THURSDAY, NOVEMBER 23, 1905.

## ZOOLOGY OF THE VERTEBRATA.

*A Student's Text-book of Zoology.* By Adam Sedgwick, M.A., F.R.S. Vol. ii. Pp. xv+705; illustrated. (London: Swan Sonnenschein and Co., Ltd.; New York: The Macmillan Company, 1905.) Price 21*s*.

THE first volume of this "Student's Text-book of Zoology" was published in 1898, and dealt with the invertebrate animals except echinoderms and arthropods. It was then hoped that another volume would suffice to complete the book, but that sanguine estimate was far off the mark. After half a dozen years the second volume has been completed, thicker than the first by a hundred pages, and the echinoderms, arthropods, enteropneusts, and tunicates are still to follow. A fourth volume will be required to deal with the principles of zoology. By that time the so-called student's text-book will require another title.

The first volume has a well deserved reputation for accuracy, clearness, terseness, and independence, and in the crowd of text-books it has filled a definite place to the satisfaction of teachers as well as of students. Presupposing a knowledge of "types," it dealt with the various classes in a systematic way, giving detailed classifications and taking account of a very large number of important forms. It was a successor of Claus's "Lehrbuch," but stronger in its grip, and vastly more interesting. The second volume is like unto the first, and it has been worth waiting for.

After a short introduction on Chordata, the author deals with the lancelets; then follows a discussion of the general characters of Craniata, and so on through the vertebrate series, each class, subclass, and order having its definition and general exposition followed by small print dealing with families and genera. The definitions are models of terseness; the large-print discussions of general characters are marvels of condensation and selective insight—almost peptonised extract of zoology—and the small print is monumental in its erudition. We took the last four vertebrates that happened to come into the laboratory—a water-shrew, a golden-crested wren, some young fierasfers, a specimen of Palæospondylus—and for three out of this fortuitous four we found interesting information in this encyclopædic volume. There is, however, another side to this relative exhaustiveness, that the details of classification are apt to change rapidly, and that many of the implied systematic conclusions must, from the nature of the case, have been simply accepted by the author because they were well vouched for by specialists. But there does not seem to be any way out of this except refraining from the very detailed treatment which is part of the characteristic aim of the book, or else adopting the cooperative device, which is apt to mean a lack of unity. It says much for the energy of the author that the classification of teleostean fishes is substantially that worked out by Mr. Boulenger, who supplied proofs of his work before its publication.

Leaving the question of the desirability of attempting so great exhaustiveness in what is at least called a student's text-book—a question which the gratefully recognised utility of the first volume has in part at least answered—we venture to express the hope that the final edition of the whole work will see some re-arrangement. Even unconsciously the student has what Herbert Spencer called an "architectonic" instinct; he likes some semblance of evolutionary order in his text-book. But although Mr. Sedgwick allows that enteropneusts and tunicates are chordates, they are not discussed in this volume, but must eventually be treated, we presume, at a remote distance, remote even from Amphioxus. Similarly, the annelids will be far away from the arthropods, and other instances might be given which suggest that the conditions of the production of this great work have not favoured its architectural plan.

Another carping criticism which we must make is this, that whereas the preface, like so many other prefaces, holds out the promise of "dealing fairly" with *habits* as well as with morphological aspects, we find after all that we have to be grateful for small mercies.

We confess also to some disappointment at the severity of Mr. Sedgwick's scientific mood, which may be illustrated, for instance, by this sentence:—

"As to its (the group Mammalia) origin in evolution we have nothing to say for the very good reason that there are no facts by which we can arrive at any conclusion on the subject."

(This does not, of course, refer to the affinities between Mammalia and other classes of vertebrates, which are briefly discussed.) Similarly, it is very difficult to discover what positive view, if any, the author holds in regard to the affiliation of Chordata to an antecedent stock. Incidentally, the author lifts just a little the veil with which he so successfully conceals his evolutionist convictions. Thus he says of the hag-fish:—

"To hold that a free-living animal, and a myxinoid must after all be regarded as such, can lose its eyes through disuse would seem to be an impossible position."

With such useful things to say the author might, to the advantage of his readers, have lifted the veil rather oftener. Criticisms like that of the story of the pedigree of horses are refreshing and salutary, and we regret to learn from the preface that the author has deleted a number of them. We look forward to the fourth volume to reveal more fully the author's scepticism "as to the value of some hypotheses widely held as to the course of organic evolution." It need hardly be said that Mr. Sedgwick is "a convinced evolutionist"; he also believes in the importance of natural selection, even in regard to non-living things; but "as to the origin of the manifold properties of living matter we know nothing. The Darwinian theory did not account for properties; it left their origin to an imperfectly understood interaction between the organism and the environment, and further than this we cannot at present go."

In referring to the construction which must follow criticism, Mr. Sedgwick says :—

"That is the task of the great band of workers in many departments of Biology, who, undeterred by failure and urged on by the fire, enthusiasm, and generous aspirations of youth, return time after time, generation after generation, to the assault of the fortresses of nature well knowing that their material reward will be small, that defeat means the world's neglect and that success, except the greatest, brings but a pittance of its esteem. To them I inscribe this book in the hope that it may serve if only to a small extent to smooth over the difficulties of part of the road which at first they have to travel."

We may be allowed to thank the author for doing more than "smooth over" the difficulties of the road on which all students of zoology have to travel, for he has cleared away many hindrances and pointed out many pitfalls. It would serve little purpose, however, to enter into any discussion of the numerous morphological problems in regard to which Mr. Sedgwick has made some personal and luminous contribution. We feel that we have not said enough in regard to the excellence of his workmanship, but praise of what is masterly is gratuitous. The book's scholarliness, clearness, and carefulness of statement are obvious, but those who work with it will discover other virtues—a suggestive scepticism, a mature judgment, and a more indefinable quality which we can only hint at in the phrase "morphological insight."

## *AN ESSAY IN HISTORICAL CHEMISTRY.*

*The Study of Chemical Composition: an Account of its Method and Historical Development.* By Ida Freund. Pp. xvi+650. (Cambridge: The University Press.)

MISS FREUND is to be congratulated on having written a very interesting book. It is true that her subject-matter is to be found in many other quarters; she has really written a historical treatise on what is generally called stoichiometry; but having chosen as her title "The Study of Chemical Composition," she has left herself, so to speak, unfettered, and has been able to write somewhat more discursively than if she had compiled a treatise. Indeed, in the preface to the work she confesses :—

"Although anxious to trace separately the *historical development* in the discovery and in the establishment of certain laws and classes of phenomena, I have made no attempt to produce anything sufficiently complete or even sufficiently proportioned to deserve the name of *history*. I have preferred to deal in greater detail with a few researches, especially such as I could repeatedly utilise from various points of view, than to treat a greater number more cursorily, believing in what Lavoisier said more than a century ago that 'in such matters as these, the choice of proofs is more important than their number.'"

The result is a fairly full, indeed in some instances a very full, account of classical researches in the sphere to which she has confined her attention; the only omission is that of all reference to the laws of dilute solutions, and in this she was guided by the fact that the subject has been recently fully treated in many works which are easily accessible.

Beginning with a sketch of the method of the inductive sciences, quotations from Bacon, Jevons, Kant, Whewell, and Mill are introduced, with illustrations of deductive reasoning by Kepler, Lavoisier, Davy and others, having as its basis classification, generalisation, and law. Next follows a fairly detailed study of the phlogistic theory, giving an excellent summary of the views held by the phlogistonists. Here Cavendish's reasons for his choice of the terminology of the phlogistic theory might with advantage have been inserted. Examples of Lavoisier's and Stas's work, and of Morley's synthesis of water are given to illustrate the basis on which the doctrine of the "conservation of mass" is founded. But laws may be of two kinds, exact and approximate; the difference is illustrated by Boyle's law and van der Waals's improved form. We do not notice, however, the remark that van der Waals's formula itself is only a rough approximation to the expression of the behaviour of gases under high pressures. Landolt's experiments, which may be now accepted as a proof of the accuracy of the constancy of mass, are cited; the reviewer does not know if Landolt has published the fact that his doubts disappeared only after he had used silica instead of glass vessels.

Affinity is the subject of the next historical sketch; here the views of Bergmann and Berthollet are very well summarised; and this naturally leads to the conception of fixed ratios by Proust, and the succeeding work of Dalton and Berzelius, with reference to the ideas contended for by Laurent.

The author now harks back to theories of matter, taking up the subject at its earliest start in India and Greece. The speculations of Bacon, Descartes, Gassendi, and Boyle are described, generally in their own words. Next follows a full account of Dalton's atomic hypothesis, of Gay-Lussac's law of volumes, and of Avogadro's generalisation. Berzelius's attitude towards the rival views is explained, and a clear account is given of the veteran Cannizzaro's successful attempt to obtain full recognition of the justice of Avogadro's views, so long overlooked. The determination of atomic weight by means of specific heat, and an excellent account of Mitscherlich's work and its latest development by Retgers (this last, so far as the reviewer knows, has not previously been accessible except in original papers), complete this part of the subject. The periodic arrangement of the elements, and its bearing on the determination of atomic weights, leads naturally to a consideration of the doctrine of valency, and Miss Freund has not omitted to state the attempts which have been made to represent valency in terms of the electronic theory. A chapter on isomerism follows, and the concluding chapter treats of the constitution of matter and the genesis of the elements.

From this sketch it will be seen that Miss Freund has brought together, in a compact form, a great deal of interesting matter. She has quoted freely from the authors whose views she presents, and, on

the whole, with great judgment. The work is professedly a compilation, but it is a compilation by one who knows the subject. It would perhaps have been too much to expect that independent opinion on the many matters discussed should have been expressed, but we are at least put in possession of many views in an interesting and readable form. The work should be read by all advanced students of chemistry.

