THURSDAY, JUNE 15, 1905.

SOME RECENT BOOKS ON CELTIC.

Keltic Researches. By E. W. B. Nicholson. Pp. xviii+212. (Oxford: Clarendon Press; London: Henry Frowde, 1904.) Price 21*s.* net.

The Mythology of the British Islands. By Charles Squire. Pp. x+446. (London: Blackie and Son, Ltd., 1905.)

The Literature of the Celts, its History and Romance. By Magnus Maclean. Pp. xv+400. (London: Blackie and Son, Ltd., 1902.)

THOSE who have the study of Celtic at heart cannot but be rejoiced at the strides which it has made in recent years. At no period have the inhabitants of the Celtic countries—those of Wales and Ireland more especially—shown a keener interest in their languages and institutions than at the present day; the number of scholars engaged in Celtic research has never been so great; and this Celtic revival, so-called, is like to prove no passing outburst, fanned by eccentrics and sentimentalists; rather we should see in it the coming of the race into its own again, the reaping after many days of a rich harvest of literature and legend.

In the case of the Welsh, the movement has been partly the cause, partly the effect of the movement towards improved education, and is no longer of yesterday. It can be traced back some seventy years, to the founding of the British schools by the late Sir Hugh Owen. Thirty years later the same enlightened patriot added discussions, both learned and practical, on matters affecting the Principality, to the musical and literary contests at the Eisteddfod. About the same time the study of the Welsh language, which owed what life it had to the devoted labours of Chancellor Silvan Evans, received a fresh direction from the papers and speeches of Prof. Rhys, who inveighed against the school of Dr. Owen Pughe, and pointed the way to more scientific methods. The last fifty years have been marked by a steady, if gradual, advance; the interest in Wales and things Welsh, and the sense of nationality, have become ever keener and more real, the language has secured a fresh lease of life, and the study of philology and history has been, and continues to be, vigorous and fruitful; not the least happy augury for the future is the fact that a number of younger men, natives of the Principality, have already made a name in these fields.

Unlike the Welsh, by which it may have been in part suggested, the Irish revival is of comparatively recent date. It is none the less vigorous on that account. Within the last few years, owing largely to the efforts of the Gaelic League, Irish has been studied with eagerness by persons of every shade of opinion, and a determined attempt has been made to develop native industries. A society has been founded for the publication of Irish texts—it has already done considerable work—and a special school, the School of Irish Learning, has been started to give students a scientific training in the language and to open up the rich treasures of Irish literature. The necessary funds are provided in part by voluntary subscription, and the generous donor may hope that he is helping to raise up a race of scholars as devoted as O'Curry and O'Donovan, as distinguished as Stokes and O'Grady. Up to this present, there has been no corresponding movement among the Scotch Highlanders or the other Celtic peoples, but it will not be the fault of their congeners if their national aspirations remain unawakened. The Pan-Celtic Congress, which met for the first time in 1901, has for one of its aims to increase the feeling of union among "the sea-divided Gaels" themselves; it is attended by delegates from all the Celtic districts, as well from Brittany as from those on this side of the Channel.

Apart from the enthusiasm of the Celtic-speaking races for their own language and institutions, there is a growing tendency among the other inhabitants of these islands—themselves far from purely Teutonic—to recognise the importance of the Celtic element and to wish to be enlightened as to its history and literature. It is doubtless to meet this demand that there have appeared of late years a number of books on Celtic subjects, written not so much for the specialist as for the general public. Of the books at the head of this notice two—Mr. Squire's "Mythology" and Mr. Maclean's "Literature"—are of this more or less popular character. All three alike are the work of men whose distinctions are not confined to Celtic, and bear witness to the increasing interest which it is exciting among the British nation as a whole.

Mr. Nicholson's "Keltic Researches," as the subtitle indicates, are a series of studies in the history of the ancient Goidelic languages and peoples. The author's first object is to demonstrate to philologists certain unrecognised or imperfectly recognised linguistic facts; but, inasmuch as he has not made Celtic his one and only study, he does not write in a narrow, specialising spirit; his linguistic facts are important, but he values them chiefly for the light which they throw on history in general, on the Pictish question, on the Menapian settlements, and on the distribution of the Celtic languages in Britain and on the Continent. The main philological result of the book is to show that the loss of original *p*, a loss supposed to be the main characteristic of the Celtic languages, is of comparatively late date in the Goidelic group, that, in fact, *p* was kept at Bordeaux until the fifth century A.D. Those who wish to be satisfied as to the soundness of his linguistic foundation are advised to turn to the appendices, which make up a third of his book, immediately after reading the first eight pages.

We need scarcely point out that much of his matter is controversial, and that some of his conclusions are liable to be disputed. For instance, many will refuse to admit that the Picts spoke a tongue virtually identical with Gaelic; they will maintain with Stokes that they spoke something nearer akin to Welsh, or with Zimmer and Rhys that their language was not Aryan at all. On the other hand, there can be little doubt as to the correctness of his main linguistic results. Exception may be taken to the interpretation of his *pièces justificatives*, the Rom tablets and the Coligny calendar; but he is certainly right in inferring that, besides those of the Gallo-Brythonic branch, there existed in

Gaul a language or languages closely akin to Goidelic or ancient Gaelic of the British Isles. Strange to say, although every Celtist knows that the peoples of the Gallo-Brythonic group had *p* for *qu* from time immemorial—petor in Gaulish petorritum = Latin quatuor—and that those of the Goidelic branch retained *qu* like the Romans, the greater number have chosen to assume that Gaulish was co-extensive with Celtic on the Continent. In spite of the evidence of such names as Aquitania, Sequana, Sequani, it was the fashion to suppose that *qu* was unknown in Gaul and that all the Celts alike dropped the consonant *p* of the Indo-European parent speech, as, for instance, in Aremorica, Armorica, where *are* is approximately equivalent to the Greek παρά. In laying stress on the fact that the retention of the old *qu* and Indo-European *p* are characteristic of the Pictavian and Sequanian languages he has done valuable service to the cause of philology, and recalled Celtic scholars from a path of error. He does not, indeed, claim to be the first to point out that the Celtic languages of the Continent were not of one and the same type. He tells us that as early as 1847 Jacob Grimm showed that the charms in the work of Marcellus of Bordeaux were in a language virtually identical with old Irish, and that Pictet afterwards proved that Indo-European *p* was retained in one of these charms in the prefix *pro*. Half a century later (in February, 1891), in a paper read before the Philological Society, Prof. Rhys brought together certain *qu* names from the Continent to prove the same thesis, and proposed that the language in Gaul akin to Goidelic should be called Celtican. He insisted on the significance of the words of Sulpicius Severus in Dialog. I. 27, "Tu vero, inquit Postumianus, vel Celtice, aut si mavis, Gallice loquere, dummodo jam Martinum loquaris." So, too, Mr. Macbain, in the introduction to his etymological dictionary of the Gaelic Language (Inverness, 1896), inserts among the *q* group by the side of Goidelic "dialects in Spain and Gaul." This was not long before the Coligny calendar and the Rom inscriptions came to light, showing that the Sequani and the Pictones, at any rate, spoke languages belonging to the same group as old Irish.

There can be no question that the book deserves study. If it sometimes betrays inexperience—and the author would be the first to admit this—it shows signs of many-sided learning, and in some cases of rare insight; the whole breathes an impartiality and generous candour which are wanting in many searchers after truth.

"The Mythology of the British Islands," by Charles Squire, is an introduction to Celtic myth, legend, poetry, and romance. It is intended, as we have seen, not for the learned, but for the ordinary reader, and the subject is approached from the literary rather than from the scholastic standpoint. Believing that the classic fount from which the poet so long drew inspiration has lost its potency, that the Greek stories can no longer be handled save by the genius alone, the author has attempted to put the natives of these islands in possession of a new heritage of myth and tradition, a heritage which is as much their own as that of the Teutons and Scandinavians.

Although the Welsh mabinogi and romances, and much of the Gaelic saga, have been made accessible in translations, it is unlikely that the British public as a whole can have formed anything like an adequate idea of Celtic mythology. The works in point contain but few explanations, and he who opens them for the first time, while he may be sensible of their charm, cannot but be bewildered by the novelty of his surroundings. He feels that he has ventured into a new world, peopled by characters whose very names are, for the most part, unfamiliar. If he wishes to understand their setting, to trace the connection between them, he must peruse innumerable lectures and learned essays, a task which is like to prove no light one. Mr. Squire's book is calculated to meet his difficulty. In it he will at last be formally introduced to the personages of Celtic mythology, to the gods and giants of the Gaels, to the champions of the Red Branch of Ulster—heroes of an epic almost worthy to rank with that of Troy—and to Finn and his Fenians. He will also make acquaintance with the chief figures of the Brythonic Pantheon, with the earlier race of gods, and with Arthur and his knights, who will be seen to belong to the same company.

As our author does not claim to have written an original work, it goes without saying that we are not called upon to enter into a discussion of his subject-matter. He has studied the works of the best scholars, and for the most part he adheres to them faithfully. It is possible that in some cases he may show himself over positive, that he may be inclined to treat as certain what his authority has advanced as a conjecture. But since his sole object in writing is to gain a larger audience for the studies of others, slips of this kind cannot be regarded as serious.

In our opinion his book is both useful and attractive. His treatment of his subject is thorough and conscientious, and he has realised his hope of presenting it in a lucid and agreeable form. It will be matter for surprise if he does not inspire his readers with some at least of his own enthusiasm.

Of Mr. Maclean's "Celtic Literature" there is no need to say more than a few words. It is some time since it appeared, and we doubt not that many of the readers of this Journal are already well acquainted with it It is the first attempt to give in brief compass an account of Celtic literature from the earliest times to the present day. Like Mr. Squire's "Mythology," it is intended to serve as a popular introduction; at the same time, it aims at satisfying those in quest of information as to original sources and books of reference. From both points of view it has much to recommend it; it will leave the general reader with a clear idea of the main outlines of the subject, while the student will find in it a painstaking and, within certain limits, a trustworthy guide. We are inclined to prefer the chapters dealing with Celtic literature in modern times, with the Highland bards before the Forty-five, with the master gleaners of Gaelic poetry, &c. The pages which describe the influence of Celtic on English literature are also interesting reading. The book ends with a survey of Celtic studies and a list of Celtic scholars past and present.

WEATHER INFLUENCES.

Weather Influences: an Empirical Study of the Mental and Physiological Effects of Definite Meteorological Conditions. By Dr. E. G. Dexter. Pp. xxxi+286. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) Price 8*s.* 6*d.* net.

THE effect of changes of weather on human activities has been the subject of much discussion, and each of us has no doubt formed an opinion on how he individually is affected by different meteorological conditions. The problem as affecting the behaviour of humanity in the mass has, however, received but scant attention hitherto. The statistical method affords the means of obtaining numerical results which enable us to estimate the importance of such effects.

Meteorological statistics are nowadays available from most centres of population; social statistics are also plentiful, yet of these only a limited number can be made to yield information on the general conduct or the working capacity of the community as a whole. In the book before us Dr. Dexter has collected and discussed sixteen classes of data culled from school records, covering both questions of attendance and conduct, police records dealing with cases of assault, drunkenness, murder, suicide, arrests for insanity, discipline in penitentiaries and the health of the force, the death register, registers of attendance in the out-patient departments of hospitals, and records of the number of clerical errors discovered in the books of certain banking establishments. The latter are the only data studied which deal exclusively with mental activities. All the records refer to New York City or to Denver, Colorado. The meteorological statistics with which they have been compared were obtained from the U.S. Weather Bureau.

The effects of seasonal changes are first discussed, and then the influence of each of the meteorological elements is considered separately. The general method of arranging the material for this purpose will be clear from the following description of that of dealing with the connection between temperature and assault. The days falling within the period considered were arranged in groups according to their mean temperatures, each group extending over a range of 5° F. On the assumption that temperature has no effect on assault, the number of days in each group is proportional to the "expectancy" of assault for that group. The actual number of occurrences of assault on the days of the group is computed as a percentage of the "expectancy," and curves have been drawn using the "occurrences" as ordinates and temperatures as abscissæ.

In dealing with the element rainfall the usual meteorological distinction has been drawn between days of rainfall, on which 0·01 inch of rain or more was measured, and dry days. It seems a pity that a further subdivision was not made. Most of us would be inclined to draw a wide distinction between showery days with only a few hundredths of an inch of rainfall and days of steady downpour. Even if such a further subdivision had been adopted, days with a few heavy showers would not be distinguishable from days of continuous fall; probably a classification on the basis of duration rather than amount of rainfall would yield results which would repay the labour involved in tabulating the records of self-registering rain gauges.

The majority of the curves show fluctuations which are greatly in excess of any which could be due merely to accidental variations. The number of data is in some cases extremely large (about 40,000 cases of assault), and there can be no doubt about the genuineness of the effects of meteorological changes.

The interpretation of the results is, however, a matter of considerable difficulty, and the possible influence of other than meteorological causes has to be steadily borne in mind. The general line of argument adopted regards the curves as compound functions of "irritability" or "emotional state" and "available" or "reserve energy." Thus, to return to the temperature-assault curve, we find a marked deficiency of occurrences at low temperatures. This has been taken to mean that under these conditions so large a portion of the vital energy is used up in supporting normal metabolic processes that the surplus available for active disorder is small. Under warmer conditions our pugilist, in addition to being more out of doors and thus seeing more of his neighbour, has more reserve energy available for active warfare, and the work of the police is proportionately increased. Above 65° the curve commences to rise with increased rapidity. Fighting energy is now at its prime, and at the same time "irritability" or quarrelsomeness is rapidly increasing. The temperature group 80°–85° shows a conspicuous maximum in the relative frequency of assaults. In the next group, 85°–90°, the curve exhibits a sudden drop. Irritability may very possibly be at a maximum, but the energy necessary to commence war is lacking, and a mere desire to fight is not a punishable offence. It is an interesting fact that the curve for women shows the above effects even more conspicuously than the one for men. A similar accentuation of the general characteristics is shown in all cases in which the number of data is sufficiently large to justify a separation of the sexes, so that it would appear that women are, on the whole, more susceptible to weather influences than men.

Some of the most interesting and at the same time most inexplicable curves are those which show the effect of the height of the barometer on human activities. With a few exceptions all classes of data show a marked excess of occurrences for periods of low barometer and a corresponding deficiency when readings are high. We cannot set this down to the direct effects of the diminution of pressure on the human organism; crime, &c., does not increase with altitude. Attempts at explanation by calling to our aid the usual accompaniments of a low barometer, viz. wind, rain, or cloud also fail, for when the effects of these elements are considered separately we find that in a number of cases the results contradict the hypothesis. Dr. Dexter directs attention to the peculiar "feel" which some people have for the approach of a storm, but this hardly amounts to an

explanation. It has been suggested that the radio-active emanation which is always present in the atmosphere in varying quantities may not be without influence on the human organism, and if, as Elster and Geitel suppose, this emanation is mainly derived from the underground air, which is more copiously discharged into the atmosphere as pressure decreases, it may be possible to establish a connection between the "storm feel" and the presence of radio-active emanation. If this be so we should expect to find the effect more pronounced with a falling than with a rising barometer, and, in the absence of direct measurements of the amount of emanation, the results obtained from a classification of the days, or perhaps better still, by a subdivision of the data used in constructing the present curves, on this principle would probably be interesting. Such a separation might prove profitable from a purely meteorological point of view, apart from all considerations of emanations, radio-active or otherwise. Possibly the peculiar abnormalities shown by most of the data for days of calm may be to some extent due to similar causes. The connection is, however, a very complicated one; attempts to trace a similarity between days of calm and days of low barometer fail signally.

We cannot here enter into a discussion of all the results or criticise the individual conclusions arrived at. In the final chapter Dr. Dexter further develops his thesis of the "available energy" and "emotional state" in the light of all the accumulated evidence, and comes to the conclusion that the effect of weather changes is greater on the former than on the latter, at any rate in its practical effects on conduct.

The study of the problems dealt with in the book is not without a certain practical interest to all who are responsible for the control of large numbers of individuals. If certain meteorological conditions can be shown to have a deleterious or beneficent influence on conduct or working capacity, it is well that we should recognise the fact as clearly as possible, and do what we can to mitigate the harmful conditions. Man cannot hope to control the weather, but he can modify the highly artificial conditions under which he lives to a very large extent.

A LIMNOLOGICAL MONOGRAPH.

Le Leman, Monographie Limnologique. By Prof. F. A. Forel. Vol. iii. Part ii. Pp. 410–715. (Lausanne: F. Rouge et Cie., 1904.)

IN the issue of this, the second part of his third volume, Prof. Forel completes his great monographic study of the Lake of Geneva. The veteran pioneer of scientific limnological research is to be congratulated on the successful termination of his monumental task, commenced some half-century ago.

The impetus which the study of lakes has received from the labours of Forel has now carried us so far that we find it difficult to realise the arduous nature of the work accomplished by him, who had in so many different directions to make the first tentative trials of methods of research with which all students of limnology are now familiar. The completed work is not merely a compendious study of the Lake of Geneva, but is besides of the utmost value as a general study of the nature of fresh-water lakes. In his painstaking study of this one lake he has been so fortunate as to observe and explain in a satisfactory manner many phenomena of general scientific interest and importance, among others the mysterious rise and fall of the waters of the lakes now known as seiches, the peculiar abyssal fauna of the lake, &c.

The present part of the work, which is mainly historical, deals with such varied subjects that it is difficult to particularise. Nothing having the slightest connection, direct or indirect, with the Lake of Geneva is destitute of interest for Prof. Forel, and we find here discussed many questions which a less enthusiastic limnologist might have been content to leave to students of other departments of knowledge. He gives a *résumé* of the history of the surrounding countries, of legislation, the fluctuations of population, local traditions, &c. More particularly apposite to the subject are the history of the lake dwellings, undertaken fifty years ago, in company with a band of archæologists of which he laments that he is the only survivor, the history of navigation, of fishing, and of pisciculture.

