Prof. J. A. Fleming. Pp. xv + 408. (London: E. and F. N. Spon, Ltd., 1898.)

THIS work, as Prof. Fleming explains in his preface, has grown out of, and may be considered as taking the place of, his well-known smaller work, "Short Lectures to Electrical Artisans," published about twelve years ago.

"In recasting the information in such a manner as to conform more nearly to the present state of knowledge the author still desired to fulfil the original aim of supplying electrical artisans and engineering students with a brief and elementary account of the scientific principles underlying modern applications of electricity in engineering. With this object in view the use of mathematical symbols has as far as possible been avoided, but at the same time an endeavour has been made to give the reader clear notions on the quantitative measurements which lie at the root of all application of electrical facts in the arts."

This endeavour is more than justified by the present admirable volume.

After two introductory chapters, one on magnets and magnetism describing the simpler properties of permanent and electro magnets, and the other on measurement and units in which the bases of physical knowledge and the principles of "absolute" measurement are explained, the quantitative connection between currents and their magnetic effects is discussed under the heading "Magnetic force and magnetic flux." This discussion might equally well have been entitled "the magnetic circuit," as it virtually amounts to an explanation of that useful conception; and it is appropriately followed by a comparison of the present system of measurement with the "rational" system suggested many years ago by Mr. Oliver Heaviside, the advantages of which are particularly striking in magnetic circuit problems. Chapters iv. to vii. deal with electric currents and the theory of their measurement, electromagnetic induction, and electromagnets, with a discussion under the last head of magnetic curves, hysteresis, and the molecular theory of magnetism; chapters viii. and ix. are on the theory of alternating currents and on measuring instruments respectively; and chapter x., a longer one than the rest, is devoted to the various methods of generating currents. The book concludes with an appendix on the measurement of the earth's horizontal magnetic field strength, a table of natural sines, cosines, and tangents, and an index.

From what has been said, it is plain that Dr. Fleming's work is far more than a mere enlarged edition of the "Lectures to Electrical Artisans." It may be best described as a clear and brief—sometimes, we are tempted to think, almost too brief—but always admirably clear account of those parts of electrical theory which should be grasped by the better class of junior student of practical electricity. Such an account has, we venture to think, long been needed. Valuable as are descriptions of such things as Coulomb's balances and Wimshurst machines in the ordinary text-book, the importance of early guiding the thoughts of the youthful electrician into the channels which lead most directly to the regions of his subsequent activity cannot be too strongly emphasised. Life is too short, for all but the very gifted men, to do more than make a distant acquaintance with what, from the electrician's point of view, are the ornamental parts of his science; and it is largely because Dr. Fleming recognises the truth of this, that his book cannot fail to be of very great value to both teachers and students of electrical technology. A. P. C.

OUR BOOK SHELF.

Natural Hygiene or Healthy Blood, the Essential Condition of Good Health and how to attain it. By H. Lahmann, M.D. Translated from the German by Dr. H. Buttner. Pp. v + 253; plates 5. (London: Swan Sonnenschein and Co., Ltd., 1898.)

THE book before us is a learned exposition which aims at two very laudable objects—the reform of clothing and diet, and the banishment of disease. With regard to clothing little is said: the author's children are represented in a state of nudity; this, together with the prescription of constant air baths, and declamations against the amount of clothing worn by man at the present day, makes one think that in his heart of hearts the author regards the entire disuse of all clothing as the beau ideal.

With regard to diet and disease much is said, and much that is both interesting and instructive. For instance, we are informed that although bacilli may occasion disease, they only play a subordinate part. The essential cause of all disease is "dysæmia," or a deficiency or wrong proportion of the "vitalised" mineral constituents in the blood. All dysæmia is dietetic, and arises from too much water (the author, by the way, seems to have an objection to water baths: air baths are the things to have), too much common salt, or the too limited consumption of uncooked fruit and vegetables. Mankind in general, except the author, his children and the inmates of his sanatorium, appear to be suffering from this "dietetic dysæmia," and will be a ready prey to the first bacillus that settles on them. The whole book is unfortunately pervaded by the spirit of fanaticism, but nevertheless is well worth reading. Although doubtless the importance of the so-called inorganic salts in their combination with organic substances is greatly exaggerated, still the physiological chemistry of the subject is well considered, and the author has spared no pains to collect the results of erudite researches which tend to support his theory. His remarks upon the cooking of vegetables are well worthy of attention, especially in this country. F. W. T.

Applied Geology. By J. V. Elsden, B.Sc. (Lond.). Part I. Pp. vii + 96. (London: "The Quarry" Publishing Co., Ltd., 1898.)

The author of this work states in his preface that circumstances have made it necessary to publish the earlier chapters separately, and that, therefore, these chapters scarcely give an adequate idea of the scope of the completed work.

The part thus published contains little but what can be found, often in much more detail, in such well-known books as the work on field geology by Sir A. Geikie, Mr. W. H. Penning's "Field Geology" and his "Engineering Geology," and the "Treatise on Ore Deposits" by J. A. Phillips and Prof. Louis.

The first chapter deals chiefly with geological surveying, but far too briefly to be of much use. Outcrops are then illustrated by figures resembling those of Sopwith's geological models.

The rule given on p. 14 for ascertaining the thickness of beds by multiplying the breadth of the outcrop, in a direction at right angles to the strike, by the sine of the angle of true dip, should be supplemented by the proviso "having, in case the surface is not horizontal, first reduced the observed outcrop to that which would be observed if the surface were horizontal."

The second chapter is devoted to problems relating to dip and strike, the method of solving which, both by trigonometry and by construction, is clearly explained. In the third chapter unconformity, overlap, curved strata and normal faults are defined and illustrated. In the fourth chapter problems relating to faults are dealt with in a similar method to that made use of in the chapter on dip and strike.

The fifth and last chapter of the part published describes, in the space of twenty pages, stratified ore deposits of gold, platinum, tin, iron, manganese, aluminium, copper, &c., at various typical localities.

Taking the volume as a whole, it is obvious from the small number of pages devoted to so great a variety of subjects that some matters are inadequately dealt with. On the other hand the book is well illustrated by fifty-seven figures, the explanations are clear, and the work is calculated to be of considerable practical use, more particularly in the case of dip, strike and fault problems.

An ideal work on applied geology should, in addition to taking hypothetical cases, discuss, as far as possible, problems in mining, tunnelling, water supply, &c., which have been actually met with, and should be illustrated by concrete examples from definite localities in which the theory of the geologist has been tested by the execution of the engineering work. May we hope that we shall not have long to wait for such a work?

Flora of the County Donegal. By Henry Chichester Hart. Pp. xxiv + 392; with a map. (Dublin: Sealy, Bryers, and Walker, 1898.)

The publication of a flora of one of the dampest parts of our islands—one of the most uniformly peat-buried, and one of the hitherto least worked—is pleasing; and the pains evidently bestowed on this book make it welcome. Less than one half of the "Flora" is taken up by the enumeration of the phanerogams, ferns and *Characeæ* of Donegal; of the rest, over sixty pages are occupied by a long report on the climate, and one hundred by a discussion of the distribution in Ireland and Great Britain of the plants of the county. New observations on the altitudinal range of plants, and new statements of their times of flowering are things pleasant to see: from the latter, it appears that the "perpetually recurring storms" and the "deficient summer heat" retard the vegetation, so that blossoms appear even later than in the East Highlands. Mr. Hart does not call attention to this; it is a point deserving inquiry. Too long have authors of works such as this been content to copy or to make approximations at dates of flowering. In discussing the vegetation, the lines laid down long ago by H. C. Watson are carefully followed. As a common basis for comparison of different floras they are valuable; but one can only wish that the splendid chance which so uniform a vegetation offers had led to a consideration of vegetative formations—a subject only just touched upon. This discussion of the vegetation contains several suggestive observations, of which by no means the least in interest is that on the poverty of Donegal in *Cruciferæ*, *Leguminosæ*, *Umbelliferæ*, *Compositæ* and *Orchidaceæ*: of the last order, *Orchis maculata*, we are told, alone is able to live on the outlying islets; yet these plants, with their tuberous roots, might be expected to be able to tide over bad seasons.

It is a pity that the old error of calling *Neottia* a parasite should appear here; but such errors are rare; and the book, if not strikingly original, will at any rate be serviceable to all who find an interest in the botany of North-west Ireland. I. H. B.

The Reliquary and Illustrated Archæologist. Edited by J. Romilly Allen. New Series. Vol. iv. Pp. 288. (London: Bemrose and Sons, Ltd., 1898.)

This attractively produced quarterly review of archæology is "devoted to the study of the early Pagan and Christian antiquities of Great Britain; mediæval architecture and ecclesiology; the development of the arts and industries of man in the past ages; and the survivals of ancient usages and appliances in the present." The volume now before us, containing the numbers published this year, is well up to the high standard of its forerunners. The articles will interest students of the archæology of Great Britain; and they are so well illustrated that all who are interested in antiquities may derive pleasure from reading them. Many of the articles are noteworthy. Mr. Leader Scott describes a Gallic necropolis discovered in Italy, on a tract of land at the foot of an indentation of Mount Montefortino, near Arcevia (Ancona). In addition to the archæological aspects, the necropolis affords an interesting study from an ethnological point of view. Mr. Henry Balfour contributes a short paper on the modern use of bone skates and sledges with bone runners. The editor writes on primitive anchors, pot-cranes and their adjustments, and other subjects; Mr. R. A. Gatty describes the objects found in the Barrow at How Tallon; Mr. H. Ling Roth contributes a paper on Benin art, and there are numerous notes on archæology and kindred subjects.

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.*]

Asymmetry and Vitalism.

IN your issue of September 22, Prof. Pearson, referring to the views expounded by Prof. Japp in his interesting address on "Stereochemistry and Vitalism," shows that, if chance be the only factor at work in the replacement of asymmetrical groups in symmetrical molecules, the production in nature of an excess, however small, of compounds of one-sided asymmetry must undoubtedly have taken place. But, ignoring the mechanical interpretation of the phenomenon (thus avoiding the stumbling-block hinted at by Prof. Pearson), and taking, according to present experience, for granted that, in the artificial introduction of asymmetry into a symmetrical compound, equal amounts of two inversely-active bodies are formed, so as to give rise to an optically inactive mixture or compound (in a way recalling to mind the separation of equal and corresponding amounts of positive and negative electricity), other objections may, in my opinion, be brought against Prof. Japp's views.

The point at issue is this: out of inactive material, vegetal and animal organisms are building up substances with asymmetrical molecules, and optically-active, such as albumins and carbohydrates. In which fact, joined with the chemists' then ascertained inability to prepare artificial active compounds from inactive substances, Pasteur saw an essential difference between the forces that are acting in living nature and such as are coming into play in our laboratories; he called, accordingly, the former asymmetrical, the latter symmetrical forces. This alleged barrier fell to the ground after the successful preparation, by Perkin and Duppa and by Jungfleisch, of racemic acid from succinic acid, and the separation, by means of a simple crystallising process, of sodium ammonium racemate into dextro- and lævo-tartrate, differing by their inverse hemihedral faces, and mechanically separable from one another. Being aware that the spontaneous separation of racemic acid into its two active forms afforded a strong argument against his theory, Pasteur uttered the belief that, even in that phenomenon, some asymmetrical outward agent, such as the organic germs contained in the atmosphere, might be the separating cause; but that hypothesis, inadequately supported by Joubert and Bichat with the doubtful evidence afforded by their experiments, cannot hold its ground against the facts discovered by Scacchi and Wyrouboff, and especially by Van 't Hoff and Deventer, respecting the so-called "transition-point" of some double salts, a class of compounds among which the racemates are but a particular case.

On Prof. Japp's view the asymmetrical forces are brought into play in another way and at another moment than on Pasteur's. He contends that, while simple asymmetry (exemplified by dextrotartaric or lævotartaric acid) is caused by asymmetrical actions, double asymmetry, as displayed by racemic acid, is caused by symmetrical actions: no asymmetry comes into play in the latter case, not even when the racemate is separating into its two enantiomorphs, as for every right-handed crystal a corresponding left-handed one is formed. But here is the point. When "the two kinds of crystals are to be picked out, and placed each in a vessel by itself," the intervention of an intelligent force, the intelligent and living (whether mediate or immediate) act of man is needed, as, both kinds having the same solubility, specific gravity, melting point, &c., behave in the same way towards all the separating symmetrical and non-living agents we dispose of in our laboratories. The conscious separation, carried out by man, may be compared with the unconscious one caused by bacteria and moulds, which agents are also able to destroy one kind rather than the other: the common side of both actions is that they are brought about by living organisms, formed of asymmetrical material, and therefore able to act asymmetrically.

Now, granting that, according to Prof. Japp's interpretation of facts, intervention of life cannot be dispensed with in the above separation, I believe that, supposing no substance endowed with molecular asymmetry to exist on our planet, it would be, not merely conceivable, but actually possible to produce as much simple asymmetry as might be desired, by means of an amount of one racemic compound (such as some racemate) liable to separation into active kinds, by the crystallising process, without any interfering asymmetrical force. In point of fact, after the spontaneous separation (the suitable temperature being granted) into the enantiomorphous crystals, we may always imagine a force, neither intelligent nor living, and acting in a symmetrical way, that would by chance single out *one* crystal: from that single, asymmetrical crystal (whether right- or left-handed), as was shown among other similar instances by Fischer and Wallach, other compounds can, on introducing asymmetrical groups, be prepared, displaying (without any previous separation into enantiomorphs) *simple* asymmetry. For, while a racemic compound always comes into existence when we start the synthetic process with a symmetrical and therefore inactive substance, such is not the case when we are operating on active, already asymmetrical compounds, as one active kind rather than its enantiomorph (with respect to the newly-introduced group) may be formed, the other one being partially or totally excluded. The pre-existing asymmetry has a directing influence upon the newly added atoms: asymmetry begets asymmetry, as life begets life. This argument does not only fit the hypothesis that a single crystal be selected: provided that the supposed force act for so short a time as to allow but a small part of the crystals to be removed, there is some chance for there being an excess, however small, of either one or the other enantiomorph to which the above remarks may as well apply.

The following illustration may perhaps convey a clearer idea of the fact stated. Supposing molecular asymmetry to have come on to our planet from outward space (an origin ascribed by some to life), let us imagine one primordial racemic compound to have spontaneously separated into its two enantiomorphs, and these to have been whirled round and scattered about vacant space by some vortex, so as to allow one simply asymmetrical particle to reach our globe. This may, without the intervention of any peculiar force differing at all from such as are acting in chemical synthesis, have originated all the now existent asymmetrical compounds. Some other planet might nevertheless have been reached by a particle of the other enantiomorph; the ensuing molecular asymmetry would accordingly have been the perfect reverse of ours: that celestial body might be inhabited by living creatures akin to ourselves, but built up of dextrogyrous albumins; its vine-grapes would yield *l*-glucose instead of *d*-glucose, &c. I do not mean to contend that there is any probability of such events having taken place, and am only pointing out that such an hypothesis is in no way absurd or inconceivable. Nay, it might even be enlarged. Although unlikely, a universe (in which our planet might well be included) can be imagined, being formed by pairs of celestial bodies endowed with equal and inverse asymmetry, so as to be comparable with a set of enantiomorphous crystals, into which a mixture of racemous compounds would separate. It matters little whether the enantiomorphs be near one another, as in the case of a crystallising solution, or as wide apart as the celestial bodies we are considering: there is in both cases *in a determinate point of space* one kind of simple asymmetry (the other one being excluded), a result attained without any absolutely asymmetrical action, and especially life, coming into play.

That the way followed by living organisms in their preparation of active substances, differs from the processes carried on in laboratories, is quite another question: the capital point is that, in one way as in the other, the final result is the same, and that the formation of the first asymmetrical group is not necessarily connected with that of the first living particle, as Prof. Japp contends. In my opinion, the problem of spontaneous generation is not likely to be ever reduced to the far simpler question of the origin of molecular asymmetry.

Turin, October. GIORGIO ERRERA.

I WILL endeavour to reply to the various criticisms which have appeared in NATURE on my address to the Chemical Section of the British Association.

Prof. Karl Pearson points out—what was, of course, obvious—that if only a small number of asymmetric molecules—say twenty—were to be formed under the influence of symmetric forces, there might be a preponderance of either right- or left-handed enantiomorphs, or even that all might be of one kind. He then goes on to suggest that such asymmetric compounds might have been spontaneously formed in the past, and might "be endowed with a power of selecting their own asymmetry from other racemoid compounds," and might thus act as "breeders."

This is a view which, as I have found in private discussion, is held by several organic chemists. My reason for rejecting it is that it attributes to the "breeding" process (to employ Prof. Pearson's concise, but, as we shall see, not altogether accurate expression) an efficiency which experiment does not justify. I will explain this important point in detail, as those who appeal to the "breeding" process seem to me to do so in a somewhat vague and elastic way.

This influence of already existing asymmetric molecules, or of asymmetric groups within the molecule, manifests itself in two ways, which I will distinguish as *asymmetric induction* and *asymmetric selection*.

(1) *Asymmetric Induction.*—If we introduce into an asymmetric molecule a fresh asymmetric carbon atom, or if we render asymmetric a carbon atom which was not previously so, the asymmetry already present will influence the character of the new asymmetry, and of the two possible arrangements of the new asymmetric carbon atom, one will predominate, or may even be the sole form. This influence, however, is entirely *intra*molecular; all attempts to convert asymmetric induction into an *inter*molecular action have failed. Thus various attempts have been made to obtain an optically active substance by allowing a reaction which under symmetric conditions would yield a racemoid mixture, to proceed in a solution containing another optically active substance; but this dissolved substance was invariably found to be without influence on the course of the reaction, and the resulting product was optically inactive. This influence, therefore, so far as experiment goes, does not extend from molecule to molecule, although within the molecule it is very powerful.

If the protoplasmic theory of vital synthesis is correct, according to which the molecules of carbon dioxide and other non-living molecules first combine with the living protoplasm and are afterwards eliminated in the form of asymmetric compounds, this asymmetric induction probably determines the asymmetry of the resulting compounds. But even supposing living protoplasm to consist of molecules—of which we have no proof—such molecules exercise their peculiar synthetic functions only under the influence of life, and are, therefore, useless as "breeders" for the purposes of Prof. Pearson's argument. Prof. Pearson's twenty non-living asymmetric molecules, formed by the chance play of mechanical forces, would, so far as experiment informs us—although I freely admit that mere negative results are not conclusive—have no more influence on the asymmetry of other molecules formed in their neighbourhood than one toss of a coin has upon another toss.