W. R.

## THE KEW INDEX OF FLOWERING PLANTS.

*Index Kewensis Plantarum Phanerogamarum; Supplementum Secundum, nomina et synonyma omnium generum et specierum ab initio anni MDCCCXCVI usque ad finem anni MDCCCC complectens.* Ductu et consilio W. T. Thiselton-Dyer confecerunt herbarii horti regii botanici Kewensis curatores. Leucocoryne–Zygostates et emendanda addenda. Pp. 105–204. (Oxford: Clarendon Press, 1905.) Price 12*s.* net.

THE second and concluding part of supplement ii. of the "Index Kewensis" follows quickly on the first. This means that we now have a list of the names and synonyms of genera and species of flowering plants published from the foundation of binominal nomenclature to the end of 1900—complete except for a serious gap in supplement i. representing the last third of the alphabet for the years 1886–1895. Three parts of the first supplement appeared between September, 1901, and November, 1903; the fourth is therefore much overdue. Its delay is the more to be regretted as the period with which it is concerned was one of considerable activity in systematic botany, including, for example, the great development of the Berlin school under Dr. Engler's direction. It is to be hoped that the completion of this portion of the work, for which Kew is not responsible, will soon be announced.

The best way to appreciate the Kew index is to call to mind the time before its appearance, when getting at the origin of a name meant often a long book-hunt, and sometimes a remarkable revelation of the wonderful and remote places in which it was possible to publish names, such, for instance, as the Melbourne *Chemist and Druggist*, in which, if we remember rightly, some species were published by the late Baron von Mueller. These literary researches were often extremely interesting, but they were not botany, and a failure by some botanists to realise their importance often caused worry and inconvenience to subsequent workers. In passing, we may note a feature of the index to which reference was made at the conference on nomenclature at Vienna last June. It was pointed out that the list of names of genera which a large majority of members agreed must be retained, even though they were not the earliest published names, departed very little from the names recognised in the index—it might even have been possible to have taken the index as a starting point.

The present number makes quite interesting reading, for it marks in a striking way the progress of systematic botany during the five years under consideration. Africa, especially tropical Africa, has afforded much material for work, as evidenced by parts of the Kew Floras, the catalogue of Dr. Welwitsch's Angolan plants, and other publications in this country; and the numerous papers on African botany issued from Berlin. The completion of the "Flora of British India" is chronicled by numerous citations in various genera of grasses; and there is also ample indication of the activity of North American botanists in working out their flora. Here and there is evidence of an important monograph, as that of Bromeliaceæ by Dr. Mez, or of Monimiaceæ by Miss Perkins, in a list of new species, combinations or reductions. Some entries under a quaint or unfamiliar name form a record of antiquarian research and love of priority; such, for instance, are those under Sitanion, a name of Rafinesque which antedates the well known Elymus; these names are promptly reduced to synonymy. It is, however, not always so easy to follow the reductions. For instance, American botanists seem generally agreed that Lewisia, a genus founded by Pursh, must be restored for certain species of Calandrinia; but the index quotes them only as synonyms, referring them back to Calandrinia. In looking down the columns one is struck by the large number of personal species-names, which seems to indicate a want of imagination on the part of some authors; thus nineteen out of forty-two new species of Polygala, and thirteen of twenty-two of Lissochilus, have names recalling the person who first collected or was in some way or other associated with the plant. A few omissions might be noted, though that has probably been done already by those concerned. A curious citation is given, under Peperomia and Panicum, of two species from Dr. Andrews's Christmas Island monograph.

In conclusion, we would express the hope that the record of the next five years, now nearly ended, may be available at as short an interval as possible.

A. B. R.

## OUR BOOK SHELF.

*Sugar and the Sugar Cane.* By Noël Deerr. Pp. viii+395+xix. (Altrincham: Norman Rodger, 1905.) Price 7*s.* 6*d.* net.

So many effects have already been ascribed by politicians and journalists to the Brussels Sugar Convention, that one hesitates to add to its account the recent large output of sugar-cane literature in this country, but there can be little doubt that the brighter prospects which the Convention seemed to promise sugar-cane planters has encouraged publication on this subject, and hence the issue, within the comparatively short space of three years, of four books, in English, dealing with the cultivation of the sugar cane or of the production of sugar therefrom.

There was, of course, much leeway to make up, since the interesting and important results achieved during recent years as the result of the cultural experiments carried on in British Guiana, the West Indies, Mauritius, Hawaii, Java, Queensland, India, and elsewhere were for the most part only available in the uninviting form of Government reports, and similarly there existed no general and concise account of the improvements recently brought about in the machinery used in sugar factories.

Mr. Deerr sets out with the object of "presenting in one consecutive whole a general view of the cane sugar industry," and it may be said at once that he achieves this object fairly successfully.

The arrangement of the volume coincides with the sequence of operations in the production of sugar, the earlier chapters dealing with such subjects as cane varieties, cultivation, influence of soil and climate, manuring and so on, and the later chapters with the harvesting of the cane, its transport to the factory, the extraction of the sugar, processes for the preparation of the commercial varieties of sugar, the disposal of molasses, the analysis of sugar products, and so on.

The objection might be made that some of these later chapters, notably those relating to the use of the polariscope, the estimation of "glucose," and the analysis of sugar-cane products are not sufficiently detailed to enable a novice to carry out the operations described, and yet are so full as to be tedious to anyone merely desirous of grasping the general principles upon which the processes are based.

The book will, however, be found useful by planters and sugar-estate managers who desire to be *au courant* with the progress made on the scientific side of their industry.

The volume is well illustrated—in this connection particular mention may be made of the coloured plates showing stems of some of the principal varieties of cane—and the text is remarkably free from errors, which is perhaps to be attributed to the fact that the book "was seen through the press" by the publisher, Mr. Norman Rodger.

*My Strange Pets, and other Memories of Country Life.* By R. Bell. Pp. vi+308. (Edinburgh: Blackwood and Sons, 1905.) Price 6*s*.

"It is well known that the emu is a native of Australia, where on its vast plains they might have been seen in vast numbers" (p. 2). "The kick of an emu is a serious if not a dangerous one. . . . When sporting they spring up in the air, kicking sideways." Sentences like the above occurring close together at the beginning of a volume, and followed later by others of the same type, make one wonder whether the publishers or their printers keep a proof-reader on their establishments. But grammatical slips of this nature are not the only faults by which the work is disfigured, and the classically educated reader will scarcely fail to experience a severe mental shock when he finds the statement on p. 51 that "'lemur,' in the language of Madagascar, means 'night-wandering ghost.'"

Apart, however, from blemishes, Mr. Bell's book contains much interesting information with regard to the ways of many kinds of foreign creatures—from emus and rheas to jerboas and snakes—in confinement, accompanied by valuable hints as to the best manner of keeping them in health. The author, indeed, claims to have been the first to breed emus in Scotland, and it is perhaps a little characteristic of his nationality to find that the experiment undertaken for amusement turned out a financial success. The subject of foreign "pets" forms, however, only a portion of the volume, and the author records a number of more or less commonplace observations regarding the animals of his own country. As he appears to be an experienced angler, the statement of his disbelief in the theory that fresh-run salmon never habitually feed while in the rivers is worthy the best attention of the officials of the Scotch Salmon-Fishery Commission.

Throughout his life the author appears to have been specially interested in travelling menageries, and in a chapter on this subject he reproduces a long extract from the *Scotsman* of April 10, 1872, describing the sale of Wombwell's menagerie in that year. In this extract Wombwell is stated to have purchased the first rhinoceros and the first pair of giraffes ever imported into this country. As regards the former animal this statement is not strictly true, as witness the Indian rhinoceros described by Dr. Parsons in the early days of the Royal Society. If the statement with regard to giraffes be trustworthy, the fact has been generally overlooked by writers, George the Fourth's giraffe, received in 1827, and the four young animals obtained by the London Zoological Society in 1836, being generally regarded as the earliest importations. Wombwell's giraffes, it is stated, died before they were publicly exhibited. Although containing little that is absolutely new, the book is distinctly readable and entertaining. R. L.

*Simple Lessons on Health for the Use of the Young.* By Sir Michael Foster, K.C.B., M.P., &c. Pp. vii+114. (London: Macmillan and Co., Ltd.; New York: The Macmillan Company, 1905.) Price 1*s*.

Many writers have tried their hands at the production of a small work which shall suitably present to a child's mind those elementary facts of healthy living which, as now generally recognised, should form an essential part of education; but it must be said that hitherto no one has wholly succeeded. Many have failed from an unnecessary elaboration of scientific detail, and others from a faulty presentation of the subject-matter.

Sir Michael Foster's manual makes no pretence at covering the whole of the necessary ground. He makes it clear in the preface that his object is to show how the reasons for *some* of the rules which ought to guide us in the physical conduct of life may be explained even to the very young. The subjects dealt with are:—fresh air, food and drink, light and cleanliness. The physiological basis of certain health principles could not be more happily expressed; but as to how the individual can best meet his hygienic needs in his daily life and circumstance the writer has little—far too little—to say. With this reservation it may be said that Sir Michael Foster's little book is a model of what simple lessons on health to the young should be, and that, as an illustration of how these matters should be presented to young children, it is unequalled by any other book with which we are acquainted. For this reason, if for no other, all those who are likely to have the important duty cast upon them of instructing the young on these vital matters should carefully study its simple, clear, and wholly satisfactory method of treatment.

*Actualités scientifiques.* By Max de Nansouty. Pp. 365. (Paris: Schleicher Frères, 1905.) Price 3.50 francs.

Such a collection of short readings in French as is here provided will prove of service to young students of science who are either learning French or are desirous of keeping up their knowledge of the language by reading which will not take them far from their serious work in science. There are eighty-four popular essays, each of three or four pages, divided into seven groups dealing respectively with physics and chemistry, astronomy and meteorology, electricity and its applications, agriculture, hygiene, psychology and physiology, and applied sciences.

The volume may appeal to a few general readers interested in popular accounts of progress in pure and applied science There are no illustrations.