The history of navigation is treated very fully, from the canoe of the lake dweller to the modern steamer, and is illustrated with reproductions of many ancient pictures of ships; with such fulness of detail is the subject treated that we have a list of steamers plying on the lake from the *Guillaume-Tell* of 1823 to those of the present day.

The ancient tradition of the "éboulement du Lauredunum" is discussed in its scientific bearings. The tradition, supported by contemporary chronicles, is that in the year 563 A.D. a mountain was precipitated into the lake, destroying a castle, villages and churches, causing a flooding of the shores of the lake, and much destruction of property and life in Geneva. He shows that a landslip, such as has occurred several times in history, could not account for the production of great floods. Although he has abandoned the belief that earth movements habitually produce seiches, he admits that a great earthquake might be the cause of the land-slide, and coincidently of a great seiche, which would cause destruction on the shores of the lake. He thinks it more probable, however, that at a time of ordinary flood, when the waters of the lake were very high, an ordinary seiche of no more than a metre of amplitude might cause considerable flooding in Geneva, and perhaps wash away some wooden bridges and houses, the connection with the landslip being a mere coincidence.

In his philosophical reflections at the conclusion of his work, Prof. Forel claims that there have been few problems presented to him in the course of his investigations which he has not been able to solve, and the more difficult of these few are general problems, not belonging to his special province, and the solution of which must be sought in other lakes. He would, however, guard against this assertion being misunderstood as a boastfully complacent assumption that he has exhausted the subject. Every naturalist has his limits, determined from within by the extent of his powers, from without by the state of the

sciences in the age in which he lives. What is accomplished in one generation is the foundation for the achievements of the next.

That the subject is not exhausted we may easily see by remarking the progress that has been made in one of its departments most easily reviewed, since Prof. Forel finished that part of his work. In biology, even in the simple cataloguing of the lacustrine animals and plants, it is obvious that the work accomplished under his guidance is no more than a beginning in this direction, and specialists in any branch find abundance still to do. It is with no intention of belittling the work of Prof. Forel that this aspect of the subject is adverted to. It is a great work patiently carried through, and will serve as a foundation for all future limnological studies.

HENRY SIDGWICK'S ESSAYS.

Miscellaneous Essays and Addresses. By Henry Sidgwick. Pp. vii+371. (London: Macmillan and Co., Ltd., 1904.) Price 10*s.* net.

IN this volume we have the first instalment of the shorter essays of that brilliant thinker, Henry Sidgwick. They have been chiefly collected from journals and reviews, but two are now published for the first time. His philosophical lectures and papers are reserved for a companion volume. In a way, the selection of articles now before us illustrates a period of thirty-six years of the life of one of the most striking personalities of our time, and on that account, and from their breadth of view, they have a value even though the occasion of their appearance is long past.

Of the sixteen papers, six are literary or critical, six deal with questions of socialism and economics, and four with education and university affairs. We were surprised and somewhat disappointed to find no reminiscence of his activity in connection with the education of Englishwomen, but perhaps more may be expected when the histories of Newnham and Girton come to be written.

A detailed review of the essays on Shakespeare, Matthew Arnold, and Clough, or of those on political economy or sociology, hardly falls within the sphere of this Journal, but few of our readers who are interested in the burning question of the best education for men of science will regret having read Sidgwick's essay on "The Theory of Classical Education," reprinted from F. W. Farrar's "Essays on a Liberal Education," which was originally published in 1867. In the light of the recent controversy on the Greek question much of this excellent paper reads as if it had been written yesterday, and it is difficult to avoid the reflection that if several of the writers of controversial letters to the *Times* had read this essay of forty years ago, both their matter and manner might have been improved.

With respect to the classical element in a scientific education, Sidgwick was of opinion that although science had at length broken its connection with what was so long the learned language of Europe, yet everyone who aspires to become a "learned" man of science will require to read Latin with ease, but that the sole stock-in-trade of Greek necessary for him would be a list of words that he could learn in a day and the use of a dictionary that he might acquire in a week. In other words, he appeared to be in favour of the retention for the highest class of science students of that modicum of Greek which is at present compulsory at Oxford and Cambridge, only he would perhaps have liked to see it reduced and treated as a distinct part of the direct teaching of English.

A clear distinction is drawn between natural and artificial educations, and between the effects of literary and of scientific training. With regard to the latter Cuvier's famous remark is quoted with approbation:—

"Every discussion which supposes a classification of facts . . . is performed after the same manner; and he who has cultivated this science merely for amusement, is surprised at the facilities it affords for disentangling all kinds of affairs."

He admits that a student of languages could not honestly claim an analogous advantage for his own pursuit. The editors are justified in the inclusion of the essay on "Idle Fellowships" in spite of the fact that the evils of which it complains have greatly diminished. The general educational considerations discussed are of so wide a bearing that they are not less true now than in 1876, when the essay was published.

We feel certain that those who peruse this volume will share our gratitude to the editors for their share in the re-publication.

OUR BOOK SHELF.

The Insulation of Electric Machines. By H. W. Turner and H. M. Hobart. Pp. xvi+297. (London: Whittaker and Co., 1905.) Price 10*s.* 6*d.* net.

THE perfecting of the modern dynamo electric machine, and the necessity of high potential differences have within recent years quite altered our ideas about insulation. Electrical engineers have come to view the subject from a different standpoint on account of the importance of disruptive strength of the material apart from conduction pure and simple. The book under review appears at a very appropriate time. Our knowledge of the physical properties of insulators is now sufficient, and the want of a really good book on the subject is great enough to justify its appearance. It will be welcomed by the electrical engineer as a most valuable addition to his library.

The book opens with an account of the requisites for insulating materials, and the most perplexing phenomena met with during the testing of the same. Why is it that air has comparatively such low dielectric strength, and yet it is a very good insulator as ordinarily understood? Again, why does the apparent dielectric strength per unit thickness of such a substance as mica vary with the thickness? These and many other matters difficult to understand are laid before the reader. The properties of insulating materials and the influences of temperature and moisture upon them are next dealt with. The authors quite rightly lay stress upon the testing of insulators at, or even exceeding, their working limits of temperature, and the futility of baking to obtain temporary insulation unless moisture be permanently excluded. When dealing with the influence of brush discharge mention might with advantage have been made of the production of nitric acid, and the ultimate

breaking down of the insulation. The production of ozone—the forerunner of the above effect—is a matter of the utmost importance to electrical engineers, especially in damp climates.

That portion of the book dealing with varnishes is most valuable. The pros and cons. of the use of linseed oil, which undoubtedly has a very extended use at the present time, and other acid bodies are well set forth, as are those of the use of insulators of paraffin origin. The uses to which oils can be put as insulators, their various characteristics, their purity and methods for purifying and drying are carefully dealt with. Presspahn-mica is advocated instead of micanite for high tension working.

An important part of the work is that which deals with insulation of armatures, field-coils, and transformers. It is well shown upon what the so-called "space-factor," that is the ratio of area of copper to gross area of slot, depends. Very valuable suggestions are made with regard to pressure tests. Long time high pressure tests are likely to injure apparatus, and are not recommended—a few seconds' application is sufficient. The appliances in use for taping and handling insulation material, and a most interesting description of the tools employed, together with a useful bibliography, close what is really a valuable book. The printing is good, and the illustrations are excellent. ERNEST WILSON.

Insect Life. A Short Account of the Classification and Habits of Insects. By Fred. V. Theobald, M.A. With numerous illustrations (53 in the text). Second edition, revised. Pp. xi+235. (London: Methuen and Co., 1905.) Price 2*s.* 6*d.*

THE first edition of this work was published in 1896, and the public interest in entomology is evidenced by the increasing number of books on the subject which reach a second edition within a comparatively short time of publication. A cheap popular illustrated book on insects seems at present to be assured of a sale at least sufficient to cover expenses, which was not the case a few years ago.

The second edition is exactly similar to the first as regards its size, illustrations, and general contents; but here and there we notice occasional additions. There is much useful information in the book, but we regret that the second edition has not been more carefully revised, for, apart from occasional misprints, several erroneous or obsolete statements contained in the first edition have been repeated in the second. Thus on p. 3 (note) we read, "The total number [of insects] described, however, is under 250,000." This is probably based on Kirby's estimate in his "Text-book of Entomology" (1885) of 222,000; but the later estimate given in the second edition (1892) was 270,000, which would require to be augmented by many thousands to be correct for 1905. On p. 87, "The so-called Apples of Sodom found near the Red Sea," should, of course, be the Dead Sea. While it is true, as stated on p. 105, that *Danaus chrysippus* is the only European species of the genus, the much larger insect occasionally found in England is the common North American *D. eripus* (or *D. archippus*), introduced, but which may not improbably become naturalised in Europe, and has established itself within the last half-century in many of the Pacific Islands, as well as in Australia and New Zealand. Lastly (p. 166), it is possible that the bite of the species of tsetse fly which destroys cattle in South Africa may be "comparatively harmless to man"; yet, as Mr. Theobald must certainly know, the terrible sleeping sickness of Western and Central Africa is now ascribed to the bites of different species of tsetse flies infesting those regions.

We hope that when this little book reaches a third edition Mr. Theobald may have an opportunity of enlarging it, for entomology, like other sciences, advances so rapidly that it is not possible to bring it up to date, unless the author gives himself a free hand in this direction.

The Radial Area-Scale. Patented by R. W. K. Edwards. (Richmond, Surrey: Morgan and Kidd.) Price 3*s.* 6*d.*

THIS ingenious instrument is designed for use in finding the approximate areas of irregular plane figures such as indicator diagrams. It consists of a sheet of transparent celluloid marked with eleven scales on lines radiating from a point at equal angular intervals of about 3°, and so divided that a scale reading is proportional to the area of a sector from the centre up to that point. When used, the sheet is laid over the figure to be measured, and is adjusted until the figure is just contained within the bounding radials, with its outline cutting the nine inner scales each in two points. The outer and inner readings at these points are now taken and the two sets added; the difference between the two sums gives the required area. The entire operation occupies about three minutes. Applied by the writer to a 3″ circle and a 6″ semicircle, the results were correct in both cases to within ¼ per cent. As the outside radials include an angle of about 30°, the instrument is quite quickly adjusted over large or small figures of any shape, and the scales are clear and easy to read. To ensure a good approximation, Simpson's rule has been cleverly applied in figuring the scales. The instrument seems likely to be of considerable service, and should be widely known.

A Preparatory Course in Geometry. By W. P. Workman and A. G. Cracknell. Pp. viii+56. (London: W. B. Clive, 1905.) Price 9*d.*

THE little book by Messrs. Workman and Cracknell is preparatory to a forthcoming work on "Geometry, Theoretical and Practical," on which the authors are now busily engaged. It consists essentially of a set of exercises on the accurate scale drawing of lines, angles, triangles, and polygons, and requires the reading off of quantitative results as regards lengths and angles. Areas, ratios, and the general properties of circles are not reached in this volume. It trains the youth in the proper use of the drawing-pencil, straight-edge, scale, protractor, set-square, and compass, and gives him a concrete knowledge of, and practical insight into, geometrical truths as a preliminary to more formal work. Teachers using the book would do well when valuing class work to act on a suggestion contained therein, and give varying credit according to the degree of accuracy disclosed by the results. The book gives good promise of another very interesting class book of elementary geometry.

The Evolution of the World and of Man. By George E. Boxall. Pp. xi+191. (London: T. Fisher Unwin, 1905.) Price 5*s.*

A SINGLE example to show how Mr. Boxall proposes to supplement the deficiencies in the story of evolution as told by science will enable possible readers to estimate the value of his book. On p. 30, after stating that geology tells us the order in which various strata were laid down, he continues:—"but no attempt has as yet been made to estimate the temperature, for instance, when the granite was first deposited, and yet this should not be a difficult problem to solve. Thus, of the true metals, aluminium is the only one which appears in the granite, . . ." and the account continues with the same disregard of scientific fact. Mr. Boxall expresses his own view of the value of the book by not troubling to provide an index to it.

LETTERS TO THE EDITOR.

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

The Possibility of Reducing Mosquitoes.

IN his able review of James and Liston's interesting "Monograph of the Anopheles Mosquitoes of India," published in your issue of May 25, Dr. Stephens recapitulates the arguments of these authors in favour of their hypothesis that "the task of materially reducing the number of Anopheles in any place will undoubtedly be one of great magnitude." As the subject is one of the greatest sanitary importance, it may perhaps be advisable to add that the validity of these arguments is by no means accepted by all students of the subject. They are based for the most part on the results of some anti-mosquito work done at Mian Mir by Dr. Christophers and Captain James. Perhaps those of your readers who are not medical men may not be cognisant of the fact that an exhaustive and, I think, destructive criticism of this work has been published by Colonels Crombie and Giles, Captain Sewell, and myself—*vide British Medical Journal*, September 17, 1904, and *Journal of Tropical Medicine*, 1904. My own conclusions were that the operations cost too little to be effective, and that no exact method was employed for enumerating the numbers of mosquitoes present before and after their commencement. So far as I am aware, Dr. Christophers and Captain James have not replied to our criticisms, and I therefore feel justified in assuming that the case has gone against them by default. I should add that I hear on very good authority that the operations at Mian Mir are now being continued on a better basis.

The principal argument of our authors appears to be that the local reduction of mosquitoes will be wholly or largely impracticable because of immigration of the insects from outside. Thus they mention four methods by which Anopheles are dispersed, namely, by flight, by streams, by carriages, and by gradual spreading in all directions "by short stages," and think that the last method is "overlooked by those who have no intimate knowledge of mosquito habits, but who readily draw up schemes for their wholesale destruction." I fear that these very self-evident facts were well known and carefully considered long before the authors commenced their researches, and, moreover, that they do not by any means establish their case. It is quite obvious that a considerable number of mosquitoes must always find their way by diffusion into any area of operations; but this is not enough. What the sceptics have to prove is that the number of immigrants must be so large as nearly, or completely, to compensate for the local destruction. This is quite a different proposition, and one which will, I think, tax their ingenuity to maintain. If the local mosquito-density is to remain the same in spite of local destruction, it can only be by means of an abnormally large compensatory immigration setting in coincidentally with the commencement of the work of reduction. But what is there to determine such an extraordinary and suicidal influx? Mosquitoes do not, like a gas, exist under a pressure which compels them to fill up a vacuum, and we can scarcely suppose that they voluntarily move in the direction of their own destruction. But, even if they do rush in to fill the local vacuum, they must, in order to do so, forsake the outlying tracts of country (which will be correspondingly benefited by their absence), so that the total average reduction over the whole area influenced by the operations will be exactly the same whether migration takes place or not—an argument which appears to have been overlooked by the sceptics.

Owing to the fact that the to and fro movements of all random wandering must tend to annul each other—that is, that the vectorial sum of such movements must tend to zero—I think that migration is not likely seriously to counteract the effect of anti-propagation measures. I should like to refer those interested in this part of the subject to a paper by me, published in the *British Medical Journal* for May 13, in which I have endeavoured to approach the subject analytically. My results agree with those of the late Mr. Ronald Hudson, who kindly commenced a similar analysis for me shortly before his lamented death, and also, I may add, with general experience, which shows that though a few mosquitoes may occasionally wander to considerable distances, the large bulk of them remain near their breeding pools. I venture to think that those who would prove the converse must do so, not by citing individual cases of long wandering, but by making a much more exact numerical determination of the amount of immigration than they have yet attempted, and by showing that it greatly exceeds the local birth-rate—a somewhat difficult task. That their observations are not always those of others may be seen from the following quotation from Dr. Malcolm Watson's report on the highly successful anti-malaria measures carried out in the Federated Malay States (*Journal of Tropical Medicine*, April 1, p. 104):—"A definite improvement in the health of Klang was evident when only the swamps nearest to the main groups of houses had been dealt with, and while other swamps within the town were still untouched. The mosquitoes from these did not appear to travel any distance, and there has been no evidence of dangerous immigration of Anophelines from the extensive breeding places which until the middle of 1904 existed just outside the town boundary, and some of which still remain."

So far as I can see, the case must be the same for mosquitoes as for most other organisms, including man. We should be very much surprised if anyone were to maintain that the population of the British Isles, for instance, would remain the same after abolition of the birth-rate. Why, then, should we assume such a proposition for mosquitoes? RONALD ROSS.

The Romance of the Nitrogen Atom.

THE letter of Dr. F. J. Allen (NATURE, May 4) on the critical temperature of living substances has interested me immensely. The ideas contained in it have often presented themselves to me in a crude way, and I hope Mr. Allen will find opportunity for elaborating them. I have often thought, when pondering over what one may venture to call the *versatility* of nitrogen, that a useful book might be written on the chemistry of the nitrogen compounds, including the mineral and organic compounds of that element in one view. If it did no other service it would help to save the mind of the chemical student from being enslaved by the phrase, "the chemistry of the carbon compounds." If the phrase "Ohne Phosphor kein Gedanke" is true, may we not with equal truth say "Ohne Stickstoff kein Leben"? The marvellous powers stored in the carbon atom are sufficiently *en evidence* in chemical science; yet may we not recognise the nitrogen atom as the magic "demon" (borrowing a figurative term from Clerk Maxwell) that holds the wand, that (under given conditions such as are noted by Dr. Allen) turns the atoms of oxygen and hydrogen hither and thither in the multiplex atomic relations of growth and metabolism in the living organism, and especially in that little understood complex we call chlorophyll? We know that the inert N_2 molecule of the atmosphere is made up of atoms which, in the nascent state, are possessed of great chemical energy, and we may fairly, I think, explain the inertness of ordinary atmospheric nitrogen by the stability of its molecule (N_2) as arising out of a difference in the ionic constitution of the two atoms which form the molecule. Is it not here that we may seek for the explanation of the otherwise puzzling fact that in the extremely stable compound NH_3 the nitrogen atom is trivalent, while in the oxides, halides, &c., it is pentavalent? The action of the nitrogen atom, in the way suggested by Dr. Allen, is illustrated by the well known necessity in the fertilisation of soils for the conversion of NH_3 into nitrates of alkaline bases, in order that the nitrogen in a *more unstable state of combination* may do its special work in the internal economy of the plant. I recollect discussing this matter some years ago with Dr. Voelcker, when I had the pleasure of meeting him at an agricultural gathering in this neighbourhood. The modern idea of ionisation of atoms seems also to throw light upon the fact that N_2

and H_2 combine to form NH_3 under the influence of the silent electric discharge, while at the temperature of the spark-discharge NH_3 is again split up into N_2 and H_2. The running down also of HNO_3 through the whole series of oxides into ammonia in the Grove cell is full of interest from this point of view, and the subject, with its manifold ramifications, is a fascinating theme for a thesis.