(2) *Asymmetric Selection.*—This is of two kinds. The first is that discovered by Pasteur, in which the different degree of affinity of one asymmetric base for two enantiomorphous acids (or of one asymmetric acid for two enantiomorphous bases) comes into play, and a separation may be effected, depending on the different solubilities of the resulting salts. But how this process would be available for Prof. Pearson's purpose, one hardly sees. In the most favourable case, his twenty asymmetric molecules would combine with a limited number—twenty, or some simple multiple or sub-multiple of twenty—of molecules from some racemoid mixture that happened to be present, and there would be an end of their action. There is no question of "breeding" here. Their number would not be increased by the process.

The other kind of asymmetric selection, which is a modification of that described by Pasteur, was discovered by Kipping and Pope. It depends on the fact that certain asymmetric substances, when in solution, alter in a different degree the solubility of two enantiomorphs, without actually, as in the previous case, entering into definite chemical combination with them. In this way a partial separation of enantiomorphs may sometimes be effected. But the applications of the method are very limited. Thus Kipping and Pope found that whilst, by means of a concentrated solution of glucose, they could effect a partial separation of sodium ammonium dextro- and laevo-tartrates—substances which spontaneously crystallise separately (*i.e.* not in racemic combination) at ordinary temperatures—in the case of mandelic acid, which is racemic at ordinary temperatures, no separation was effected, the tendency to form a solid racemoid overcoming any tendency to separation due to the presence of the glucose. Moreover, this action has never been observed, except with concentrated solutions of the selective substance; and it is, therefore, quite impossible that Prof. Pearson's twenty molecules—doubtless in a state of unlimited dilution—could in any way influence the solubility of other substances present.

My contention with regard to this "breeding" question, so far as non-living matter is concerned, therefore is: Asymmetric induction "breeds" only within the molecule, and without thereby adding to the number of molecules; asymmetric selection does not "breed" at all.

In fact, I do not see what Prof. Pearson is to do with his twenty molecules when he has got them. They will not "breed" in the sense he contemplates. On the other hand, if the process which produced them should go further, so as to yield a sensible quantity of substance, both enantiomorphs must be formed; and as the chances are equal in favour of the two asymmetric events; as, moreover, the occurrence of either event does not influence that of the other; and as the number of molecules in a sensible quantity is very great, Le Bel's ratio,

$$\frac{\text{Number of occurrences of event I.}}{\text{Number of occurrences of event II.}}$$

will not differ sensibly from unity.

Several of my critics seem to think that a mere sensible preponderance of one enantiomorph is sufficient. This is not the case unless the minority can be "bred" out of existence; and I do not think that under symmetrical conditions this is possible. We must bear in mind that, in the case of at least 99 per cent. of those optically active compounds which are products of the living organism, only one enantiomorph is found. It is the total disappearance of the opposite form which we have to explain.

Prof. Pearson, referring to the hypothesis of the asymmetric carbon atom, says: "Such a *geometrical* hypothesis cannot give the *dynamical* explanation of rotatory polarisation required by the physicist."[1] Every chemist, of course, fully recognises this; and in addressing an audience of chemists, I did not think it necessary to introduce so obvious a qualification of my statements. In the present undeveloped state of stereochemistry we are compelled provisionally to treat, as statical, problems which are in reality dynamical. The atoms are considered as being at rest in the positions of equilibrium about which they actually oscillate or revolve. Or, as Van 't Hoff puts it, the problems of stereochemistry are tacitly treated in the form in which they might be conceived to present themselves at the absolute zero of temperature.

Prof. Fitzgerald makes two suggestions, either of which, he considers, would dispose of my contention that single asymmetric forms cannot arise under chance conditions. In the first of these he supposes a mixture of two enantiomorphs to separate spontaneously into its right- and left-handed crystalline forms. If life then started from a few such centres, there would probably be a preponderance of one or the other form; "if it started from a single centre, it *must* have been either right- or left-handed."

In reply I would point out that this spontaneous separation of enantiomorphs is confined to crystalline substances; and I should have thought it fairly obvious that crystalline substances cannot possibly form the organic structural material of living organisms. Can Prof. Fitzgerald imagine crystallised protoplasm?

Prof. Fitzgerald's second suggestion is that life "probably started either in the northern or in the southern hemisphere, and in either case the rotation of the sun in the heavens may be a sufficient cause for a right- or left-handed structure in an organism growing under its influence."

In attributing the origin of the molecular asymmetry of compounds produced in the living organism to the apparent diurnal motion of the sun, Prof. Fitzgerald has been anticipated by Pasteur. I had, therefore, carefully considered the question before writing my address. I do not assign any importance to the negative result of the experiment which Pasteur made with the object of detecting such an influence. Indeed, we need not consider Pasteur's experiment at all, inasmuch as nature has been carrying out for us on this very point an experiment of a similar character which has lasted from the first appearance of life on our planet to the present day—and has equally yielded a negative result. For, if this supposed influence were at work, the asymmetric compounds of vegetable origin produced in the northern and southern hemispheres respectively ought to display

[1] Prof. Pearson waives any objections to my reasoning "arising from the fact that it is based on a purely geometrical hypothesis as to the constitution of molecules," &c. But even if Prof. Pearson feels inclined to put forward these objections, he will find that I point out, towards the close of my address, that the reasoning is independent of this hypothesis, and that it holds good equally of the hemihedral crystalline forms of these asymmetric compounds about which there is no hypothesis at all.

asymmetry in opposite senses. But nothing of the kind is observed. Cellulose, starch, saccharose, have the same right-handed asymmetry, each in its particular degree, whether the plant that produces them grows north or south of the equator.

Mr. Bartrum suggests that two enantiomorphs may crystallise from their equimolecular mixture with an unequal distribution of the right and left crystals; that then partial re-solution may occur, "roughly on the lines of the distribution of the two varieties of crystals," giving an optically active solution. Unlike Prof. Fitzgerald, Mr. Bartrum does not propose to vivify this crystalline substance offhand; he merely suggests that it may have been "the first ancestor of lævo-rotatory protein."

This is vague. As far as I follow its meaning I should read it: "Leave a soluble, crystallisable, asymmetric organic compound, of suitable character and composition, which has been formed and separated by the chance play of mechanical forces, long enough exposed to the action of other matter under the influence of these forces, and it will, in due course, first turn into protein and then come to life." I do not think that this statement misrepresents Mr. Bartrum's position, and I will leave it to speak for itself.

Mr. Bartrum's process of separation is also open to the objection that it would at best yield only an optically active *mixture—i.e.* with a mere preponderance of one enantiomorph; and as I have already pointed out, that is not a solution of the problem.

Mr. Herbert Spencer considers that I have ignored a universal law of "segregation" which he formulated in 1862 in his "First Principles," and which he there referred to three "abstract propositions" now quoted by him. He asserts that this law of segregation would account for the separation of dextro-protein and lævo-protein, if these were once formed; and he instances the formation of hæmatite nodules and flints in chalk-formations as an illustration of the power of segregation in nature.

I think that Mr. Spencer does not quite realise to what extent enantiomorphous molecules are alike. Every symmetric form of energy (such as heat), and every symmetric material agent, is identical in its action upon two enantiomorphs: whatever happens to the one happens to the other. And in none of these facts is there the slightest violation of the law of the conservation of energy—although Mr. Spencer's corollary to his third proposition would suggest the contrary. As regards the separation of enantiomorphs, I do not know whether Mr. Spencer would interpret his third proposition to mean that they must be separable by diffusion; but from the foregoing illustration which he gives of segregation in the inorganic world he would seem to have some such process in his mind. In that case I may point out that, as indeed follows from what I have already said, the rate of diffusion of enantiomorphs is the same; no such separation is possible.

If Mr. Spencer will consider this absolutely identical behaviour of enantiomorphs under all symmetric influences, I think he will perceive that the phenomena of "the formation of hæmatite nodules and flints in chalk-formations, or of siliceous concretions in limestone"—phenomena in which only crystalline or crypto-crystalline compounds of symmetric molecular structure are concerned, and which occur under the influence of symmetric forces—are not comparable with the separation of two enantiomorphous colloids such as dextro-protein and lævo-protein. Short of some asymmetric influence, nothing could separate these; and I am still waiting for my critics to tell me where, prior to the existence of life, such an influence was to be found.

Prof. Errera writes with special knowledge of the subject of molecular asymmetry, and I have nothing to criticise in his statements, so far as they deal with known fact or accepted theory. Some of his suggestions are exceedingly ingenious. I must admit, for example, that a force neither intelligent nor living—a symmetric mechanism—might be conceived which would pick out a *single* crystal from a mixture of crystallised enantiomorphs, and thus yield a single asymmetric compound. This is, then, so far a solution of the problem, although not a solution in the sense which I contemplated, since the mechanism cannot be trusted to effect the separation of the same asymmetric form twice running, whereas the living organism, or the intelligent operator, can do so any number of times. This is the essential difference between symmetric chance and asymmetric life. It is a feat which no mechanism could perform, unless its constructor had first embodied in it the idea of asymmetry, when it would cease to be symmetric, and would be an asymmetric product of living intelligence.

Moreover, as Prof. Errera will perceive from my reply to the arguments of Prof. Fitzgerald and Mr. Bartrum, I do not consider that the separation of enantiomorphous *crystals* brings us much nearer to the spontaneous formation of those *non-crystalline* asymmetric substances that build up the living organism. Prof. Errera, it is true, goes a step further in this direction than my other critics by pointing out that—as indeed I emphasised in my address—the further chemical transformation of such an asymmetric compound by the introduction of new asymmetric groups need not yield more than a single asymmetric compound.

Prof. Errera admits that his suggestions as to the manner in which the separation of enantiomorphs may have occurred before the origin of life—thus, that different asymmetric crystals may have been whirled by a vortex into different planets—are not very probable. In fact, all my critics seem to be moving in that unreal world where a fount of type, if jumbled together sufficiently often, ends by setting up the text of *Hamlet*.

In conclusion, I repeat that it is the impossibility of any mechanical (symmetric) force *constantly* producing the same asymmetric form, or *constantly* selecting the same one of two opposite asymmetric forms—a constancy which is manifest in the same processes when effected by vital agency—to which I referred in my address. I certainly nowhere used the word "constantly"; but the idea is present throughout.

Most of my critics clearly recognise this impossibility, and therefore seek to avoid the difficulty by supposing only a few asymmetric events—or even, only a single asymmetric event—to occur. The desired result having been obtained, the initial process is assumed to stop. But in making this assumption they seem to me to do violence to all probability. Given a practically unlimited period of time, why should a particular set of mechanical conditions, acting by pure chance in a given way, not act over and over again? One can understand a gambler stopping after a run of luck in his favour; but why should a mechanical process do so?

I see no reason to withdraw any of the conclusions at which I arrived, although, had I to write my address over again, there are parts which, to guard against misunderstanding, I might express differently.

I wish to point out that the term "tetartohedral," used in my printed address in describing the asymmetric facets of quartz, is erroneously given in the NATURE report (this vol., p. 454, col. 1) as "tetrahedral." F. R. JAPP.

The University, Aberdeen, October 24.

Potential Matter.

ALLOW me to refer once more to the subject of my letter of August 18, in order to draw attention to two previous investigations with which, at the time of writing, I was unacquainted. Prof. Karl Pearson has, under the title of "Ether Squirts" (*American Journal of Mathematics*, vol. xiii. No. 4), worked out mathematically the theory of matter considered as sources and sinks of fluid, and draws attention to the fact that this theory implies the existence of "negative matter," which may exist outside the solar system. More recently A. Föppl, in a communication to the Munich Academy, dated February 1, 1897 (*Sitzungsber. der k. b. Akad. d. Wiss.*, 1897, i. p. 93), has published a short paper under the title, "Ueber eine mögliche Erweiterung des Newton'schen Gravitations-Gesetzes." Starting from the idea that there is a difference in kind between the electrical and magnetic fields of force on the one hand, and the gravitational field on the other, because the flux of force through a sphere converges towards zero with increasing radius of the sphere for the electric and magnetic fields, but not, as usually defined, for the gravitational field, Föppl gives the necessary extension to Newtonian law of gravitation in order to remove the distinction. This, of course, implies "negative matter." There is a marked difference between the expression for the energy of the gravitational field on Föppl's hypothesis with that which is derived from the ether squirt theory; but it is not necessary to enter into this question.

There are some points in my former communication, to which previous writers on the subject have, however, not, as far as I know, drawn attention. Among them is the insufficiency of the ordinary hypothesis to account for the rotational momentum of our solar system which cannot be self-generated, the possibility of having evidence of anti-matter in comet tails and coronal streamers, and the idea of potential matter.

ARTHUR SCHUSTER.

Solar Radiation.

AT the conclusion of his British Association lecture on Phosphorescence,[1] Mr. Jackson makes a suggestion with regard to solar radiation which will doubtless receive due attention from those who are interested in solar physics. It is one of especial interest to me because, by an entirely different train of thought, Mr. Jackson has arrived at a possible explanation of the relation between sun-spots and terrestrial magnetic disturbances which is practically identical with a suggestion I have recently put forward in a paper on "The cause of the darkness of sun-spots," published in the *Astrophysical Journal* (April 1897).

In this paper I attempted to show that absorption by relatively cool material offers no satisfactory explanation of the darkness of sun-spots, and that the spectroscopic evidence is really quite compatible with a relatively high temperature even in the umbra of a spot.

But in abandoning the absorption hypothesis, one is brought face to face with an apparent contradiction of Kirchhoff's law. Thus it is certain from the low mean density of the sun that the interior region under enormous pressures must be vastly hotter than the photosphere. If, therefore, spots are really breaks in the photospheric clouds through which we obtain a glimpse of the interior, why is it that the radiation from them is apparently so much less intense than from the photosphere? The clouds of condensed matter may, of course, possess a much higher radiating power than the gaseous mass below them; but this, according to Kirchhoff's law, should be entirely compensated by the enormous depth of the feebly radiating interior mass.

To meet this difficulty I suggested that the radiation from the interior, at the transcendent temperatures which must exist even a few thousand miles below the sun's visible surface, may possibly not be apparent as visible light, but may occur in wave-frequencies of a higher order than the known spectrum; and "may be effective in producing those magnetic disturbances which are characteristic of large umbræ."

Mr. Jackson however, if I have rightly understood him, supposes that it is not so much a question of temperature as of molecular structure that determines the wave-frequency of the radiation; and he regards the light of the photospheric clouds as a phosphorescent glow induced by undulations of a high order of frequency which are emitted by the simpler uncondensed materials. The condensed clouds containing more complex molecular groups acting as a screen, and converting the invisible radiant energy of high frequency into ordinary light.

With regard to this interesting speculation, one would like to know more particularly what is the nature of the evidence on which the idea is based that very simple molecular systems give rise to undulations of high frequency? There can scarcely be any analogy between the behaviour of matter in highly exhausted tubes and under the enormous pressures and temperatures which must exist within the photosphere.

The case of the phosphorescent limes is an exceedingly interesting one; but is there any ground for the belief that the lime obtained from organic salts, and giving a blue phosphorescence, is really simpler in molecular structure than a lime which glows red?

J. EVERSHED.

Kenley, Surrey, October 14.

Hibernating Reptilian Embryos.

WILL you allow me space to correct an error that has crept into the account given in the *Christchurch Press*, and reprinted in the last number of NATURE (p. 609), of Prof. Dendy's successful investigation of the development of the egg of the Tuatara lizard, *Sphenodon*.

The fact of an embryo hibernating within the egg was not, as stated, unknown among vertebrates, an exact parallel being offered by no less well-known a reptile than the European pond-tortoise (*Emys orbicularis*). This was first observed in Austria, in the last century, by Marsigli, whose statement has been corroborated by Miram in 1857, eggs laid in his garden at Kieff in May hatching eleven months later, and by Rollinat in 1894, the latter author concluding that hatching does not, as a rule, take place in France before the twenty-second or twenty-third month after oviposition.

I need hardly add how pleased I feel at the result of Prof. Dendy's investigations showing the close resemblance which the development of *Sphenodon* bears to that of the tortoises, since I believe to have been the first systematist to follow Cope (1885) in placing the Rhynchocephalia in close proximity to the Chelonia with the remark: "The affinities of the Rhynchocephalia to the Chelonia are at least as great as to the Lacertilia" (Cat. Chelon., 1889, p. 1).

G. A. BOULENGER.

British Museum (Natural History), October 23.

Organic Variations and their Interpretation.

I SHOULD be glad if Mr. Cunningham would tell us upon what evidence he founds his opinion that, in crabs, "it is certain that the number of ecdyses depend on age, not on size."

This assumption lies at the base of Mr. Cunningham's criticism of Prof. Weldon's arguments; but, even apart from that, the matter is one of such general biological interest that I hope he will respond to an invitation to substantiate a view which to me, at any rate, is altogether novel. I have always understood that exuviation was a phenomenon essentially connected with the process of growth in Crustacea rather than with the mere passage of time, and it is needless for me to remind Mr. Cunningham of the familiar facts and published statements which support this generally accepted view. Will Mr. Cunningham, on the other hand, tell us how many cases of exuviation, unaccompanied by growth, he has observed among Crustacea?

Unless Mr. Cunningham can revolutionise the present state of knowledge on this subject, his criticism, based on the greater relative growth of young crabs in 1893 than in 1895 and 1898 (which in itself is probable enough), falls to the ground; for he admits that "change in the proportions of a crab occurs only at the ecdysis." In assuming that, on the whole, similarity of size in young shore-crabs indicates an equal number of moults, Prof. Weldon appears to me to be quite in accord with our present knowledge of the subject. Certainly—to modify Mr. Cunningham's phrase—the frequency of exuviation in different *Carcini* corresponds much more closely with their relative growth than with the periods of time occupied.

Plymouth, October 22. WALTER GARSTANG.

Wall Mirages.

MR. R. W. WOOD, who describes a mirage on city pavements, in NATURE of October 20 (p. 596), may like to refer to the second volume of NATURE (p. 337, August 25, 1870), where he will find an account of mirages seen by looking closely along a wall, which was exposed to a hot afternoon sun. The mirage must be very common, and needs only looking for. Mr. Wood's interesting letter may lead others to photograph this curious phenomenon in our own country. A wall will be easier to deal with than a pavement. C. T. WHITMELL.

Leeds, October 22.

A White Sea.

I HAVE received several letters respecting this phenomenon (see p. 496), and have distributed the samples of water to two gentlemen who were desirous of examining it. Will you permit me to say that subsequently I received another application from a bacteriologist on the continent, and that the letter was unfortunately lost before complete perusal. Hence my failure to acknowledge its receipt. JAMES W. BARRETT.