## 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 British Association and our Colonies.

THAT four hundred members of the British Association have recently visited the principal places of interest in South Africa, that they have been the recipients of magnificent hospitalities, that they have read papers and discussed points of importance bearing upon the development of African colonies, are facts well known to the reading public. Although so much has been written and said about what the association has done, but little has been conjectured as to possible outcomes from this remarkable excursion. To many the expedition may appear as a gigantic "picnic," the members participating in which have had a hurried glance at Africa and have returned with that modicum of knowledge which is proverbially regarded as dangerous. If, however, we turn to a list of the names of those who were members of the association party, and observe that it includes those of recognised leaders in science, literature, and in a variety of professions, casual conclusions of this nature are at once dispelled. What is realised instead is that South Africa has been visited by a number of specialists whose services are frequently retained by Governments and corporate bodies. No doubt these gentlemen have learned much, but it is difficult to imagine that they left South Africa without leaving some small return. Now that they are back in Britain it is tolerably certain that they have brought with them opinions bearing upon railways, mines, agriculture, emigration, and on other matters connected with the development of South Africa, all of which will command attention. A well known eastern country which sends its experts to exploit the western world attains a similar end by systematised departmental methods.

The benefits of greatest importance, however, may be the resultant of personal and friendly relationships which have been established between leading men of science and practical workers in two related countries. These relationships should stimulate reciprocity, remove misconceptions, and pave the way to cooperation in various directions. Regarded from this point of view, it is difficult to escape from the conclusion that the meeting of the British Association in South Africa has played an important part in strengthening a union between a parent and its offspring.

Should views of this description meet favour, it remains for members of the British Association and others to consider the possibility of extending the work of such national importance. One method by which this might be attained would be the organisation of an intercolonial meeting of the British Association. The difficulties connected with the organisation of such a convention, say in London, to be supplemented by visits to various centres in Britain, to which representatives and visitors from oversea connections should be invited, have already been informally discussed by home and colonial members of the British Association. They do not appear to be insuperable, and it may be anticipated that such an undertaking would meet with national approval and support.

JOHN MILNE.

### The Stone Age of the Zambesi Valley, and its Relation in Time.

ABOVE and below the Victoria Falls stone implements are present in profusion, both in the river gravels on the highest margins of the Zambesi valley and also spread broadcast, along with rolled gravel, on the basalt platforms of the ancient river channel below the Victoria Falls. Stone implements are also found in abundance along the highest banks of the Zambesi below the present falls, at the junction of the "desert sands" and the underlying basalts. (I use the term "desert sands," for, though its surfaces are now wooded, it has been deposited under Æolian desert conditions.) At the base of these "desert sands," which form the highest margin of the old Zambesi valley below the present falls, and resting immediately on the basalt platform, are horizontal beds of chalcedony, ferruginous sandstone, and quartzite sandstone; these are certainly the products, and have been formed at the base of the "desert sands."

These "desert sands," which occur on both sides of the Zambesi valley, I was able to examine for some distance below the Victoria Falls. They are of considerable thickness, at places fifty, sixty, and perhaps a hundred feet in depth. The railway from the falls to Bulawayo passes through these sands, and good sections are to be met with. There are no stone implements, pebbles, or stone of any description to be found throughout their entire structure until we reach the very bottom, where the horizontal beds of chalcedony, ferruginous sandstone, &c., rest *in situ* on the basalts. The chalcedony layer varies in thickness from a few inches to two feet or more. I may here remark that the majority of the implements are made of chalcedony; likewise to a great extent are the pebbly gravels of the river, both above and below the Victoria Falls. Of the thousands of implements and rolled pebbles that I handled, very few were made of any other substance but the rocks that lie at the base of the "desert sands," and I did not find a single implement made of basalt or dolerite. The quarries of the prehistoric men were the beds that lie at the base of the "desert sands," and when they were fashioning their implements along the horizon of the chalcedony formation there can be no doubt that the Zambesi was flowing at their feet, a smooth and noble stream, precisely as it flows now through the "desert sands" above the present falls, and the basalt and dolerite platforms were sunk under the waters of the river.

The evidences that the river gravels and included implements now resting upon the basalt platforms below the Victoria Falls were deposited by the Zambesi when it flowed at a height of 400 feet or 500 feet above its present level are as follows:—Above the Victoria Falls, on the left bank of the river, near the ferry to Livingstone Island, the river gravels are well in evidence. They consist of rounded pebbles of chalcedony, quartzites, and various other rocks; the contained implements are more or less water-worn, and of the same character as those in the gravels below the Victoria Falls. I took from this horizon implements of Palæolithic type.

When we pass below the Victoria Falls to the Rain Forest, we can realise without doubt that the Zambesi once flowed over this area, and that its southern cliff must once have been the falls of the river. In the water-worn gullies of the Rain Forest implements and rounded pebbles are to be found of the same character as those in the beds above the Victoria Falls; they must have been deposited there by the river when the Rain Forest area formed part of its bed. When we travel further down the course of the old river-bed we find on the platforms and promontories of the basalt, now eroded by deep lateral ravines, which overlook the zigzags of the cañon, where the Zambesi rushes 400 feet below, deposits of implement-bearing gravel. We cannot therefore escape from the conclusion that these implements and pebbles were deposited there by the Zambesi when it flowed over these surfaces prior to the excavation of the chasm. From these surfaces I took implements some of which, if found in Europe, would be called typical Palæolithic types.

If I am correct in my observations as to the method of deposition of these implements, we may be satisfied that an immense period of time has elapsed since Palæolithic man lived on the banks of the Zambesi. We cannot at present measure that period by our chronological record, but we may be satisfied that man lived there when the Zambesi below the Victoria Falls flowed 500 feet above its present level, and before its waters had carved out through hard basaltic beds the wonderful chasm that now extends for forty miles below the Victoria Falls. Perhaps geologists may in the future be able to arrive at some trustworthy conclusions as to the rate of retrocession of the falls of the Zambesi, and the carving out of its chasm, which would give a more or less accurate determination of the period when primæval man occupied the Zambesi valley. At present we can only say that a great lapse of time must have occurred; but this deduction, being based

on recognisable geological factors, namely, the wearing out of the chasm of the Zambesi and the retrocession of its falls, we have an advance in our positive knowledge as to the remote age of the Palæolithic stone implement beds of South Africa. H. W. FEILDEN.

### Terminology in Electrophysiology.

TAKING the diagram given by Dr. Fraser Harris (p. 5), all writers will agree with him that A is positive plate and negative pole, and I believe that the use of the word "zincative" has gone some way to promoting this agreement.

Dr. Harris goes on to say that no loophole for confusion could be left if the qualifying words *externally* or *internally* were added, by stating, *e.g.*, that A is internally electropositive to B and externally electronegative to B.

I find three objections to this suggested clarification:—(1) The expressions thus qualified are cumbrous, and must infallibly become abbreviated in current language by omission of the qualifying words.

(2) The expression "externally electronegative" contradicts the conventional use of the word "electronegative" which is attached to the plate and not to the pole.

(3) There is no provision for the complementary qualification to denote that a tissue is capable of being aroused to electromotive action, *i.e.* capable of being rendered zincative, *i.e.* zincable.

I freely admit that this convenient jargon offends the ear while arousing the understanding. I will gladly bury the words "zincative" and "zincable" when they have fully served their purpose as danger-signals that confusion is possible; but until we have agreed that active tissue shall be called "externally or galvanometrically negative" or "internally electropositive" I do not think loopholes for confusion have been closed. I should be satisfied with the old external word "negative" if it did not involve the conception of an internal "propagation of a wave of negativity," and the occasional misstatement that a wave of electronegativity is propagated through nerve and muscle. I should be glad to say that A is electropositive to B if I were not convinced that the prefix "electro" would be occasionally dropped to the further confusion of the reader accustomed to be told that A was (externally) negative.

So that, *en attendant mieux*, in order that there may be no confusion as to my own meaning that A is externally negative and internally positive, I say that A is like zinc or zincative. The parable, if there be parable, is intended to point out and avoid a confusion, but there appears to be an unfortunate tendency to confuse an indication of confusion with an introduction of confusion.

The physicist does not help us much. When he has appreciated the ambiguity of our physiological language, which is of physical origin, he supposes it to be no more than another case of the ambiguity familiar to us in the naming of accumulator poles, where, in order to avoid the perplexities that would arise from calling the same plate positive during charge and negative during discharge, the convention has become accepted always to call positive the plate that is connected with the positive pole of the charging battery or dynamo.

Our trouble is that there is among physiologists no accepted clear convention analogous with this convenient custom of miscalling the positive plate of an accumulator in a perfectly intelligible manner. Therefore again, when it seems particularly desirable to indicate seat of activity and direction of current internally as well as externally I still say "*zincative*" in order that there may be no mistake of meaning. A. D. WALLER.

BOTH Dr. Harris (p. 5) and Prof. MacDonald (p. 28) somewhat misrepresent the use by physicists of the signs + and −. As applied to a closed circuit they are purely relative, each point being simultaneously positive to all points on one side of it and negative to all those on the other. The confusion arises from the fact that terms belonging properly to electrostatics were adopted long ago in describing the phenomena of the galvanic battery.

It is impossible to define direction in a circle—or any closed circuit—with less than four points—one lying in a different plane from the other three. In a circle drawn on paper, one of these is given, namely, the position of the observer behind or in front of the paper. If we put two others on the circle there is still ambiguity, for we may go from + to − in either direction, as in the armature coils of a dynamo; but with the use of three symbols the ambiguity vanishes. Thus *abc, bca, cab* indicate one direction, and *cba, acb, bac* indicate the other. As with formulæ containing an asymmetric carbon, the enantiomorph is given by turning the diagram over.