Bishop's Stortford, May 30. A. IRVING.

An Inverted Slab in a Cromlech.

THE remarkable articles on Stonehenge and other monuments by Sir Norman Lockyer have naturally stimulated reflection upon all that concerns megalithic remains, and therefore, perhaps, the following curious circumstances may be of some interest.

At Henblâs, in Anglesey, is a cromlech, or rather, I suppose, a dolmen, of remarkably rude and massive aspect. Two uprights remain, the larger of which is about 15 feet high by 9 feet thick, and both are very rough and irregular in shape. Resting against these, at an angle of about 20° or rather less from the horizontal, is a thinner stone, about 3 feet thick and some 13 feet square, presumably a top-stone. All are of a hard quartzite, which occurs among the schistose rocks of the district. No good exposure of this is known within a mile or so of the cromlech (a fact which Captain Evans, of Henblâs, informs me was pointed out to him long ago by Sir Andrew Ramsay). But at the base of the uprights are some obscure exposures that appear to me to be *in situ*, and I am inclined to think, therefore, that the materials were obtained on the spot.

Now the supposed top-stone is rough, like the uprights, on its upper surface, but its under-side is beautifully and finely ice-worn! It is clear, therefore (for it is certainly not a boulder), that it has been turned upside down.

Further, not only is it ice-worn, but the *direction* of the ice-movement can be made out, there being distinct lee-sides to its finely striated bosses, and these lee-sides look to N.N.E. But the natural direction of glaciation in the district is to S.S.W. Therefore, the stone has not only been turned upside down, but turned round as well.

If the materials were brought from some distance, these facts are, of course, of less interest. But if, as I think much more probable, they were obtained on the spot, it is clear that they throw a little light upon the proceedings of the builders in their work of lifting these great stones.

Achnashean, near Bangor. EDWARD GREENLY.

The Cleavage of Slates.

I FIND that I owe Mr. Fisher some apology for a carelessly worded allusion in my notice of Dr. Becker's memoir (p. 20, May 4). In pointing out that the theory which I criticised had been anticipated by Mr. Fisher, I ought, perhaps, to have mentioned that the latter had somewhat qualified his original hypothesis, though the postscript notifying this qualification was, I believe, only privately printed.

Mr. Fisher's further contribution to the question (pp. 55, 56, May 18) is of interest. If it be granted that the cleavage of the Westmorland slates coincides with the plane of greatest distortion, it becomes less necessary to urge the case of the colour-spots in the Llanberis slates; but the suggestion that these have been formed subsequently to the cleavage seems to raise some difficulty. I have seen examples in which the ellipsoidal green spots are shifted by small faults, which are quite obsolete as planes of weakness. This seems to imply that the faults, and *a fortiori* the spots, are older than the cleavage-structure. ALFRED HARKER.

St. John's College, Cambridge, June 7.

The Inheritance of Acquired Characters.

Is the following an instance of such inheritance? Lately I heard a missionary at a May meeting tell of the marvellous facility with which Chinese children memorise whole books of the Bible; the four Gospels, and sometimes the Acts also, being an easy feat for children of ten or twelve years. Having carefully sought information from other authorities, I find these facts confirmed, and that the same applies to Mohammedan children. We are aware that for ages their ancestors have been compelled to memorise long portions of their sacred books, and although occasionally we meet with a child of any nation with a gigantic memory, that differs widely from the case of a people where it has become a general characteristic.

June 7. W. WOODS SMYTH.

THE UTILITY OF AN ANTHROPOMETRIC SURVEY.[1]

THE Government which has shown so scientific a spirit as to create a Council of Defence, a constant spirit of intelligence to safeguard the Empire amid the development of armaments of other nations, might surely devote attention to that recommendation which stands first in the report of the interdepartmental committee on physical deterioration:—"With a view to the collection of definite data bearing upon the physical condition of the population, the committee think that a permanent anthropometric survey should be organised as speedily as possible. . . ."

What are the results to be expected from such a survey as was sketched out at the Cambridge meeting of the British Association last summer? An improvement in the education of the people will surely follow.

At the time of the Elementary Education Act, 1870, the re-distribution of the populace, that progressive change by which the increasing majority become citizens and cease to be country folk, was not realised. The increasing demands of intellectual exercises upon the time of the children and loss of domestic education were not foreseen, or their effect in making the requirement most urgent that the physical side of education should be brought under educational authority or otherwise definitely provided for. Hence a generation passes and there is an outcry for physical education. Let us hope a coming generation may not be crying in turn that the moral side of education suffers from want of due attention.

The effect of registration—the national survey of deaths—has been a clear guide and a very great safeguard to the public health. One may quote some of the words of Dr. Farr which are to be found in his first letter to the first annual report:—"Diseases are more easily prevented than cured, and the first step to their prevention is the discovery of their exciting causes"; again, "indirect influence (of these reports) upon practical medicine must have been very great. The constant endeavour after exactness of diagnosis and precision of nomenclature is itself a wholesome discipline, which reacts inevitably upon treatment." Who at that time could prophesy the value, topographical and historical, we now find in these reports?

The anthropometric survey will have upon the sphere of education an equally large and discriminating, if often indirect, influence; it will react upon medicine as well as upon education; it will detect any deterioration of the young adult that is due to the factory and workshop; it will determine the influence of environment upon physique, and, as Mr. John Gray says, "without an anthropometric survey, we are in this important question of sound national physique 'like a log drifting nowhere'; with a survey, we should be like a ship, steering by chart and compass to its destination."

In the influence of body and mind upon one another, it is to anthropometry we must look for certainty of judgment. Mr. H. G. Beyer pointed out to the

[1] Physical Deterioration; being the Report of Papers and Discussions at the Cambridge Meeting of the British Association, 1904, on the Alleged Physical Deterioration of the People and the Utility of an Anthropometric Survey. (Occasional Papers of the Anthropological Institute, No. 2.)

American Association for the Advancement of Physical Education how important it was to make a study of "fatigue" in its relation to training and education, to find out the conditions under which our work has its maximum beneficial effect, and the limits to the exercise of our muscles favouring the performance of intellectual work. From data worthy of credence, he was of opinion that brain work influenced favourably bodily development, as well as *vice versâ*.

The basis of these and similar observations requires to be broad, and it was interesting to note at the Cambridge meeting how the want of the proposed survey was evident to nearly every speaker. Prof. Cunningham has pointed out how changed conditions of life are palpably attended by changes of physical standard, but we have no clear knowledge of these changes, the best facts concerning our country being still those collected five-and-twenty years ago by the anthropometric committee of the British Association. The racial substitution of a dark element for a fair in the population of London, noted by Dr. Shrubsall as an outcome of his investigations on hospital inmates and healthy individuals, demands a survey to determine its extent and nature.

In the remarks upon deterioration, made at the Cambridge meeting by the president, Mr. Balfour, this requirement stands out quite plainly again in his expression of opinion that fresh air has so large an influence upon the physique of the race.

That a knowledge of the conditions of respiration in towns is at the present day of eminent importance is also patent to everyone who may read, in a recent report of the Registrar General, that in the urban districts of England the death rate from respiratory system diseases is no less than double that of the rural districts.

Now while much attention has been paid to the air of schools and buildings, we have no knowledge whether the lung movement—the chest expansion—of the town dweller is much less than the countryman's, and the answer of a survey to this question is highly desirable. It may be that want of exercise of lung is a deteriorating influence like bad quality of air.

Now that a practical scheme of anthropometry with a responsible recommendation of such a scheme lies before our legislators, concerning a matter absolutely beyond the reach of private effort, surely the nation cannot afford to despise such knowledge, nor is the day past when this country can give a lead in the organisation of information to aid the public health.

Unlike Sweden, Germany, and Italy, we have no conscripts to form a source of similar information. The methods proposed are simple:—height, weight, chest girth; head-length, breadth, and height; breadth of shoulders and hips; vision and degree of pigmentation are to be measured. Economy and efficiency will be observed by the provision of whole time surveyors instructed at a single centre, and 80,000 adults and 800,000 children should be measured annually, re-visiting each district every ten years.

The eugenics of Mr. Galton are not at present practical politics, though, as an analogous subject, it is interesting to note that the stud books of hunters, shires, and hackneys have not only improved the breed, but raised the standard of health and improved the average of health in horses exhibited.

As to expense, the sum required is less than that spent on stud books, and similar to that of the Geological Survey. Provision is made, though not too liberally, for the survey of the land on which we live; surely it is not too much to ask that a scheme for the survey of the people should be established upon a national basis.

PHOTOGRAPHY AND NATURAL HISTORY.[1]

DRY plate photography cannot be altogether regarded as an unmixed blessing. The facilities which it affords to the amateur have brought down upon us a veritable avalanche of books on natural history subjects, some of which had better never have been written.

Mr. Snell's unpretentious little volume is, however, not of this number. On the contrary, it is of its kind excellent, and will prove a boon to those who are fond of nature-photography but, by force of circumstances, are unable to afford an expensive camera or to spend time and money in search of subjects far afield.

Commencing with a most useful chapter on the methods to be adopted in photographing living animals, the author, in the following chapters, demonstrates the practicability of the rules he has

FIG. 1.—Spider's Web or Snare. From Snell's "The Camera in the Fields

laid down. Small mammals, birds, reptiles, Amphibia, fishes, and insects are each, in turn, made to furnish illustrations. Finally, some very valuable hints are given on the photography of botanical subjects.

There are tricks, it is said, in every trade! This is notoriously true of photography. Some of the more harmless sort are lucidly described in this volume. The methods, for example, employed in the photography of mice and rats, snakes, and young birds will come as a surprise to many. Many of us, probably, have been amazed at the apparent skill and patience displayed by many "nature-photographers" in securing pictures of field-mice climbing wheat stalks, or rows of nestlings sitting peacefully along a bough. Such pictures, it now appears, may be

1 "The Camera in the Fields." By F. C. Snell. Pp. 256. (London: T. Fisher Unwin, 1905.) Price 5s.

secured in the privacy of a small back yard! It is only necessary first to catch your mouse. This done, he is penned in a glass cage and confronted by the camera. So soon as an attractive posture has been assumed, the exposure is made. A suitable background is all that is needed to deceive even the very elect!

Thus is the mystery explained of some of the wonderful pictures of "wild life with the camera" that have excited the envy and admiration of many who have sought, and sought in vain, in our fields and hedgerows to obtain similar pictures!

The illustrations in this book are unusually good and plentifully distributed. The specimen given herewith was selected with no little difficulty, inasmuch as the high standard of excellence, both in taste and execution, which these pictures present rendered choice difficult. W. P. P.

THE NATURAL HISTORY OF THE BAHAMAS.[1]

TWO years ago there was published in this country an account of a cruise to the Andaman and Nicobar Islands[2] by an American party for the purpose of obtaining natural history and ethnological specimens for the National Museum at Washington, and every Englishman worthy the name who read that work can scarcely have failed to experience a feeling of shame that it was not long ago anticipated and rendered superfluous by the enterprise of his own countrymen. If such a feeling exist in the case of a work dealing in a more or less cursory manner with the results of a private expedition to remote islands of little or no commercial importance, how must it be intensified when we find an American scientific society undertaking a systematic biological, geological, historical, and sociological survey of a group of islands which are supposed to rank among the more important possessions of the British Crown?

That the work should have been undertaken by American enterprise is, *ipso facto*, a confession that it required doing; in other words, that it ought to have been done by Englishmen, and the fact of its being left to our Transatlantic cousins is virtually an admission that our rulers—in spite of what we are being continually told as to the all-importance of science if we are to continue to hold our position as a nation—are blind to the needs and signs of the times in matters scientific! That we should have hitherto possessed no detailed and comprehensive account of a group of islands dotted over an area about as large as the British Islands, which has formed part of our Empire for generations, is, indeed, little short of a national disgrace, and the fact that Americans have cut in and done our own work for us in our own possessions speaks volumes as to the amount of attention that has been paid to the cry of "Wake-up, England!"

The contrast between our own apathy and American enterprise in scientific matters of this nature is intensified when we compare what is being done for the natural history of the Philippines by their new owners with what has been left undone in the case of the West Indies (and many other islands we could mention) by their ancient lords. We were about to urge our rulers, for very shame, to set about doing for the other West Indian islands what Americans have already accomplished for the Bahamas, but we fear we should only be speaking to deaf ears, and therefore refrain. Let us add that in all this we have not one spark of jealousy, but rather unbounded and respectful admiration, in regard to the work our American cousins have so successfully and so thoroughly carried out.

The trustees of the Geographical Society of Baltimore have, it appears, set themselves to accomplish two main objects by means of the body they govern, namely, in the first place, to furnish their public with an annual course of lectures connected with geography, and, in the second place, to foster geographical research in general, and from time to time to publish monographs dealing with some particular piece of geographical investigation carried out under the auspices of the society. The volume before us is the first of these proposed monographs, and its completeness and wealth of illustrations render it a more than usually striking and handsome example of American thoroughness.

The object of the expedition was to investigate the origin and natural history of the Bahamas, and also to conduct studies on lines intimately associated with the well-being of their inhabitants. The scientific staff included no less than twenty-four members, with Dr. G. B. Shattuck as director, most of whom are specialists in one or more particular departments, the special subjects of investigation being geology, tides, terrestrial magnetism and climatology, soils, botany, mosquitoes, fishes, other vertebrates, medicine, and history. Even this, however, by no means represents the full force employed in making public the results of the expedition, for many of the collections were handed over to specialists who did not accompany the latter, the reptiles and amphibians being, for instance, consigned to Dr. L. Stejneger, the birds to Mr. J. H. Riley, the mammals to Mr. G. S. Miller, and so on.

For months previous to the departure of the expedition, the director was engaged in equipping and organising its various sections, procuring the necessary apparatus, so that everything, even down to the most minute detail, should be in such a state of completeness that work might be commenced the very moment of arrival. The expedition sailed from Baltimore on June 1, 1903, equipped for a two months' cruise. Since a number of its members were in Government offices, from which they could only obtain leave during the months of June and July, the length of the cruise had been necessarily limited to that period, and every effort had consequently been made that work should progress with the greatest possible despatch during the time available. Unfortunately, bad weather was experienced during the outward voyage, so that Nassau, the first stopping place, was not reached until June 17, and as it was necessary to start on the return journey before the end of July, only about five weeks were left for work. The more southerly islands of the Bahama group had in consequence to be left unvisited; but apart from this omission, the greater part of the work which had been planned was brought to completion, and all the members of the staff are to be congratulated on the rapidity with which they executed their respective tasks. Except dredging and fishing, most of the work was done on shore, but all the field-work was, of course, merely preliminary to study in the laboratory. In examining the living products of the sea-bed—a sight of rare beauty—great advantage was derived from the glass-bottomed boat which formed part of the equipment.

Our statesmen should not fail to notice that, according to opinion in America, the construction of the Panama Canal in the near future (which is said to be assured) is destined to bring renewed prosperity to

[1] "The Bahama Islands." Edited by G. B. Shattuck. Pp. xxxii+630; 93 plates. [New York: The Macmillan Co.; London: Macmillan and Co., Ltd. (published for the Geographical Society of Baltimore), 1905.] Price 2*l.* 2*s.* net.

[2] "In the Andamans and Nicobars." By C. B. Kloss. (London: John Murray, 1903.)

the West Indies, and the hope is expressed by the editor that the facts recorded in the work before us "may be instrumental, if only in a small degree, in causing the Bahama Islands to share" in this prosperity. Commentary on this statement is superfluous.

The picture presented by the islands is well described in the following passage by the editor:—

"No words can describe the beauty of Nassau as one approaches the harbour from the sea. The ocean of deep sapphire suddenly changes to a lagoon of emerald green surrounded by shores of snow-white coral sand. Beyond, the white limestone houses of the town, intermingled with groves of graceful palms, and half-concealed by gorgeous poincianas, rise in a gentle slope against a sky of purest blue. The green transparent water; the intense blue of the sky; the blotches of blood-red poincianas; the snow-white drifts of coral-sand; the vivid green of the foliage—all these unexpected and yet harmonious contrasts strike the eye together, and stamp on the memory a picture of rugged beauty which nothing can efface. The impression thus received does not suffer when later the tourist wanders about the quaint old town to examine at leisure the details of the picture."

Our limits of space allow of only a brief reference to the details of the work of the expedition. An interesting and important feature connected with the geology of the Bahamas is that they are composed almost entirely of débris derived from corals and other calcareous organisms, and rest on a shallow, submerged platform, separated by deep ocean-troughs from the adjacent land-masses of North America and the West Indies. Few of the Bahama animals appear to be distinct from those of the mainland, although some of the mammals have been described (in earlier publications) as separate local races. Of some of these latter the skulls are now for the first time figured. An attractive feature of the volume is formed by the numerous coloured plates of marine Bahama fishes, which convey an excellent idea of the brilliant hues characteristic of all fishes which haunt coral-banks. Of especial interest is the plate of the "mouse-fish" or Sargasso-fish, the remarkable shape and coloration of which are doubtless developed to harmonise with its surroundings of floating seaweed.

This notice may be fitly brought to a close by the expression of our opinion as to the high value and importance of the work initiated by the Baltimore Geographical Society, and by the tendering of our congratulations to all those by whom it has been so successfully and faultlessly executed. R. L.