22 Cavendish Square.

SURFUSION IN METALS AND ALLOYS.[1]

THE author points out that metals and alloys may be maintained in a fluid state at temperatures which are many degrees below their true freezing points, and states that this fact has been but little studied. As regards salts, the question of surfusion has recently received much attention. Ostwald (*Zeit. für Physikal. Chem.*, 1897, vol. xxii. p. 3) has shown, as the result of an investigation

1 NATURE, October 6, p. 562.

1 "Surfusion in Metals and Alloys." By Prof. W. C. Roberts-Austen, C.B., F.R.S. (Abstract of a paper read at the Royal Society, May 26.

of great interest, that a very minute quantity of a solid will cause a mass of the same substance to pass from the surfused to the solid state. His work, moreover, has led him to distinguish between the *meta-stable*, or ordinary condition in which surfusion takes place, and the *labile* condition which occurs at temperatures much below the melting point. Ostwald's paper, and one by M. Brillouin (*Ann. de Chim. et de Phys.*, 1898, vol. xiii. p. 264), on the theory of complete and pasty fusion, led the author to offer the Royal Society the results of his own experiments on the surfusion of metals.

Metals do not appear to have been examined from the point of view of surfusion until the year 1880, when some excellent experiments on the surfusion of gold were made by the late Dr. A. D. van Riemsdijk (*Ann. de Chim. et de Phys.*, 1880, vol. xx. p. 66), by whose early death, which occurred last year, Holland has lost a skilful physicist. He pointed out that:—

"Faraday, in his memoir on regelation, published in 1858, stated that acetic acid, sulphur, phosphorus, many metals and many solutions, may be cooled below the freezing temperature prior to solidification of the first portions" ("Experimental Researches in Chemistry and Physics," p. 379). On the other hand, in their treatises on physics, Danguin (vol. i., 1855, p. 892) and Jamin (vol. i., 1859, p. 105) mention tin as the only metal which is capable of remaining liquid at a temperature 2·5° below the true solidifying point of the metal.

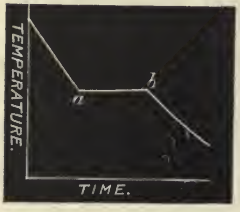


FIG. 1.

FIG. 2.

Van Riemsdijk's contribution to the subject of surfusion of metals consisted in showing that the well-known phenomenon of *éclair*, the brilliant flash of light which often attends the solidification of the metal in the ordinary assay of gold, is really due to surfusion. He also pointed out that surfusion could be either stimulated or hindered by suitably modifying the conditions, but he made no attempt at thermal measurements. It was not until ten years after van Riemsdijk's work that the recording pyrometer, which the author submitted to the Royal Society in 1891 (*Proc. Roy. Soc.*, 1891, vol. xlix. p. 347), enabled such measurements to be readily effected.

After a brief description of this appliance, the nature of which is now well known, it is stated that the freezing point of a metal, or the initial freezing point of an alloy, may be represented by one or other of three typical curves. Two of these are shown in the accompanying figures, which indicate the nature of the curves, traced by the recording pyrometer. Fig. 1 shows the freezing point curve of a pure metal, the horizontal portion, *a b*, indicating the actual solidification of the mass, the sharpness of the angles at *a* and *b* attesting the purity of the metal. The initial freezing point of most alloys would resemble Fig. 1 in having the corner *a* sharp, while the point *b* is generally rounded off.

The third type of curve, which may be a modification of the other two types, indicates the occurrence of surfusion, the bend at *a*, Fig. 2, showing the amount of surfusion which was observed. The author has detected pronounced cases of surfusion not only in gold, but in copper, bismuth, antimony, lead, and tin. Surfusion, moreover, is not confined to pure metals, and he showed in 1893, that the eutectic alloy in the bismuth-copper series presents a marked case of surfusion. In order to study surfusion, it is necessary to make the galvanometer (to which the thermo-junction is attached) very sensitive. The method of effecting this is described, the thermo-junction itself being in all cases suitably protected and placed in the cooling mass of metal or alloy. A curve, traced by the aid of such a sensitive method, if it represents the surfusion of a metal or an alloy, does not merely show a slight depression as in the case of pure gold shown at *a*, Fig. 2: the slight depression becomes a deep dip. It is, in fact, possible by the methods described by the author to ascertain what takes place during the surfusion of an alloy, and the results are shown in two plates appended to the paper. From these plates one illustration (Fig. 3) has been selected. It is the autographic representation of the surfusion of an alloy of 64 parts of

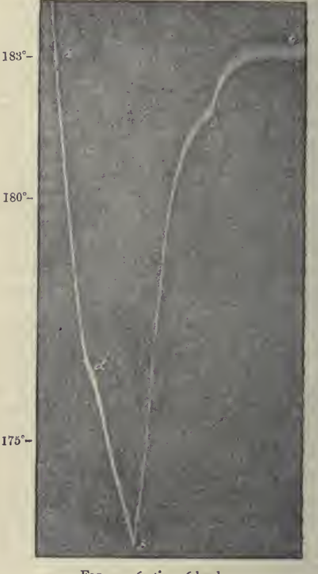


FIG. 3.—64 tin, 36 lead.

tin and 36 parts of lead. The line *a b* represents the surfusion of the mass which, as the scale shows, fell 10 degrees below its true point of solidification before it actually became solid. The solidification of the mass is recorded by the horizontal line *c*. This autographic record also shows that something happened during surfusion, for there are points at *d* and *e*. These proved to be due to the falling out of lead at *d*, and to its having to be remelted at *e*. The entire mass then became solid.

Experiments such as the one described have enabled the author to trace the crossing of solubility curves of certain metals in each other in the same way as had previously been effected in the case of salts by H. le Chatelier and by Dahms.

This crossing of the solubility curve of lead and tin is shown in Fig. 4, but for a description of it reference must be made to the original paper.

The first experimental evidence as to the identity of the behaviour of saline solutions and metallic alloys as regards selective surfusion, has thus been afforded by

Prof. Roberts-Austen. The question is, as he shows, one of much theoretical interest, and should lead to further experiments.

The author then adopts a method previously used by Spring (*Bull.* Acad. Roy. Belg., vol. xxviii., 1894, p. 40). He proceeds, after quoting experiments by Ostwald, Demarçay, Pellat, Colson and Russell, to show that alloys may be formed by the vaporisation of certain metals *in vacuo* at so low a temperature as 50° C. He

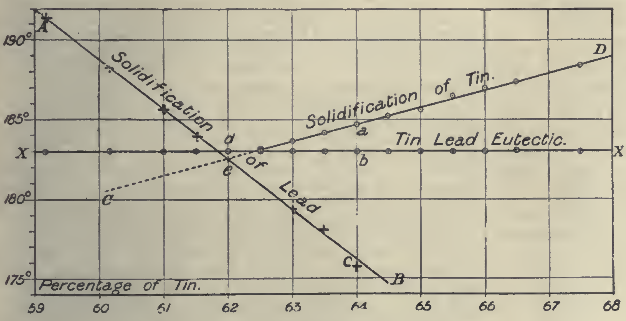
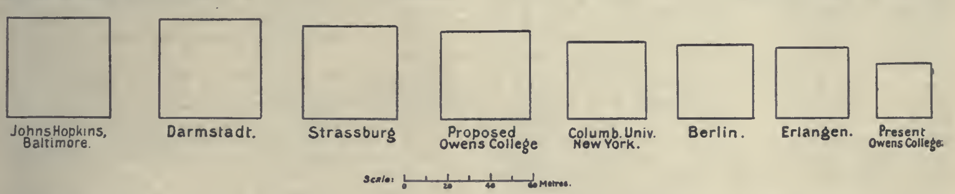


FIG. 4.—Freezing point curves of lead tin alloys.

concludes by pointing out that the results given in the present paper reveal additional points of similarity between the behaviour of alloys and that of ordinary saline solutions. He trusts, therefore, that it may be useful as a continuation of his investigation on the "Diffusion of Metals," which formed the subject of the Bakerian Lecture of 1896.

THE NEW PHYSICAL LABORATORY OF THE OWENS COLLEGE, MANCHESTER.

THE laboratory of which the foundation-stone has been laid, on the twenty-fifth anniversary of the occupation of the present Owens College buildings, will be the largest and most completely equipped in this country. It stands on a separate plot of ground adjoining the Owens College site, and consists of a main building and a large annexe, the latter being more especially intended for electro-technical work. The principal building is 100 feet long and over 60 wide, and consists of a basement and three stories. The diagram gives the comparison as regards dimensions with some of the principal laboratories abroad. The squares represent square area of floor space of the working rooms, *i.e.* all corridors, cloak-rooms, &c., are excluded, and the floor space of the different stories added up. It will be seen that the only laboratories materially larger than the proposed building are those of Baltimore and Darmstadt. But provision has been made for future extension, the plot of ground secured by the College being sufficiently large to double, if necessary, the size of the building.



The cost of the building with fittings and new apparatus is estimated at 30,000*l.* Of this sum 17,000*l.* has been subscribed, in one sum of 10,000*l.*, one of 5000*l.*, and two of 1000*l.* In the plan ample provision for research work has been made. Two large rooms, for instance, are exclusively devoted to spectroscopic work, one of them being arranged to hold a large Rowland grating. It is intended to have at least one room set aside for constant temperature work, and to establish a small plant for the production of low temperatures. An electro-technical laboratory will be added, in which large currents will be available for electric furnaces.

One of the features of the laboratory will be a carefully planned system of ventilation combined with an attempt to exclude dust, as far as possible, from all rooms, and especially from the instrument cases. The plenum system, much used at present, had to be rejected, because it takes up too much valuable basement space, because it is ineffective as regards exclusion of dust, and because the inevitable noise and mechanical shaking due to the fans would have seriously interfered with the work of the laboratory. The architect is Mr. J. W. Beaumont, who, before finally drawing the plans, was sent by the Council of the Owens College to visit the principal modern laboratories of Germany.

In seconding a vote of thanks to Mr. Henry Simon for laying the foundation-stone, Prof. Schuster gave a short description of the building. In the course of his remarks he said :—

In the general plan of the building I have departed considerably from that adopted in some of the recent continental buildings. The designer of a laboratory may take either one or other of two opposite views, according as he wishes to differentiate as much or as little as possible between different rooms and between different classes of students. The present tendency is to adopt the former course, and to draw a rigid line of separation between the rooms set aside for elementary and for advanced work. This system is carried out to such an extreme in one of the most recent and, in some respects, most perfect of German laboratories that a separate division with a staircase of its own is provided for the elementary students, who thus can never be brought into contact with their more fortunate colleagues admitted to the main part of the building.

I have adopted the opposite course, for I consider that a free intercourse between different classes of students is of great benefit and educational value. My object has been to throw the students together and not to separate them, so that the beginner may occasionally see his more advanced colleagues at work, and the latter will have an opportunity to overlook and sometimes to assist their juniors. To some extent, the separation of students is necessitated by the requirements of space and apparatus, but we may do much to minimise instead of exaggerating the division.

Most of the rooms devoted to the highest kind of work are sufficiently large to accommodate several students. In this matter also I have not followed the practice now in fashion, which favours small rooms for single students. It is no doubt very convenient to those engaged in original investigations to have undivided command over a space in which they are absolutely undisturbed, and in which they may leave their apparatus secure against interference. But having regard not only to individual convenience but to the general good of the laboratory, my experience leads me to believe that the advantage lies with the older and less luxurious times, when space was valuable and a number of men were forced to work together.

I remember the old laboratory of the great Helmholtz, in which we were about half a dozen students carrying on research work in a room in which each of us had to be satisfiedwith a table.

The Professor used to spend an hour a day with us, conversed with each about the work he was doing, and we could all daily hear him speak and give his advice about a variety of subjects in a way which would have been impossible if we had been shut up in single rooms. We became interested in each other's work, and thus increased our experience and obtained a much broader view of the range of physics. I consider the experience thus gained to have been quite invaluable, but curiously enough the Professor did not himself realise the importance of this mutual intercourse, and a few years later, when he drew up the plans of a new laboratory, he adopted what has with reason been called the principle of solitary confinement, each student having a separate small room assigned to him. The result, I think, showed that the advantage secured by the increased privacy was too dearly paid for. It became impossible for the Professor to make the round of all the rooms each day, he ceased to exercise the same supervision as before; and the students, left to themselves, soon only looked after their own individual interests and lost touch with their comrades.

A great deal of attention has recently been given to the splendidly equipped laboratories of the German polytechnic schools, and the remarkable development of German industry is not unnaturally ascribed to their influence. But if it be our wish to emulate these laboratories, we should remember that the polytechnic school is only one part of a complete system of education which is not possible to copy here. We should inevitably be led to failure if we tried to solve the educational problem of this country by importing one particular type of institution, without regard to the previous training of the students attending it, and what is more difficult to ascertain, their future career or position in life.

We shall do better if we attack the problem by forming a clear idea as to whom we want to educate, and then doing the best we can with the material at our command.

In the industrial life of a country two distinct classes of men are needed. There are in the first place the leaders, on whom all the burden of further progress will fall. We look to them for future discoveries and inventions, and we must provide them with the proper tools to work their way, and weapons to overcome their obstacles. Though necessarily few in numbers, these men who are specially endowed to serve their country by their intellect and enterprise should receive our first attention. At first sight their education seems easy enough, for what can we do more than lead them up to the highest level of their subject. Yet there is one danger so serious that I believe it lies at the foundation of the distrust with which the greater part of the industrial community still looks upon education. The want of confidence in the teaching profession, which is a national characteristic to be reckoned with, because probably not to be cured, has had the effect of establishing a rigid system of teaching and examining, which undoubtedly tends to subdue, if not to kill, individuality. Where any pronounced originality exists, our whole effort should be to foster and develop it. I feel no doubt that the success of our university will entirely depend on the manner in which we allow room for individuality and originality in our courses, while the continued success of our college must depend on the freedom which we claim for individual teaching, even if in special cases the students should be kept out of the university altogether. Far better that a man of original mind should go through life without a a degree, than that he should artificially be driven into the broad path of common-place reasoning. This country has never been wanting in men of the type I am speaking about; they are not brought up in the polytechnic schools of Germany, and never will be brought up by any schools formed on that pattern. Whatever success Germany has achieved is due to the stringent slavery of its schools, followed and corrected by the absolute freedom of its universities.

I have spoken of two types of students, and the second is no less important than the first. The great majority of men are neither discoverers nor inventors, and they are for that very reason all the more in need of an education which will fit them for their life's work. It is in the instruction of this numerous class of students that we have most to learn, and it is in the intelligent organisation of their teaching that we are behind other countries. It has become a matter of vital importance for this college to offer a thorough training to those men, who, though they may not be leading spirits or originators, yet form a necessary portion of the community and fill responsible positions in our industries. We have taken the first step to-day to remove one of the causes, which has hitherto prevented the physical department attracting these students in sufficient numbers. Our accommodation has till now been hopelessly deficient, but I hope that those who take the trouble to look through our plans will find that, as regards space and disposition of rooms, we may in future court comparison with any other institution. May I express the hope that the support which we shall get from our friends, will enable us to say the same of our equipment and instrumental appliances. I am, however, quite aware that building and equipment alone will not entirely solve the problem. Certain difficulties of instruction will have to be overcome, which will require not only the co-operation of different departments of the college, but also the help and advice of the manufacturers in whose workshops our students will have to complete their education. I attach the greatest importance to this help, and believe that real progress in what may be called the highest branch of technical education can only be secured by a frequent and sympathetic consultation between the teachers and employers of labour.

One further remark I should like to make in order to remove the objection which I know has been urged against our college, that we wish to unite in it students of different classes, and that, as in Germany, the university instruction should be entirely separated from that of the polytechnic school. But the separation of the two kinds of institutions in that country has not been chosen deliberately to secure the best educational result. It has been the consequence of the very high standard of classical education, which the universities require, and which it was not possible to enforce on the technical students. No one can urge that the literary requirements of our college or of our university are such as unjustly to exclude any one who is fitted to receive a higher technical education. If we want to find a country the educational institutions of which have grown unhampered by historical tradition, we must go to the United States of America, and amongst their universities we shall find some whose success we need not be afraid to emulate. I confess that no other institution has ever impressed me so much as regards efficiency in teaching organisation and completeness of laboratory organisation as the Cornell University at Ithaca. The class of students visiting that university are nearly akin to those we wish to attract, and if the citizens of Manchester could see the appliances of the physical laboratory and of its splendidly equipped dynamo house, I think we should have no difficulty here in obtaining the neces sary funds for furnishing appropriately the rooms of our new laboratory.

The extraordinary development of electrical industries in the United States, and the great value which is in that country attached to a university education, may encourage us in the hope that the efforts we are making to extend and improve our electrical teaching will meet with some success.

I hope that the stress I have laid on our intentions regarding electro-technical teaching will not give rise to the impression that we mean to neglect other branches of physics. Our laboratory will provide arrangements for optical and more particularly spectroscopic work, which will at least be equal to that of any other institution; nor shall we forget the necessary machinery to produce very low temperatures by means of the liquefaction of air.

I had some hope originally to add a small astronomical observatory, but although the plans are such that it could be added at any time, the question of expense has for the present prevented us from carrying out a project for which there was no such pressing necessity.

THE INTERNATIONAL CONFERENCE ON SCIENTIFIC LITERATURE.

THE official report of the proceedings of the second International Conference on Scientific Literature, recently held in the rooms of the Society of Antiquaries, the rooms of the Royal Society being under repair, is given below. The names of the delegates who attended the Conference have already been published in NATURE (p. 579).

ACTA.

OPENING MEETING, TUESDAY, OCTOBER 11.

(1) Prof. Darboux moved that Sir John E. Gorst be the President of the Conference. The vote having been unanimously accepted—

(2) Sir John Gorst took the chair and welcomed the delegates. It was then resolved—

(3) That Prof. Armstrong be the Secretary for the English language.

That Prof. Korteweg be the Secretary for the German language.

That M. La Fontaine be the Secretary for the French language.

(4) That the Secretaries, with the help of shorthand reporters, be responsible for the *procès verbal* of the proceedings of the Conference in their respective languages.

(5) Prof. Foster read out the names of delegates appointed to attend the Conference, and gave an account of the correspondence relating to the non-representation of certain countries.

The following resolutions were then agreed to:—

(6) That the ordinary hours of meeting be 11 a.m. to 1 p.m., and 2.30 to 4.30 p.m.

(7) That each delegate shall have a vote in deciding all questions brought before the Conference.

(8) That English, French, and German be the official languages of the Conference, but that it shall be open for any delegate to address the Conference in any other language, provided that he supplies for the *procès verbal* of the Conference a written translation of his remarks into one or other of the official languages.