In diagrams of electric circuits some portion of the apparatus, either the source of E.M.F. or the place where it is being used, is tacitly taken as the third symbol, and the signs + and − put on either side of it to indicate which way the current flows. Dr. Waller's word "zincative," to anyone who knows how zinc behaves, indicates without possibility of error the direction of the current across the region that generates it, and the electrically-minded student may trace its course thence by arrows, remembering that while the circuit is closed the tail of each arrow is positive to its head, but directly the circuit is broken the whole of the side that ends with a head is positive to the whole of the side that ends with a tail.

To the physicist the terminology formerly used by physiologists was most confusing—in my own case it conveyed an entirely wrong impression until I had made an experiment with my own hands. It is most desirable that the anomaly should be removed, and in my opinion it may best be done by dropping the unsuitable terms positive and negative, and saying either that current flows from the more active to the less active part of a tissue or that the one is zincative to the other. GEORGE J. BURCH.

University College, Reading, November 11.

### Action of Radium Salts on Gelatin.

ON continuing the experiments detailed in NATURE of October 26, I found that lead and strontium salts produced the same results upon gelatin as was the case with radium, but the strontium "growths" were much less vigorous than the others.

On considering the results, it is seen that the metals named are those which form insoluble sulphates, and it occurred to the writer that the "growths" were simply a precipitate of some insoluble body formed by the action of the salts used upon the gelatin.

Various solutions of bouillon and gelatin were prepared, and to each were added a few drops of solution of radium or barium or lead salts, with the result that in each case a precipitate was obtained which on careful examination was found to consist of a sulphate, or at all events an insoluble compound, containing sulphur.

The precipitate produced by the radium salt was tested to see whether it was in any way different from that produced by the barium salt, but, with the exception that it was radio-active, it appeared to be similar in all respects. It was insoluble in strong acids, and gave a sulphide on fusion with sodium carbonate on charcoal, and qualitatively contained no other metal than barium.

In making the experiments, a few drops of the gelatin were placed on a glass slide, and particles of radium and barium salts added as described in the last communication. The "growths" appeared. Some solution of barium nitrate or radium salt was now added to the liquefied jelly. The usual precipitate appeared, and this was filtered off through a porous tube. The clear jelly was now tested with radium and other salts, and no growth could be seen even after seven days.

I think this proves very conclusively what the alleged "growths" are, viz. that they are nothing more than finely divided precipitates of insoluble barium salts. I have examined these precipitates with the highest microscopic power at my disposal, and cannot, in any case, perceive that there is anything of the nature of cell division occurring.

Of course, many pairs of particles may be found, but the grouping must be purely fortuitous.

As there is only a limited amount of matter in the gelatin which can be precipitated by the radium, a concentration occurs at the point of contact of the salt with

the gelatin, and then a slow diffusion of the remaining salt takes place downwards, and this might give rise to the idea that the thing was really growing.

W. A. DOUGLAS RUDGE.

Woodbridge School, Suffolk.

### The Spectrum of the Positive Rays (Canal-Strahlen).

IN former publications (*Ann. d. Phys.*, vol. xiv., p. 524, 1904; vol. xvi., p. 490, 1905; "Die Elektrizität in Gasen," Leipzig, 1902, pp. 446, 457) I have expressed the opinion that the carrier of the line spectrum of a chemical element is the positive atom-ion, while, on the other hand, the band spectrum is due to the re-combination of positive atom-ions with negative electrons. From this it would follow that the particles of the positive rays (being positive atom-ions) should emit the line spectrum of the gas in which they are produced. Moreover, since these particles possess a considerable velocity, their spectrum lines, observed in the direction of the rays, should have a position and breadth differing from the position and breadth when the lines are observed in a direction normal to the rays. Again, since the positive rays ionise the gas traversed by them, re-combination of positive and negative ions must take place in their path; the gas traversed by the positive rays must therefore emit the band spectrum, which will be superposed on the line spectrum due to the positive rays themselves. The lines of the band spectrum must have the same position whether they are observed in the direction of the positive rays or in a direction at right angles to them, inasmuch as their carriers do not possess the velocity of the positive rays.

I now state briefly the results of an experimental spectrographic examination of the light emitted by a gas traversed by positive rays. (1) Nitrogen shows simultaneously the band and the line spectrum, hydrogen shows simultaneously the series spectrum (H$\alpha$, H$\beta$, . .) and the many lines spectrum. (2) The line spectrum emitted normally to the positive rays and the line spectrum emitted in the direction of the rays are different; the former shows in hydrogen sharp lines of the known wave-length, while the latter shows these "stationary" lines, and besides them, on their ultra-violet side, new widened lines ("displaced" lines). (3) This displacement is greater when the velocity of the positive rays is greater. (4) The lines of the band spectrum (many lines spectrum) have the same position and breadth whether they are observed in the direction of the positive rays or in a direction at right angles to them. A full account of the investigation will be published shortly.

Göttingen, November 3. J. STARK.

### Replicas of Diffraction Gratings.

KINDLY allow me to correct a statement contained in your notice of Mr. R. J. Wallace's replicas of diffraction gratings in your issue of November 2 (vol. lxxiii. p. 21).

It is there stated, as also in the *Astrophysical Journal* from which the extract was taken, that I first flood the grating with oil in my method of producing replicas. This I may say I have never done except when making experiments, my procedure being exactly the same as Mr. Wallace's, viz. to flood the grating direct with the clarified celluloid solution, dry it in much the same way, but using special precautions to ensure perfectly even drying, stripping and mounting in a similar manner to Mr. Wallace, but leaving out the gelatin coating, which in my opinion is quite unnecessary.

I beg to enclose you one of Mr. Wallace's first quality (average) replicas, kindly sent to me by him in exchange for one of my own, as also a couple of mine for comparison. The great difference to be noted in their surfaces and performance is due to the peculiarities in the surfaces of the original gratings, one of my own replicas having a brightness in the first spectrum on one side of at least four times that of the other, and twice that of Mr. Wallace's replica.

The grating from which the very bright replica is taken is a "Rowland" of 14,438 lines to the inch, and was formerly the property of the late Dr. Common. The original of the other is a very beautiful specimen of recent work on the Rowland engine, 15,038 lines to the inch. Now, whilst the latter when mounted on parallel plane glass gives comparatively feeble spectra, when mounted on prisms for direct-vision purposes, and tilting the prism to the angle required for the minimum deviation for the diffraction spectrum, first order, the brightness approaches that from the "Common" grating, whilst its much greater freedom from scattered light renders it very suitable for prominence and similar work, the dispersion being about equal to five 60° flint glass prisms in the centre of the spectrum, and decidedly greater at the red end.

This increase of brightness is, of course, attributable to the form of the grooves, less interference being produced under the latter condition, and this notwithstanding the increase in dispersion.

It may be of interest to some to know that I have succeeded in mounting these grating films on a perfectly flattened ring of glass, so that, by avoiding the use of glass as a base, light of very short wave-length can be examined by this means, either in the one case by transmission to about $\lambda$ 2600 or by reflection to as low as $\lambda$ 1850, and possibly lower. (The discovery of this reflective property for ultra-violet light was made by Mr. Morris-Airey, of the Victoria University, last year.) In order to examine by reflection either a partial vacuum is created behind the film when mounted on a glass ring or the film is mounted on a concave surface, which, although not giving the lines of the grating their true form, gives very fair resolution.

I have also succeeded in making concave replicas practically as perfect as plane ones, by rotating the grating during the drying process at such a rate that the paraboloidal curvature of the solution was practically the same as that of the grating. Anyway, the difference is so slight that when dry no rings can be seen on examining it by monochromatic light before the film is stripped from the grating. The difficulty of silvering these replicas satisfactorily has, however, prevented further progress, for the present at least.

In justice to Mr. Wallace I ought to say that, in a reply to a letter from me, he states he obtained his information from a patent I once took out in connection with the application of these grating replicas to colour photography; but the method there described is not the one I have adopted in making my replicas.

THOMAS THORP.

Whitefield, near Manchester, November 6.

THE article referred to by Mr. Thorp was, as mentioned in its first two lines, simply a *résumé* of Mr. Wallace's article in the *Astrophysical Journal*; and the statement corrected by Mr. Thorp was taken from that journal. It may be said, however, that the three gratings sent by Mr. Thorp have been compared, under similar conditions, and the results are in full accordance with the descriptions given above.

The second "Thorp" replica (15,120 lines) is a beautiful specimen in appearance, having none of the mottling which appears on the 14,438-line copy, but its first-order spectra are excelled in brightness by the first-order spectrum on one side of the latter, which is a similar replica to those that have produced such remarkably good results in eclipse and other observations when attached to just an ordinary hand-camera or a simple modification thereof.

THE WRITER OF THE NOTICE.

### Aurora of Novemb*r 15.

AN extraordinary aurora was seen here on November 15 at 6 p.m., in appearance something like a "stormy" sunset. The lower part of the aurora was illumined with a bluish-green light, and had an altitude at the centre of about 10°. Above this, extending for a further ten or fifteen degrees, the sky was brilliantly illuminated with streamers of a rosy red colour. I did not wait for its disappearance, but at 9.30 p.m. red streamers were visible in the N.N.W.

I looked for the Leonids this morning continuously from 1.20 to 2.35 from the vantage ground of the Dartmoor hills (1500 feet). I saw only one Leonid at 2.30, but the moon would prevent small ones being seen. The night was perfectly clear. ROWLAND A. EARP.

Buckfastleigh, S. Devon, November 16.

TRAVELLING this evening between Plymouth and Exeter, I pulled the screens over the light in my compartment to enjoy the moonlight, and was rewarded by seeing a fine display of aurora borealis, which was, I hope, witnessed by some other of your readers.

Between 9 p.m. and 9.30 p.m., when near Totnes, there was a bright flattened arch near the northern horizon, with white streamers rising from it at intervals, and very bright patches of rose-red, extending from north-east to north-west, and passing nearly overhead. At 9.15 one of these patches, on the right of the Great Bear, was a veritable "pillar of flame," and was more remarkable because of its contrast to the moonlight, which was very brilliant.