NOTES.

THE council of the Society of Arts has awarded the Albert medal of the society for the present year to Lord Rayleigh, "In recognition of the influence which his researches, directed to the increase of scientific knowledge, have had upon industrial progress, by facilitating, amongst other scientific applications, the provision of accurate electrical standards, the production of improved lenses, and the development of apparatus for sound signalling at sea."

THE De Morgan medal of the London Mathematical Society has this year been awarded to Dr. H. F. Baker, F.R.S., for his researches in pure mathematics.

THE annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, South Kensington, on Thursday, June 29.

THE annual general meeting of the Society of Chemical Industry will be opened on Monday morning, July 10, at University College, Gower Street, when the president, Dr. Wm. H. Nichols, will deliver an address.

THE fourth International Ornithological Congress was opened by Prof. Oustalet at the Imperial Institute on Tuesday. Dr. Bowdler Sharpe, the new president of the congress, delivered an address.

THE death is announced of M. Edouard Simon, the eminent French engineer. He took an active part in the management of the Société d'Encouragement pour l'Industrie nationale, and contributed twenty-four papers to its proceedings.

AT the National Museum at Washington a series of specimens has been arranged to illustrate the associations and mode of occurrence of gold in nature, and Mr. George P. Merrill, the curator, has published in the *Engineering and Mining Journal* a useful list of associations represented in the collection. In the forty-eight cases enumerated, the gold occurs native, and in particles of sufficient size to be recognised by the unaided eye.

WITH the view of lessening the danger of lead-poisoning now encountered by diamond-cutters, the Dutch Government has offered a prize of 6000 florins for the most satisfactory substitute for the tin-lead alloy now used for holding the diamonds during the process of cutting. Applications, which may be written in English, should be sent before January 1, 1906, to Dr. L. Aronstein, Polytechnic School, Delft, Holland.

IN the Free Library at Hampstead there is displayed at present a selection from the collection of flint implements made by the late Mr. Henry Stopes. The exhibit gives a sample, not only of the whole collection, but of that part which deals with the ancient inhabitants of the Thames Valley, and it has been selected to interest the passer-by and educate his eye what to look for in his walks abroad.

Science announces that Dr. Franz Boas has resigned the curatorship of the anthropological department of the American Museum of Natural History. He will continue his connection with the museum, conducting the researches and publications of the Jesup North Pacific Expedition and of the East Asiatic Committee.

A REUTER message from Fort de France (Martinique) dated June 12 reports that Mont Pelée in the past few days has been displaying some renewal of activity. It is reported that on Saturday night, June 10, "the dome suddenly became illuminated. The dome collapsed on Sunday morning, and a mass of mud overflowed into the valley below, while a cloud of smoke rose to a height of 1000 yards."

THE departmental committee appointed by the Board of Agriculture and Fisheries to inquire into the nature and causes of grouse disease has made the following appointments:—Dr. C. G. Seligmann as bacteriologist to the commission, Mr. A. E. Shipley, F.R.S., as expert on the subject of internal parasites, Dr. H. Hammond Smith as assistant bacteriologist and additional field observer, and Mr. G. C. Muirhead as field observer.

THE Anthropological Institute of Great Britain and Ireland has arranged with Mr. J. J. Harrison to publish a full scientific report upon the physical and psychophysical characteristics of the pygmies whom the latter has brought to this country. For this purpose the council of the institute has appointed a select committee consisting of the following anthropologists and medical men, who, with the assistance of Mr. Harrison, will carry on the necessary investigations:—Sir Harry Johnston (chairman),

Prof. Arthur Thomson, Dr. A. Keith, Dr. W. H. R. Rivers, Dr. R. Murray Leslie, Prof. W. Gowland, Mr. J. Gray, and Mr. T. Athol Joyce.

THE committee of the Privy Council appointed to consider and determine certain points in connection with the establishment of a National Museum and National Library in Wales has decided that the two institutions should be separate, the National Museum to be established at Cardiff and the National Library at Aberystwyth. The support, local and otherwise, offered by Cardiff for the foundation and maintenance of the museum and library included:—(1) four acres at Cathays Park (20,000*l.*); (2) collections in municipal museum and art gallery (38,000*l.*); (3) a capital sum of (7500*l.*); (4) public subscriptions amounting at present to (32,500*l.*); (5) a ½*d.* rate under Museums and Gymnasiums Act, 1891 (1940*l.*); and (6) collections of books in municipal library (81,766 volumes and 9118 prints, drawings, &c.) (30,000*l.*).

DR. HENRY DE ROTHSCHILD (says the Paris correspondent of the *Chemist and Druggist*) has recently offered two prizes for competition which will be awarded next year. The first one is a prize of 200*l.* for the best work on the subject of the best alimentary rations of a child from its birth until the age of two years. The second one is a prize of 120*l.* for the best study on the supply of milk to a big city (hygiene, technology, transport, legislation, sale, &c.). These prizes may be divided should the jury of award consider it advisable. The competition is open to foreigners, and papers should be sent in before June 1, 1906. The secretary is M. C. Nourry, 49 rue des Saints-Pères, Paris.

IT was mentioned last week that the U.S. Weather Bureau is taking up the discussion of meteorological observations from the point of view of their relations to solar physics. The programme of the bureau with regard to the coordination of solar and terrestrial observations is, it may be noted, on the lines of the resolution of the Southport meeting of the International Meteorological Committee, which constituted a commission for the express purpose of that coordination. The commission held its first meeting at Cambridge last year, and will meet again at Innsbruck in September. Prof. Bigelow is one of the members, and there is no doubt that the work in this direction of the Washington Weather Bureau will be carried out in cooperation with the commission.

THE provisional programme drawn up and circulated by Prof. Hildebrandsson for the meeting of the International Meteorological Committee, referred to in the preceding paragraph, is mentioned in *Symons's Meteorological Magazine* (May). Among the subjects put forward for discussion are suggestions for improving observations which may be used for the comparison of phenomena over wide areas, especially with regard to noting the exact time of observing each instrument, reducing observations to standard conditions, and the like. Attention is to be directed to the very important question of the causes and the prognostics of widespread heavy rains, the importance of which as affecting floods is naturally felt much more on the Continent than in our country of mild extremes. Prof. Pernter is to suggest a more precise classification of meteorological stations according to the equipment and the nature of the observations carried on. The question of the possibility of extending the use of wireless telegraphy for obtaining reports from the eastern Atlantic, and many others on which an international understanding is desirable, will be taken up.

A LARGE portion of the March issue of the *Proceedings of the Philadelphia Academy* is occupied by the first portion of a paper by Mr. H. A. Pilsbry on the terrestrial molluscs of the south-western United States.

IN the *American Geologist* for April Mr. L. M. Lambe describes in detail, with an excellent figure, the structure of the cheek-teeth of a Canadian representative of the genus Mesohippus, one of the forerunners of the horse.

THE Perthshire Museum, which from the very beginning of its existence has devoted its energies to the illustration of the biology and physiography of the district, has just published an illustrated hand-book to the collection, which forms a short but excellent guide to the animals, plants, and rocks of the county. This is as it should be, and the museum is to be heartily congratulated on the line it has taken up.

IN the *Johns Hopkins University Circular*, No. 5, Mr. E. A. Andrews discusses the so-called *annulus ventralis* of the crayfishes of the genus Cambarus, and confirms the view that its function is to serve as a sperm-receptacle. It is, however, further shown that this structure, which is common to all the members of the genus in question, and is unknown in other crayfishes, is essential to reproduction, and if eliminated would lead to the extinction of the group. In the same issue Mr. R. E. Coker discusses Dr. H. Gadow's theory of orthogenetic variation among tortoises and turtles, and comes to the conclusion (from the examination of a very large number of specimens) that it is not confirmed by the evidence available.

FISHERMEN and fishmongers in Illinois appear to have been aware for some time of the existence of a shovel-beaked sturgeon belonging to a species unknown to science. Eight specimens of this white sturgeon, as it is called by the local fishermen, have, however, recently come under the observation of Messrs. Forbes and Robinson, by whom the species is described as the representative of a new genus, under the title of *Parascaphirhynchus albus*, in the *Bulletin of the Illinois Laboratory of Natural History* (vol. vii., art. 4). Its uniformly light colour, long small eye, long and narrow snout, bare under-parts, small and numerous plates, and superior number of ribs differentiate it sharply from the common shovel-beak or "switch-tail" (*Scaphirhynchus platyrhynchus*). About one specimen in 500 of the sturgeons taken at Grafton, Illinois, belongs to the new species.

THE occurrence of a layer of mesodermic tissue in the anterior part of the head of embryos of the laughing-gull forms the subject of an elaborate article by Mr. H. Rex in parts ii. and iii. of vol. xxxiii. of Gegenbaur's *Morphologisches Jahrbuch*. The occurrence of mesoderm in this part of the head of sauropsidan embryos is, it appears, a comparatively new discovery, and the laughing-gull was selected as a good subject for further investigations concerning this feature. Three articles, two by Mr. G. Ruge and one by Mr. P. Bascho, in the same issue are devoted to the discussion of the nature of certain alleged vestiges in man of the *panniculus carnosus* of the lower mammals, such as the musculus sternalis, and the so-called *achselbogen*. Much turns on whether the former of these muscles constitutes a superficial branch from the upper layer of the pectoral muscles, or whether it has no genetic connection therewith. The view that the structures in question are really functionless representatives of a skin-muscle is supported. In a fifth article Mr. E. Goppert discusses the last part of Dr. Fleischmann's studies on the cranial skeleton of the Amniota.

WE have received the year-book for 1905 of the Livingstone College, which gives interesting details of the past year's work, experiences of past students from the mission fields in all parts of the world, and a few hints on risks to health in the tropics and how to avoid them.

THE *Journal of the Royal Sanitary Institute* (vol. xxvi., No. 5, June) contains notes on minimum sanitary requirements for building bye laws by Mr. Searles Wood, on isolation hospitals by Dr. Davies, a lecture on canned foods by Prof. Kenwood, and other interesting papers, reviews, and notes.

THE *Sitzungsberichte der kaiserl. Akad. der Wissenschaften* (Wien, Bd. cxiii., Heft viii. and ix., Abt. iii.) contains a paper by V. L. Neumeyer on intraperitoneal cholera infection in the salamander; this animal he shows is fifty to sixty times less susceptible than the guinea-pig, an extremely active phagocytosis taking place on injection of the microbe. Prof. M. Löwit contributes an exhaustive study of intravascular bacteriolysis.

LIEUT. CHRISTOPHERS, I.M.S., in a third report (*Scientific Mem. Gov. of India*, No. 15), details experiments on the cultivation of the Leishman-Donovan body of kala-azar, a disease of Assam. Rogers and Leishman have obtained flagellated protozoa in cultivations of the parasite. Christophers corroborates this, and although the flagellated forms are very like Trypanosomata, he does not commit himself as to their exact nature.

A FOURTH fascicle of Mexican and Central American plants, described by Dr. J. N. Rose, and forming vol. viii., part iv., of the *Contributions* from the United States National Herbarium, contains several revisions of genera in addition to the enumeration of many new species. Synopses are provided for Mexican species of Ribes, Parosela, otherwise known as Dalea, and Heterocentron; the opinion that Œnothera is a polymorphic combination leads to the formation of a new genus Raimannia, concurrent with Hartmannia and Lavauxia, and several species of Ternstrœmia are collated under the name of Taonabo.

THE Imperial Department of Agriculture for the West Indies has published the full report by Dr. F. Watts on sugar cane experiments in the Leeward Islands during the year 1903–4, and the results are presented in an abridged form in the pamphlet series Nos. 33 and 36. Reference has previously been made to the experiments with different varieties of canes, in addition to which manurial experiments have again been carried out. As the result of trials for four years the conclusion is arrived at that when, as is the custom, pen manure is worked into the soil, no advantage attends the addition of other artificial manures, and that phosphates may even tend to decrease the yield of plant canes. It has, however, been found advantageous to add nitrogenous manures to land planted with ratoon canes. The importance of nitrogenous manures is also affirmed by Prof. J. B. Harrison in his report referred to in the *Agricultural News*, May 6, which relates to sugar cane experiments in British Guiana.

WE have recently received three circulars, Nos. 21, 22, and 23, also a bulletin, No. 55, from the Forestry Bureau of the United States Department of Agriculture. Circular No. 33, entitled "What Forestry means to Representative Men," contains extracts embodying the opinions of fifty experts, including President Roosevelt, regarding the value of scientific forestry. They all agree without exception that proper forest conservation is of vital importance to the welfare of the country. That the Department of Agriculture thoroughly realises this fact is shown by circulars Nos. 21 and 22, wherein is set forth the very liberal conditions under which practical assistance is given to farmers, lumbermen, and others in handling their forest lands, as well as the practical assistance offered to all tree planters. Bulletin No. 55, entitled "Forest Conditions of Northern New Hampshire," gives a detailed account of the condition, composition, and stand of timber in this region, with valuable suggestions as to the possibility of extended afforestation and the seemingly much needed forest organisation and conservation in New Hampshire.

THE *Century Magazine* for June contains an interesting article by Mr. Gilbert H. Grosvenor entitled "Our Heralds of Storm and Flood," and gives a graphic description of the work of the U.S. Weather Bureau. The author rapidly reviews the whole of the useful operations of this service, but deals more especially with the predictions of floods, cold waves, and storm warnings. The cost of the Weather Bureau and its numerous branches is set down at one million and a half dollars yearly, while the amount of saving to property is estimated at thirty millions. One of the most remarkable cases of flood prediction cited was that of 1903, which was announced twenty-eight days in advance, after torrential rains extending over some 300,000 square miles. This flood caused terrible damage to property, but the public was prepared for it, and the loss was many millions of dollars less than it otherwise would have been. Much care is given to warnings of cold waves in early spring and autumn; the bureau aims at giving at least twenty-four hours' notice of their occurrence, and occasionally issues many thousand telegrams within a few hours. These blighting frosts sometimes destroy in one night the prospects of the agriculturist for the year. The storm warnings issued to the seafaring community form, perhaps, the greatest success of the efforts of the bureau. It is estimated that on the Great Lakes alone, the loss to shipping caused by storms has been reduced by 50 per cent. The article is beautifully illustrated with photographic reproductions of damage by floods, representations of clouds, and the freaks of tornados; the fact of straws, &c., being driven into trees can, fortunately, scarcely be realised in this country.

MESSRS. ARMBRECHT, NELSON AND CO. have issued a special price-list of the rare elements and their salts; a noticeable feature is the quotation for 16 oz. bars of metallic calcium. This metal, which for so long has been sold at a prohibitive price, is now obtained by a simple electrolytic process, and has become a comparatively cheap commercial article.

THE influence of a magnetic field on luminous radiation forms the subject of the Nobel lecture which was delivered by Prof. Zeeman before the Swedish Academy of Science in 1903, and has recently been printed (Stockholm: P. A. Norstedt & Fils). It deals with the history of the discovery and the theoretical significance of the "Zeeman effect."

THE fourth volume of Ostwald's "Annalen der Naturphilosophie" contains a brief sketch, by B. N. Menschutkin, of the life and work of M. W. Lomonossoff. Reference has already been made in these columns (NATURE, vol. lxxii. p. 42) to Prof. Menschutkin's more complete study in the Russian language of the work of this eighteenth century philosopher; the present abstract being written in German deserves notice, as it will serve

to make more widely known the views of a man of science whose speculations were in advance of the age in which he lived.

IN the *American Journal of Science* (vol. xix. p. 345) Mr. B. J. Harrington describes an investigation of a peculiar variety of fœtid calcite found near the township of Chatham, in the Grenville region of Canada. The calcite, although nearly pure, when struck or scratched evolves a powerful and unpleasant odour, which is shown to be due to hydrogen sulphide occluded in the mineral in minute cavities, probably in the liquid state. The proportion of hydrogen sulphide is about 0·016 per cent. of the weight of the calcite. A striking property of this variety is that when heated to 160° C. it shows a strong, deep yellow phosphorescence, which persists during several minutes after its removal from the source of heat.

IN part i. of vol. ix. of the *Transactions of the Royal Dublin Society*, Prof. J. A. McClelland continues the investigation which has already been mentioned in these notes (vol. lxxi. p. 543) of the relation between the atomic structure of substances and their power of giving rise to a secondary radiation under the influence of the β and γ rays of radium. It is shown that as the atomic weight increases the secondary radiation also increases, and that, as regards the latter, the elements may be arranged in a series of groups which correspond strictly with the periods of Mendeléeff's classification. The curve connecting atomic weight and the power of giving rise to a secondary radiation is of particular interest, as it throws light on the manner in which atoms are built up from electrons. It is important to note that the density of a substance has comparatively little influence on its power of producing secondary radiation.

THE catalogue of geological literature added to the Geological Society's library during the year ended on December 31, 1904, has just been issued. The catalogue is published by the Geological Society at the price of 2*s*.

THE index number of the *Psychological Review* for 1904 has just been published by the Macmillan Company of New York. The index is a very complete bibliography of the literature of psychology and cognate subjects for the year 1904, and has been compiled by Prof. Howard C. Warren, of Princeton University. It occupies no less than 240 pages, and contains 3445 entries of separate papers or volumes by psychologists of all nations.

OUR ASTRONOMICAL COLUMN.

A PROBABLE NOVA IN OPHIUCHUS.—From an examination of the Henry Draper memorial photographs in 1899, Mr. Fleming came to the conclusion that the star R.S. Ophiuchi was of the Nova type. Its spectrum, as shown on a plate taken on July 15, 1898, contained the hydrogen lines Hζ, Hϵ, Hδ, Hγ, and Hβ, and the lines at $\lambda\lambda$ 4656 and 4691 as bright lines, thus resembling Novæ Sagittarii and Geminorum. A spectrum obtained on July 14, the preceding day, confirmed the presence of these bright lines, whereas one photographed on August 28, 1894, was simply of the K type without bright lines.