(9) Prof. Foster having formally presented the Report of the Committee of the Royal Society, copies of which were forwarded, in April last, to the several Governments represented at the Conference, the discussion of the recommendations was opened, and it was resolved—

(10) That the Conference confirms the principle that the Catalogue be published in the double form of cards and book.

(11) That Schedules of Classification shall be authorised for the several branches of science which it is decided to include in the Catalogue.

(12) That geography be defined as limited to mathematical and physical geography, and that political and general geography be excluded.

(13) That anatomy be entered on the list as a separate subject.

(14) That a separate schedule be provided for each of the following branches of science.

Mathematics.	Palæontology.
Astronomy.	Anatomy.
Meteorology.	Zoology.
Physics.	Botany.
Crystallography.	Physiology (including Pharmacology and Experimental Pathology).
Chemistry.	Bacteriology.
Mineralogy.	Psychology.
Geology (including Petrology).	Anthropology.
Geography—Mathematical and Physical.	

(15) That each of the sciences for which a separate schedule is provided shall be indicated by a symbol.

(16) Prof. Foster announced the reception of a letter from the German Chargé d'Affaires to the President of the Royal Society, stating that Geiheimer Regierungs-Rath Professor Dr. Klein, of Goettingen, had been appointed German Delegate to the Conference.

The regulations to be observed in the preparation of cards or slips were then taken into consideration, and it was resolved—

(17) That Italian should be added to the list of languages not requiring translation.

(18) That for each communication to be indexed at least one slip, to be called a *Primary Slip*, shall be prepared, on which shall be either printed or type-written or legibly hand-written in Roman script—

(i.) *Title-entries.*—The author's name and the full title of the communication, in the original language alone if the language be either English, French, German, Italian, or Latin.

In the case of other languages, the title shall be translated into English or such other of the above five languages as may be determined by the Collecting Bureau concerned; but in such case the original title shall be added, either in the original script, or transliterated into Roman script.

The title shall be followed by every necessary reference, including the year of publication, and such other symbols as may be determined. In the case of a separately published book, the place and year of publication, and the number of pages, &c., shall be given.

(ii.) *Subject-entries*, indicating as briefly as possible the principal subjects to which the communication refers. Every effort shall be made to restrict the number of these subject-entries.

Such subject-entries shall be given only in the original language of the communication if this be one of the five previously referred to, but in other cases in English or in such other language as has been used in translating the title.

[The Belgian delegates stated that they abstained from voting on the part of this resolution relating to subject-entries.]

SECOND MEETING, WEDNESDAY, OCTOBER 12.

(19) Prof. Korteweg having expressed the desire to be relieved of his office, it was resolved that Prof. Weiss be appointed Secretary for the German language.

The following resolutions were adopted:—

(20) That the registration symbols used in the Catalogue be based on a convenient combined system of letters, numbers, or other symbols, adapted in the case of each branch of science to its individual needs, and in accordance, as far as possible, with a general system of registration.

(21) That the authoritative decision as to the Schedules be entrusted to an International Committee, to be hereafter nominated by this Conference.

(22) That the Conference is of opinion that the Delegates should be requested to take steps in their respective countries to organise local committees charged with the study of all questions relating to the International Catalogue of Scientific Literature, and to report within six months to the International Committee.

(23) That the International Committee (Resolution 22) be instructed to frame a report, not later than July 31, 1899, which shall be issued by the Royal Society, and incorporated in the decisions of the Conference.

(24) That in all countries in which, or wherever, a Regional Bureau is established, as contemplated in the 16th Resolution of the International Conference of 1896, the Regional Bureau shall be responsible for the preparation (in accordance with Reg. 7 of the Royal Society's Report) of the slips requisite for indexing all the scientific literature of the region, whatever be the language in which that literature may appear.

That each Regional Bureau shall transmit such slips to the Central Bureau as rapidly and as frequently as may be found convenient.

That in the case of countries in which no Regional Bureau is established, the Central Bureau, failing other arrangements, shall. upon special mandate, endeavour to undertake the work of a Regional Bureau.

[The Belgian delegates stated that they abstained from voting on this resolution.]

(25) That the following recommendations of the Royal Society relating to the preparation of the Book Catalogue be referred to the International Committee for their favourable consideration, viz.:—

"At determined regular intervals, not necessarily the same for all sciences, the Central Bureau shall compile from the slips and issue in a book form both an authors' and a subject index of the literature published within that period.

This Book Catalogue shall be obtainable in parts corresponding to the several sciences for which slips are provided, and in such divisions of parts as may be hereafter determined.

In compiling the authors' index, in each of the sciences, the authors' names shall be arranged in alphabetical order, and each name shall be followed by the title of the paper and the necessary reference, and any other such symbols as may be determined.

The Book Subject Catalogue shall be compiled from the slips, as follows:—

(i.) The subject entries shall be grouped in sections corresponding to the registration letters on the slips, *i.e.* to the several sciences.

(ii) In each science the several subject entries shall be arranged under headings corresponding to the registration numbers on the slips, the which headings and numbers shall be those contained in the authorised schedules of classification.

(iii.) The divisions indicated by registration numbers may be further subdivided by means of significant words or symbols.

(iv.) The nature of the subject entry may vary. Thus, as suggested in the cases of Mathematics and Physiology, it may be the title only; whilst in other sciences a special entry, more or less different from the title, may be provided on each slip. In all cases, the number of subject entries to be copied from a slip shall be determined by the number of registration numbers on the slip.

(v.) The mode of arranging subject entries under a registration number, or under the subdivisions of a number afforded by significant words or symbols, may vary. They may either be arranged in the order of authors' names placed alphabetically, in which case the author's name shall precede the subject entry in the Book Catalogue, or they may be arranged either in an arbitrary order, or in some order suited to the particular series of entries.

When in preparing an issue of the Book Catalogue, it is found that a registration number has no entries collected under it, the number and corresponding heading may be omitted from that issue.

To each part of the Book Catalogue corresponding to an authorised schedule, there shall be appended an alphabetical index of the headings, and if expedient, also of the significant words appearing in that part, showing on which page of the part each may be found.

After the publication of the first issue of the Book Catalogue, the Director of the Central Bureau shall consult the Committees of Referees as to the desirability of making changes in the classification, and shall report thereon to the International Council, who shall have power to authorise such changes to be made as they may think expedient."

(26) That the following recommendations of the Royal Society providing for International Conventions in connection with the Catalogue be adopted:—

"Each region in which a Regional Bureau is established, charged with the duty of preparing and transmitting slips to the Central Bureau for the compilation of the Catalogue, shall be called a 'constituent region.'

In 1905, in 1910, and every tenth year afterwards, an International Convention shall be held in London (in July) to reconsider and, if necessary, revise the regulations for carrying out the work of the Catalogue authorised by the International Convention of 1898.

Such an International Convention shall consist of delegates appointed by the respective Governments to represent the constituent regions, but no region shall be represented by more than three delegates.

The rules of procedure of each International Convention shall be the same as those of the International Convention of 1898.

The decisions of an International Convention shall remain in force until the next Convention meets."

27. That the following recommendations of the Royal Society relating to the constitution of an International Council, which shall be the governing body of the Catalogue, be adopted:—

"Each Regional Bureau shall appoint one person to serve as a member of a body to be called *The International Council.*

The International Council shall, within the regulations laid down by the International Convention, be the Governing Body of the Catalogue.

The International Council shall appoint its own Chairman and Secretary.

It shall meet in London once in three years at least, and at such other times as the Chairman, with the concurrence of five other members, may specially appoint.

It shall, subject to the regulations laid down by the Convention, be the supreme authority for the consideration of and decision concerning all matters belonging to the Central Bureau.

It shall make a report of its doings, and submit a balance sheet, copies of which shall be distributed to the several Regional Bureaux, and published in some recognised periodical or periodicals, in each of the constituent regions."

(28) That the following recommendations of the Royal Society relating to International Committees of Referees be referred for consideration to the International Council when constituted:—

"The International Council shall appoint for each science included in the Catalogue five persons skilled in that science, to form an International Committee of Referees, provided always that the Committees shall be as far as possible representative of the constituent regions. The members shall be appointed in such a way that one retires every year. Occasional vacancies shall be filled up by the Committee itself, subject to the approval of the Chairman of the International Council, and a member thus appointed shall hold office as long as the member whose place he fills would have held office.

It shall be the duty of the Director of the Central Bureau to consult the appropriate Committee or Committees by correspondence or otherwise, on all questions of classification not provided for by the Catalogue Regulations; or, in cases of doubt, as to the meaning of those Regulations.

In any action touching classification the Director shall be guided by the written decision of a majority of the appropriate Committee, or by a minute if the Committee meets.

Provided always that when any addition to or change of the schedule of classification in any one branch may seem likely to affect the schedule of classification of some other branch or branches, the Committees concerned shall have been consulted; and provided also that in all cases of want of agreement within or between the Committees, or of other difficulty, the matter shall have been referred for decision to the International Council.

All business transacted by the Committees shall be reported by the Director to the International Council at their next ensuing meeting."

THIRD MEETING, THURSDAY, OCTOBER 13.

The following resolutions were adopted:—

(29) That the Committee contemplated in Resolution 21 be constituted as follows:—

Prof. Armstrong.	Prof. Poincaré.
Prof. Descamps.	Prof. Rücker.
Prof. M. Foster.	Prof. Waldeyer.
Dr. S. P. Langley.	Prof. Weiss.

That this Committee be at liberty, if any of those named are unable to serve, to appoint substitutes, and also to co-opt two new members.

(30) That the International Committee be termed the "Provisional International Committee."

(31) That the Provisional International Committee shall be governed by the decisions of the Conference, but shall have the power of introducing such modifications in detail as may appear necessary.

(32) Dr. Adler, referring to Resolution 20, said that he desired to place on record his view that the concluding words—"and in accordance, as far as possible, with a general system of registration"—the addition which he had agreed to as an amendment of his original Resolution, must not be regarded as modifying the first part of the Clause, or as in any way throwing open the whole question of notation and classification.

(33) Prof. Rücker having made a statement as to the probable cost of the undertaking, aud the Delegates having stated what assistance in their opinion might be expected from their respective countries, it was resolved—

That the Delegates to this Conference be requested to obtain information, and to report at an early date to the "Provisional International Committee," as to what assistance, by subscription or otherwise, towards the support of the Central Bureau, may be expected from their respective countries.

(34) M. Mascart called attention to Resolution 22 as being, in his opinion, incorrect in English, the intention being that the

local Committees therein referred to should report to the International Committee.

(35) The Royal Society was requested to undertake the editing, publication, and distribution of a verbatim report of the Proceedings of the Conference.

(36) It was resolved that the *procès verbal* of the Conference be signed by the President and Secretaries.

(37) On the motion of Prof. Armstrong, the thanks of the Conference were accorded to the Society of Antiquaries for the use of their rooms.

(38) On the motion of Prof. Klein, a vote of thanks to Sir John Gorst for presiding over the Conference, and his conduct in the chair, was passed by acclamation.

(39) On the motion of M. Darboux, a vote of thanks was passed to the Royal Society for their work in preparation for the Conference and their cordial reception of the Delegates.

(Signed) John E. Gorst, President.
Henry E. Armstrong
H. La Fontaine
E. Weiss } Secretaries.

NOTES.

The British Institute of Preventive Medicine, which was founded with the view of establishing in this country a national home for bacteriological work in all its branches, has made considerable progress towards the achievement of this aim during the past few years. The bacteriological laboratories are now fully organised, the serum therapeutics laboratory is on a firm footing, whilst the applications of bacteriology to hygiene are finding full recognition. A further addition has just been made to the departments of the Institute in response to the growing demands of the times. A large laboratory at Chelsea has been assigned to investigation and instruction in technical bacteriology. In this laboratory the agriculturist, the chemist, the brewer, and others will find the instruction provided that they individually require for successfully employing the living agents of fermentation. Investigations will also be undertaken, and it is hoped that the laboratory will become a centre of useful work, and promote the advancement of a line of research of the greatest importance to the industries of the country. We have had hitherto to rely upon the research work of foreign laboratories in this direction. The laboratory has been named the Hansen laboratory, in recognition of the pioneer work of the distinguished investigator, and will be under the superintendence of Dr. G. Harris Morris. The formal opening of the British Institute will take place early in the new year, when the public will have an opportunity of inspecting the provisions made for furthering the objects of the Institute. The occasion will also be marked by the issue of a fresh volume of *Transactions* of the Institute, the first number of which was recently reviewed in these columns.

A letter signed "D.Sc. (Lond.)," referring to a Science and Art Department's examination, appeared in Nature of September 8 (p. 435), and in it the writer gave the following as an instance of anomalies which occur in examinations:—"A student sat for the examination in May last in the advanced stage of practical organic chemistry. He was required to answer two questions, and to analyse two substances (unknown), as well as to find the halogen element present in an organic solid, and to determine the melting point of this solid. The written questions were correctly answered, the analyses were correctly done, the halogen was correctly determined, and the melting point of the substance was less than 1 per cent. too low. The description of the practical work was also fairly well done; but this student is returned as having failed, notwithstanding that there are two classes of success, first and second class. It would be interesting to know, in the face of this, the standard the examiners require for a first class success." Particulars which enabled the examiner to again look at the paper worked by the candidate referred to were afterwards furnished us by "D.Sc.," and the examiner now reports upon it as follows:—"The written questions were partly answered, and on this part of the examination the candidate would have been allowed to pass; but the analyses were both very badly done, and the answers quite wrong. For the detection of the halogen and for the melting point he received the full marks awarded to this part of the work." It will be seen from this that the suggestion of unfair marking made by our correspondent is entirely without foundation. With regard to the other point referred to in the letter, we are sorry to say that "D.Sc." would not furnish us with the name of the class in which he said that by the new rules the earnings this session will be reduced 75 per cent. We regret having unconsciously done an injustice to the Department of Science and Art by the publication of his letter.

The following interesting announcement appears on a page in the catalogue of Messrs. Johnson, Matthey, and Co., Hatton Garden, London:—"In furtherance of scientific research, Professors and recognised scientific investigators will with pleasure be supplied with metals of the platinum group, in moderate quantities, and for periods to be arranged, free of charge, on condition that the precious metals are ultimately returned (in any form), and that the results of the investigations are furnished."

A plea for a national Antarctic expedition is made by Sir Clements Markham in a pamphlet published by the Royal Geographical Society. As was pointed out last week, in referring to the special Antarctic number of the *Scottish Geographical Magazine*, the only hope of maintaining the credit of our country in the work of exploration lies in an appeal to the patriotic feelings of those who possess the power which wealth supplies of providing the funds. The Council of the Royal Geographical Society generously offers to head the list with a subscription of 5000*l*. This example should be the means of showing that geographers are willing to help geographical discovery so far as their funds permit; and it also expresses their views upon the necessity of Antarctic exploration in an unmistakable form. It is earnestly to be hoped that the desire to enable the nation to retain its position as the first in exploration and discovery will inspire our wealthy countrymen to provide an amount equal to at least ten such subscriptions as that of the Royal Geographical Society. If this sum is not forthcoming, the prestige and credit won by former explorations will have to be resigned, and other nations will take our place as leaders in the work of geographical discovery.

An attendant at the Pathological Institute attached to the Vienna General Hospital, died on October 18 from bubonic plague. It is believed that the man became infected by handling cultures of the plague bacillus. His duties were to look after the animals kept for the bacteriological study of the plague, but how he became infected has not yet been discovered. There is no doubt that the case was one of plague, an examination of the sputum having revealed the presence of the plague bacillus. Since the assistant's death, Dr. Müller, who attended him, has also died from the plague, and a nurse infected by it is described as in a condition which leaves little hope of recovery.

The *Times* correspondent at Copenhagen announces that an international monument in honour of the famous Danish physician, Dr. Hans Wilhelm Meyer, who died three years ago, was unveiled in that city on Tuesday. Dr. Meyer was the discoverer of what are called adenoid growths. He found that the space between the nose and the throat, which ordinarily is an open cavity, is in certain persons suffering from deafness more or less closed by a large, soft mass. He found that this mass in numerous cases causes lifelong deafness, obstructs nasal respiration, and greatly retards the mental development of the patients, who are generally young. He succeeded in removing these growths by operation. Shortly before his death his discovery was universally recognised as being of the utmost importance. The monument has been erected by international subscriptions, committees having been formed in almost every civilised country, and not only members of the medical profession but also grateful patients contributing. The memorial is a bronze bust of more than life-size, resting upon a granite base. In front stands a figure of Hygeia, beneath which is inscribed the name "Hans Wilhelm Meyer." On the other side may be read the names of all the countries which have contributed to the memorial. The monument is the work of the Danish artists Bissen and Runeberg.

THE death is announced of Dr. Eugenio Bettoni, director of the Fisheries Station at Brescia, at the age of fifty-three years.

SIR JOHN MURRAY, F.R.S., has resigned the post of scientific member of the Fishery Board for Scotland, to which he was appointed by the Crown in January 1896.

THE opening meeting of the new session of the Institution of Electrical Engineers will be held on Thursday, November 10, when a paper will be read by Prof. Silvanus P. Thompson on "Rotatory Transformers." The annual dinner will take place in the Grand Hall of the Hôtel Cecil on Wednesday, December 7.

A DISPATCH describing a series of attempts to climb Mount Sorata, or Illampu, in the Eastern cordillera of the Andes of Bolivia, has been sent to the *Daily Chronicle* by Sir Martin Conway. The highest point attained was well over 23,000 feet, and probably as much as 24,000 feet, but the summit was not reached.

WE learn from *Science* that the U.S. Fish Commissioner has presented to Cornell University a collection of fresh-water and salt-water fishes, numbering between four and five hundred thousand specimens. The collection, in so far as it consists of living fishes, will be of great value not only to the zoological department, but also to the College of Forestry, in which a course in pisciculture and venery is to be introduced. It is understood that duplicates of this collection are to be presented to other institutions.

THE existence of a number of species of silk-spinning worms in the Sewaliks and Himalayas, and the extensive use of silk as a material for dress, make the question of sericulture in India a matter of great interest. The *Pioneer Mail* of October 7 prints an account of three different sets of experiments in progress during the current year in the North-Western Provinces to establish silkworm rearing—one in the plains, another in the Dun Valley, and the third on the Himalayas. All were carried out under different conditions of temperature, and all achieved a degree of success that is encouraging.

THE *Athenæum* announces that Don Francisco Coello de Portugal, who occupied in Spain the foremost rank as a geographer, has just died at Madrid at an advanced age. He had originally embraced the military career, and after having quitted the army in 1865 with the rank of colonel, he devoted himself chiefly to the science of geography, and published an excellent "Atlas of Spain and its Colonies," which will now, of course, be out of date. He was president of the Geographical Society of Madrid, and frequently represented Spain as delegate at scientific congresses.