I think I am right in saying that a similar display has not been seen in the south of England for twenty-five or thirty years, and the last "rose-red" display that I can remember was in 1870. R. LANGTON COLE.

November 15.

## *A LUNAR THEORY FROM OBSERVATION.*

ON June 3, visitation day at the Royal Observatory, Greenwich, the editor, who is a member of the board of visitors, asked me to write an account of my researches on the moon for NATURE. I delayed doing this for a few months in order to render my account more complete.

The moon's longitude contains about 150, and the latitude about 100, inequalities over 0″.1. The arguments of these inequalities, and the mean longitude of the moon, require a knowledge of three angles connected with the moon, viz. the moon's mean longitude, the mean longitude of perigee, and the mean longitude of the node. The other angles involved in the arguments define the position of the sun, planets, the solar perigee, &c., and their values are to be determined from other observations than those of the moon.

The problem that I have had in view, therefore, is to determine the values of three angles as functions of the time, and to give a list of some 250 inequalities in all as accurately as possible.

Before the time of Newton, this was clearly the only way the problem of the moon's motion could be attacked, only the limit worked to was then more nearly 500″ than 0″.1. Since the time of Newton, the method has been almost entirely abandoned. Many mathematicians have attempted to calculate how the moon ought to move; the comparison between its observed and theoretical course has been rough in the extreme. No attempt has been made to verify from observation the coefficients of those inequalities for which a theoretical value had been calculated; observation has merely been required to furnish values for those constants which are theoretically arbitrary, and, as I shall show, the determination of these constants has often been rendered less accurate than was necessary by the tacit assumption that all theoretical terms had been accurately computed.

My point of view, as I have said, is that which was necessarily the only one before the time of Newton. Let us consider the application of this most ancient of all methods to the time when no observations were possible except a record of eclipses.

The two principal inequalities of the moon's longitude are

$$22640'' \sin g + 4586'' \sin (2D - g),$$

where $g$ is the mean anomaly and D the mean elongation of the moon. Whenever the moon is either new or full, $2D = 0$; at such times, therefore, the two inequalities are indistinguishable from a single inequality

$$22640'' - 4586'' = 18054'' \sin g.$$

The "evection," as the smaller inequality is called, could evidently not have been discovered until the moon was observed near its quarters; moreover, a correct value of the eccentricity of the moon's orbit could never have then been obtained. On the other hand, so long as the sole object of astronomers was to obtain places of the new and full moons it did not matter whether the two inequalities were separated or not. Roughly speaking, material of a limited class is always good enough for generalisations confined to the same class; it is unsafe to extend the generalisation to a wider class, as in this instance it would be wrong to predict for the quarters of the moon from the formula $18054'' \sin g$.

When we have an extended series of observations and wish to determine whether a term $x \sin \alpha t$ runs through the errors, and, if so, to determine $x$, the theory of least squares directs us to multiply each error by $\sin \alpha t$ and add. But before equating

$$x \Sigma \sin^2 \alpha t = \Sigma \epsilon \sin \alpha t$$

we must pause and consider whether there may not be some other error $y \sin \beta t$ running through the observations such that

$$y \Sigma \sin \alpha t \sin \beta t \text{ is not zero.}$$

Now an interfering term of this sort may arise in two ways:—(1) $\beta$ may differ so little from $\alpha$ that throughout the whole series of observations the difference between $\alpha t$ and $\beta t$ does not take indiscriminately all values from 0° to 360°; (2) the difference between $\alpha t$ and $\beta t$ may be exactly equal to the mean elongation of the moon, in which case, since the observations are not uniformly distributed round the month, the two inequalities are liable to be confounded, just as the elliptic inequality and the evection were confounded in the early days of astronomy. Interference of the first kind can be eliminated by sufficiently extending the series of observations, but no amount of observations will obtain a correct result in the second case if the mathematical point is overlooked.

As a result of attending carefully to these considerations, I have succeeded in obtaining practically the same value of the eccentricity of the moon's orbit from two different series of observations compared with two different systems of tabular places. Hansen and Airy have given values of the same quantity differing by more than one second of arc. For the same reason, the value of the parallactic inequality of the moon obtained by me corresponds closely with the value of the solar parallax obtained in other ways. The consideration neglected by Airy in this case was the possibility of error in the tabular semi-diameter.

I have determined from the observations the coefficient of every term the coefficient of which was known to exceed 0″.1. This constitutes, as I have said, the solution of the problem of the moon, as it presented itself before the time of Newton. It forms, too, the proper basis for comparing observation with theory. Previously the only thing known about the vast majority of terms was that whereas the apparent errors of Airy's tabular places frequently exceeded 20″, those of Hansen's seldom differed from the mean of neighbouring observations by so much as 5″, a quantity that might be attributed to errors of observation entirely. When, however, Newcomb in 1876 came to re-determine the value of the moon's eccentricity (in his immediate object he was not particularly successful owing to the neglect of the considerations I have just set down), he brought to light a term the coefficient of which is one second, and the argument of which was at the time unknown. The discovery of this term shows how unsafe it is to test the tables by the mere inspection of the series of errors of individual observations. However, in all my far more

exhaustive search I only brought to light one fresh inequality that runs through the errors, and that is to all appearance due to an error in the adopted parallax of the moon. My analysis, however, enables me to say that the solution of the problem of three bodies, as recently completed by E. W. Brown, is final. This might fairly be inferred from its agreement with Hansen and Delaunay, and from the numerous equations of verification employed throughout by Brown. But on my analysis a further remark may be based; not only are Brown's expressions a correct solution of his differential equations, but those differential equations do really represent, with all necessary accuracy, the problem of three bodies as presented by nature. The problem has been solved. If in the future a method as much superior to Hill's as Hill's is to Hansen's were to be invented, it would no doubt be worked out numerically, but no matter how ingenious it might be, the test of its accuracy would be—does it agree with Brown?

Another inference may be drawn from what I may call my empirical lunar theory. As the coefficients of solar terms are verified by Brown's calculations with a probable error of about 0″.04, that is presumably a measure of the accuracy of the constants. Moreover, on comparing the planetary and figure of earth terms with theory, larger discordances are found, especially in the figure of earth terms and in the Jupiter evection term. There is no special difficulty in obtaining these terms from observation; they are presumably determined as accurately as the others. Consequently, appreciable errors still exist in the theoretical values of the figure of earth terms and the Jupiter evection term.

Two suppositions of Hansen's on which he founded alterations of his tables have also been disproved, a mechanical ellipticity of the moon and an eccentricity in the face that it exhibits to the earth.

I come now to another class of investigations. The theory of the moon is deficient in that it does not explain the cause of a term of period of about 300 years and coefficient 15″ which observation shows to exist. This deficiency of theory is an inconvenience in many ways. It renders the determination of the secular acceleration of the moon, and the resulting measurement of tidal retardation, impossible from modern observations. It will be years, possibly two centuries, before from observation alone a really accurate estimate of the missing term can be given, unless, as is much to be hoped, theory accounts for it in the meanwhile. This unknown term renders difficult also the determination of the motion of the node and perigee. The position of the perigee is found by measuring an arc equal to the mean anomaly back from the mean position of the moon, and it is fairly clear that the unknown term is also an inequality of the anomaly. Hence the motion of the anomaly contains a periodic part that it is difficult to allow for accurately. I have determined the motion of the node and perigee over a period of 150 years, and I get small differences from the theoretical values recently published by Brown. Possibly the cause that produces the term of long period also produces a small motion of the node and perigee. Hansen assumed an empirical term of 240 years' period for this unknown term, but before Hansen's tables had been in the Nautical Almanac for twenty years, Newcomb found it necessary to change the period assumed to 273 years. Each assumption was associated with an argument in the hope that it would turn out to be the correct argument, but both in turn have been disproved. My own idea as to the term is that its period is more nearly 350 years, and I have no suggestions to make as to its argument. There are also smaller terms of 40 and 70 years' period approximately, or possibly the errors assume a more complicated form still. The periods are so long that the uncertainty is great.

The last section of my investigations deals with the ancient solar eclipses and the value of the secular accelerations. The three angles mentioned at the outset of this paper as requiring measurement contain terms proportional to the square of the time. It is evident that these terms become of considerable importance at remote epochs. Also on their accurate determination depend (1) the degree of assistance that astronomy can extend to chronologists; (2) a numerical estimate of the tidal retardation of the earth's diurnal rotation.

I have succeeded in showing that the alteration of two of the secular terms renders total, or at any rate central, five ancient eclipses which are partial according to the existing tables. This may, of course, be an extraordinary coincidence, but it seems more natural to suppose that records of the eclipses have come down to us because they really were striking phenomena worth recording—in one case the account says "fire in the midst of heaven," which seems to indicate the corona, and therefore totality. There is also the further fact in favour of these corrections that one of them is confirmed and the other supported by the ancient lunar eclipses. It may be of interest to mention that the most ancient eclipse of the five was communicated to me from the British Museum after I had deduced corrections from the other four, and that the corrections already found satisfied the condition of totality for the newly discovered eclipse. To such an extraordinary piece of luck the words of Virgil seem applicable:—

> "Turne, quod optanti divom promittere nemo
> Auderet, volvenda dies en attulit ultro."

It had occurred to me to wonder whether it was worth while to write to the British Museum, but the chance seemed so small that I was letting the days slip by without doing so.

Ancient eclipses, therefore, give an accurate measure of the relative distances of three points, the positions of the node, the sun, and the moon. The next question is, "Where is the equinox relatively to these three points?" My first interpretation of my results proceeded thus:—The position of the sun relatively to the equinox has never been called in question. We may be assumed to know it. Therefore my calculations determine the distance of the node from the equinox. This view of the matter, I now am glad to say, was found on examination to be untenable. In the words of Dante, what I spun in October did not last until the middle of November (the date of the first meeting of the Royal Astronomical Society):—

> "a mezzo novembre
> non giunge quel che tu d'ottobre fila."
> Purg., vi., 143.