Miss Cannon recently examined the light curve of this star since 1888, and found that it varied considerably and rapidly about the time at which the bright line spectra were obtained. Thus on May 31, 1898, the magnitude was only 10·8, but a month later, on June 30, it had become 7·7, and it subsequently decreased, at the regular rate of about one magnitude per month, until on October 8 it was only 10·8 again. A minor recrudescence took place in 1900, followed by another decrease, and since then the magnitude has remained faint at about 10·0, just as other Novæ, *e.g.* P Cygni, have, since the waning of their initial outbursts, remained fairly constant. An examination of several good chart plates revealed only a single star in the position occupied by this body. As many previous Novæ, having spectra similar to that of this star at its brightest, have been shown to have existed in the same positions prior to their discovery, Prof. Pickering contends that R.S. Ophiuchi should be classed as a Nova, when its proper designation would become Nova Ophiuchi No. 3, the new stars of 1604 and 1848 having appeared in the same constellation (Harvard College Observatory Circular, No. 99).

OBSERVATIONS OF PROMINENCES ON THE SUN'S LIMB.—In No. 5, vol. xxxiv., of the *Memorie della Società degli Spettroscopisti Italiani*, Prof. Mascari gives, for 1904, his usual annual summary of the observations of solar prominences made at the Catania Observatory. From the tables given we see that the prominence activity was augmented during 1904, also that the law that as the daily frequency of prominences increases their mean heliographic latitude decreases was confirmed; in 1902 the value was 48°·4, in 1903 it was 42°·1, but in 1904 it decreased to 36°·6. During the first quarter of last year the prominences occurred with a greater frequency in the southern hemisphere, but during the other three quarters the reverse was the case, the mean daily frequencies for the year being:—northern hemisphere 1·57, southern hemisphere 1·33.

A plate issued with the preceding number of the same journal shows, graphically, the positions and magnitudes of the prominences observed on the limb during the period March 14 to May 11, 1902, at the observatories of Catania, Kalocsa, Odessa, Rome, and Zurich. By thus combining the observations made at different places, it was possible to obtain a complete daily record for the whole period, with the exception of four days. Several outstanding disturbances are obvious, especially one extending from N. 42° W. to N. 84° W., and enduring as a limb disturbance from March 14 to 18.

DETERMINATION OF METEOR RADIANTS.—Commenting on a mathematical paper, on the determination of meteor radiants, recently read before the Royal Astronomical Society by Mr. Chapman, Mr. Denning issues a warning against the acceptance of any radiant, except in special circumstances, determined from the observations of less than five paths. The errors of observation, unless the observer has had much experience, are sufficient to overburden the catalogue of radiant points with a number of false radiants if three paths be accepted as sufficient data. When the altitude of the radiant is small, the meteors traverse long paths, and a consideration of three of these may give a satisfactory value, otherwise three is wholly insufficient. Mr. Denning advises meteor observers to keep a careful record of all faint showers suspected, and endeavour to corroborate them at the subsequent recurrences of the same epochs. By doing this and combining the results, well supported radiants may be established (*Monthly Notices of the Royal Astronomical Society*, April).

THE DEVELOPMENT OF SPECTROCHEMISTRY.[1]

THE series of optical researches carried on by the late Dr. J. H. Gladstone, at first in collaboration with the Rev. T. Pelham Dale, established the important fact that Newton's expression for refraction, $(n^2-1)/d$, is not constant, but varies considerably with the temperature. On the other hand, it was found that the more simple ratio $(n-1)/d$ remains practically constant.

Soon after 1860, Hans Landolt came forward with his optical researches. He began by confirming the results of Gladstone and Dale. He proceeded a step further, however, by following the example of Berthelot, and comparing the refractivity, not of equal, but of molecular

[1] Abridged from a discourse delivered at the Royal Institution on Friday, May 26, by Prof. J. W. Brühl.

quantities of the substances. If P represents the molecular weight, the product $[(n-1)/d]P$ is the *molecular refraction*.

Landolt examined particularly the fundamental question whether a different grouping of the same number of atoms of the same elements—which is the cause of isomerism—has any influence on the optical properties of bodies.

He established the important fact that only the relative weight of the elements is of influence on the molecular refraction of a compound, while the different grouping of the atoms has no appreciable effect; and this made it possible to determine the atomic refractions of the elements. The atomic refraction of carbon, for instance, was obtained by comparing the molecular refractions of two compounds which differed only by one atom of carbon; and in a similar manner the atomic refractions of the remaining elements were determined.

With the aid of these constants it was now possible to calculate *a priori* the molecular refraction of many organic compounds from the elements composing them, and Landolt showed that the calculated molecular refractions agreed very well with those determined by experiment.

Gladstone, in the course of his researches, was able to confirm Landolt's results in many cases. But he also found a considerable number of substances in which the observed molecular refraction was completely at variance with that obtained by adding the atomic refractions together. The exceptions were so numerous that they really seemed to overthrow the whole law of summation.

Shortly before 1880, when I was studying the literature of chemical optics, a brief note published by Gladstone in the *Journal of the Chemical Society* for May, 1870, excited my attention and curiosity. The author there discusses the exceptions to Landolt's rule of summation. He shows firstly that in all such cases the molecular refraction is never found to be too small, but always too great. Then he shows that whole classes of compounds behave in this abnormal fashion.

All optically abnormal compounds proved to be rich in carbon. Gladstone, therefore, examined the effect which a gradual increase of carbon in the composition of a body exerted on its refractivity. He found that there actually was an increase in the excess of the experimental as compared with the calculated molecular refraction, but the increase was not regular enough to explain the anomalies.

The saturated hydrocarbons, or *paraffins*, of the general composition C_nH_{2n+2}, showed *normal* molecular refraction. Also the *olefines*, containing two atoms less of hydrogen, were found normal by Gladstone. On the other hand, the hydrocarbons, containing six atoms less of hydrogen, viz. the *terpenes*, gave molecular refractions about 3 units larger than would correspond to their composition.

With the aromatic hydrocarbons, such as benzene, toluene, &c., containing eight atoms less of hydrogen, this abnormal excess amounted to 6 units:—

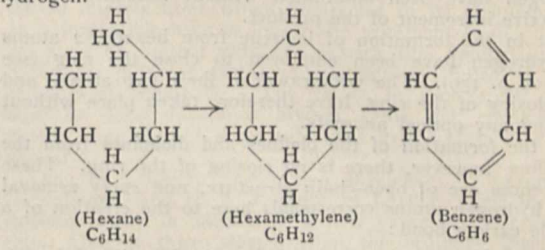
Paraffins	(C_nH_{2n+2})	Normal	
Olefines	,,	$-H_2$	,,
Terpenes	,,	$-H_6$	,, +3
Benzene and derivatives ...	,,	$-H_8$	,, +6

With still further decrease in the quantity of hydrogen contained (*i.e.* with further increase of carbon), there resulted greater and greater refractive increments. The last member of the series, however—pure carbon without any hydrogen, represented by the diamond—proved to be perfectly normal in its optical properties.

It seemed to me really extraordinarily remarkable that all optically abnormal substances, without exception, gave a too *high* molecular refraction. It was no less astonishing to me that the saturated hydrocarbons were optically normal, but became more and more abnormal at successive withdrawals of hydrogen—while pure carbon, uncombined with hydrogen, is again completely normal.

But I was most particularly struck by the quantitative amount of the abnormality in the case of benzene compounds, especially their refractive increment of *six* units. The number 6 fascinated me. I could not help thinking that therein lay the key to the mystery, and I lost no time in making use of it.

According to Kekulé's ingenious hypothesis we can imagine benzene, C_6H_6, to have arisen from the saturated hydrocarbon hexane, C_6H_{14}, by successive removal of hydrogen.



Thus altogether four pairs of hydrogen atoms have been removed. The elimination of the first pair was made the occasion to form another *simple* carbon bond, like those already present in hexane, and with it the ring was closed. The splitting-off of the other three pairs of hydrogen atoms, on the other hand, resulted in the formation of three *double* bonds of carbon atoms—a kind of bond which does not occur in the optically normal hexane.

Now Gladstone had found that benzene exhibits a refractive increment of 6 units. Reading this, I was struck in a moment by the thought: might not this abnormal refractive increment of benzene be due to its double carbon bonds, which are absent in the optically normal hexane? If this were so, I went on to reason, since *three* double bonds in benzene correspond to a refractive increment of 6 units, therefore *one* double bond must entail the increment of 2.

These ideas received no support whatever from the then known facts. For Gladstone had stated expressly that the olefines, *i.e.* open-chain hydrocarbons, containing *one* double carbon bond, were optically *normal*. However, I did not allow myself to be discouraged; and my expectations were confirmed by the very first experiment. The olefine examined not only proved to be optically abnormal, but gave the predicted refractive increment of 2 units, corresponding to the presence of *one* double carbon bond. Gladstone, therefore, as I had supposed, was mistaken in this case. Further experiments proved that not one of the olefines was optically normal. Without exception they gave the refractive increment of 2 units, one-third of that of benzene.

I next proceeded to examine the di-olefines—substances which contain *two* double carbon bonds. Here also, in conformity with expectation, a constant refractive increment was found, double as large as that of the olefines and two-thirds of that of benzene:—

Paraffins	(C_nH_{2n+2})	Normal	
Olefines	,,	$-H_2$	,, +2
Diolefines	,,	$-H_4$	,, +4
Benzene compounds... ...	,,	$-H_8$	,, +6

The dimensions of our subject this evening prevent the detailed demonstration of these important facts by experiment. I will only show you that the spectrum of a saturated hydrocarbon (a paraffin) is distinguishable at a glance from that of a substance containing double bonds.

On this screen we project the electric spectrum of metallic calcium. First we cause the rays of light to pass through a prism filled with paraffin oil. Then we exchange this prism for another, filled with a substance containing atoms linked by double bonds. (Experiment.)

In the second case you observe, first, a much greater deviation of the whole spectrum, *i.e.* greater *refraction*, and secondly, far wider intervals between the coloured lines of the spectrum, *i.e.* greater *dispersion*, which is usually correlative to the refraction.

Thus quantitative experimental confirmation was obtained for the view that abnormal refractive increments which increase with the diminution of hydrogen contained in the substances are caused by the presence of double carbon bonds.

At the same time, however, the experiments yielded a second result of fundamental importance. The olefines contain 2, and the diolefines 4, atoms of hydrogen less than the paraffins. Similarly the refractive increment of the olefines is 2, and of the diolefines 4.

Benzene, C_6H_6, contains 8 atoms of hydrogen less than the corresponding paraffin, hexane, C_6H_{14}. The increment of benzene, however, amounts not to 8, but to 6! Thus

in the formation of benzene from hexane, 2 atoms of hydrogen have been eliminated without influence on the refractive increment of the product.

But in the formation of benzene from hexane, 2 atoms of hydrogen have been employed to close the ring (see Fig. on p. 159). The withdrawal of these two atoms, and the closing of the ring, have therefore taken place without causing any optical anomaly.

In the formation of the olefines and diolefines from the paraffins, however, there is no closing of the ring. These substances are of open-chain structure, and *every* removal of 2 hydrogen atoms corresponds here to the creation of a double carbon bond :—

$H_3C{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_3$ Hexane (C_6H_{14})

$CH_2{=}CH{\cdot}CH_2{\cdot}CH_2{\cdot}CH_2{\cdot}CH_3$ Hexylene (C_6H_{12})

$CH_2{=}CH{\cdot}CH_2{\cdot}CH_2{\cdot}CH{=}CH_2$ Diallyl (C_6H_{10})

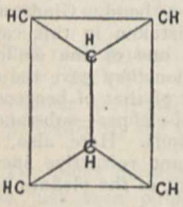
Hence, also, the refractive increment of the olefines and diolefines is directly proportional to the number of hydrogen atoms removed from the paraffin.

From all this it follows that the removal of hydrogen atoms causes optical anomalies only where double carbon bonds are created by the process. *The splitting-off of hydrogen which results in a closing of the ring is, on the other hand, without abnormal optical influence, and produces no refractive increment.*

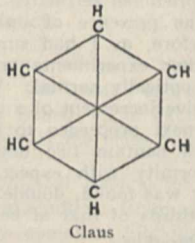
This latter principle, which has since been confirmed many times by experiment, has proved of the same importance as the first in the investigation of the chemical structure of bodies.

A few examples will show how these two principles can be utilised for the discovery of chemical structure.

Besides the formula already mentioned for benzene—that suggested by Kekulé—several others have been proposed, *e.g.* those by Ladenburg and Claus :—



Ladenburg



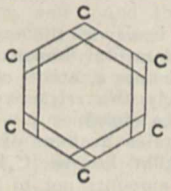
Claus

Neither of these graphic formulæ is reconcilable with the results of spectrochemical investigation, because the neighbouring carbon atoms contained in them are associated only by single, cycloid, or ring-closing affinities, and not by any so-called double bonds. Substances of this kind should be optically normal, while benzene and its derivatives are, as a matter of fact, abnormal. Kekulé's formula for benzene is really the only graphic representation of its structure in a single plane which is confirmed by chemical optics.

Thus it can be at once determined by optical methods whether a given body belongs to the paraffinoid, olefinoid, or cycloid products, whether these products contain double bonds or not, and, if so, how many.

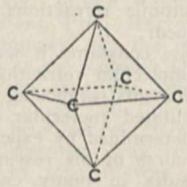
Now, too, we can imagine why the diamond, *i.e.* pure crystallised carbon, is, as already mentioned, optically normal. We obtain an idea of the chemical constitution of the mineral, and of the way in which the atoms of carbon are perhaps combined in the sparkling gem.

For the reasons already stated, the diamond cannot possibly contain any double bonds; a combination, say, in the form



with one atom of carbon at each of the six corners, and with each atom connected with its neighbour by a double bond, is altogether impossible.

Imagine, however, at each of the six corners of a regular octahedron, a single molecule of marsh-gas, CH_4, *i.e.* altogether C_6H_{24}, and then imagine all the 24 hydrogen atoms successively removed, so that each carbon atom is connected with each of its neighbours only by a single bond, and thus all six atoms of carbon are united together in a single whole. Then you obtain, as the most simple representation of the molecule of the diamond, a regular octahedron, with one atom of carbon at each of its six corners, while the edges represent the mutual bonds :—



Several simple molecules of this kind may be combined into one crystallised particle of the spectrochemically normal diamond.

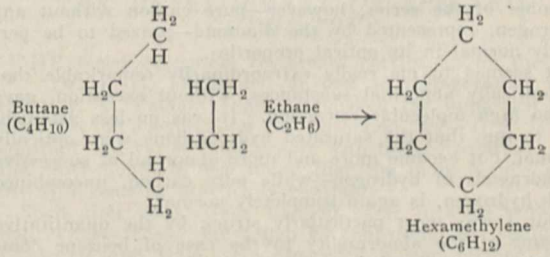
Thanks to the explanation of the optical behaviour of benzene, with the resultant discoveries, it all at once became possible to understand the causes of the spectrochemical abnormality of whole classes of bodies, such as the olefines, diolefines, terpenes, aromatic compounds, &c., and light was cast on the chemical constitution of whole classes of bodies.

At the same time, however, it at once became apparent why both Landolt and Gladstone had succeeded in observing complete optical normality in very numerous substances of the most various types—alcohols, acids, ethers, hydrocarbons, &c. And now it was understood why in such bodies the molecular refraction is determined solely by the component elements, while the different grouping of the atoms, *i.e.* the isomerism, remains without any appreciable optical influence.

All the bodies of this kind proved to be either paraffins, *i.e.* saturated hydrocarbons, or simple derivatives of the same. But the paraffins, as we now know, are always optically normal, because they contain no double carbon bonds. For this reason all such simple derivatives of the paraffins must also be normal. Their molecular refraction will thus always correspond to the elements of which they are composed, however the atoms may be grouped, *i.e.* chemical isomerism is here also without influence.

For the same reason, however, all cycloid (ring-shaped) closed formations, if they contain no double carbon bonds, must be optically normal, for those bodies also may be conceived as originating in the simple replacement of hydrogen by paraffin fragments, and may therefore be regarded as combined paraffins.

Thus we can imagine the hexamethylene already mentioned not only as formed from hexane by removal of *two* hydrogen atoms from the ends, but also as arising from ethane and butane, *i.e.* from two paraffins, by the removal of *four* hydrogen atoms and welding together of the remains :—



As a combined paraffin, hexamethylene must be normal, as is also confirmed by experiment, and here we see again, as in the case of the diamond, that a progressive removal of hydrogen and increase of carbon need not lead to the slightest optical anomaly.

At the same time there arises here a case of the optical influence of isomerism, for hexylene, which has already been mentioned, with the same formula (C_6H_{12}) as hexamethylene, but in structure an olefine :—

$$CH_2=CH\cdot CH_2\ CH_2\cdot CH_2\cdot CH_3$$

possesses the familiar refractive increment of 2 units. This example again shows how the spectrochemical behaviour of a body discloses its chemical structure by enabling us to distinguish with certainty between an optically normal cycloid (or ring-substance) and an isomeric open-chain olefinoid formation, which is optically abnormal.

Carbon can thus act variously upon light according to the manner in which its atoms are combined. We can therefore transfer the refractive increment of the double bond to the atom itself.

In the diamond, and in all paraffinoid carbon compounds, the atomic refraction of carbon equals 5 : it is therefore equal to 10 for two carbon atoms. The double bond increases the refraction by 2, so that for two carbon atoms with a double bond the refraction amounts to 12. The atomic refraction of *one* carbon atom with a double bond is therefore equal to 6, *i.e.* 20 per cent. greater than that of the atom with the single bond :—

	Atomic Refraction
1 Carbon atom C (diamond and paraffins)	5
2 Carbon atoms 2C (diamond and paraffins) ...	10
Double bond	2
2 Carbon atoms with a double bond (C=C ...	12
1 Carbon atom with a double bond (C= ...	6

Carbon, being a quadrivalent element, can also appear with *triple* bonds :—

$$R.C\equiv C.R$$

Experiment has shown that carbon with a triple bond also acquires a special atomic refraction.