A CORRESPONDENT sends us a letter he has received from Ballyarthur, in the Vale of Ovoca, County Wicklow, with reference to a curious object observed in the sky on Wednesday evening, October 19, about six o'clock. The object was visible in the south-west, and looked like a three-quarter moon. It was moving gradually from south-east to north-west, and appeared to the observer to go down behind the Croghan Kinsella mountain. It was of a golden colour, and was seen for four or five minutes. The suggestion is made that the object was a meteor, but it may have been merely an escaped balloon. Perhaps it was seen by other observers in Wicklow or Wexford, who could give further particulars concerning it.

WE learn from the *British Medical Journal* that it has been determined to appoint a special commission, to consist of five members, to conduct investigations regarding plague in India. The specific duty of the commission will be to inquire into the origin of the various outbreaks of plague, and the manner in which the disease is spread. An official statement also is required as to the efficacy of the serum treatment and the prevention of plague by means of inoculation. So far as the nominations to serve on this commission have been made public two Indian civilians, Messrs. J. R. Sewwett and A. Cumine, have already been appointed; but it is understood that three other members will be nominated by the Secretary of State for India, to proceed from this country, of whom one will act as chairman, while two will be experts.

PARTICULARS concerning the expedition which will leave England in the course of the next few days for the purpose of visiting the almost unexplored island of Sokotra, situated about 150 miles east-north-east of Cape Guardafui, are given in Tuesday's *Times*. The party will consist of Mr. W. R. Ogilvie Grant, of the department of zoology in the British Museum; Dr. H. O. Forbes, the director of the Liverpool Museums; and Mr. Cutmore, taxidermist attached to the latter institution. The Royal Society, the Royal Geographical Society, and the British Association have provided part of the funds for the undertaking. The expedition will sail for Aden, proceeding thence to Sokotra by the Indian Marine guardship *Elphinstone*, which, in compliance with a request made by the authorities of the British Museum, has been kindly placed at the disposal of Mr. Grant and Dr. Forbes for the purpose of conveying them to the island and back to Aden on the termination of their stay. The main object of the expedition is to investigate thoroughly the fauna of the place and make large and complete collections in every branch of zoology.

THE space to be devoted to the various sections of the Paris Exposition of 1900 has been arranged by the Commissioner-General as follows:—

	Sq. ft.
Agricultural and food products	20,000
Army and navy	3,300
Chemical industries	5,160
Education, instruments, practical sciences, and arts	11,470
Fine arts	(not yet known)
Forestry, hunting and fisheries	3,300
Heating apparatus	4,500
Horticulture	(not yet known)
Machinery and electricity	50,000
Manufactures	25,000
Mines and mining	7,700
Textiles	13,000
Transportation and civil engineering	20,000
Total	163,430

IT is of great importance that those who are engaged in archæological research should be properly trained; therefore the British School at Athens by supplying the needful training is doing very valuable work. This was the text of the remarks made by the Bishop of London at the annual meeting of the

School, held on Thursday last. Referring to the excavations at the prehistoric capital of the island of Melos, discovered at Phylákopi, the director of the School, Mr. Hogarth, said that the School began to excavate it in 1896, little suspecting the great importance of the site. It was proving a second Hissarlik, an undisturbed repository of the products of the primitive civilisation of the Ægean from the "Mycenæan" age back to the Neolithic period. Much had been eaten away by the sea, but what was left was equal in extent to Tiryns. Mr. Hogarth picked up the work where Mr. Cecil Smith left it, and after determining the limits of the city on south and east, and digging test trenches to obtain a relative chronology of the potsherds, in which the site was marvellously rich, proceeded to open out the great barrack-like structures on the north and west. Here were remains of three settlements, divided by layers of débris, the middle and lower ones being singularly well preserved. The best rooms were on the higher ground to the west. The blocks were divided by narrow lanes with covered drains down the centre. The depth varied from seven metres to three metres. In the two lower settlements was found a mass of pottery, and almost as many vessels, complete or little broken, as in a large cemetery. These covered the whole development of the potters' art up to the fine Mycenæan work. Fabrics, shapes, and decoration were in many cases new. The most notable vase was pipe-shaped and decorated with four scantily-clad figures, bearing fish in either hand. This was about the most interesting primitive Ægean vase in existence. In several rooms painted fresco was found, in one case white and gold lilies on a red ground; in another a beautiful scene of the sea with flying fish and marine growths, and a man working a casting net. Of the primitive symbols now attracting so much attention on Cretan stones, &c., over fifty distinct examples were found scratched in clay before baking. Many fine steatite vases, clay lamps (unknown previously on early sites), and other stone utensils and implements came to light. There was a little bronze and bone, but no gold or silver.

Referring to the collection of mollusca in the Madras Government Museum, Mr. Edgar Thurston states, in his report for the year 1897–98, that a right-handed chank shell (*Turbinella rapa*), that is, a chank shell with its spiral opening to the right, was acquired in the Madras bazaar for the small sum of Rs. 150. A shell of this nature, found off the coast of Ceylon at Jaffna in 1887, was sold for Rs. 700. Such a chank is said to have been sometimes priced at a lakh of rupees (Rs. 1,00,000); and, writing in 1813, Milburn says ("Oriental Commerce") that a chank opening to the right hand is highly valued, and always sells for its weight in gold. Further, Baldæus, writing towards the close of the seventeenth century, narrates the legend that Garroude (Garuda) flew in all haste to Brahma, and brought to Krishna the chianko or kink-horn twisted to the right.

It has been suggested by several people that the recent wreck of the *Mohegan* on the Manacles Rocks was due to a local deviation of the compass of the ship. In a letter to the *Times*, Prof. A. W. Rücker points out that a disturbance of a magnitude sufficient to have caused the disaster is most improbable. He remarks:—"During the magnetic survey of the United Kingdom, carried out by Dr. Thorpe and myself, observations were made at twelve places in Cornwall. Of these Lizard Down, Porthallow, and Falmouth were the nearest to the scene of the disaster, and at all of them the deviation of the compass from the normal magnetic meridian was extremely small. The largest disturbance of this kind which was observed in Cornwall occurred at St. Levan, near the Land's End, and only amounted to eleven minutes of arc, or less than two-tenths of a degree. The largest disturbance of the dipping needle was at Mullion, and was only fourteen minutes."

Mr. F. H. Glew, of 156 Clapham Road, sends us a photograph of an oscillatory electric discharge which was taken in daylight. The photographic shutter was connected with a coherer and relay, so that the first component of the discharge operated the shutter and allowed an image of the succeeding components of the discharge to be caught. Mr. Glew suggests that a similar arrangement might be employed for photographing lightning in the day-time. Mr. Glew also sends us a photograph of a flash of lightning taken with a vibrating lens. From the multiple image produced, and the rate of vibration, he calculates that the total duration of the flash in question, which appears to have been of a triple compound nature, was one-nineteenth of a second, or less than one-half of a single vibration of the lens. He has also used a rotating photographic plate, but finds the vibrating lens to be more satisfactory.

Two papers on the circulation of the residual gaseous matter in Crookes' tubes, read before the Physical Society by Mr. A. A. C. Swinton, appear in the October number of the *Philosophical Magazine*. The experiments described lead to the conclusion that "at very high exhaustions there exists a molecular or atomic stream from anode to kathode, which carries a positive charge and travels at considerable velocity outside of the opposite kathode-stream."

When the poles of an arbitrary plane are taken, with respect to the conics of a Steiner's surface, it is known that another Steiner's surface is obtained. Prof. Brambilla, writing in the *Rendiconto* of the Naples Academy, iv. 7, has extended the same property to the two non-ruled surfaces of the fourth order, one in four-dimensional and the other in five-dimensional space, which, when projected from one or two arbitrary centres on our space, produce Steiner's surfaces.

The phenomenon of equilibrium in mixtures of isomorphous substances has been studied by Küster since 1890. A further investigation, leading to somewhat different conclusions, is given by Signor Giuseppe Bruni in the *Atti dei Lincei*, vii. 5, who finds that the curve of congealment of a mixture deviates to a marked extent from the straight line obtained by Küster, and that serious objections can be raised against the latter's views on the coefficient of distribution. Signor Bruni, however, concludes that, in respect both of the variations in the temperature of congealment and of the distribution of the solid and liquid phases, isomorphous mixtures always follow completely the general theory of Van t' Hoff on solid solutions.

A somewhat novel line of investigation, which bids fair to throw light on certain problems of petrology, has been taken up by Prof. R. V. Matteucci in connection with the last eruption of Vesuvius. The method consists in artificially cooling portions of flowing lava, so as to partially or totally check the crystallisation of the substances contained in their magma; and in this way it appears possible to obtain information as to the exact stages at which different minerals separate out from the first exit of the lava up to its final consolidation.

The coasts of Japan are peculiarly liable to incursions from spring tides, of which the one occurring on June 15, 1896, in the course of eighteen minutes swept away 9381 houses and 6930 boats, killing 21,909 people and wounding 4398. To minimise the damage done to life and property by such inroads, protective forests have been planted at various places along the littoral. Dr. Seiroku Honda, Professor of Forestry in the University of Tokyo, writing in the *Bulletin* of the Imperial University College of Agriculture, gives an interesting account of these protective forests, and advocates their further extension to parts as yet unprotected. The action of these forests is three-fold: they check the force of the tidal wave; they delay its advance, giving more time for saving the lives of inhabitants living behind the forest; and, lastly, they prevent houses and property from being washed away into the sea. Dr. Honda gives a list of the trees which are best adapted for this purpose.—In the same number of the *Bulletin* Dr. Diro Kitao, by the use of the equations of elasticity, has endeavoured to reduce the calculation of the shrinkage and swelling of wood to mathematical principles.

THE interpretation of death among the lower organisms is ably dealt with by Signor Angelo Andres in the *Rendiconto del R. Istituto Lombardo*, xxxi. 13. The author, after pointing out the objections to Weismann's views, starts with the conception that living organic matter does not in itself possess any reason for dying, and that, on the other hand, this reason pertains to single individuals; in other words, that living matter remains in itself immortal, and that only the modality of the individual dies. An examination of the lowest forms of algæ leads Signor Andres to the conclusion that the first indications of true death occur in the Diatomaceæ, in which the process of subdivision leads to a gradual diminution in the size of the frustules, as also in the Volvocinæ, where the phenomenon of death is still more marked. The cause of death, it would appear, is to be sought in the differentiation which, by the specialisation of structure and function, leads to the perfectioning, both anatomically and physiologically, of different species.

THE *Engineering Magazine* for September contains an article on the bacterial process of sewage purification, which is at the present time attracting a considerable amount of attention; and is under investigation by a Commission appointed by the Local Government Board. The purification of sewage is a process of destruction of the organic matter by means of bacteria, and finally of the bacteria themselves from inanition. These bacteria are divided into two classes—ærobic, which require oxygen for their growth, and do their work best when sewage is exposed to the air; and the anærobic, which do not require oxygen for their growth, and do their work best in the dark. The former process of purification has been in use in this country for some years, having been first adopted by Mr. Bailey Denton in the system known as intermittent filtration through beds of earth. The latter system is of more recent origin, and has only been prominently before the public since the septic system was adopted by Mr. Cameron, the Borough Surveyor at Exeter. Besides the works at Exeter, others are in operation at Sutton and Yeovil, all of which are described and illustrated in the article by Mr. Rudolph Hering.

A SHORT account of the various steps that have been taken in the acclimatisation of trout in South Africa is given by Mr. J. D. F. Gilchrist in his report of 1897 on the sea and inland fisheries of Cape Colony. So far back as 1884 Mr. Lachlan Maclean began the experiment of trout acclimatisation in the Colony by importing 20,000 ova; and in spite of various difficulties and failures he proved its practicability. His experiments showed that the rearing of trout from imported eggs was feasible, and it is due to his success that the rivers are now being gradually stocked with valuable fish. The Cape Government took up the subject in 1890, and about a year later a hundred thousand trout ova were procured from Guildford, Surrey, a large number of which were hatched successfully. The work has since been carried on by the Cape Agricultural Department, and has undergone a steady progressive development. The trout turned into the rivers thrive exceedingly well, and many of them attain a large size.

AMONG other matters mentioned in the Report of the Marine Biologist referred to in the foregoing note, are trawling experiments performed with a view to introduce new and improved methods of fishing. It has been demonstrated that there is an excellent trawling ground rivalling the North Sea in productiveness, within easy reach of Cape Town. A satisfactory feature of the work is the discovery that soles occur abundantly on the fishing grounds, and can be readily got by trawling. As a scientific result of the experiments it may be mentioned that six different kinds of flat fish, one of which is new to science, have been discovered. The subject of temperatures, currents, &c., of the sea in relation to the scientific side of fishing investigations is being taken up; and Mr. Gilchrist announces that arrangements have been made at about a dozen different places for physical observations of this kind to be carried on.

THE latest number of *Janus*, a journal which is open to contributors from all parts of the world in divers tongues on subjects relating to the history of medicine and medical geography, contains an interesting and well-written article on medical archæology dealing with the significance of the plant Silphium and its therapeutic value amongst the ancients. Dr. Kronfeld of Vienna is the writer, and he has illustrated his article by a reproduction of the well-known dish of Arkesilas, now in the "Cabinet des Médailles" of the National Library in Paris. Graphic and very realistic scenes are depicted indicating the immense store set by the ancient Greeks upon this remarkable plant, whose habitat was located in Cyrene. Its applications seem to have been as diverse as they were valuable, and amongst its numerous uses we find it treasured as furnishing the earliest and most delicate of vegetables, also spice, whilst its therapeutic reputation was almost as universal as that claimed for some of our modern nostrums by their inventors! Silphium has long since disappeared from Cyrene, but Falconer has found in the northern parts of Cashmere a plant which is regarded as being very closely allied to its historic predecessor.

THE Geological Survey has just published a brief Supplement to the Memoir on the Geology of Flint, Mold, and Ruthin, by Mr. A. Strahan. This Supplement contains records of borings put down in the reclaimed portion of the estuary of the Dee; and these are of importance as proving the presence of Upper Coal-measures, which do not appear at the surface and were not previously known to exist in Flintshire or West Cheshire. In this region the Middle Coal-measures are the productive strata, and the new information shows that the Upper Coal-measures may underlie much or all of the Cheshire Trials, and would consequently have to be penetrated in winning the coal. The price of the Supplement is 2*d*.

IN the *Journal of Applied Microscopy* (Bausch and Lomb) for August is a description of the Histological Laboratory of the Harvard University at Washington, D.C.

WE have received part 4 of vol. xxv. of Engler's *Botanische Jahrbücher*, occupied chiefly by a continuation of Pfitzer's review of the classification of Orchideæ, and the commencement of a systematic paper on the Monimiaceæ by J. R. Perkins.

WE have received the Reports of the Botanical Exchange Club for 1896 and 1897, both bearing the date 1898, the latter edited by Mr. G. Claridge Druce. They are both occupied by a record of new British localities, and by remarks on "critical" British species. The discovery is recorded of a new British sedge, *Carex chordorhiza*.

IN the *Revue Générale des Sciences* for September, M. L. Mangin has a short article on the sexuality of Fungi, in which he shows the remarkable advance that has been made during recent years in the discovery of sexual organs in various classes of Fungi. Especial reference is made to the researches of Harper on the Ascomycetes, of Dangeard on the same class of Fungi, of Sappin-Trouffy on the Uredineæ, and of Thaxter on the Laboulbeniaceæ.

The *Journal* of the Royal Microscopical Society for October contains a continuation of Mr. F. W. Millett's report on the recent Foraminifera of the Malay Archipelago collected by Mr. A. Durrand, and the usual summary of current researches in zoology, botany, and microscopy. Among the latter is an abstract of Mr. Lewis Wright's important paper on microscopic images and vision.

The *Biologisches Centralblatt* continues its useful summaries of recent researches in vegetable biology and physiology. In the numbers for September 15 and October 1 are contributions by Dr. R. Keller on the nyctitropic movements of leaves; on the mechanical action of rain on plants; on the flexibility of axial organs, and their capacity for resisting strain; on the comparative intensity of assimilation in plants in the Tropics and in Central Europe; and on the freezing of plants.

The *Naturwissenschaftliche Wochenschrift* for October 2 contains an interesting paper by F. Schlechert, being a report of observations on several points of vegetable physiology. He finds that the highest temperature in the interior of a stem (12 cm. depth from the surface) occurs about midnight, the lowest between noon and 3 p.m. While the chief factor which governs the temperature of the interior of a tree is the temperature of the surrounding air (about twelve hours earlier), it is also affected by the temperature of the soil, by that of the ascending current of water, and by the degree to which the twigs are exposed to direct sunlight.

The papers read at the third annual congress of the South-Eastern Union of Scientific Societies, held at Croydon in June, are printed in the *Report and Transactions* just published by Messrs. Taylor and Francis. Among the subjects of the papers are: The place of geology in education; entomology as a scientific pursuit; the nature of the soil in relation to the distribution of plants and animals; natural gas in Sussex; photography in relation to science; ideals for natural history societies, and how to attain them; and the folk-lore of amulets and charms. The volume thus contains information of interest and value to the members of all natural history societies.

From the United States we have received the following official publications:—"Principal Poisonous Plants of the United States," by V. K. Chesnut (U.S. Department of Agriculture *Bulletin* No. 20); a very useful publication, but the illustrations to which might be improved; we should hardly have recognised two of the imported European weeds, *Solanum nigrum* and *Conium maculatum*. Sixth Report on Kansas weeds (*Bulletin* No. 30, Experiment Station of the Kansas State Agricultural College, Manhattan); in this, and in other similar American publications, we note the introduction of the practice of noting graphically, by small maps, the distribution of the various species throughout the different States.

There is an interesting paper in the *American Naturalist* for September on some European museums, especially from a geological and mineralogical point of view, by Mr. E. O. Hovey. The small "Roemer Museum" at the quaint mediæval city of Hildesheim, near Hanover, is especially commended. Those visited by the writer in Russia presented no particular features of interest, the value of the magnificent collection of minerals in the Imperial Mining Institute at St. Petersburg being greatly marred by a faulty arrangement. Brief accounts are also given of the Natural History Museum at Berlin; the University Museum at Naples; the Museum of Natural History at the University of Geneva; the collection of minerals at the Jardin des Plantes, and the splendid collection of the École des Mines, Paris; the Museum of Practical Geology in Jermyn Street, London, and the collection at the British Museum; and the Woodwardian Museum, Cambridge.