The position of the node, in fact, may be inferred with certainty from the gravitational calculations of Prof. Brown. Hence my eclipse results determine the position of the sun as well as of the moon. The conclusion is that the sun's motion is being accelerated.

The most obvious hypothesis to account for this observed fact—it does not follow that it is the only hypothesis—is that the æther has a sensible retarding effect. It may seem curious that the resistance of the æther should accelerate the earth's orbital motion, but that undoubtedly would be the effect. The total energy must be diminished, and this implies that the planet falls in towards the sun and consequently revolves faster in its orbit. P. H. COWELL.

## SCIENCE AND ART OF CRICKET.

THE golfing world already owes a debt of gratitude to Mr. Beldam for his "Great Golfers." This companion volume, setting forth on the same lines the styles of play of our greatest cricketers, cannot fail to appeal strongly to all lovers of the most English of our national games. The method adopted here is identical with that of the earlier book. Each of the many batsmen pictured has been photographed in one or more characteristic attitudes before, during, or after the striking of the ball, and after a careful study of every picture Mr. Fry has set down his own interpretation for the guidance of the reader. No better guide could have been got, for among the great cricketers of our day Mr. Fry stands conspicuous as one who has studied the art of cricket with phenomenal success.

The book is divided into two parts. In part i. (individualities) close on 300 photographs are given of eighteen of our best known batsmen, including Grace, Ranjitsinhji, Trumper, Fry, Hill, Jackson, Duff, MacLaren, and so on. In part ii. (strokes illustrated) the various kinds of recognised strokes are systematically discussed and illustrated by photographs of other great batsmen. There is, of course, a good deal of repetition of the same ideas in the letterpress of these two parts, but each has its own value. In the one case it is the individual batsman whose pose and actions are being studied; in the other it is the kind of stroke which is the object of discussion, and this is helped out by an appeal to the example of a number of different cricketers. The volume ends with a short but very practical and interesting chapter upon the art of timing with the camera. We learn that the operator sometimes used a finger release of the shutter and sometimes an electric. The latter method enabled Mr. Beldam to act, in same cases, both as bowler and photographer. The requisites for good work of this kind are complete knowledge of the mechanism and capabilities of the camera, thorough acquaintance with the game itself, and a delicacy of judgment which must be partly inborn and strongly developed by practice. We are not told what proportion of photographs taken were failures, but the beauty and clearness of the 600 here shown prove that Mr. Beldam is a master hand in the art of taking action-photographs.

Where almost every picture is admirable, and illustrates some essential part of a particular stroke, it is not possible to choose for reproduction any that might be regarded as representative. W. G. Grace, for example, is shown in twenty-six different attitudes, and all have some lesson to tell. In the photograph reproduced we have the finish of an on-drive, in which the turn of the body has aided powerfully in giving full effect to the stroke. The eyes are still looking at the spot where the ball was when it was struck. The whole series of photographs proves that all great batsmen follow the ball with their eye right up to the moment of striking. It is this which gives precision, just as in golf.

Ranjitsinhji is figured in twenty photographs, and it is in the comparison of these with the attitudes of other cricketers that the limitations of the method of

FIG. 1.—W. G. Grace—Finish of an On-drive.

[1] "Great Batsmen, their Methods at a Glance." By G. W. Beldam and C. B. Fry. Pp. xiv+716; illustrated by 600 Action-photographs. (London: Macmillan and Co., Ltd., 1905.) Price 21s. net.

instantaneous photography appear. Except in a few cases there is no appreciable difference between his attitudes and those of others; the characteristic style of Ranjitsinhji depends upon the rapidity of the successive movements which go to make the complete stroke, and this is necessarily lost in the momentary picture. One very characteristic poise of body is given in the eighteenth of the series of pictures of the Indian cricketer. Here we have the finish of the well known leg-glance. To quote from Mr. Fry's

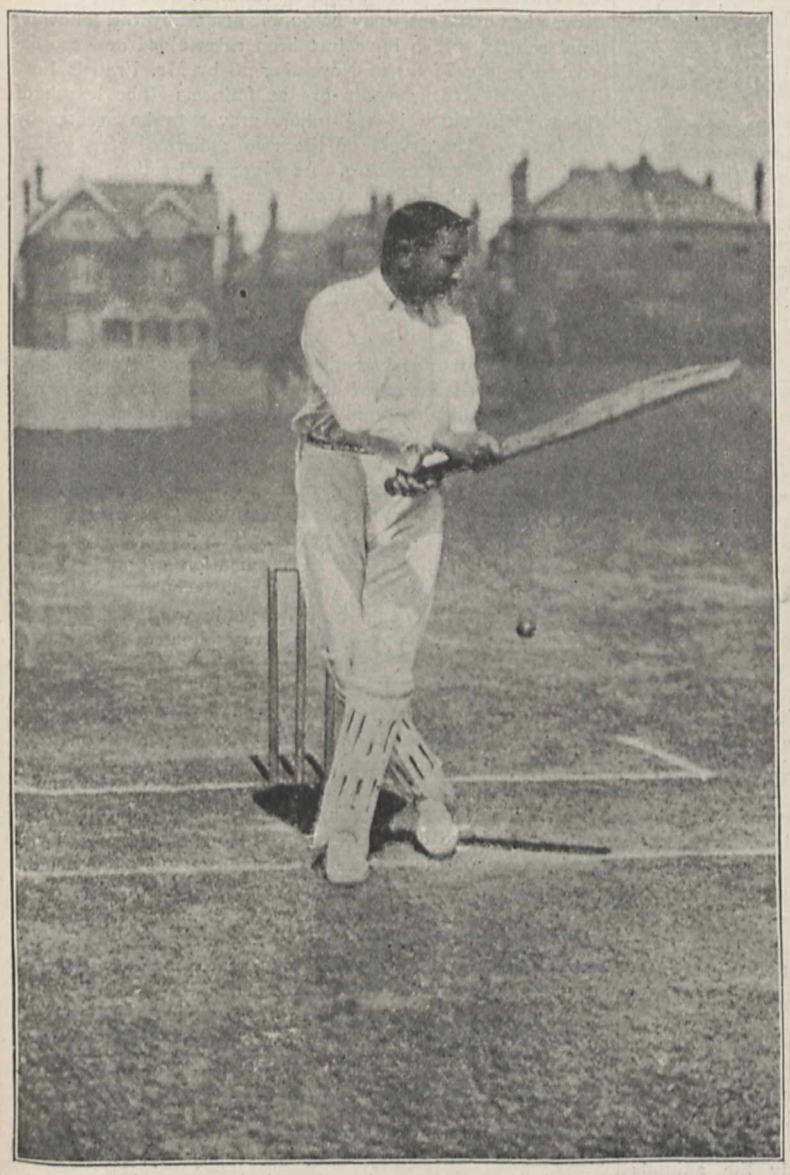

FIG. 2.—K. S. Ranjitsinhji—Finish of the Leg-glance.

description:—"the unique part of the stroke is the foot work . . . the left foot is moved across right in front of the wicket, passing immediately across the right. The body from the hips upwards is twisted round towards the leg-side. The bat, at the instant it meets the ball, is perfectly upright just in front of the left knee. Playing this stroke in this way would be impossible for anyone less supple and less quick than Ranjitsinhji."

This is not the place for discussing in any detail the many different kinds of strokes recognised in cricket, though a good deal might be spoken regarding the dynamical principles underlying some of the methods indicated. For example, the lowering of the grip of the right hand in defensive strokes, as when the player plays back, is the obvious way of getting a more powerful couple to act on the bat and prevent it being rotated by the impulse of the ball. The player probably does not think of it in that way, but by experience he has found it to be the most effective method. The important distinction between wrist play and arm play is referred to again and again, and the value of wrist play insisted upon with great incisiveness. It seems to us, however, that Mr. Fry occasionally directs attention to evidence of powerful wrist play in certain attitudes where, strictly speaking, it does not to any marked degree exist. To bring out our meaning more precisely, let us suppose the batsman is taking his stand at the wicket. His first position with the bat resting in the block hole and his eyes looking towards the bowler gives him such a stance that when he rises upright with the bat drooping easily in front of him the face of the bat is directed straight towards the bowler. This is the zero position through which the bat will swing with its face always properly oriented. If he lifts both arms at the same rate by a rotation about a horizontal axis parallel to a line through the shoulders, the face of the bat will still look in the same direction; but if he moves the arms in any other way the conditions of the geometrical constraint imposed by the grip of the hands on the handle will necessitate a combined rotational and translational motion. Let anyone with bat in hand try to shape for a drive or a cut and endeavour at the same time to prevent the bat rotating round its own axis of figure, and he will find himself forced into the most awkward and constrained of attitudes. In the description of plate xxii., showing Grace preparing for the on-drive the finish of which we have reproduced, the last sentence reads thus: "If you study the turn of his bat you will see that in order to bring the face of the bat against the ball he must put in a pronounced turn of the wrist." The truth is that if the right elbow is kept down the bat must take the position shown, and the accompanying *turn* of the wrists is slight, involuntary, and *natural*, and mainly in the left wrist. In plate xxiii., reproduced above, the geometrical conditions of constraint compel a rotation of the bat round its axis in the opposite direction. Let anyone go through the motions slowly with the initial and final attitudes as shown in these two plates, and he will find the bat take the positions pictured passing through the zero position with face looking front, and through the whole motion he will not be *sensible* of any wrist action at all. The coordinated but geometrically

complex movements of arms and body give to the bat held by the two hands a complex screw motion which may approximately be described as a rotation about an oblique axis outside the bat altogether. Plate ii. of L. C. H. Palairet's series, showing his second position, is a perfect illustration of the remarks just made; with the attitude of body and arms as given it would be impossible for the bat to have any other position without an unnatural turn of the wrists.