Thus it becomes possible to establish the presence of this kind of bond in substances, and to distinguish it from the double and simple bonds—a further criterion of structure.

In consequence of these discoveries it became highly probable that all multivalent elements, such as carbon, possessed an atomic refraction varying with the kind of bond, while the univalent elements, such as hydrogen, display constant optic values because atoms such as theirs can only be linked with a simple bond.

Later researches have confirmed this. The univalent halogens give, like hydrogen, constant atomic refractions, both in the elementary state and in their compounds. The multivalent elements, on the other hand, such as oxygen and nitrogen, display different optical values, according to the kind of bond.

In the course of such researches the behaviour of oxygen as a quadrivalent element, which had been previously conjectured, was established with certainty, and afterwards confirmed synthetically by Collie, Tickle, and others.

The theory which accounted for the optical abnormalities of certain classes of bodies, making them, in fact, abnormalities no longer, has proved extraordinarily fruitful. It formed the starting point of all subsequent discoveries in the subject, and, indeed, we may describe the progress of this branch of science during the last twenty-five years as based essentially on this conception.

For not until we had fathomed the mystery of the benzene refractive increment 6 was it possible to know for certain that the variable valency of the multivalent elements is always of determining influence on the optical behaviour of bodies. Thus for the first time a spectrochemical method was called into being for the study of chemical structure, and the foundations were laid of what we now call "spectrochemistry."

We must now return once more to the formula for refractivity. Newton's expression $[(n^2-1)/d]P$ had proved not constant for the temperature in the case of fluid bodies, and was, therefore, replaced by Gladstone and Dale's more satisfactory ratio $[(n-1)/d]P$. For twenty years and more this did admirable service. As, however, the number of observations kept on increasing, even this formula betrayed imperfections which finally led to its abandonment. It is impossible here to follow the argument in detail, and we must be content with the remark that comparisons of bodies in different states of aggregation failed to yield satisfactory constants. The values of $[(n-1)/d]P$ for a fluid or solid substance always came out considerably greater than for the same substance in the state of gas or vapour.

Then by a happy chance two physicists, L. Lorenz, of Copenhagen, and H. A. Lorentz, of Leyden, came forward simultaneously in 1880 with a new expression for refraction. One of them started from the ordinary theory of light, the other from Maxwell's electromagnetic theory of light based on Faraday's views, and they both reached the same result, viz. that the true measure of refractivity is furnished by the expression

$$\left(\frac{n^2-1}{n^2+2}\right)\frac{P}{d}$$

Experimental tests showed that this theoretical expression was, in fact, for all bodies, practically unaffected not only by temperature and pressure, but also by the state of aggregation.

Chemical tests confirmed the utility of the new optical standard, since the operation of all the laws before mentioned was observed to be even more exact when the new constant was applied.

Moreover, the expression for refraction proved valuable in another respect. It was found to be very suitable for measuring the *dispersive* power of bodies.

If n_v and n_r denote the refractive indices for the limits of the visible spectrum, *i.e.* for violet and for red light, the difference of the refractivities for these end-rays of the spectrum,

$$\left(\frac{n_v^2-1}{n_v^2+2}-\frac{n_r^2-1}{n_r^2+2}\right)\frac{P}{d}$$

is the measure of the power of different bodies to *disperse* light—to broaden out the spectrum. This ratio proved to be constant as regards temperature, pressure, and state of aggregation.

Gladstone had already observed that dispersion, like refraction, was connected with the chemical nature of bodies. Quantitative relations were, however, only obtained when a constant for refractivity had been found. And then from the molecular dispersions of compounds the atomic dispersions of their elements were deduced.

We cannot enter here into the relations which were thus shown to exist between the chemical composition of substances and their power to disperse light. We need only remark that the case as a whole is analogous to that of refraction. Dispersion is, however, a still more sensitive and more constitutional property, and therefore in many cases it is specially adapted as an aid to research on chemical structure.

It only remains to add a few remarks on the applications of spectrochemistry in science and in practical life.

It has already been shown the principles on which spectrochemical methods of examination in general can be applied to the solution of scientific problems, to the discovery of the chemical structure of single substances or whole classes of bodies.

Now there is a large number of substances, some of them artificially built up by synthesis out of their elements, some of them occurring in the vegetable and animal kingdoms, or even in inorganic nature, the structure of which is of remarkable delicacy and instability. Among them are, for instance, the so-called "tautomeric" compounds, hydrogen peroxide, and many other unstable compounds. Substances of this kind are of a very special interest, for in consequence of their tendency to change, they are the principal cause of metamorphoses, the unceasing circulation of matter, the eternal birth and decay that go on in nature.

Research in the atomic structure of such bodies by purely chemical methods is often very difficult, and not seldom impossible, because, owing to their sensitive organisation, chemical interference leads either to changes in the grouping of the atoms, which cannot always be controlled, or even to total decomposition.

In such cases it is of course of the greatest value to be able to examine the constitution of the bodies without affecting them chemically; and spectrochemistry, as we have seen, gives us the means of doing so. By observing the behaviour of light on its passage through the various substances, we gain an insight into their structure without in any way disturbing it.

In the last ten years the spectrochemistry of the nitrogen compounds has also made remarkable progress. Nitrogen is of the greatest importance as an essential constituent of the proteids, the alkaloids, and many other animal and vegetable products. But its high valency and the extraordinary variety of combinations into which it can enter with other elements surround it with special complications. Regardless of these, however, the spectrochemical examination of nitrogen compounds has already yielded useful results, especially in the study of the alkaloids. It is to be expected that this optical method will also be of use in the chemistry of the albuminoids, the study of which is now being prosecuted with so much vigour.

One class of substances of increasing importance both to science and to chemical industry is that constituted by the natural and artificial perfumes. An overwhelming majority of them consist of derivatives of the terpenes. We have already mentioned that Gladstone, in this subject also a pioneer, was the first to study the optical behaviour of the terpenes. Since then the explanation of the structure of these bodies and of a large number of rich natural perfumes derivable therefrom has been rendered easier by the use of spectrochemical methods. Similar assistance has been rendered to the synthetic preparation of valuable scents, such as ionone, the artificial scent of violets. In every scientific laboratory and in every rationally conducted chemical factory where work is being done on perfumes, the spectrometer is now an indispensable testing instrument, and hence also an implement in industrial production.

When scientific research opens up new methods of observing nature, it is generally not long before a use is found for these methods in practical life. The need is soon felt of perfecting, and at the same time simplifying, the scientific apparatus. Efforts in this direction have not been wanting in the case of the spectrometer, and they have been crowned with the most brilliant success.

Prof. Abbe, the distinguished physicist who died not long ago, and after him Dr. Pulfrich, constructed spectrometers on the principle of total reflection. These instruments are distinguished from those formerly in use by their extraordinary simplicity and convenience, and they allow also of much more rapid work.

Such instruments, known as total reflectometers, have been made for the most exact scientific measurements, and also for medical and technical purposes. Special forms are in use for the examination of fats and oils, milk and butter; to determine the amount of salt contained in salt solutions; the amount of alcohol and extractive matter in beer; for the examination of blood and albuminoids in pathological fluids, &c. Several of these ingeniously contrived instruments give not only the refractive index and the dispersion of a substance immediately, without any calculation, but also directly the percentage of dissolved matter, *e.g.* of alcohol and extractives in beer.

THE MIOCENE FORMATION OF MARYLAND.

WE have received from the Maryland Geological Survey a memoir on the Miocene formation of the State, in two volumes, text and plates. This is the second of a series of reports dealing with the systematic geology and palæontology of Maryland, that on the Eocene having been previously published, while reports on other formations are in progress. We may heartily congratulate the State geologist, Dr. Wm. Bullock Clark, on the appearance of these volumes, which in type and illustrations leave nothing to be desired, while the subject-matter, the result of labours extending over fifteen years, represents the combined work of field geologists and of experts in various branches of palæontology.

Of special interest is a chapter by Mr. W. H. Dall on the relations of the Miocene of Maryland to that of other regions and to the recent fauna. He points out that the differentiation of faunas in European and North American areas was well established before the beginning of the Tertiary, so that in the early stages of that epoch the faunas in the west show American characteristics clearly as compared with those of Europe. Other differences, suggesting migrations, occur in the relative time of appearance of certain groups; as, for instance, in America, the first influx of Nummulites is in the upper beds of the lower Oligocene, just as these lowly forms of life were about to disappear from the European fauna, where they had long flourished. In the history of the American Miocene there are many differences and many points of agreement with European equivalents, which are duly pointed out. As in Europe, the Miocene was a period of elevation, of plication of the earth's crust, of denudation, and of the deposition over extended areas of sediment, chiefly of clays, sands, and marls, more or less consolidated. Diatomaceous deposits also occur.

In an introduction Dr. Clark discusses the general stratigraphic relations of the Miocene deposits of Maryland, which have long been known for the rich faunas which they contain. The Oligocene is not represented, and the strata lie unconformably on the Eocene. The palæontological relations, the subdivisions and geographical distribution of the strata are dealt with by Mr. G. B. Shattuck, who gives an elaborate table showing the localities and horizons of the species. The bulk of the volume is taken up with the systematic palæontology, the results of an exhaustive study of the fauna, embracing both a critical review of the species described by previous authors, as well as descriptions of a large number of new forms. As remarked by Dr. Clark, the description of species of fossils is of little scientific importance to the geologist, unless the object is something more than the mere multiplication of new forms. In the present case the endeavour has been made to clear up doubtful points in synonymy and to give as complete an account as possible of the geological and geographical ranges of the fossils. All groups from the Mammalia to the Radiolaria, Foraminifera and plants come under notice. The higher vertebrates are dealt with by Dr. E. C. Case, the fishes by the late Dr. C. R. Eastman, many of the invertebrates by Dr. G. C. Martin, the Echinodermata by Dr. Clark, and the remaining groups by other authorities.

The palæontology is illustrated by 135 plates, while in the volume of text there are sections, numerous pictorial views, and a coloured geological map. The work is well indexed, and there is a useful geological bibliography.

MINERAL PRODUCTION OF INDIA.

AN interesting new departure has been made by the Geological Survey of India in devoting the last issue of the *Records* (vol. xxxii., part i.) to a review of the mineral production of India during the years 1898 to 1903, by Mr. T. H. Holland, F.R.S., director of the Survey. This review, which covers 118 pages, with 6 plates, compares very favourably with the statistics of many countries where the facilities of obtaining information regarding the mineral production are far greater than in India. The period covered is six years, and it is intended in future to issue quinquennial reviews. The minerals are divided into two groups:—(1) those for which fairly trustworthy returns are available, and (2) those for which definitely recurring particulars cannot be procured. It is curious to note that in the review of mineral production in India issued by Sir George Watt in 1894, four minerals, salt, coal, iron ore, and petroleum, were the only representatives of the first group, whereas it is now possible to obtain trustworthy returns of the production of thirteen minerals, coal, gold, graphite, iron ore, jadeite, magnesite, manganese ore, mica, petroleum, rubies, salt, saltpetre, and tin.

The production of salt, which was 358,000 tons in 1898 and 336,000 tons in 1903, showed considerable fluctuations during the period under review; but in the case of all other minerals there was substantial progress. The Indian coal output rose from 4,000,000 tons in 1897 to 7,500,000 tons in 1903. The production of gold steadily increased from 390,505 ounces to 603,218 ounces. The production of saltpetre also increased, the average

annual exports having amounted to 382,000 cwt. The petroleum industry increased at a greater rate even than coal mining, the production having risen from 19,000,000 gallons in 1897 to 88,000,000 gallons in 1903. Rubies form, next to petroleum, the chief source of revenue from minerals in Burma, the value of the output having risen from 57,950*l*. to 98,575*l*. In the case of mica, India is the leading producer, and supplies half the world's consumption. The value of the mica produced in 1898 was 53,890*l*., and in 1903 86,277*l*. The waste heaps are now turned over to supply the cheaper varieties required for the manufacture of micanite for electric insulation. The rapid development of the manganese ore industry has been very remarkable. Twelve years ago mining had hardly begun, and now more high-grade ore is produced than in any other country except Russia. The value of the output in 1898 was 27,426*l*., whilst in 1903 it was 132,741*l*. Jadestone, which is being exported in increasing quantities to the Straits and China, with an average annual value of 44,770*l*. for the mineral exported, must be classed among the important minerals, its value being seven times that of the tin and half that of the rubies. Iron ore is mined to supply the Barakar works and the old charcoal furnaces still persisting in the more remote districts. In view of the fact that the imports of iron and steel are increasing year by year, there appear to be good grounds for utilising the abundant ore supplies by starting iron works on a large scale. During the period under review the graphite deposits of Travancore and the magnesite deposits of Salem received attention, and now form serious items in the comparatively limited markets of these minerals. Tin is more widely distributed in India than is generally recognised, and in South Burma river gravels are washed for tin with considerable commercial success.

The minerals for which statistics of production are incomplete are of a very varied nature, the list including alum and aluminium ore, amber, antimony, arsenic, asbestos, borax, building stones, chromite, clays, copper ore, corundum and other abrasives, gem stones, glass-making sands, lead, silver and zinc ores, millstones, mineral paints, mineral waters, phosphates, rare earths, slate, sodium compounds, steatite, and sulphur. It is evident that there is great scope for development in the mining of metalliferous minerals and of minerals that are needed for the more complicated chemical and metallurgical industries. This is not surprising in view of the fact that by-products are indispensable sources of profit in modern chemical and metallurgical practice; and India must continue to pay taxes on imports until industries arise demanding a sufficient number of chemical products to complete an economic cycle. Until that time, ores that will not pay to work for their metal contents alone must necessarily be neglected.

DISEASES OF FOREST TREES.

THE Board of Agriculture and Fisheries has recently issued a set of nine diagrams illustrating the diseases of forest trees. The set is composed of forty-five coloured figures. Very scant attention has been paid to this important branch of forestry in the past, and it is only within comparatively recent times that such works as those of Hartig and Sommerville, Tubeuf and Smith, Marshall Ward, Massee and others have directed attention to the importance of the study of tree diseases from a practical point of view. By such means the public has come to realise that plants, like animals, are subject to various ailments which, if not attended to, may become epidemic and cause serious loss, not only in forestry, but also in the sister industries of agriculture and horticulture. As an instance of the serious loss which may be caused by fungus disease in trees, we need only mention the larch canker fungus, which has in many cases reduced one of the most stately trees of Europe to an unsightly cripple, and is thereby responsible for the loss of many hundreds of thousands of pounds in this country alone. Its ubiquity in this country is no doubt in a large measure due to the lack of proper care in the selection of localities and proper treatment of this timber tree. This is only one of the many examples of the havoc which may be wrought by epidemics among forest trees, and in addition to this the fruit-grower, the farmer, and the gardener could also furnish parallel examples to swell the list. As we have already stated, the importance of these matters is becoming greater as scientific investigation proceeds. It is of vital importance in practice that a plant disease of any kind should be recognised in its earliest stages, as it is then in most cases capable of being stamped out. It is too late to adopt preventive measures when the presence of the disease is made known by the destruction of the crop.

The importance of the whole subject to the public in general is shown by the fact that the Board of Agriculture has issued the above valuable series of diagrams, each illustration being accompanied by a printed description on a separate sheet.

The set contains the best series we have of the diseases of forest trees, and should find a place not only in all our universities and colleges, but in every school throughout the country. It is absolutely indispensable to all foresters and to those interested in the growth and production of timber.

The price, which is one shilling per diagram, should bring the set within the reach of all.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The council of the Senate has had under its consideration an offer received from the Surveyors' Institution to provide scholarships in the university, with the object of affording facilities for the higher education of surveyors in branches of scientific knowledge cognate to their profession. The council, after consultation with the Board of Agricultural Studies, is of opinion that the offer should be gratefully accepted. The scholarships will be called "The Surveyors' Institution Scholarships"; they will be three in number, one to be awarded annually. Each scholarship will be tenable for three years, and will be of the value of 80*l*. per annum.

The general board of studies has approved the name of Mr. A. N. Whitehead for the degree of Doctor in Science.

In the mathematical tripos, part i., the senior wranglers (bracketed equal) are Mr. J. E. Littlewood and Mr. J. Mercer, both of Trinity.

OXFORD.—The following have been appointed examiners in the science schools:—P. J. Kirkby (physics), D. H. Nagel (chemistry), Gustav Mann (physiology), J. G. Kerr (zoology), Robert Howden (anatomy), James Ritchie (pathology), D'Arcy Power (surgery), W. W. Fisher (preventive medicine and public health).

Decrees have been passed to authorise the expenditure of 475*l*. on extending the system of electric lighting in the university museum, to raise the total emoluments of the Wykeham professor of physics to 800*l*. a year, and to raise the salary of his demonstrator in advanced work by 100*l*. a year, so that he may take charge of the laboratory both in vacation and term time on occasions of the absence of the professor.

The honorary degree of D.Sc. has been conferred on Prof. Ray Lankester, who delivered the Romanes lecture on June 14, and the degree of D.M. on Prof. William Osler.

Only one man of science—Prof. G. H. Darwin—is included in the list of honorary degrees for the Encænia this year.

PROF. A. S. MACKENZIE, professor of physics in Bryn Mawr College, has been appointed to the chair of physics in Dalhousie College.

THE Senate of the University of Birmingham has decided to invite Sir Archibald Geikie, F.R.S., to deliver the Huxley lecture in 1906.

WE learn from *Science* that it is announced that Harvard University has received an anonymous gift of 20,000*l*. for a museum of social ethics, and 10,000*l*. from Mr. Jacob H. Schiff, of New York, for explorations in Palestine.

AN exhibition of practical work executed by students of technical classes and by candidates at the recent annual examinations of the City and Guilds of London Institute will be opened at the Imperial Institute on Wednesday, June 28, by the Right Hon. Earl Spencer.