Mr. W. S. Blatchley, State Geologist of Indiana, has issued his report (occupying 1197 pages) on the work accomplished by the department of geology and natural resources during the year 1897. A large proportion of the energies of the department were employed during that year in collecting data for a detailed report on the coal area of the State, shortly to be published. The present report includes papers of economic importance relating to petroleum, stone and clay resources of the State, the reports of the chiefs of the divisions pertaining to mines, natural gas and illuminating oils, and a long descriptive illustrated catalogue (666 pp.), by Mr. A. W. Butler, on the birds which have been observed within the State of Indiana, with an account of their habits.

A second English edition of Prof. von Meyer's well known "History of Chemistry from the Earliest Times to the Present Day" has just been published by Messrs. Macmillan and Co., Ltd. The first English edition, translated from the original German edition by Dr. George McGowan, appeared in 1891. Dr. McGowan is alike responsible for the present volume, which is translated from the second German edition, with numerous additions and alterations. It is unnecessary to refer here to the value of the work, or to add to the account of it given in our review of the English version (Nature, vol. xliv. p. 289). It is sufficient to say that in the second edition, published in 1895, Prof. von Meyer made use of all the additional sources of information on subjects of historical chemistry which had become available since the original work was written. "Among these," Dr. McGowan remarks, "are the Berzelius-Liebig and the Liebig-Wöhler *Letters*, the *Letters* and *Journals* of Scheele, Priestley's *Letters*, and the autobiographical fragment which Liebig left behind him. In addition, there are the recently published and valuable historical researches of Berthelot on the chemistry of the early Middle Ages, and the writings of Ladenburg, Schorlemmer, Thorpe, Grimaux, and others on the development of chemistry within certain definite periods, or on the life and work of particular chemists." These additions add to the value of what has always been a volume of great interest to students of chemistry, and we do not doubt that the new edition will be even more successful than the former one.

The additions to the Zoological Society's Gardens during the past week include a Siamang (*Hylobates syndactylus*) from Sumatra, a Thick-necked Terrapin (*Bella crassicollis*), a Siamese Terrapin (*Damonia subtrijuga*), a Burmese Tortoise (*Testudo elongata*) from Siam, an Amboina Box Tortoise (*Cyclemmys amboinensis*) from Borneo, presented by Mr. Stanley S. Flower; a Negro Tamarin (*Midas ursulus*) from Guiana, presented by Mr. E. F. Brooker; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss Abchurch; a Pig-tailed Monkey (*Macacus nemestrinus*) from the East Indies, presented by Mr. R. O Bell; a Common Paradoxure (*Paradoxurus niger*) from India, presented by Mr. H. A. Cottrell; two Capybaras (*Hydrochærus capybara*) from South America, presented by Mr. Basil J. Freeland; a short-winged Weaver-bird (*Hyphantornis brachyptera*) from South Africa, presented by Miss Alice Heale; an Emu (*Dromæus novæ-hollandiæ*) from Australia, presented by Sir Cuthbert Peek, Bart.; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Miss Peek; two Starred Tortoises (*Testudo elegans*) from India, presented by Mr. J. Freeman; a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, a Rabbit-eared Bandicoot (*Peragale lagotis*) from Western Australia, a Vulpine Phalanger (*Trichosaurus vulpecula*) from Australia, deposited; six Mute Swans (*Cygnus olor*) from Holland, purchased; two Rosy-faced Love-birds (*Agapornis roseicollis*), bred in the Menagerie.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN NOVEMBER :—

November 1. 5h. 17m. to 6h. 0m. Occultation of 103 Tauri (mag. 5·5) by the moon.
5. 4h. Mars 3° 41′ N. of the moon.
12. Mars rises at 9h. and visible afterwards throughout the night in Cancer. Diameter of the planet 9″·6.
15. Mars. Illuminated portion of disc = 0·900.
15. Jupiter becomes visible as a morning star. Polar diameter 28″·8.
15. Meteoric shower from Leo in the early morning hours. (Radiant 149° + 23°.)
16. 7h. Vesta 10′ N. of the moon.
17. 10h. 11m. Minimum of Algol (β Persei).
20. 7h. Minimum of Algol (β Persei).
22. 7h. 9m. to 8h. 13m. Occultation of 19 Piscium (mag. 5·2) by the moon.
23–24. Meteoric shower from Biela's comet. (Radiant 25° + 43°.)
25. 12h. Uranus in conjunction with the sun.
28. 14h. 7m. to 15h. 6m. Occultation of 103 Tauri (mag. 5·5) by the moon.
29. 11h. 19m. to 11h. 49m. Occultation of the star DM + 24°, 1033 (mag. 6·0) by the moon.

COMET BROOKS.—A telegram from Kiel, dated October 21, informs us that at 7h. Geneva time, on October 20, Brooks found a comet in position R.A. 14h. 32m. 8s. and Decl. + 60° 26′. It was moving in a south-easterly direction, and was described as "bright." A later telegram, dated October 22, gives the position of the comet from an observation made at Pola on October 21, at 16h. 48·5m. Pola mean time; this was R.A. 15h. 4m. 12s. and Decl. + 57° 50′.

The comet was thus situated in the constellation of Draco, and moving to the south of the star β Draconis.

THE LARGE SUN-SPOT.—In this column for September 8 we drew attention to the large spot that had a few days previously made its appearance on the eastern limb of the sun, and remarked that "the spot will be well worth watching during the remaining period of its visibility, especially as many years may perhaps elapse before observers are favoured with another spot of similar size."

At the present time there is another great spot, larger, perhaps, than the one referred to above, which is now beautifully visible near the centre of the solar disc. This very compact group, which is not situated very far from the solar equator, is composed of two large umbræ surrounded by rather irregular shaped penumbræ, with several small spots scattered around them. Another smaller spot is also following the large one.

It will be well for observers to look out for an aurora and magnetic storm when the spot passes the central meridian, as was the case when the spot, previously referred to, was in the same position on September 9 last.

THE HARVARD ASTROPHYSICAL CONFERENCE.—It was on the occasion of the dedication of the Yerkes Observatory that the Americans held their first astrophysical conference. So great was the success of this, their first trial, that it was expected that more would be held in after years. For this we had not long to wait, and we have now before us a full account of the conference recently held at Harvard, the oldest observatory devoted to astrophysical research, contributed to *Science* (October 7) from the pen of Prof. M. B. Snyder. There could have been no more appropriate place of meeting in America for the second conference than that of the Harvard College Observatory, for Prof. E. C. Pickering's vast organisation of work in all modern branches of astronomy is second to none.

The conference was presided over alternately by Prof. J. R. Eastman, of the United States Naval Observatory, and Prof. Hale, of the Yerkes Observatory, and the meetings were not only held on August 18, 19 and 20, but were carried over to a series of adjourned meetings held during the course of the subsequent week.

The papers read were very numerous, and dealt with all kinds of astrophysical work. The work carried on at Harvard formed, perhaps, the chief item in the programme. Some of the papers dealt with were as follows :—

Prof. George Comstock, on "Some investigations relating to zenith telescope latitudes"; Dr. Harold Jacoby, on "Photographic researches near the pole of the Heavens"; Mrs. Fleming, on "Stars of the fifth type in the Magellanic clouds," which establishes another connection between these objects and the Milky Way.

Prof. Solon Bailey presented a paper on "Variable stars in clusters," which is a subject most interesting in the light of recent investigations.

We notice that general plans for observing the total eclipse of the sun on May 28, 1900, were briefly discussed, and a committee appointed to consider the work of organisation.

Another important question brought up at the conference was the creation of a permanent astronomical and astrophysical society. This proposal was formally accepted, and a committee, consisting of Profs. Hale, Comstock, Pickering, Newcomb and Morley, was appointed to consider the organisation.

THE KNIGHT-DARWIN LAW.[1]

THE law under the above title is known to botanists through H. Müller ("Befruchtung der Blumen," Eng. trans., p. 4), who says that Andrew Knight "laid down the law that in no plant does self-fertilisation occur for an unlimited number of generations." This he call's Knight's Law, and later, in substantially the same form, it becomes the Knight-Darwin Law. For the statement of Knight's Law the reader is referred to that author's celebrated paper: "An account of some experiments on the fecundation of vegetables" (Phil. Trans., 1799). The words, however, do not occur in Knight's paper, and I imagine that Müller got them from Charles Darwin's paper on the fertilisation of papilionaceous flowers, where occurs the passage (*Gardener's Chronicle*, 1858): "Andrew Knight many years ago propounded the doctrine that no plant self-fertilises itself for a perpetuity of generations."[2] The words are not given in inverted commas, and I strongly suspect that, with a singular lapse of his usual accuracy, my father was merely giving his own interpretation of the conclusion which seemed to flow from Knight's expressions when taken with the whole of the context. For in the "Effects of Cross- and Self-fertilisation," 1876, p. 7, he quotes Knight's actual words. After referring to Sprengel, he goes on: "Andrew Knight saw the truth much more clearly, for he remarks: 'Nature intended that a sexual intercourse should take place between neighbouring plants of the same species' . . ." and again: "'Nature has something more in view than that its own proper males should fecundate each blossom.'" Here we have simply the general statement that hermaphrodite flowers are not necessarily self-fertilised; a statement of fundamental importance in floral biology. If the positive statement that "no plant self-fertilises itself for a perpetuity of generations" is to be found elsewhere in Knight's writings, I think Darwin would have quoted it.

In the "Origin of Species" (edition i., p. 96) he refers to Knight in the following words: "Nevertheless I am strongly inclined to believe that with all hermaphrodites two individuals, either occasionally or habitually, concur for the reproduction of their kind. This view, I may add, was first suggested by Andrew Knight."

Lastly, in 1868 ("Variation of Animals and Plants," ii. p. 175), after speaking of his own hypothesis, "that it is a law of nature that organic beings shall not fertilise themselves for perpetuity," he adds: "This law was first plainly hinted at in 1799, with respect to plants, by Andrew Knight." If he had known any positive expressions—going beyond the nature of a hint—in Knight's writings, would he not have quoted them? It seems, therefore, that, as far as Knight is concerned, the law should be a general statement of the tendency to cross-fertilisation of hermaphrodites, and not the positive statement quoted by Müller.

When we pass from Knight's share in the law to Charles Darwin's—there are difficulties in fixing on the most authentic wording of the law. The earliest form is that occurring in the "Origin of Species" (ed. i. p. 97).

"These facts alone incline me to believe that it is a general law of nature (utterly ignorant though we be of the meaning of the law) that no organic being self-fertilises itself for an eternity of generations; but that a cross with another individual is occasionally—perhaps at very long intervals—indispensable."

In the sixth edition of the "Origin." 1872, he retains the above passage with the omission of the words "utterly

[1] A paper read before Section K (Botany) at the British Association, 1898.
[2] This sentence is quoted by Müller, "Historical Introduction," p. 29.

ignorant though we be . . . law," and with the addition of a reference to his own experiments, *i.e.* to those on cross-fertilisation.

This is the most strongly worded form of the Law, and one which is generally adopted. But shortly after the publication of the "Origin," *i.e.* in 1862, the Law took a vaguer form in the "Fertilisation of Orchids" (ed. i., 1862, p. 359), where he wrote: "Nature thus tells us, in the most emphatic manner, that she abhors perpetual self-fertilisation." This form of the Law is adopted in the "Effects of Cross- and Self-fertilisation" (p. 8), where he writes: "If the word perpetual had been omitted, the aphorism would have been false. As it stands, I believe that it is true, though perhaps rather too strongly expressed."

The aphorism is clearly not a literal statement of fact, and in describing it as "true," he probably meant that perpetual self-fertilisation is very strongly and very generally guarded against in nature. For he well knew that "some few plants seem to be invariably self-fertilised" ("Cross- and Self-Fertilisation," p. 3). With regard to these cases he makes the just remark: "These exceptions need not make us doubt the truth of the above rule, any more than the existence of some few plants which produce flowers, and yet never set seed, should make us doubt that flowers are adapted for the production of seed and the propagation of the species."

It is only fair to add that this argument also occurs in the "Variation of Animals and Plants under Domestication" (vol. ii. p. 91, 1868), and was therefore of considerably earlier date than his book on "Cross- and Self-Fertilisation" (1876).

To sum up:

(1) If the expression, Knight-Darwin Law, is to continue in use, it ought to be applied to a statement on which Knight and Darwin are undoubtedly agreed, *i.e.* that "nature intended that a sexual intercourse should take place between neighbouring plants of the same species."

But the name of Knight-Darwin Law is now firmly associated with the positive statement "that no organic being fertilises itself for an eternity of generations," and it would be useless to suggest a new nomenclature.

(2) If we are to take a Darwinian version of the Law, it seems to me fairer to take the form, "nature abhors perpetual self-fertilisation," which my father adhered to in his later books.

An example of what seems to me the misuse of the Knight-Darwin Law occurs in my friend Mr. Willis' excellent book, "Flowering Plants and Ferns" (vol. i. p. 46). "In Myrmecodia, &c., Burck has found crossing absolutely prevented, the flowers never opening. Hence the Knight-Darwin hypothesis must be abandoned." If the abandonment of the hypothesis means the recognition of cases of apparently continuous self-fertilisation, the abandonment was made in 1868 by Darwin himself, as I have already shown. But Willis' abandonment seems to me part of an implied contention that Charles Darwin's generalisations are no longer a sufficient basis for floral biology. He seems to think that if the Knight-Darwin Law is not true, the fundamental principles underlying the study of the mechanism of flowers must be sought elsewhere than in Charles Darwin's works. In this point of view I think he is mistaken.

The attitude of the earlier writers towards the problem of cross-fertilisation seems, if I may venture to say so, to be elsewhere rather hastily treated by Willis (*loc. cit.*, p. 45). Take the following passage: "The advantages of cross-fertilisation are often great, and frequently enormous, and as at the first glance they appear to be obtained at little or no cost, we are inclined to expect this method of propagation to prove almost universal. The earlier workers at this subject in fact set out with the idea that cross-fertilisation was, so to speak, the primary object of a flower's existence, whilst self-fertilisation was actually harmful." Almost the whole of this seems to me to be unintentionally misleading.

That all "earlier workers" did not consider cross-fertilisation the primary object of a flower's existence, is shown by the following passage from "Cross- and Self-Fertilisation," p. 3: "We should always keep in mind the obvious fact that the production of seed is the chief end of the act of fertilisation; and that this end can be gained by hermaphrodite plants with incomparably greater certainty by self-fertilisation than by the union of the sexual elements belonging to two distinct flowers. Again, reviewing in 1876 ("Cross- and Self-Fertilisation," p. 8) his own treatment of the question in the "Fertilisation of Orchids" (1862), Darwin says: "I should have added the self-evident proposition that the propagation of the species, whether by self-fertilisation or by cross-fertilisation . . . is of paramount importance." Willis, therefore, seems to me completely wrong if he includes Charles Darwin among the earlier who considered cross-fertilisation the primary object of a flower's existence.

Nor, I think, is self-fertilisation ever treated by Darwin as positively harmful, though *perpetual* self-fertilisation is so treated. Self-fertilisation is constantly and correctly considered as less advantageous than cross-fertilisation—and in this sense (always bearing in mind the paramount importance of fertilisation of some sort) it may be said that self-fertilisation is relatively harmful.

Whatever may be the case with other naturalists, Darwin was certainly not inclined to expect cross-fertilisation to prove almost universal. Speaking of orchids, he says ("Fertilisation of Orchids," ed. i. p. 359): "Considering that the anther always stands close behind or above the stigma, self-fertilisation would have been an incomparably safer process than the transportal of the pollen from flower to flower. It is an astonishing fact that self-fertilisation should not have been an habitual occurrence." He saw clearly that plants pay a price for being so constructed that cross-fertilisation is possible; in fact, he saw that the evolution of the flower is the result of a gain and loss account between the advantage of cross-fertilisation and the risks and injuries consequent on the flower being open instead of closed, and therefore chasmogamic instead of cleistogamic. And this is in all essentials the theory which Willis ("Flowering Plants and Ferns," p. 46) gives as Macleod's, and proposes as a basis for floral biology, when the Knight-Darwin Law has been abandoned, and H. Müller's theory also given up. I am not able to read Macleod in the original Dutch, but it would appear from Willis's paper in *Science Progress*, 1895, that Macleod's contribution to the subject is full of valuable matter, but the essence of his theory (as given by Willis) seems to me to contain nothing with which my father was not familiar. What I object to is the tendency to condense Charles Darwin's contribution towards floral biology to a Knight-Darwin Law, and then, when the abbreviated statement does not explain everything, to abandon—not so much the law—but the general point of view which can only be gathered from Darwin's books as a whole.

The fact is that some modern biologist uses the Knight-Darwin Law in an inverted way, *i.e.* in a manner the reverse of Charles Darwin's way of using it. It was not to him a basis for the investigation of floral structures, but a generalisation extracted from that subject to serve as a foundation for the study of wider questions, such as the origin of sexuality. This is clearly shown in a passage from the first edition of the "Fertilisation of Orchids," where, after enunciating nature's abhorrence of perpetual self-fertilisation, Darwin goes on ("Fertilisation of Orchids," 1862, p. 359): "This conclusion seems to be of high importance, and perhaps justifies the lengthy details given in this volume. For may we not further infer as probable . . . that some unknown great good is derived from the union of individuals which have been kept distinct for many generations." H. Müller, perhaps, understood my father's use of the Law when he said ("Fertilisation of Flowers," p. 22) that the Knight-Darwin Law is not necessary for the elucidation "of the forms of flowers." But he would hardly have said as much of Knight's statement, that hermaphrodite flowers are adapted for intercrossing—which is the very foundation of the science of floral mechanism.

I now pass on to another writer—Knuth—who, in his useful "Blütenbiologie," seems also to be open to criticism in his treatment of the Knight-Darwin Law. In speaking of H. Müller's great work, he says ("Blütenbiologie," vol. i. p. 25): "The laws of Knight, Darwin, Hildebrand, Delpino gave no explanation of the numerous cases of efficacious self-fertilisation, nor of cleistogamy." Here Knuth does not seem to remember the conditions of thought under which the Knight-Darwin Law came into existence. As Loew ("Einführung in die Blütenbiologie," p. 143) has well said, self-fertilisation was formerly assumed to be the rule in hermaphrodite plants. In calling attention to the existence and importance of cross-fertilisation in hermaphrodites, Knight and Darwin assumed the existence of self-fertilisation. From the point of view of floral biology the important thing was the recognition of cross-fertilisation, and the law in which, unfortunately, this conclusion has been entangled need not "explain" the facts which the framers of the law assumed to be a part of common knowledge. With regard to cleistogamy, in its ordinary sense it is clear that there is no contradiction between the Knight-Darwin Law and the facts, as Loew has clearly pointed out ("Einführung," p. 144).