The effect of the true wrist-action is well described in the later part of the book. It is as effective in cricket as in golf, bringing into play a rapid acceleration just at the instant of impact. It is at the foundation of all graceful batting. As Mr. Fry well remarks, "wrist-work is the chief secret of a versatile, neat and effective style."

The book is full of a great variety of most interesting and instructive points. Those among us whose cricket is a memory will almost wish they were twenty or thirty years younger if only for the chance of testing the soundness of the teaching of Messrs. Beldam and Fry's remarkable volume; while the youthful devotee eager to improve himself in the most attractive part of our national sport will get many valuable hints from a careful perusal of its pages and study of its pictures. C. G. K.

## NOTES.

THE council of the Royal Meteorological Society has awarded the Symons gold medal to Lieut.-General Sir Richard Strachey, G.C.S.I., F.R.S., in recognition of the valuable work which he has done in connection with meteorological science. The medal will be presented at the annual general meeting of the society on January 17, 1906.

THE suggestion made by Prof. Milne in our correspondence columns this week, that an intercolonial meeting of the British Association should be held in London, is well worthy of consideration. Such a conference of representatives of science in British dominions beyond the seas and at home would strengthen the bond of union existing between them, and do something to coordinate the intellectual forces of our Empire. It is essential that men of science widely separated from one another should have opportunities of exchanging opinions upon investigations and results in which they are interested; and the advantages of such conventions are felt long after the meetings have ended. It is probable that Prof. Milne's proposal will meet with the approval of members of the association engaged in scientific work.

MEMBERS of the British Association who recently visited the Victoria Falls will be interested to learn that the small herd of hippopotami that frequents the islands above the Falls, and adds substantially to the attractions of the place, has again become troublesome. Apparently the animals have been irritated by the increasing traffic on the Zambesi; for a note in *South Africa* of November 18 states that several boats have been upset, causing one fatality and several narrow escapes. "Hippo, from any sentimental point of view," it is remarked, "are hardly the sort of things to be preserved as pets on a portion of the river where there is constant traffic, and it is to be hoped that every effort will be made to exterminate them before more serious accidents occur. . . . Those desirous of seeing the hippo in their natural haunts should find some more solitary spot where there is less danger to human life."

THE *British Medical Journal* announces that the next meeting of the German Society of Experimental Psychology will be held at Würzburg on April 10–13, 1906. Reports will be presented on the following subjects:—(1) The relations between experimental phonetics and psychology (by E. Krueger); (2) experimental æsthetics (by O. Kuelpe); (3) the psychology of reading (by F. Schumann); and psychiatry and individual psychology (by R. Sommer).

THE account of the surveying work connected with the construction of the Simplon Tunnel, in NATURE of November 9 (p. 30), may be supplemented by the following final results, which have just been ascertained and are described in the *Times* of November 18 by Mr. Francis Fox. The actual measurements are as follows:—The length of the tunnel, which is 12½ miles, proves to be greater by 31 inches. The levels of the two galleries were within 3½ inches of one another. As regards direction, the axis of the tunnel, driven from the north end, deviated 4 1-3 inches towards the west, whilst the line driven from the south end deviated 3 2-3 inches towards the east; consequently the greatest divergence from the true line was 4 1-3 inches, which is well within the calculated probable error.

A *Times* correspondent gives in the issue of November 20 a graphic description of the means taken to stamp out yellow fever in Panama. The first cases of the disease were concealed, and it was not until a serious epidemic was in progress that President Roosevelt, on his own initiative, Congress having refused to aid him, appointed Judge Magoon to Panama as Resident Governor of the canal zone with autocratic power. The prevalence of fever was bad enough, but the demoralisation of public spirit in the American colony was worse. Governor Magoon found that, while some in utter panic were fleeing from the isthmus as a plague-spot, others had fallen into a state of cynical bravado. They professed contempt for the mosquito theory of disease dissemination, and refused to obey the preventive rules which had been formulated. They took a boastful delight in exposing themselves to mosquito bites, and tore holes in the netting which had been placed over the windows of the office buildings and hotels. The Governor soon changed all this, expressed his own fear of the disease, insisted that the evidence of the transference of the disease by mosquitoes was overwhelming, and arranged for the fumigation of every building in the city. Medical inspectors were also appointed who daily examined every inhabitant. The effect of these measures is shown by the figures of the incidence of the disease:—in May there were 38 cases; in June 62 cases; in July, after the institution of these measures, 42 cases; in August 27 cases; in September 6 cases; and since then not a single case, although a reward of 50 dollars, gold, has been offered for a notification.

MR. C. O. STEVENS, writing from Bradfield, Reading, states that on Friday last, November 17, widespread attention was attracted and curiosity aroused by sounds as of heavy-gun practice and rifle firing that made themselves felt, as well as heard, in the neighbourhood for miles around. They occurred, on and off, from about 11.30 a.m. until 4 p.m.

To the Irish Fisheries Board we are indebted for a copy of the first instalment of a list of the marine copepod crustaceans of Ireland, by Mr. J. Pearson, published as No. 3 of "Scientific Investigations" for 1904. The author states that previous students have mainly confined their investigations to the pelagic types, and that consequently

much remains to be ascertained concerning the parasitic and bottom-dwelling forms. The present section deals with littoral types and those infesting fish.

IN the report of the council of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, attention is directed to the important work which has been recently accomplished in the matter of scientific publications. Unfortunately, this has somewhat crippled the society's resources, and unless additional support be accorded a pause must be made in the good work. It is estimated that the total number of visitors to the society's museum during the year will be about 17,000.

THE October issue of the *Emu* contains some beautiful photographic illustrations of the haunts and nests of the Australian lyre-bird, as well as of the bird itself. It is, however, sad to learn that, in the opinion of Mr. Kitson, the author of the accompanying notes, the lyre-bird is destined to disappear ere long from the Victorian bush unless it develops the habit of nesting in trees, as is occasionally its practice at the present time. The main persecutor is the European fox, which has been introduced with only too much success into its haunts. In South Gippsland, on the other hand, man is the criminal, and breech-loaders, forest spoliation, and bush-fires will, it is thought, before long complete their fell work, and render the lyre-bird unknown in a district where it formerly occurred in thousands. A supplement to this issue contains a useful "key" to the birds of Australia drawn up by Mr. A. C. Campbell on the "dichotomous" plan, that is to say, by according two contrasting diagnostic characters to each species.

WE regret to have to record the death of that eminent French naturalist Jean Frédéric Émile Oustalet, of whom a brief obituary notice is published in a recent issue of *La Nature*, to which journal the departed zoologist was a constant contributor. Born at Montbéliard on August 24, 1844, Oustalet passed the whole of his scientific career in the service of the Paris Museum, which he entered as an assistant in 1875. In August, 1900, he became professor of "mammalogy," with special charge of the menagerie, and co-director of the École des Hautes Études. He died "in harness" at St. Cast (Côtes du Nord) on October 26. The laureate of the Institute of France in 1877, Mr. Oustalet was secretary to the committee for ornithological investigations, and president of the Ornithological Congress in 1900. He was a Chevalier of the Legion of Honour, and had likewise received decorations from other countries. Among his more important works may be cited "Recherches sur les Insectes fossiles," "Monographies des Mégapodes," and "Les Oiseaux de la Chine."

THE *Journal of the Royal Sanitary Institute* for November (xxvi., No. 10) contains an address by the Duke of Northumberland on the occasion of the opening of the new hospital for infectious diseases at Newburn; Prof. Kenwood's address on the public health delivered at the opening of the medical session at University College; particulars of model cottages at Earswich, York, by Mr. Appleton; and a discussion on aspects of the pure milk question, together with notes, reviews, &c.

THE Michigan State Agricultural College Experiment Station has issued two useful Bulletins (June). No. 229 details interesting observations by Mr. Marshall on the associative action of bacteria in the souring of milk. Experiments prove that the activity of lactic acid-forming bacteria may be much increased by admixture with another bacterium which itself does not produce lactic acid. In No. 230 Mr. Sackett describes several bacterial diseases of plants prevalent in Michigan, viz. pear blight, bacteriosis of beans, black rot of cabbage, wilt of cucumber, soft rot of sugar beet, and blight of Irish potato, tomato, and egg-plant.

IN the *Arkiv för Botanik* (vol. v., No. 3) Dr. J. Eriksson takes up the subject of the origin and spread of rust diseases in plants to combat the views of Klebahn, Marshall Ward, and others. Criticising the argument that the *uredo*-stage can carry infection through a severe winter, he lays stress on the want of proportion between the development in autumn and the intensity of the disease in the following summer.

AS the first of a series of articles to appear in the *Indian Forester* on Indian forest fungi, Mr. E. J. Butler describes a trichosporium disease observed in Casuarina plantations; the fungus spreads through the cambium and ruptures the bark. Considerable interest attaches to the notes by Mr. F. B. Manson on the preparation and sale of rubber grown on the rubber plantation at Mergui, from which it is evident that good Para can be produced in Lower Burma.

IN a small brochure ("Die Lichtentwickelung in den Pflanzen") Prof. H. Molisch deals with the subject of light emission by plants. The production of light is confined to fungi, bacteria, and Peridineæ in the plant world. Prof. Molisch determined that the luminosity of meat is caused by a bacterium, and showed that the bacterium can generally be produced in a few days by partially immersing a piece of meat in brine. The emission of light from wood has been traced to the same source, and similarly decaying leaves of oak and beech may become luminous. The connection between nutrition, growth, and luminosity has been studied by Beijerinck. As to the teleological factor in the production of light, little is known except that it is an oxidation process; Prof. Molisch postulates a substance, photogen, that produces light waves in the presence of oxygen.