THE announcement is made in *Engineering* that Mr. Yarrow has placed at the disposal of the council of the Institution of Civil Engineers the sum of 10,000*l.* to be applied to the education of necessitous members of the engineering profession. It is pointed out that the engineering industry of the country will benefit from this help to technical education. The old system of premium apprenticeship is passing away, and it is coming to be recognised that the prosperity of any manufacturing nation rests on engineering, and that a foundation for the commercial success of a country cannot be maintained without the aid of a body of scientific engineers. The era of happy-thought invention is fast passing, and the opportunity for original work must chiefly depend on the application of science to perfecting known principles. Gratitude should, therefore, be felt for the public spirit which has placed in the hands of the Institution of Civil Engineers the means of giving a better training to a class that has had few opportunities in the past.

THE foundation-stone of the new buildings of University College, Reading, was laid on June 6 by Lord Goschen, Chancellor of the University of Oxford. The freehold of the new buildings is a gift to the college by Mr. Alfred Palmer. The erection of the college hall and the buildings for the practical study of various branches of pure and applied science will be undertaken immediately, but substantial additions must be made to the building fund before the scheme as a whole can be carried out. At the luncheon following the ceremony, Mr. W. M. Childs, the principal of the college, said the day would be memorable in the annals of the college because of a splendid benefaction. Throughout its history the college had been exposed to peril by the absence of endowment. He then announced that Mr. George William Palmer had informed the president of the college of his intention to offer a sum of 50,000*l.* as a permanent endowment fund, to be called "The George Palmer Endowment Fund." In a letter to the president announcing his intention, Mr. Palmer said:—"My intention is to provide that the capital fund of the endowment shall not be applied to the erection of buildings, but shall be permanently invested, and that the income shall be applied to the educational work of the college. I also desire to make it a condition of my gift that the college shall maintain its *status* as a university college in the town of Reading, and that it shall always give higher teaching in literature and in science, and, further, that it shall carry on evening classes, open at moderate fees to those engaged in earning their living during the day-time." Lord Goschen, in the course of a few remarks, referred to the direct missionary work which had been conducted by the old universities through the university extension lecturers. They were, he said, the missionaries of culture throughout a great part of our islands, and they had carried the flag of culture into many a town. A great variety of subjects is now taught in the college, but all that is taught, said Lord Goschen, is taught in a thorough, academic, and scientific manner. It is for the professors to see that the cause of culture, the cause of scientific study, shall not be neglected in these days. "Amid the hustling of those who champion various causes," continued Lord Goschen, "may I at least put in a word for higher culture? May I echo what Mr. George William Palmer has written, that literature and science may hold their own in this country apart from useful knowledge?" The president of the college announced that 80,000*l.* is required for the building fund, and of that sum 35,700*l.* has been subscribed.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 11.—"On the Resemblances existing between the 'Plimmer's Bodies' of Malignant Growths, and Certain Normal Constituents of Reproductive Cells of Animals." By Prof. J. Bretland **Farmer**, F.R.S., J. E. S. **Moore**, and C. E. **Walker**.

The authors, continuing their investigations on malignant growths, have examined the so-called "Plimmer's Bodies" of cancer cells in connection with the cytological changes that occur in cancer and in reproductive cells respectively. The "Plimmer's Bodies" are found in many cancerous growths, and are most commonly encountered in the younger or growing regions of the tumour. They appear in the form of vesicles, and they consist essentially of a fairly well defined wall containing a clear space in which is suspended a small darkly staining granule (Figs. 1 and 2). They are most commonly to be met with in

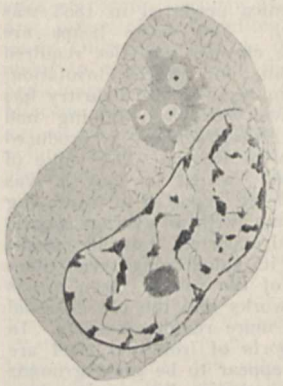


FIG. 1.

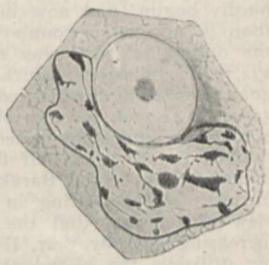


FIG. 2.

FIGS. 1 and 2.—Examples of "Plimmer's Bodies" from carcinoma. 1. Three small "Bodies" in an archoplasm. 2. Later stage in the development of the "Bodies."

tumours of a glandular or glandular-epithelial origin. They lie in the cytoplasm of the cancer cell, and usually in close proximity to the nucleus. In size, they vary from excessive minuteness to that of the nucleus itself.

The special interest attaching to them depends on the fact that they have commonly been regarded as peculiar to cancerous cells, although Honda believes he has occasionally also encountered them in inflammatory tissues. They have been variously interpreted. Some investigators have regarded them as parasitic organisms, more or less intimately connected with the etiology of the disease, whilst others have seen in them a differentiation of the cytoplasm of the cancerous cell itself. It has been suggested also that they might be derived from the centrosomes within the archoplasm, but the observations of Benda that centrosomes coexisted independently of them in the cell have rightly been held to disprove this hypothesis.

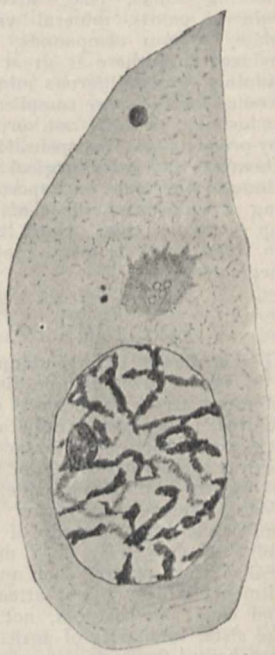


FIG. 3.—Archoplasm with centrosomes lying outside it in prophase of the first maiotic division in testis of mouse.

The authors' investigations indicate, however, that there are good grounds for re-considering the whole position, and a comparison of the processes that normally obtain during the final stages of development of the reproductive elements in man and the other mammalia appears strongly to suggest that a parallel between the "Plimmer Bodies" of cancer and certain vesicular structures occurring regularly in the gametogenic, but not in the ordinary somatic, cells, may be found to hold good.

It was shown in 1895 that during the prophase of the heterotype (first maiotic) mitosis of the spermatogenetic cells, the archoplasm undergoes a highly characteristic and peculiar metamorphosis. In normal somatic, or pre-maiotic, cells, the archoplasm is seen to lie beside the nucleus as a dusky mass of protoplasm in which are con-

tained the centrosomes. That is, the attraction sphere consists of the archoplasm *plus* the centrosomes.

But during the prophase of the heterotype mitosis these constituents become separated. The centrosomes are found to lie *outside of*, and detached from, the archoplasm (Fig. 3). At the same time the archoplasm itself undergoes a change. It becomes vesiculated, and finally, at the close of this cell generation, it is lost in the general cytoplasm of the daughter cells.

In the prophase of the second maiotic division (homotype) the same phenomena recur. When the homotype mitosis is over, the constituents of the sphere, or at least some of them, enter into direct relation with parts of the

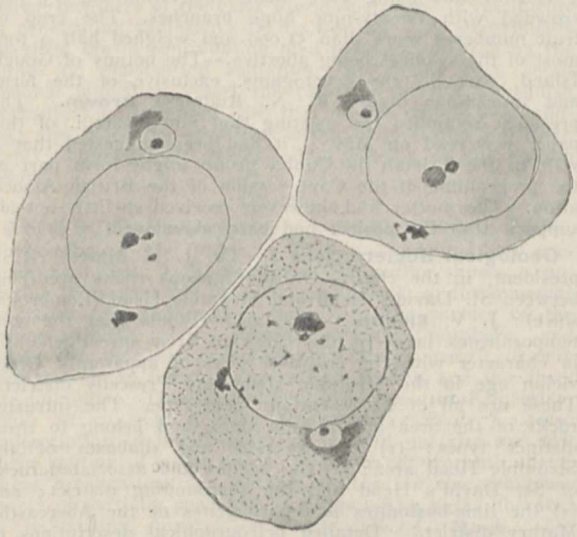


FIG. 4.

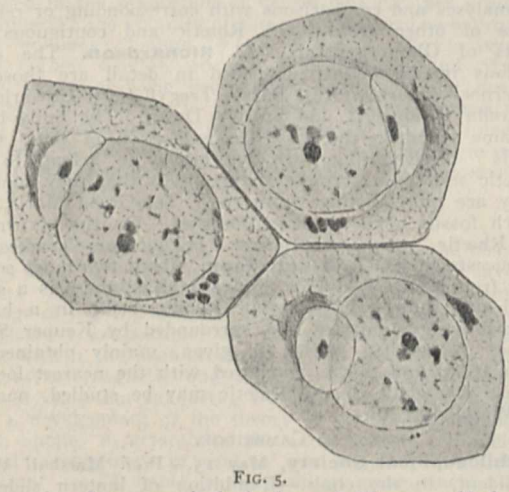


FIG. 5.

FIGS. 4 and 5.—Later stages in the development of the spermatid of mouse.

spermatozoon which arises by further differentiation of the cell. As regards the archoplasm, it is again seen to contain a number of minute vesicles which continue as before to grow in size, whilst each contains a single refractive and stainable granule (Fig. 3). Subsequently, several of these vesicles fuse together, so that at a later stage in the metamorphosis of the cell into a spermatozoon there only remains a single large clear body, bounded by a distinct membrane, containing in the centre one or more darkly staining granules (Figs. 4, 5, 6).

This body, originally described in 1895 as the archoplasmic vesicle, is a very conspicuous and apparently constant feature peculiar to the spermatogenetic cells of, at any rate, the Vertebrata, and it has since been encountered beyond the limits of that group.

When fully developed it often assumes a size approximating to that of the nucleus. Indeed, the latter is often deformed and made to assume a crescentic or cup-like shape owing to the enlargement of the adjacent archoplasmic vesicle. The vesicle and its contents ultimately form the so-called "cephalic cap" of the spermatozoon.

The remarkable similarity between the structure just described and those known as "Plimmer's Bodies" will have become obvious. It is not, perhaps, accidental that just as in the case of nuclear divisions, so also in the cellular inclusions, a parallelism between the cells of reproductive tissues and of cancer cells should be found to exist. But the cells of cancer are not therefore regarded as *identical* with those of the sexual cells, as was carefully pointed out in the first communication of the authors in 1903.

But the resemblances between what have been termed gametoid and the true gametogenic cells now seem to be even more significant than they appeared to be at that time. Both classes of cells are autonomous to a very high degree, and both possess the faculty of continuous or intermittent multiplication independently of the tissue requirements of the organism. And finally, both exhibit cellular and nuclear metamorphoses which not only, *mutatis mutandis*, resemble one another, but differ materially from those pertaining to the normal somatic cells.

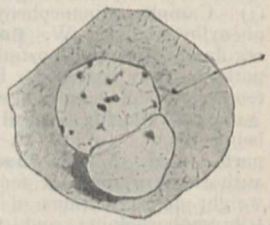


FIG. 6.—Slightly later stage in the spermatid of man, with centrosomes and tail.

It is possible that the malignant elements are the outcome of a phylogenetic reversion, but the matter is obscured by the disturbing influences that have been operative during the actual ontogeny of the cells and tissues from which these elements have sprung. If this be so, the connection apparent between gametoid and the true reproductive cells will acquire a still deeper significance; the full discussion of this question is reserved for another occasion.

May 18.—"The Atomic Weight of Chlorine: an Attempt to Determine the Equivalent of Chlorine by Direct Burning with Hydrogen." By Prof. H. B. **Dixon**, F.R.S., and E. C. **Edgar**.

In the whole of nine experiments described by the authors 9·1786 grams of hydrogen combined with 323·0403 grams of chlorine; hence the equivalent weight of chlorine, calculated in mass, is 35·195.

The number obtained for the atomic weight of chlorine is appreciably higher than that calculated by F. W. Clarke from the previous determinations, and is slightly higher than Stas's value:—

Clarke's calculation	Stas	Dixon and Edgar	
35·179 ...	35·189 ...	35·195 ...	H = 1
35·447 ...	35·457 ...	35·463 ...	O = 16

G. P. Baxter quotes the value 35·467 as being obtained by Richards and Wells for the atomic weight of chlorine—a number slightly higher than the authors'.

Chemical Society, June 1.—Prof. R. Meldola, F.R.S., president, in the chair.—The constituents of the seeds of *Hydnocarpus Wightiana* and of *Hydnocarpus anthelmintica*. Isolation of a homologue of chaulmoogric acid: F. B. **Power** and M. **Barrowcliff**. The authors found that the oils of these two seeds very closely resemble chaulmoogra oil, consisting chiefly of the glyceryl esters of chaulmoogric acid and a lower homologue of the same series, which has the formula $C_{16}H_{28}O_2$, and is designated *hydnocarpic acid*. The oil of *Hydnocarpus Wightiana* appears to contain also a very small proportion of an acid or acids belonging to the linolic or linolenic series.—The constituents of the seeds of *Gynocardia odorata*: F. B. **Power** and M. **Barrowcliff**. The oil expressed from the seeds was found to consist of the glyceryl esters of linolic acid or isomerides of the same series, palmitic acid, linolenic and *iso*linolenic acids, and oleic acid.—The relation of ammonium to the alkali metals. A study of

ammonium magnesium and ammonium zinc sulphates and selenates: A. E. H. **Tutton.** With regard to molecular volume, the topic axes, and molecular refraction, the ammonium salt of any double salt group of the series behaves almost exactly like the rubidium salt.—Camphoryl-azoimide: M. O. **Forster** and H. E. **Fierz.**—Influence of substitution on the formation of diazoamines and aminoazo-compounds, part iii., azo-derivatives of the symmetrically disubstituted primary *meta*diamines: G. T. **Morgan** and W. O. **Wootton.** The following new diamines have been prepared and characterised:—*6-chloro-4-nitro*-m-*phenylenediamine*, *6-bromo-4-nitro*-m-*phenylene-diamine*, and *di-iodo*-m-*phenylenediamine*.—Diazo-derivatives of monoacylated *para*diamines: G. T. **Morgan** and F. M. G. **Micklethwait.**—The significance of optical properties as connoting structure; camphor-quinone-hydrazones-oximes: a contribution to the theory of the origin of colour and to the chemistry of nitrogen: H. E. **Armstrong** and W. **Robertson.**—Solubility as a measure of the change undergone by isodynamic hydrazones. (1) Camphorquinonephenylhydrazone; (2) acetaldehyde-phenylhydrazone: W. **Robertson.**—The design of gas-regulators for thermostats: T. M. **Lowry.** Two new patterns are described. By means of one of these the temperature of a bath of water may be maintained within $\pm 0^{\circ}\cdot01$ C. during several weeks, the average fluctuation being about $\pm 0^{\circ}\cdot002$ C.—The constitution of barbaloin, part i.: H. A. D. **Jowett** and C. E. **Potter.** The authors have made a number of analyses and molecular weight determinations of carefully purified barbaloin and tribromobarbaloin, and their results agree best with Tilden's formula.—Influence of substitution on the formation of diazoamines and aminoazo-compounds, part iv., 5-bromo-*as*(4)-dimethyl-2-4-diaminotoluene: G. T. **Morgan** and A. **Clayton.**—The action of magnesium methyl iodide on pinenenitrosochloride: W. A. **Tilden** and J. A. **Stokes.** Two principal products are obtained, the oxime $C_{10}H_{15}(CH_3):NOH$ (m.p. 193°), and a base $C_{10}H_{16}N(CH_3)_2$ (m.p. 122°).—The action of hypobromous acid on piperazine: F. D. **Chattaway** and W. H. **Lewis.**—Racemisation phenomena during the hydrolysis of optically active menthyl and bornyl esters by alkali: A. **McKenzie** and H. B. **Thompson.**—Estimation of hydrogen peroxide in the presence of potassium persulphate: J. A. N. **Friend.** The author now shows that if a slight excess of permanganate is rapidly added from a burette to the mixture of peroxide and persulphate, and the excess of permanganate estimated iodometrically with thiosulphate, accurate results may be obtained in the presence of any weight of potassium persulphate not exceeding 0·08 gram.—Some oxidation products of the hydroxybenzoic acids and the constitution of ellagic acid: A. G. **Perkin** and M. **Nierenstein.**—The reduction of *iso*phthalic acid, part ii.: W. L. **Goodwin** and W. H. **Perkin,** jun. The authors describe a convenient method for the preparation and separation of the *cis-* and *trans-*modifications of hexahydro*iso*phthalic acid.—Complex ammonium antimonious halides: R. M. **Caven.**—The replacement of hydroxyl by bromine: W. H. **Perkin,** jun., and J. L. **Simonsen.** The authors find that good results are obtained when the acetate of the alcohol is heated at about 150° with a solution of hydrogen bromide in acetic acid (saturated at 0°).—The ethereal salts and amide of dimethoxypropionic acid derived from *d*-glyceric acid: P. F. **Frankland** and N. L. **Gebhard.**—The influence of phosphates on the fermentation of glucose by yeast juice. Preliminary communication: A. **Harden** and W. J. **Young.** It has previously been shown by the authors that the amount of glucose fermented by a given volume of yeast juice is greatly increased by the addition of boiled and filtered yeast juice. A similar initial rapid evolution of carbon dioxide occurs when a solution of sodium or potassium orthophosphate is added instead of the boiled juice, but in this case no marked prolongation of the fermentation is observed.—A contribution to the study of alkylated glucosides: J. C. **Irvine** and A. **Cameron.**

Linnean Society, June 1.—Prof. W. A. Herdman, F.R.S., president, in the chair.—Models of restorations of some extinct Dinosaurs, Ceratosaurus and Diplodocus, also of Ichthyosaurus, Plesiosaurus, Scelidosaurus, and Stegosaurus: H. E. H. **Smedley.**—Two photographs of a palm, *Corypha elata*: J. F. **Waby.** At the general meeting of June 18, 1903, photographs were shown of two specimens of equal age; one had normally flowered, fruited, and died; the other, instead of flowers, had thrown up a secondary central growth of leaves. The information now sent completes the record; the survivor in its turn had flowered and died, the inflorescences being developed from the secondary crown of foliage. On being cut down it proved to be 68 feet in height, diameter at base 3 feet 6 inches, diameter at base of secondary growth, 1 foot 10 inches. The secondary growth itself was 4 feet in height, and the height of the spadix an additional 20 feet, 5 feet of this being bare stem, the remaining 15 feet crowded with twenty-nine huge branches. The crop of fruit numbered more than 51,000 and weighed half a ton, most of the spadices being abortive.—The botany of Gough Island, part ii., the cryptogams, exclusive of the ferns and unicellular algæ: R. N. Rudmose **Brown.** The president reminded the meeting that when part i. of this paper was read on May 4 it had been suggested that a visit to the Tristan da Cunha group might form part of the programme of the Cape session of the British Association. The matter had, however, received so little outside support that the project had been abandoned.