After the passage quoted above, Knuth goes on: "In the place of the one-sided law of the above-named naturalists (of which the general truth remains unproven) Müller set up a law, proved directly by Darwin's experiments and indirectly by the reproductive arrangements of plants in general, but especially by those of flowering plants. The law, namely, that 'when the offspring of cross-fertilisation come into serious conflict in the struggle for life with the offspring of self-fertilisation, the former (cross-bred) win the day. Only when this contest is absent can self-fertilisation suffice for reproductions for many generations.'"

I confess that this law is to me unsatisfactory. We ask ourselves "when is the struggle between cross- and self-bred offspring[1] absent?" Clearly when all the offspring are of one kind, *i.e.* all cross-bred or all self-bred: in a diœcious plant where all offspring are cross-bred, there is no question of self-fertilisation. In a plant with purely cleistogamic flowers, all offspring would be necessarily self-bred, and the law would imply that cleistogamic perpetuation may suffice. The law, therefore, amounts to this: that self-fertilisation will suffice only when it is unavoidable. This is as much as to say that any form of fertilisation is better than none. It is best to neglect this form of Müller's hypothesis, and to seek his meaning in his simpler and broader statements. In summing up his discussion in the "Historical Introduction," he says ("Fertilisation of Flowers," p. 23): "There is a good foundation, therefore, for the demand that the explanation of floral mechanisms shall rest only on the sufficient and demonstrable assumption that cross-fertilisation yields more vigorous offspring than self-fertilisation."

We have therefore as the chief points in Müller's theory:

(1) Fertilisation at any price.

(2) The increased vigour of cross-bred offspring.

Let us consider these more fully, and first for the conclusion that self-fertilisation is better than no fertilisation. This is a proposition which Müller has insisted on in the most interesting and instructive way, but it surely is not very novel in principle.[2] In a passage already quoted, Darwin reviewing, in 1876, his work of 1862 ("Cross- and Self-Fertilisation," p. 8), says: "I should have added the self-evident proposition that the propagation of the species, whether by self-fertilisation or by cross-fertilisation . . . is of paramount importance. Hermann Müller has done excellent service by insisting repeatedly on this latter point." No one had a higher respect than my father for Müller's work, and he had no disrespectful intention in describing Müller's contribution to the theory as self-evident. The interesting point is that these views did not strike him as original, because they had already occurred to himself.

That Müller based the explanation of floral mechanism on the experimental results of cross-fertilisation cannot be considered as a new departure. I should have imagined it to be notorious that this was Charles Darwin's view, if it were not that we find Knuth and others describing Müller's theory (in which this is the essential thing) as a great law of nature.

In a letter ("Life and Letters," iii. p. 291) to the late Asa Gray (September 10, probably 1866), Charles Darwin wrote: "I have seen the young seedlings from the crossed seed exactly twice as tall as the seedlings from the self-fertilised seed. . . . If I can establish this fact . . . in some fifty cases . . . I think it will be very important, for then we shall positively know why the structure of every flower permits, or favours, or necessitates an occasional cross with a distinct individual."

It seems to me that Charles Darwin's generalisations in regard to flowers may be summed up thus:—

(1) First comes what he called the self-evident proposition that fertilisation of some sort is of paramount importance. This is of the nature of an axiom.

(2) Then comes the direct observation that the vast majority of flowers are open. From this fact alone we should be justified in concluding that there is some advantage in cross- as compared to self-fertilisation, which advantage makes it worth while for flowers to run the risks and incur the expenditure necessarily connected with openness, and avoidable by cleistogamy. The innumerable adaptations for pollen-transport suggest and strengthen the same conclusion. But this is, properly speaking, only an elaboration of the fact that flowers are open.

(3) Direct experiment demonstrates the nature of this surmised advantage of cross-fertilisation over self-fertilisation.

As already pointed out, the Knight-Darwin Law in its usual form, *i.e.* no plant is self-fertilised *ad infinitum*, or in its improved form—"Nature abhors perpetual self-fertilisation"—is a generalisation drawn from observations on structure and experiments on crossing, the value of which in Darwin's opinion was rather its applicability to the problem of sex in a wide sense, than its use as a basis for understanding the mechanisms of flowers.

The point which seems to me important in the history of the subject, is that the above generalisations, which are in substance to be found in Darwin's works, are still the foundation-stones of floral biology, and would stand as firmly if the Knight-Darwin Law had never been formulated. For the naturalist who takes a wider field, and studies the origin of sex and the action of changed conditions, the existence or non-existence of perpetual self-fertilisation must always be an important question; but the law in which its non-existence is formulated, is not a fundamental canon of floral biology. FRANCIS DARWIN.

[1] I use the words *cross-bred* and *self-bred* to denote the offspring of cross- and self-fertilisation; we thus avoid the slightly obscure phrases cross-fertilised and self-fertilised seedlings which occur in Darwin's books.

[2] I am far from wishing to suggest that H. Müller's work does not contain much that is new and valuable; I am here considering only its fundamental bases.

BOTANY AT THE BRITISH ASSOCIATION.

THE subject of alternation of generations in plants played a prominent part in the work of the Botanical Section. The President (Prof. Bower) devoted a considerable portion of his address to the controversial questions connected with "the great enigma of the alternation of generations" in green plants. Mr. Lang, of Glasgow University, and Prof. Klebs, of Halle, contributed important papers on this subject, and these were followed by a general discussion on the problems of alternation. Mr. Lang gave an excellent summary and critical review of our present knowledge concerning alternations of generations in the Archegoniatæ. The recent work of this investigator on some striking cases of deviation from the normal life-history of ferns, must be ranked among the most important contributions germane to this subject which have appeared in recent years. In concluding his account of some of the main factors in alternation, the author suggested three subsidiary questions as worthy of attention—the probable line of descent in archegoniate plants, the bearing of the cytological facts on the question, and the significance to be attached to apospory and apogamy.

Prof. Klebs' paper dealt with the alternation of generations in the Thallophyta, a subject which he was particularly well fitted to discuss from a critical standpoint. After taking a general survey of the various divisions of the Thallophyta, Prof. Klebs referred more especially to certain cases which have a more direct bearing on the question of the first appearance of a regular alternation of generations. The majority of the Algæ and Fungi have two or more kinds of propagation, each of which necessarily depends upon definite external conditions. According to the conditions the different kinds of propagation may appear on the same or on different individuals, independently or in any succession. The fertilised ovum in sexual forms does not differ essentially on germination from another propagative cell. In none of these cases is there any reason for speaking of an alternation of generations. In conclusion, the author briefly referred to the possible connecting links between the Algæ and Archegoniatæ. Sir Edward Fry, Dr. Scott, Profs. Marshall Ward and Marcus Hartog took part in the discussion which followed the two contributions by Mr. Lang and Prof. Klebs.

Another important item in the programme of Section K was a semi-popular lecture by Dr. F. F. Blackman, on the breathing mechanism of plants. The lecturer gave a clear and interesting summary of the progress of experimental work on the phenomena of gaseous exchange between a green plant and the medium in which it grows, concluding with an account of some recent investigations which have not yet been published.

Algæ and Fungi.—The Committee on Fertilisation in the Phæophyceæ reported very satisfactory progress in the researches on the Fucaceæ and Dictyotaceæ. Mr. Lloyd Williams, of Bangor, whose researches have been carried out under the auspices of the Committee, gave an account of his important work on the reproduction of *Dictyota dichotoma*. *Dictyota*, an annual brown seaweed, germinates during the summer and begins to form its reproductive cells in July. The tetraspores are produced throughout the season, but the sexual cells show a remarkable periodicity. The author described the fertilisation of the oospheres by the motile antherozoids, and expressed the opinion that there are strong reasons for concluding that the factor which determines the maturation and liberation of the sexual cells, and the fertilisation of the oospheres, is the amount of illumination to which the plants are exposed.

Prof. Phillips, of Bangor, contributed a paper on the form of the protoplasmic body in certain Florideæ. In *Ceramium rubrum* and other species a strong strand of protoplasm runs along the axial cells from pit to pit. In *Dasya coccinea*, the branches of limited growth run out into pointed uncorticated filaments, the cells of which are large. Across the vacuole of these cells running from pit to pit occurs a thread of protoplasm much more delicate than the corresponding structure in *Ceramium*. In *Callithamnion byssoides*, threads of protoplasm, which exhibit incessant movement, radiate from a cushion lying over the pit and end blindly on the vacuole. All these phenomena point to the great physiological importance of the pit-communication between cell and cell.

Prof. Errera, of Brussels, communicated the results of some recent work on the structure of the yeast cell; his investigations led him to the following conclusions: (1) a relatively large nuclear body exists in each adult cell; (2) young cells contain no such body; at a later stage the old nuclear body divides, one of its two daughters wanders through the narrow connecting channel into the young cell; (3) after the division is complete, the two cells are kept together by a mucilaginous neck-shaped pedicel; (4) carbohydrates are stored up in yeast in the form of glycogen, which accumulates or disappears from the vacuoles very rapidly, according to conditions of nutrition and growth.

Mr. Harold Wager also presented a communication on the same subject; he referred to the existence of a deeply stainable body, regarded by most observers as a nucleus, and of a vacuole in close contact with the nucleus. During the division of a cell a portion of the nucleus and of the vacuole passes into the daughter-cell. Mr. Wager pointed out certain errors in the work of Hieronymus; and expressed the opinion that the "nucleus" of the yeast possibly represents an early stage in the development of the vegetable nucleus; it might be fitly designated a proto-nucleus. Mr. Wager also gave an account of his researches on the rare fungus *Polyphagus euglenæ*, a parasite on *Euglena viridis*. The material was obtained from a filter-bed at Keighley. Mr. Wager was able to follow in detail the methods of spore and zygospore formation; he noted the interesting fact that the male cell is larger, and possesses a larger nucleus than the female cell.

Prof. Marshall Ward gave an account of a new potato disease which appears to be fairly common, but has hitherto usually been confounded with the disease caused by *Phytophthora*. The pathology of the disease was dealt with, and the author referred to certain external symptoms which enable a practised eye to distinguish diseased plants from those suffering from the attacks of *Phytophthora*. An interesting feature of the disease is that the fungal hyphæ appear to prepare the way for the entrance of bacteria and other organisms into the tissues of the host-plant. The same author contributed a second paper, in which he described the action of *Penicillium* as a wood-destroying fungus.

Mr. Trow, of Cardiff, gave an account of the cytology and reproduction of *Achlya americana* var. *cambrica*. He described the nuclear division in the oogonium and antheridium; also the occurrence of fertilisation as in *Saprolegnia mixta* and *S. diclina*.

Mr. Ellis, of Cambridge, contributed a note on a method of obtaining material for illustrating smut in barley.

Pteridophytes and Gymnosperms (*Recent and Fossil*).—Mr. Lang announced the discovery of the prothallus of *Lycopodium clavatum*. A few prothalli were found wholly imbedded in the peaty soil underlying a patch of moss; three of them bore young plants, and a number of slightly older plants, the prothalli of which had disappeared, were found in the same spot. The prothalli, which present a general resemblance to those of *Lycopodium annotinum*, are of considerable size, completely devoid of chlorophyll, and fairly well provided with rhizoids. Their form is that of a thick fleshy cake, which soon becomes thrown into folds by the unequal growth of the margin. The sexual organs are borne on the upper surface; both antheridia and archegonia may be present at the same time.

Dr. Scott gave a short account of some of his recent work on the anatomy of Coal-measure plants; the most important of his contributions was a description of the structure of a new form of the genus *Medullosa* from the Lower Coal-measures of Lancashire. This extinct type of Palæozoic plants has not hitherto been recorded from a British locality, and has not previously been found in rocks of Lower Coal-measure age. The material on which the description was founded was obtained by Mr. Lomax, and the excellent sections, of which micro-photographs were shown on the screen, were prepared by this able worker. Dr. Scott showed that the type of structure represented by the Lancashire *Medullosa* is that of a polystelic *Heterangium* which bore *Myeloxylon* petioles. The same author exhibited photographs of an unusually fine specimen of the Halonial branch o. a *Lepidodendron*, allied to *L. fuliginosum*, recently discovered by Mr. Lomax. Other contributions by Dr. Scott dealt with an English example of the interesting Palæozoic fern *Botryopteris*, and with a remarkably fine example of *Zygopteris* from the Williamson Collections of Coal-measure plants in the British Museum.

Mr. A. C Seward described the external features, internal structure and geological history of the Malayan fern *Matonia*. The anatomical investigation was founded on some material received through the kindness of Mr. Shelford, of the Sarawak Museum. The stem of *Matonia pectinata* is characterised by an arrangement of vascular tissue which appears to be unique among recent ferns; there are two annular steles, and occasionally also an axial strand of xylem and phloem traversing the creeping rhizome. The genus *Matonia* has usually been regarded as a type apart, and the anatomical characters emphasise the isolated position of the genus. The two living species of *Matonia* are no doubt the survivors of a tribe of ferns widely distributed during the Rhætic and Jurassic periods.

Mr. C. E. Jones, of Liverpool, contributed a paper on the anatomy of the stem of certain species of *Lycopodium*; his communication was of the nature of a preliminary note on the subject of the general anatomical investigation of *Lycopodium*, on which he is at present engaged.

Mr. Pearson, of Cambridge, described the apogeotropic roots of the Australian Cycad *Bowenia spectabilis*; he drew attention to the occurrence of colonies of *Anabæna* in the intercellular spaces of the cortex.

Physiology and Natural History.—Prof. Errera discussed the theoretical calculation of an osmotic optimum. Recent researches made by Dr. F. Van Rysselberghe, of Brussels, have shown that vegetable cells generally answer an *osmotic stimulus* by an appropriate *osmotic reaction*, and that the relation between stimulus and reaction follows, within wide limits, the "law of Weber." Hence results the possibility of predicting the existence and value of an *osmotic optimum*. The same author also contributed a note on the unit to be adopted for osmotic measurements.

Mr. Francis Darwin read a paper of special interest on the Knight-Darwin Law. (This paper is printed in full in another part of the present number.)

Prof. Reynolds Green gave an account of some results which he had obtained confirmatory of Buchner's work on the enzyme of the yeast plant. Prof. Green found that if the yeast experimented on is in a state of active fermentation, the alcohol-producing enzyme can be procured as Buchner has stated. He described the method of investigation adopted, and concluded by stating that the enyzme obtained from yeast agrees in an important respect with other enyzme.

Prof. C. de Candolle, of Geneva, gave the results of a comprehensive comparative study of peltate leaves, with special reference to the number of species possessing such organs, their distribution among the various natural orders, and their mode of growth.

Mr. Burkill, of Kew, dealt with changes in the sex of willows. In the genus *Salix* flowers of both sexes are occasionally present in the same catkin, and the sexual organs are sometimes found to be intermediate in structure between stamens and carpels. Mr. Burkill gave the results of his examination of an extensive series of specimens and published records.

Mr. S. T. Dunn contributed some notes on the origin of railway-bank vegetation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Speaking as chairman of a meeting of the Associated Societies of Edinburgh University on Tuesday, Mr. Balfour expressed his views on examinations as follows:—I think the time is not very far back when the idea was prevalent that after all a University was little more than an examination machine for stamping a certain number of students with a hall-mark, indicating that they had satisfied a certain number of examiners, and that they possessed a certain amount of knowledge on a certain amount of subjects. But that idea belongs to the past, and everybody who realises how the University machinery may do the work of higher education in the country has long recognised that the University to be at its best must not be an examining University merely or particularly, but what is wanted is a teaching University. I do not wish to overstate the case against examinations. I have always insisted that they are a necessity. They are evils, necessary evils, evils which no skill on the part of the examiner, no dexterity on the part of those responsible for University organisation, could wholly remove. That an examination may be a good test of intellectual capacity I cannot deny when I remember the numbers of eminent men who in after life have been in the very first rank of scientific and philosophical investigators, or in the very front rank as men of letters, and who were all so distinguished in examination. But while they were reading for examination they were occupied in considering not what was the sort of truth, not what was the best method of advancing the special study in which they were engaged, and so increasing the science of the world. Not at all. They were occupied to a large amount with an immense variety of subjects, different altogether and at the same time ready for immediate use—the last thing a practical man ever does. The serious man puts out of his head that which is not necessary and is, indeed, superfluous. He focusses his mind upon the work immediately before him, and, though no doubt he may see to the right or to the left more collateral subjects which have a bearing upon the main question, he certainly is never in the position of the unhappy victim of examination, who is going over in his head, before entering the room, all the various problems it is necessary to have at his finger ends if he is to satisfy the gentleman who is examining him.

Sir W. H. White delivered an address on engineering education at the Institution of Junior Engineers on Friday last. In the course of his remarks he said he was constantly asked what course of training he would recommend for youths intended to become engineers. His advice had always been the same, and it was based on personal experience and extensive observation. Practical training in the workshop, factory, ship-yard, or other engineering establishment was, he considered, best begun when a lad was fresh from school. "Roughing it" then came easy, observation was quick, while the facility for acquiring handicrafts and manual dexterity was greatest. Familiarity with the habits and modes of thought of workmen was readily gained also, and was a valuable acquisition. During this period of practical training it was most desirable that scholastic knowledge should be maintained or extended. If this programme were carried out, a young man finished his practical course without loss of educational knowledge; and if he had the means and the capacity, he was well prepared for entry into a technical college at an age which permitted him to obtain the full benefit of theoretical training and laboratory work. With ability and energy commensurate to the task, a student thus prepared, and bringing with him considerable practical experience, ought to reap the greatest advantage from the higher course of study, and to be ready for actual work when it was completed. His observation and experience as student and professor convinced him that many youths entered technical colleges who, from want of preliminary education or of ability, could never hope to benefit much, if at all. It would be a kindness in such cases if entry were guarded by such preliminary tests and inquiries as would prevent waste of time, and permit other and more suitable training to be undergone. Perhaps the ideal system of training was that which permitted an engineering pupil to continue his scholastic training side by side with the preliminary practical experience, as the medical student attached to a hospital did. Selected men, having proved their capacity, could then proceed to a course of higher technical training without losing all contact with practical work. The latter condition could be met by arranging suitable intervals when students would suspend their studies of theory and go out to the scenes of engineering operations, where they could compare the lessons learnt in the study and laboratory with actual procedure in carrying on work.

We are glad to see that an attempt is being made to co-ordinate the educational institutions in Bristol, and so prevent the present overlapping of work and conflict of interests. At a recent meeting of the Technical Instruction Committee of the County Borough Council the following resolution was adopted: "That the governors of the Bristol University College, the governors of the Merchant Venturers' Technical College, and the Bristol School Board, be requested to send three representatives each to meet a sub-committee of the Technical Instruction Committee, for the purpose of taking into consideration the needs and resources of the city as a whole, with a view of combining all parties in one comprehensive plan for the supplying of such technical instruction as the circumstances of Bristol require."

