Nature

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

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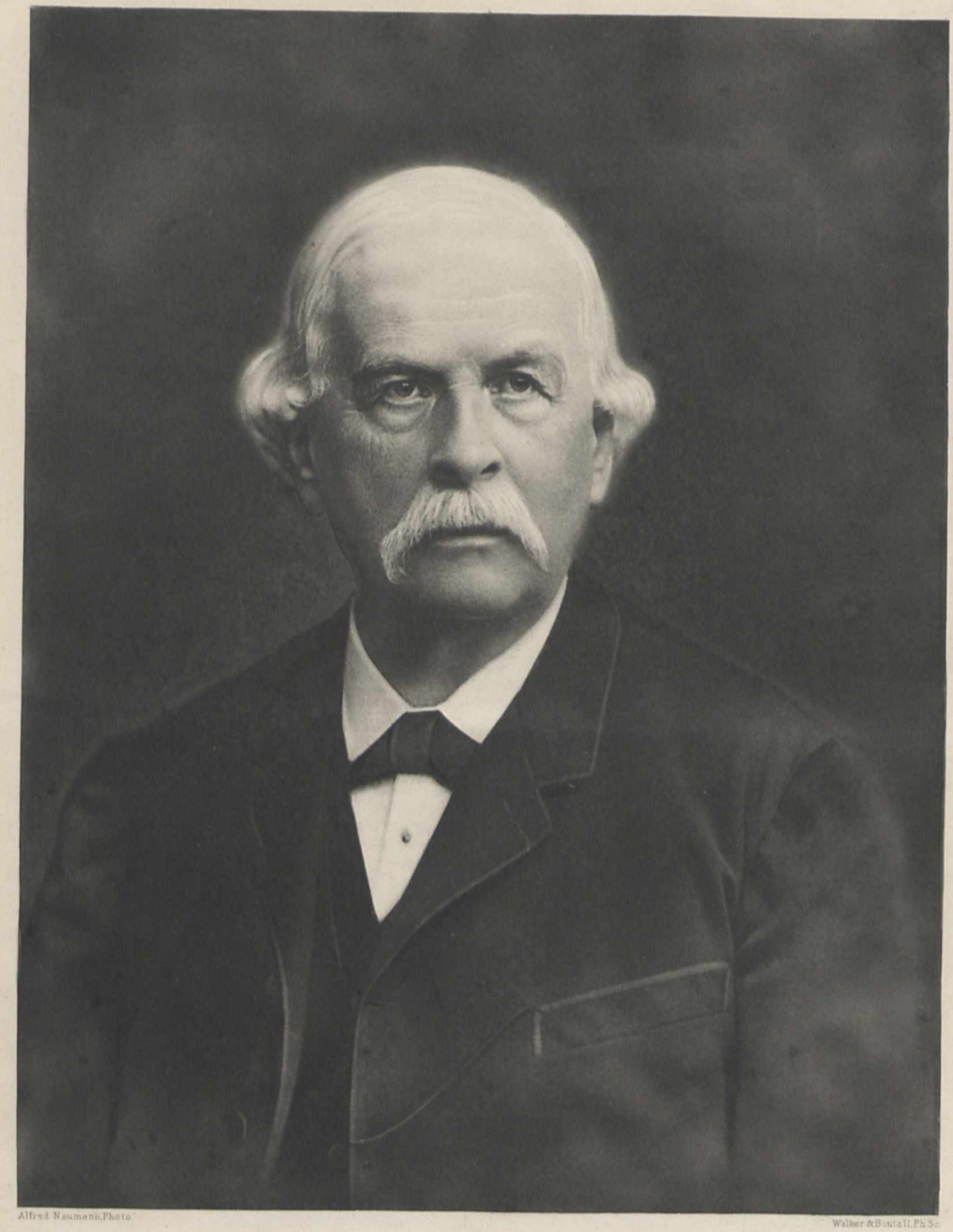
INDEX



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A. Kölliker

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 gun-cotton 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 frequentiy 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 $e^{\frac{10800}{\pi}}$, 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.)

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

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

It

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

then will

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

If

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

then will

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

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

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

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

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

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 cos ne 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

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

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

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

An equation which determines x.

While from equation (1) it may be deduced that

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

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

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

we arrive at the equations

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

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

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 switchboard, 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

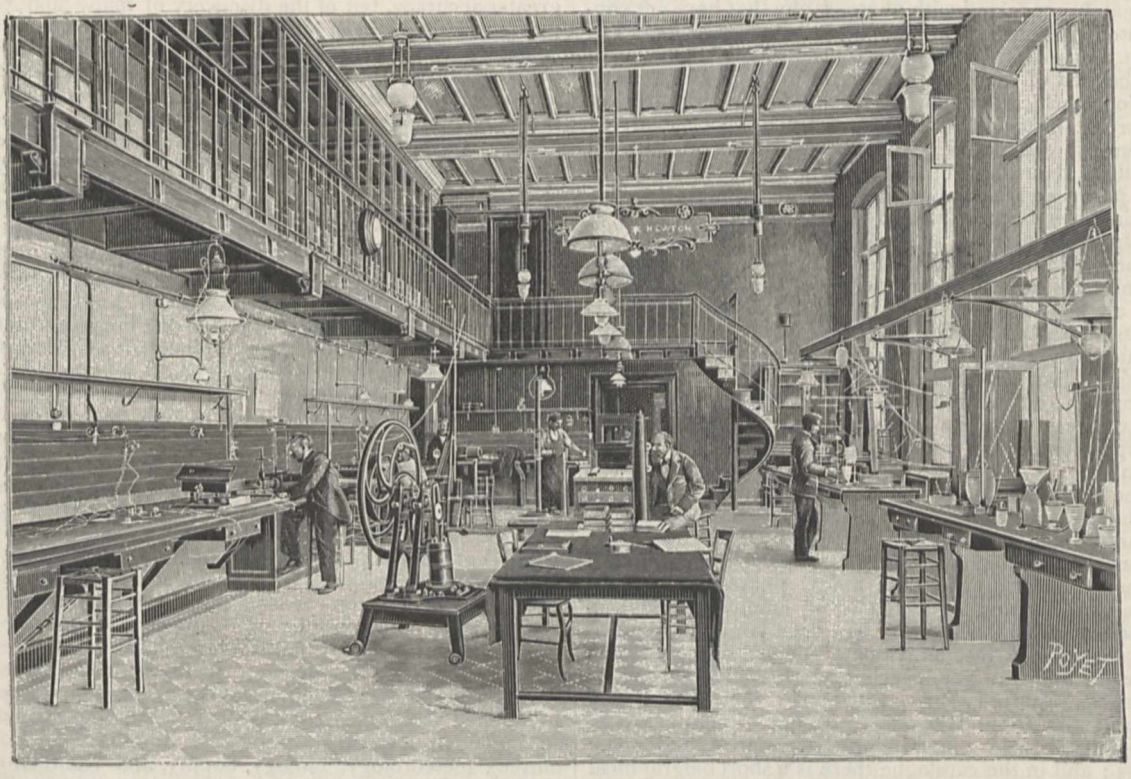


FIG. 1.—New Physical Research Laboratory at the Sorbonne.

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 photo-mechanical 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 preglacial 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:—

12*h*. *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
α 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 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.

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

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 847,620*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.

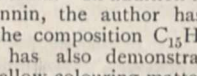
SOCIETIES AND ACADEMIES.

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



—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).

CONTENTS.