Geological Society, June 2.—Dr. J. E. Marr, F.R.S., president, in the chair.—On the igneous rocks occurring between St. David's Head and Strumble Head (Pembrokeshire): J. V. **Elsden.** The author finds that the contemporaneous lavas of the Llanrian area agree generally in character with the eruptive rocks of apparently Ordovician age in the Strumble Head and Prescelly districts. These are all of an essentially acid type. The intrusive rocks of the area are of later date, and belong to three distinct types:—(1) the gabbros and diabases of the Strumble Head area; (2) the norites and associated rocks of St. David's Head and the surrounding district; and (3) the lime-bostonites and porphyrites of the Abercastle-Mathry district. Detailed petrographical descriptions of the different types are given, accompanied in many cases by analyses and comparisons with corresponding or related rocks of other areas.—The Rhætic and contiguous deposits of Glamorganshire: L. **Richardson.** The chief sections in the county described in detail are those at Lavernock (near Cardiff), Barry, Tregyff (near Cowbridge), Quarella (Bridgend), and Stormy Down. The Sully beds, a name given to the fossiliferous portion of the "Grey Marls" of Etheridge, are determined to belong to the Rhætic series, on account of the fossils that they contain. They are quite distinct from the "Tea-Green Marls," in which fossils have not been observed.—On the occurrence of Rhætic rocks at Berrow Hill, near Tewkesbury (Gloucestershire): L. **Richardson.** About two miles south-east from Chase-End Hill (Malvern Hills) there is a small outlier of Lower Liassic and Rhætic beds, in a basin-shaped area, supported and surrounded by Keuper Sandstone. A detailed section is given, mainly obtained by excavation, and this is compared with the nearest locality where the whole of the Rhætic may be studied, namely, at Wainlode Cliff.

CAMBRIDGE.

Philosophical Society, May 15.—Prof. Marshall Ward, president, in the chair.—Exhibition of lantern slides of fungi: Prof. Marshall **Ward.**—Infection phenomena in various species of Uredineæ: I. P. B. **Evans.**—The abortive development of the pollen in certain cross-bred sweet peas: R. P. **Gregory.** Among the offspring produced by the self-fertilisation of a certain hybrid sweet pea, Mr. Bateson obtained, during 1903, a certain number of individuals the anthers of which were contabescent. The same phenomenon was repeated in 1904, with every indication that the sterility is a character which undergoes segregation in accordance with Mendelian principles. The above paper dealt with the abnormalities observed in the nuclei of the pollen-mother-cells of the sterile plants. The vegetative mitoses are perfectly regular, the first indication of abnormality being observed in the prophase of the heterotype (reduction) division. From this point onwards the distribution of the chromatin becomes more and more irregular, with the result that no normal pollen is pro-

duced. The sterility is confined to the male organs, and the development of the embryo-sac is normal.—Crosses between fully fertile varieties of barley and varieties bearing unisexual and sexless flowers: R. H. **Biffen.**—The seed-bearing habit in the Lyginodendreæ: E. A. N. **Arber.** Although the seed (Lagenostoma) of Lyginodendron, one of the most fern-like of Upper Palæozoic plants, is known, there has, so far, been no evidence as to the manner in which the seeds were borne. A new species, *Lagenostoma Sinclairi*, has, however, been recently discovered, in which the seeds are still attached to a highly branched axis, which is of the nature of a compound frond with reduced lamina. In this respect the Lyginodendreæ agree with the other known members of the class Pteridospermeæ.—Experiments on penetrating radiation: H. L. **Cooke.** The experiments described are in continuation of a previous research by the author on penetrating radiation. By means of a small portable ionisation vessel the radiation in the Cavendish Laboratory is compared with that on the roof of the building; also when the apparatus is buried in earth, and when deeply submerged in water. A discussion of the results follows.

DUBLIN.

Royal Dublin Society, May 16.—Dr. W. E. Wilson, F.R.S., in the chair.—The influence of water-vapour upon nocturnal radiation: J. R. **Sutton.** The author shows a connection between the rate of cooling of a thermometer exposed between 8 and 10 p.m. near the surface of the ground and the relative humidity of the atmosphere, and points out that his observations will not permit of any such connection between the rate of cooling and the absolute humidity. The observations were made at Kimberley, South Africa.—On floating breakwaters: Prof. J. **Joly.** A description of breakwaters which will not rise and fall to the motion of small waves, and will not transmit them. These breakwaters are suitable for use in the shallower waters of partially protected localities.—The gases liberated on pulverising minerals—monazite: R. J. **Moss.** On reducing Norwegian monazite to powder *in vacuo* gas was obtained in the proportion of nearly 0·04 c.c. per gram of the mineral; 100 volumes of this gas contained:—hydrogen, 45·63 volumes; helium, 7·63; nitrogen, 28·93; oxygen, 7·09; carbon dioxide, 10·67. The nitrogen and oxygen being in atmospheric proportions were probably due to leakage. In addition to those gases a small quantity of water was liberated in the pulverisation of the mineral. Relatively to the helium, the quantity of hydrogen is much greater than was found in gas obtained by the same method from pitchblende.

EDINBURGH.

Royal Society, May 15.—Sir John Murray in the chair.—A new form of bolometer adapted for physiological investigation: Dr. W. **Colquhoun.** By using thin metal gratings of low resistance in a Wheatstone bridge arranged as delicately as possible, the author was able to demonstrate with it the heat produced by the beating of a frog's heart.—The magnetic quality of a Boschovichian assemblage of molecular magnets: Dr. W. **Peddie.** This paper gave a development of the theory of molecular magnetism which applies to crystals of the cubic system. The close-packed arrangement of centres was adopted, but similar treatment would apply to any other arrangement. The results were applied to the experimental data obtained by Weiss in observations on magnetite. The conclusions were:—(1) the theory is capable of giving a good account of observed phenomena; (2) in Wallerant's formula, which gives the correct mathematical relation between quantities, the quantities which he interprets as magnetisation and external force should be interpreted as internal force and magnetisation respectively. Here "internal force" means the force exerted by the group of molecular magnets. The internal action is completely represented by the quartic surface $x^4+y^4+z^4=1$.—Suggestions towards a theory of electricity based on the bubble atom: J. **Fraser.** This extension of a previous communication on the constitution of matter consists essentially of suggestions without rigid mathematical development. The treatment of conduction was of interest as suggesting a possible model of a dynamical system the properties of which simulate those of an electric conductor.—The Nudibranchiata of the Scottish National Antarctic Expedition: Sir Charles **Eliot.** The paper contained the description of two new genera and two new species.

MANCHESTER.

Literary and Philosophical Society, April 4.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—Portion of a stem of *Sigillaria vascularis* giving off a branch with the structure of *Lepidodendron selaginoides*, thus confirming Dr. Williamson's conviction of the identity of these two Coal-measure plants: Prof. F. E. **Weiss** and J. **Lomax.**—Notes on the Wilkinsons, ironmasters: F. **Nicholson.**

April 18.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—A new method of producing coloured diffusion bands: H. **Stansfield.** One surface of a piece of plate glass, rendered diffusive by spoiling the polish or coating it with a diffusing film of resin or butter, was fixed so as to be nearly in contact with the reflecting surface of a polished silver mirror, the surfaces being separated at the corners by a single thickness of stamp-edging. Greater dispersion of the colours is obtained in this way than by breathing on the glass surface of a silvered mirror, as the air film can be made much thinner than the mirror glass.—Notes on chlorine: C. H. **Burgess** and D. L. **Chapman.**

May 2.—On some constituents of Manchester soot: Prof. E. **Knecht.** The author pointed out at the outset that smoke and soot did not consist of carbon alone, as was popularly supposed, and went on to show that the soot obtained from the "fat" coal which is used in the Manchester district contains at least 50 per cent. of substances other than carbon. A variety of interesting products were shown which had been isolated from an average sample of household soot collected in Manchester. These included snow-white samples of ammonium chloride, ammonium sulphate, calcium sulphate, and a beautifully crystallised paraffin hydrocarbon which was similar in properties and composition to one which was known to exist in bees' wax. The amount of heavy hydrocarbon oils contained in our household soot was found to be no less than 13 per cent. From the brown coloured acid constituents the author had prepared a dye-stuff which was capable of producing absolutely fast shades of brown on cotton, dyed samples of which were shown. Comparative analyses of samples of soot collected in London and in Prague showed that these (especially that from Bohemian lignite) were much cleaner than the Manchester soot. After commenting on the drawbacks attendant on the presence of soot in our atmosphere, chiefly due to household fires, the lecturer expressed the opinion that no amelioration could be hoped for unless the use of more efficient fire-grates could be made compulsory.

PARIS.

Academy of Sciences, June 3.—M. Troost in the chair.—Observations on the methods employed in calorimetry, with especial reference to the determination of the heat of combustion of organic compounds: M. **Berthelot.** A polemical paper in reply to Julius Thomsen. The author strongly supports the accuracy of the results obtained by the calorimetric bomb as against the combustion under atmospheric pressure.—On the dynamics of the electron: H. **Poincaré.** A discussion of a recent paper by Lorentz on electromagnetic phenomena in a system moving with any velocity smaller than that of light.—Photographs in colour of the spectrum, negative by transmission: G. **Lippmann.** In the case of photographs on bichromatised gelatin films it has been hitherto necessary to moisten the film each time it is desired to observe the colours. By alternate treatment with solutions of potassium iodide and silver nitrate the colours become permanent and visible after drying.—The preparation and properties of the chloride and bromide of thorium: H. **Moissan** and M. **Martinsen.** The chloride of thorium was prepared by the action of well dried chlorine on metallic thorium prepared in the electric furnace. Owing to the extremely hygroscopic properties of the thorium chloride it was impossible to transfer it mechanically to a vessel for analysis, and it was therefore volatilised directly into a

glass tube in a current of dry hydrogen. The purity was determined by analysis, the melting point being found to be 720° C.—On the transmission by ticks of spirillosis and of bovine piroplasmosis: A. **Laveran** and M. **Vallée.** A specimen of the larva of *Rhipicephalus decoloratus* forwarded by M. Theiler from Pretoria, and stated by him to be the cause of the transmission of spirillosis in cattle, was allowed to act upon a healthy cow, with results entirely confirming those of M. Theiler.—The evolution of the Tertiary mammals: Charles **Depéret.**—Magnetic observations at Tananarivo: P. **Colin.** Tables are given showing the results of measurements of magnetic declination, inclination, and the horizontal component taken weekly between May, 1904, and April, 1905.—The principles of anallagmatic geometry: A. **Demoulin.**—Some new experiments on the lifting power of the helix "M. Léger" at the oceanographic museum at Monaco: M. **Léger.** The apparatus proved capable of lifting a man, together with a weight representing its motor and the petrol necessary for an experiment of one hour's duration.—A new mode of application of the Pitot-Darcy tube to the measurement of the velocity of water in pipes under pressure: H. **Bellet.** The modification suggested is the use of a two-fluid manometer, water and a liquid of density slightly greater or less than that of water; carbon bisulphide tinted with iodine gave the best results.—The magnetic properties of the simple element of pyrrhotine: Pierre **Weiss.**—On a property of the tin-aluminium, bismuth-aluminium, and magnesium-aluminium alloys: H. **Pécheux.**—The action of oxygen upon cæsium-ammonium: E. **Rengade.** The rapid oxidation of cæsium-ammonium dissolved in an excess of ammonia gives the oxides Cs_2O_2, Cs_2O_3, and Cs_2O_4, all in microscopic crystals. If the oxygen is added gradually a secondary reaction takes place, the amide and hydroxide of cæsium being formed.—Pyranic phenols: R. **Fosse** and A. **Robyn.**—On a new reagent for aconitine: E. P. **Alvarez.**—On the expansion and density of some gases at high temperatures: the application to the determination of their molecular weights: Adrien **Jacquerod** and F. Louis **Perrot.** Figures are given for air, oxygen, carbon monoxide, and carbon dioxide on the basis of the nitrogen thermometer at the melting point of gold. The molecular weights based on the density determinations at 1067° C. give for CO and CO_2 results agreeing within 1/3000th with the results of analysis; for nitrogen, the value found agrees with the atomic weight, 14·008.—Osmotic pressure in colloidal solutions: J. **Duclaux.**—On the coagulation of starch: A. **Fernbach** and J. **Wolff.**—On methæmoglobin and its fluorine combination: J. **Ville** and E. **Derrien.** The authors maintain the accuracy of their results against the criticism of Piettre and Vila.—Protagon and the cerebrines and cerebric acid preexisting in the nervous tissue: N. A. **Barbieri.** The author regards the protagon of Liebricht as a mixture of cerebrin and the cerebric acid of Fremy.—On the effects of annular decortication: Leclerc **du Sablon.**—On the results obtained by the observation of arable earths in thin plate: A. **Delage** and H. **Lagatu.** A reply to various criticisms on an earlier paper.—Researches on the ethnography of the Dravidians: Louis **Lapicque.**—On the evolutions of the sexual forms in the soft-water Nereids: Ch. **Gravier.**—The simultaneous contrast of colours: A. **Polack.** The phenomenon of the simultaneous contrast of colours appears even when accidental images by the movement of the eye are completely eliminated. Under these conditions the effect of contrast depends on the state of accommodation of the eye.—On the heats of combustion and chemical composition of the nervous and muscular tissues of the guinea-pig, considered as a function of the age of the animal: J. **Tribot.**—On a new method of protection against the Röntgen rays: J. **Bergonié.** The principle of the method consists in placing the whole of the arrangements about the patient above the horizontal plane prolonging the anti-kathode, and below this plane the patient himself. The method has proved successful after six months' use.—On the denomination of the supposed agent in syphilis: Paul **Vuillemin.**—The presence of methane in the borings in Lorraine: Francis **Laur.**—Captive balloon ascents carried out over the sea by the Prince of Monaco in April: H. **Hergesell.**

DIARY OF SOCIETIES.

THURSDAY, JUNE 15.

LINNEAN SOCIETY, at 8.—Biscayan Plankton. Part VI. Colloid Radiolaria: Dr. R. N. Wolfenden.—Biscayan Plankton. Part VII. Mollusca: Dr. P. Pelsener.—(1) Longitudinal Nerves and Transverse Veins in Bamboos; (2) Some Indian Undershrubs: Sir D. Brandis, K.C.I.E., F.R.S.—Notes on a Skeleton of the Musk-duck, *Bizuria lobata*: W. P. Pycraft.—*Exhibitions: Arum maculatum*, in Relation to Insects (with lantern slides): Rev. J. Gerard, S.J.

FRIDAY, JUNE 16.

PHYSICAL SOCIETY, at 8.—On the Ratio between the Mean Spherical and Mean Horizontal Candle-power of Incandescent Lamps: Prof. J. A. Fleming, F.R.S.—The Electrical Conductivity of Flames: Dr. H. A. Wilson.—Contact with Dielectrics: R. Appleyard.—The Pendulum Accelerometer, an Instrument for the Direct Measurement and Recording of Acceleration: F. Lanchester.—A New Form of Pyknometer: N. V. Stanford.—Exhibition of a Refractometer: R. Appleyard.

MALACOLOGICAL SOCIETY, at 8.—Lecture on the Prosobranchiate Mollusca: J. E. S. Moore.—On the Extension of the Genus Macrochlamys to the Island of Mauritius: Lieut.-Col. H. H. Godwin-Austen.—Mollusca of the Porcupine Expeditions, Supplemental Notes, Part II.: E. R. Sykes.—On a Small Collection of Mollusca from Tierra del Fuego: E. A. Smith.—On two Miocene Gastropods from Roumania: R. Bullen Newton.—Revision of the New Zealand Patellidæ, with Descriptions of a New Species and Subspecies: Henry Suter.—The Conchological Writings of Captain Thomas Brown: C. Davies Sherborn.

TUESDAY, JUNE 20.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—Notes on a Recently Discovered British Camp near Wallington: N. F. Robarts.—Prehistoric Remains in West Cornwall: A. L. Lewis.

WEDNESDAY, JUNE 21.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Theories of Microscopical Vision (second paper): A. E. Conrady.—The Tubercle Bacillus: Edward M. Nelson.

GEOLOGICAL SOCIETY, at 8.—The Relations of the Eocene and the Cretaceous in the Esna-Aswan Reach of the Nile Valley: H. J. L. Beadnell.—A Contribution to the Study of the Glacial (Dwyka) Conglomerate in South Africa: E. T. Mellor.—On New Oolitic Strata in Oxfordshire: E. A. Walford.—The Causes of Variegation in Keuper Marl and other Calcareous Rocks: Dr. G. T. Moody.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—Normal Electrical Phenomena of the Atmosphere: G. C. Simpson.—Two New Meteorological Instruments; (1) Automatic Pole Star Light Recorder, and (2) The Ombroscope: S. P. Fergusson.

CONTENTS.