Science reports the following gifts to educational institutions in the United States:—The will of the late Colonel Joseph M. Bennett, who during his life-time had made generous gifts to the University of Pennsylvania, leaves to the University property valued at 400,000 dollars. The money is to be used for the higher education of women.—A sum of money, said to be 158,000 dollars, has been given by friends of Barnard College to pay the entire indebtedness of the College due to its removal to the new site adjacent to Columbia University.—A donor, whose name is withheld, has given Wellesley College an astronomical observatory and a telescope, said to be of large size.—Vassar College receives 10,000 dollars by the will of the late Adolf Sutro, of San Francisco. The same College has been given 1000 dollars by Senator Coleman, of Michigan, the income to be used to purchase books and instruments for the astronomical observatory.—The annual report of President Low to the Trustees of Columbia College states that during the year the University received 346,409 dollars for permanent endowment and 43,909 dollars for current uses.

The *Athenæum* states that the Joint Committee of the bodies concerned in secondary education, which includes representatives of the universities and the administrative authorities, has been summoned to meet on November 5, when the Government Education Bills will be taken into consideration. It seems probable, from what has taken place during the recess, that the constituent bodies will not deem it advisable to urge the Government to immediate legislation on the subject of local authorities.

SCIENTIFIC SERIALS.

American Journal of Science, October.—The compressibility of colloids, with applications to the jelly theory of the ether, by C. Barus. Various colloids were compressed in capillary tubes with mercury terminals. A solution of gelatine or albumen in water was found to have a low compressibility, and a solution of india-rubber in ether was taken as a type of a highly compressible colloid. When the colloid was compressed by the mercury, the meniscus would occasionally give way, and a droplet of mercury be projected through the substance of the colloid to a distance of 12 cm. or more. This has an interesting application to the problem of the motion of material bodies through a solid ether. The mechanism of this motion is not yet explained, but there is probably a temporary liquefaction of the colloid in front, and a subsequent solidification behind the moving body.—Eolian origin of loess, by C. R. Keyes. The amount of dust brought up out of the Mississippi valley into St. Louis is about one-hundredth inch in a day when the wind blows. An open book placed in a protected nook was after a few hours of wind so covered with dust that the print could not be distinguished. Probably the rate of deposition of the Mississippi loess is one-tenth of an inch per annum. Being spongy and absorbent, the loess retains moisture in the dry season, and gives rise to a luxuriant vegetation.—Detection of sulphides, sulphates, sulphites, and thiosulphates in the presence of each other, by P. E. Browning and E. Howe. To about 0·1 gr. of the substance dissolved in 10 cc. of water, add an alkali to slight alkaline reaction. Add zinc acetate in distinct excess, and filter. The precipitate may be tested for SH_2, on acidifying, in the usual manner. To the filtrate add acetic acid in slight excess, and barium chloride, and filter through a double filter. To the filtrate add iodine until the solution takes on a permanent yellow tinge, and then bleach with stannous chloride. A precipitate indicates the sulphite. Filter, add bromide water in faint excess to the filtrate, bleaching again with stannous chloride. A precipitate on adding bromine indicates a thiosulphate originally present.—The origin and significance of spines, by C. E. Beecher (concluded). Spinose forms were simple and inornate during their young stages, and were all derived from non-spinose ancestors. Spines represent an extreme of superficial differentiation which may become fixed in ontogeny. Spinosity represents a limit to morphological and physiological variation. After attaining the limit of spine differentiation, spinose organisms have no descendants, and out of spinose types no new types are developed.

THE following are the titles of the more important papers in systematic and geographical botany contained in the *Journal of Botany* for August-October:—Two new genera of Compositæ, *Psednotrichia* and *Adenogonium*, from Africa, by W. P. Hiern; the Mosses of Cheshire, by J. A. Wheldon; a new genus of Ericaceæ from Angola, *Ficalhoa*, by W. P. Hiern; critical notes on some species of *Cerastium*, by F. N. Williams; new species of *Crassula*, by S. Schönland and E. G. Baker; the Flowering Plants of Novaya Zemlya, by Colonel H. W. Feilden.—Mr. W. Whitwell establishes the occurrence of *Botrychium matricariæfolium*, and of its subspecies (or distinct species) *lanceolatum*, as British plants. In their Notes on Freshwater Algæ, Messrs. W. and G. S. West propose the establishment of a new genus *Stipitococcus*, near to *Perionella*.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, October 4.—J. Cosmo Melvill, President, in the chair.—The President referred to the loss sustained by the Society through the deaths of Mr. H. M. Ormerod, Dr. R. M. Pankhurst, Dr. James Rhodes, and Mr. John Wright, ordinary members; and of Prof. Ferdinand Cohn, Lord Playfair, and Mr. Osbert Salvin, F.R.S., honorary members.—Mr. H. W. Freston exhibited a male specimen of *Asagena phalerata*, an extremely rare species of spider which by itself represents the genus *Asagena*, whose nearest congener is the genus *Steatoda*. The present individual is the only male that has been found, at all events in recent years. The habitat of this species has hitherto been unknown, but it would seem now that it is a simple Theridion snare in grass amongst rocks. The most striking features of the genus are a denticulated edge to the cephalothorax, and a denticulated socket in the front of the abdomen, forming a stridulating apparatus which would produce a squeaking noise when rubbed against the rough hinder edge of the thorax.—Mr. John Butterworth read a paper on the structure of some fragmentary specimens of a new *Psaronius*, which he concluded to be the roots of *Heterangium tilioides*. The special feature of these roots was the presence of a distinct secondary thickening, which is unknown in the other species of *Psaronius*.—In a second paper, Mr. Butterworth dealt with the presence of a leaf-sheath surrounding the nodes of some of the Calamites of the Lancashire Coal-measures. Such a sheath has not been described before from British Calamites.

PARIS.

Academy of Sciences, October 17.—M. van Tieghem in the chair.—On an old alloy, by M. Berthelot. The alloy contains copper, lead, and small quantities of tin and zinc. The oxidation has taken place in such a manner, that removal of the external coating of rust shows an apparently reddish metal underneath, probably cuprous oxide. From its external appearance the metal might have been taken for pure copper.—Physiological researches on the contraction of the *sphincter ani*, by MM. S. Arloing and Edouard Chantre. Experimental results confirming the conclusions arrived at in a previous paper with regard to the existence of a number of sensitive fibres in the two symmetrical nerves of the sphincter.—On the resultant of two equations, by M. P. Gordan.—On differential equations of the second order with fixed critical points, by M. Painlevé.—On the variation of dielectric constants with temperature, by MM. H. Pellat and P. Sacerdote. Measurements were carried out with paraffin and ebonite at temperatures varying between 11° and 33°. The dielectric constant of paraffin diminishes with rise of temperature, that of ebonite, on the other hand, increasing on warming.—On the duration of emission of Röntgen rays, by M. Henri Morize. The rays from a Crookes' tube were allowed to fall through a narrow slit upon a photographic plate, the latter being rapidly rotated at a constant known velocity. The effect of rotation would be to widen the photographic image of the slit if the time of emission were appreciable. The results obtained were in general agreement with those of M. Colordeau, several images of the slit being formed, separated by equal intervals for each discharge in the primary in the coil, corresponding to successive discharges in the tube. The average duration of total emission was about one-thousandth of a second. On a new action undergone by light in traversing certain metallic vapours in a magnetic field, by MM. D. Macaluso and O. M. Corbino. A ray of polarised sunlight is passed through a sodium flame placed in an intense magnetic field, then successively through a second nicol and a cylindrical lens, is then received on a concave Rowland grating, and the second diffraction spectrum observed through a micrometer eye-piece. Under these conditions, on completing the circuit round the electromagnet parallel, bands appear on each side of the two D lines, which are displaced on rotating the analyser, the axis of each ray following the direction of the current. A lithium flame exhibits similar phenomena, but not so well marked as with sodium.—On a new hydrated chromium oxide, by H. G. Baugé. The new hydrate, which has the composition $Cr_3O_4,3H_2O$, is obtained by the action of boiling water upon the carbonate in the absence of air.—Action of sodammonium upon arsenic, by M. C. Hugot. The single product of the reaction is $AsNa_3$.—Researches on double iodides and borates, by M. H. Allaire. A mixture of a borate and a metal is heated in iodine vapour. The double salts obtained in this way were of the type $6RO.8BO_3RI_2$, where R = Mg, Zn, Cd, Mn, Ni, Co, or Fe.—On the solubility of camphor, by MM. C. Istrati and A. Zaharia. Camphor is appreciably soluble in water, the camphor in solution affecting the density, and having a perceptible rotation. The solubility is much greater in aqueous hydrochloric acid, a chlorhydrin perhaps being formed. The solubility in the latter case appears to diminish with rise of temperature.—Researches on incandescent lamps charged with an explosive mixture of methane and air, by MM. H. Couriot and J. Meunier. The glowing filament of an incandescent lamp was allowed to come in contact with an explosive mixture of marsh gas with air, under varying conditions. In no case did an explosion take place.—On the transformation of fat by direct oxidation, by M. Hanriot. Fat, treated with ozonised oxygen, gained considerably in weight; in one case as much as 23 per cent. No reducing substance appeared to be formed, tests for sugar, starch, cellulose, formic and oxalic acids giving uniformly negative results. The products of the oxidation appear to be chiefly fatty acids.—On the cause of the spiral structure of the roots of certain Chenopodiaceæ, by M. Georges Fron. The asymmetrical structure, which gives the fibrovascular bundles in a transverse section the appearance of a double spiral, is caused by the mechanical compression of the cotyledons in the radicle.—On *Blepharopoda fauriana*, by M. E. L. Bouvier.—Anatomy and physiological functions of the arborescent organs or aquatic lungs of some Holothuria. by M. L. Bordas. These organs appear to have numerous functions, as they are concerned in breathing, moving, in excretion, and in the production of numerous amæbocysts.—The pegmatic and granulitic lodes of the rock masses in contact with the granite of Ariège, by M. A. Lacroix.—On the circulation of water in the Rhône glacier, by M. F. A. Forel. Fluorescin was introduced at various points, and the times which elapsed before its appearance in the main torrent noted. The velocities found were of the same order as those for the free stream, whence the conclusion is drawn that in the interior of the glacier the water circulates without stopping in basins, reservoirs, or lakes, and hence there is no sub-glacial lake under the Rhône glacier.—Results obtained in an experimental balloon ascent on August 23, by MM. G. Hermite and G. Besançon. The curves obtained from the self-registering baro-thermograph were unusually good, the greatest height registered being 7300 metres, with a corresponding minimum temperature of −60° C.

NEW SOUTH WALES.

Linnean Society, August 31.—Mr. E. G. W. Palmer in the chair.—Contributions to a knowledge of the fauna of British New Guinea. No. i. Communicated by T. Steel. This communication consists of a number of papers by various authors describing a collection sent to Mr. Steel from Fife Bay, New Guinea, by the Rev. H. P. Schlencker. The only form new to science is a snake described by Mr. J. Douglas Ogilby as *Dendrelaphis schlenckeri*. Mr. T. Whitelegge notes the occurrence of a shrimp, *Palaemon affinis*, not previously recorded for New Guinea. Amongst the lizards, *Gehyra oceanica*, *Gymnodactylus pelagicus* and *Lepidodactylus lugubris* are recorded, apparently for the first time from New Guinea, by Mr. A. H. S. Lucas, while several other species, including the interesting form *Homolepida englishi*, described in 1890 by De Vis, are now recorded for the second time —New genera and species of fishes, by J. Douglas Ogilby. In this paper there are described as new a xiphiodontid, two species of silurids, a genus of plotosids, two pleuronectids, and a small fish, the position of which is uncertain.—On the Echinoderm fauna of New Zealand, by H. Farquhar. The Echinoderm fauna of New Zealand, as at present known, comprises two Crinoids, sixteen Ophiuroids, twenty-eight Asteroids, twenty-three Echinoids, and twenty-one Holothurians: total, ninety species. It is not homogeneous, nevertheless it contains a large number of peculiar forms which give it a strongly distinct character of its own. Its affinities are strongest with that of Australia. Omitting doubtful and deep-water forms, fifty-eight per cent. of the known species are endemic, thirty-six per cent. occur in Australia, and only six per cent. have been found elsewhere and not in Australia.—Notes on the subfamily *Brachyscelinæ*, with descriptions of new species, Part v., by W. W. Froggatt.—Descriptions of six new species of Mollusca, by John Brazier.—A contribution to a knowledge of the Arachnidan fauna of New Guinea, by W. J. Rainbow. In this paper sixty-eight species are enumerated, and of these fourteen are described as new. The most interesting specimen of the collection is a species of the family Avicularidæ, for the reception of which a new genus, *Antrochares*, is proposed. This makes the third known genus of the six-eyed Avicularidæ.—Descriptions of the eggs and nests of four species of Australian birds, by Alfred J. North.

Amsterdam.

Royal Academy of Sciences, September 24.—Prof. Van de Sande Bakhuyzen in the chair.—Prof. Bakhuis Roozeboom communicated the results of a theoretical inquiry into (1) the phenomena occurring during the congealation of a mixture of two substances, when during the process "mixed" crystals exclusively are formed, which may either be continuously mixable or not so; and (2) the changes which the solid mixture may undergo, when the two components on further cooling are transformed into other stable modifications.—Prof. Haga communicated that the phenomena of "maxima and minima of brightness as a consequence of an optical delusion," mentioned by himself on behalf of Dr. Wind at the meeting in May, were already known and described by E. Mach in the *Wiener Berichte*, II^e. Abth. Bd. 52, 54 and 57.

DIARY OF SOCIETIES.

FRIDAY, October 28.

Physical Society, at 5.—An Influence Machine: W. R. Pidgeon.—The Repetition of an Experiment on the Magneto-optic Phenomenon discovered by Righi: Prof. S. P Thompson, F.R.S.—The Magnetic Fluxes in Meters and other Electrical Instruments: Albert Campbell.

TUESDAY, November 1.

Institution of Civil Engineers, at 8.—Address by W. H. Preece, C.B., F.R.S., President, and Presentation of Medals and Prizes awarded by the Council.

WEDNESDAY, November 2.

Entomological Society, at 8.

THURSDAY, November 3.

Chemical Society, at 8.—A Determination of the Equivalent of Cyanogen: George Dean.—Note on the Action of Light on Platinum, Gold, and Silver Chlorides: E. Sonstadt.—Methanetrisulphonic Acid: E. H. Bagnall.—A Composite Sodium Chlorate Crystal in which the Twin Law is not followed: W. J. Pope.—On the Composition of American Petroleum: Dr. Sydney Young, F.R.S.—(1) On the Separation of Normal and Iso-heptane from American Petroleum; (2) On the Action of Fuming Nitric Acid on the Paraffins and other Hydrocarbons: Dr. F. E. Francis and Dr. Sydney Young, F.R.S.—On the Boiling Points and Specific Gravities of Mixtures of Benzene and Normal Hexane: D. H. Jackson and Dr, Sydney Young, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Practical Mechanics: S. H. Wells (Methuen).—University College of North Wales, Calendar for the Year 1898–99 (Manchester, Cornish).—Naturae Novitates (Berlin, Friedländer).—Key to Algebraical Factors: D. H. Vachha, 3rd edition (Longmans).—On the Instincts and Habits of the Solitary Wasps: G. W. and E. G. Peckham (Madison, Wis.).—Quantitative Exercises for Beginners in Chemistry: A. H. Mitchell, Part 1, 2nd edition; Ditto, Part 2 (Reading, National Publishing Association).—Aids in Practical Geology: Prof. G. A. J. Cole, 3rd edition (Griffin).—Almanaque Nautico, 1900 (San Fernando, Gay).—British Museum: a Guide to the First and Second Egyptian Rooms (The Trustees).—Handbook of Insects injurious to Orchard and Bush Fruits, with Means of Prevention and Remedy: E. A. Ormerod (Simpkin).—First Stage Inorganic Chemistry (Practical): Dr. F. Beddow (Clive).—Gas and Petroleum Engines: translated and edited by A. G. Elliott (Whittaker).—Through Asia: Sven Hedin, 2 Vols. (Methuen).—An Elementary Text-Book of Botany: Prof. S. H. Vines (Sonnenschein)—Bibliotheca Geographica, Band iv. (Berlin, Kühl).—Gesammelte Botanische Mittheilungen: S. Schwendener, 2 Vols. (Berlin, Gebrüder Borntraeger).—Die Moderne Entwicklung der Elektrischen Principien: Prof. F. Rosenberg (Leipzig, Barth).—Übersicht der Lepidopteren: Fauna des Grossherzogtums Baden: C. Reutti, Zweite Ausgabe herausgegeben von Meess und Spuler (Berlin, Gebrüder-Borntraeger).

Pamphlets.—On the Forestry Conditions of Northern Wisconsin: F. Roth (Madison, Wis.).—Antarctic Exploration: a Plea for a National Expedition: Sir C. R. Markham (R. G. S.)

Serials—Proceedings of the Liverpool Geological Society, Part 2, Vol. viii. (Liverpool)—U.S. Department of Agriculture: Division of Biological Survey, Bulletin Nos. 9, 10, 11 (Washington).—Scottish Geographical Magazine, October (Edinburgh).—Journal of the Franklin Institute, October (Phil^a.).—Quarterly Review, October (Murray).—Zoologist, October (West).—Journal of Anatomy and Physiology, October (Griffin).—Geological Survey of Canada Report, Nos. 627, 628, 651, 657 (Ottawa).—Bulletins de la Société d'Anthropologie de Paris, 1898, Fasc. 2 (Paris, Masson).—Mémoires de la Société d'Anthropologie de Paris, Tome ii (3^e série), 2^e Fasc. (Paris, Masson).—Journal of the Chemical Society, October (Gurney).—Bulletin of the American Museum of Natural History, Vol. xi. Part 1 (N.Y.).—Sitzungsberichte der K. Akademie der Wissenschaften, Math.-Naturw. Classe: Anatomie, &c., 1897, January to July, October to December; Ditto, Mineralogie, &c., 1897, January to July, October to December; 1898, January to May; Ditto, Mathematik, &c., 1897, January to July, October to December; 1898, January and February; Ditto, Chemie, 1897, January to July, October to December; 1898, January to March; Ditto, Register zu dem Banden, 101 to 105 (Wien, Gerold).—An Illustrated Manual of British Birds: H Saunders, 2nd edition, Parts 9 to 12 (Gurney).—Journal of the Royal Horticultural Society, October (117 Victoria Street).—Bulletin of the American Mathematical Society, October (N.Y., Macmillan).—Agricultural Gazette of N.S.W., August (Sydney). Monthly Weather Review, July (Washington).

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