A SCHEME of no little interest, and worthy of generous support, has been initiated by the Midland Reafforesting Association for planting trees on the spoil banks in the black country. Anyone who has traversed the road from Wolverhampton to Dudley by way of Gornal will have realised something of the former beauty of this district. The object of the association is to prove that plantations are still feasible on the unsightly pit-mounds that cover the land. Last autumn a six-acre plot was planted at Wednesbury and a small model plantation was formed at Old Hill. The extension of the work that is now in progress makes it necessary to employ a paid organising secretary. To provide funds for this purpose, and to obtain a larger balance than is at present available as working capital, Sir Oliver Lodge, the president of the association, is appealing for contributions. The honorary secretary is Mr. P. E. Martineau, Bentley Heath, Knowle, Warwickshire.

SEVERAL interesting memoirs have been issued by the Geological Survey of Queensland. One of the most valuable of these is a general index (Publication No. 197) to the various reports issued by the survey (Nos. 177 to 196), compiled by Mr. Russell Dixon. In Publication No. 196 Mr. B. Dunstan gives notes on the gold deposits near Mount Ubi, on the iron ore of Mount Lucy, on testing samples for prospectors, on monazite in Queensland, on a soil survey for Queensland, on boring for coal near Townsville, and on the testing of Queensland coals. He

also gives some mineralogical notes on agate pebbles occurring in abundance on the surface of decomposed basalt at Little River, on penetration-twin crystals of gypsum from Eukalunda, on tellurides of gold, silver, and lead (hessite and altaite) from Gympie, and on calcite crystals with pyrites inclusions from Golden Gate, Croydon. In Publication No. 198 Mr. Lionel C. Ball describes the occurrence of gold, platinum, tinstone, and monazite in the beach sands on the south coast of Queensland. The results obtained indicate that this is a favourable field for the use of a dredger. In Publication No. 199 Mr. Lionel C. Ball gives a preliminary report on the recent discovery of gold at Oaks View, near Rockhampton. The ore is a soft ferruginous material resulting from the alteration of an original serpentine. In Publication No. 200 Mr. Walter E. Cameron describes the central Queensland (Dawson-Mackenzie) Coal-measures. The coal is of permo-Carboniferous age, and a promising forecast is given of the great resources of this portion of Queensland in high-class steam-coal.

THE pretty and well known lecture experiment showing the alternations between longitudinal and torsional oscillations in a suspended spiral spring carrying a weight was described by Wilberforce in 1894. In the *Festschrift* commemorative of the seventieth birthday of Adolf Wüllner (Leipzig: B. G. Teubner, 1905) Prof. A. Sommerfeld describes some further experiments with spiral springs and discusses their use in the determination of Poisson's ratio. The following methods are distinguished:—statical observations, observations of the separate oscillation periods, construction and measurement of the Lissajou curves, determination of the conditions of resonance.

IN the *Arkiv* for mathematics, astronomy, and physics of the Swedish Academy, Mr. W. Walfrid Ekman gives an investigation (in English) on the influence of the earth's rotation on ocean currents. It had been observed by Dr. Nansen on the *Fram* that the drift produced by a given wind did not follow the wind's direction, but deviated some 20°–40° to the right, and a mathematical investigation by the writer of the present paper showed how this deviation could be accounted for by the earth's rotation. In the present communication account is taken of the influence of continents and of neighbouring currents. The calculations show the existence of a surface current tending somewhat to follow the shore lines, but deviating 45° from the direction of the wind in the absence of boundaries, a midwater current with a velocity almost uniform and parallel to the coast, lastly a bottom current compensating for the flow of water towards or from the land in the surface current.

THE *Popular Science Monthly* for November contains a note by Prof. Mansfield Merriman on the "cattle problem" of Archimedes. This problem occurs in the form of a poem of forty-four lines in a manuscript in the library of Wolfenbüttel, and it was brought into notice by Lessing shortly after his appointment as librarian there in 1769. The problem consists, in the first place, in determining the total number of cattle grazing on the plain of Sicily, divided into white, black, dappled, and yellow bulls and cows, from seven equations of condition connecting the numbers in the eight various categories. The problem in this form is easy, but a further rider imposes the additional conditions that the number of white and black bulls shall be a square number, and the number of dappled and yellow bulls a triangular number. Amthor showed in 1880 that numbers satisfying these conditions could be found, but instead of the total number representing a possible herd of cattle, it would consist of no less than 206,545 digits. Finally, in 1889 Mr. A. H. Bell, in conjunction with two other mathematicians, began the work of solution, and in the course of four years determined the first thirty or thirty-one and the last twelve digits of the actual numbers. It is, however, pointed out that to determine all the 206,545 digits would occupy a thousand men for a thousand years.

IN No. 2, vol. xxii., of the *Astrophysical Journal* Mr. W. W. Strong, of the Dickinson College, Carlisle (Pa.), describes the results obtained from a series of experiments on the spectrum of the magnesium spark under various conditions. The spectra were photographed with a 4-inch Rowland grating having 14,400 lines to the inch. Using magnesium poles, he found that the "principal series" lines (λλ 2802 and 2795) and the line at λ 2852 were reversed in the end-on positions, but if a copper or iron pole were substituted for one of the magnesium poles, and the remaining magnesium pole was placed *away* from the slit, the reversals did not occur. This seems to indicate that the reversals are caused by the surrounding vapour of magnesium, and, to prove this, the spark was made to pass between an iron and a magnesium pole through a fine hole. For holes of less than 0·5 mm. in diameter this "reversing layer" was entirely cut off, and the spectrum of the spark between the hole and the *iron* pole *never* showed any reversal. Other results, in connection with other lines, were also obtained, but an attempt to get a measurable "Doppler" effect was defeated by the diffuse nature of the lines.

THE Journal of the Meteorological Society of Japan for June last contains several useful articles, including one (in Japanese) by I. Hattori on oyster development and meteorological conditions, and notes on the climate of the Bonin Islands (in English) by T. Okada. In the summer of 1901 a station was established by the Tokio Meteorological Office at Peel Island, one of the largest of the group; the station is situated in lat. 27° 5′ N. and long. 142° 11′ E. In addition to the automatic records, observations have been regularly made at 10h. a.m. and 2h. p.m., and the results are published for the years 1902–4. The principal facts relating to this isolated Pacific station may be interesting to some of our readers. The mean annual temperature is 71°·8, the mean monthly maximum being 79°·5, in August, and the minimum 61°·5, in January; the highest temperature recorded was 91°·4, in September, and the lowest 45°·5, in February; no frost or snowfall has been recorded, and vegetation is astonishingly luxuriant. North-westerly winds blow almost constantly from December to February, inclusive; the easterly monsoon prevails from July to October, inclusive. The rainy seasons are June and September, and the driest months are April and January; the total annual rainfall is about 54 inches, and, on an average, there are 147 rainy days in a year. The mean annual relative humidity is 75 per cent.

IN the October number of the *Journal de Physique* M. H. Buisson gives particulars of a new determination of the mass of a cubic decimetre of pure water. The author criticises the usual method of determining the volume of a solid by measurement of the linear dimensions; in his experiments two parallelepipeds of quartz, almost cubes, of four and five centimetres edge were used, their densities, and hence their volumes, being determined by the hydrostatic method, after correcting all the data to 0° C. The geometrical dimensions of the cubes were then ascertained by two distinct optical methods based on the

principle of interference. By a comparison of the two sets of values, the ratio of the litre to the cubic decimetre was found in two determinations to be 1·000026 and 1·000029 respectively. The error on the kilogram is thus +26 to +29 milligrams.

MESSRS. SWAN SONNENSCHEIN AND CO., LTD., have published a third edition of "Sanatoria for Consumptives," by Dr. F. Rufenacht Walters. The book, the first edition of which was reviewed in NATURE for July 6, 1899 (vol. lx. p. 221), gives a critical and detailed description, together with an exposition, of the open-air or hygienic treatment of phthisis.

DR. H. C. VOGEL, director of the Astrophysical Observatory at Potsdam, has edited the third edition of Newcomb-Engelmann's "Populäre Astronomie," published by Mr. W. Engelmann, Leipzig. Many additions have been made, both to the text and illustrations, particularly in the sections devoted to spectrum analysis, photometry, photography, and other branches of astrophysics; and the whole work has been satisfactorily revised. Short biographies of deceased astronomers from Thales to Keeler, arranged according to their years of birth, are given near the end of the volume.

WE have received from Mr. H. K. Lewis, 136 Gower Street, W.C., a copy of No. 23 of his *Quarterly List* of additions to the circulating library. The list contains more than 100 titles, and includes several important new books and new editions on the various subjects covered by the library. There are brief notes to most of the books which, while not pretending to give the subscriber an exact idea of the book, enable an opinion to be formed on its general scope. On looking through the books included we notice that, since the first number appeared, considerable extension in the scope of the library has taken place. The library has been long known as a useful medium for the supply of medical literature, and the inclusion of all branches of technological and general scientific books, commenced some two or three years ago, should add to its value.

## *OUR ASTRONOMICAL COLUMN.*

DISCOVERY OF A COMET, 1905*b*.—A telegram from the Kiel Centralstelle announces the discovery of a comet by M. Schaer at Geneva on November 17. At 8h. 7·8m. (M.T. Geneva) the position of the comet was

R.A. = 4h. 22m. 32s., dec. = +86°.

The apparent daily movement of this object is given as −54° in R.A. (*i.e.* 3h. 36m.) and −1° in declination.

A second telegram from the same source announces that the comet was observed at Bamberg on November 18·075. The position, at 6h. 50·6m. (Bamberg M.T.), was

R.A. = oh. 58m. 19·5s., dec. = +80° 40′ 5″.

It thus appears that this object was first seen near to Polaris, and is now travelling quickly down through Cepheus towards Cassiopeia.

NOVA AQUILÆ NO. 2.—The results of a number of observations of Nova Aquilæ are recorded in No. 4052 of the *Astronomische Nachrichten*.

On September 29 Prof. Wolf recorded the magnitude of the Nova as 9·6–9·7, which indicated scarcely any decrease in the brightness since September 17.

A photograph, taken on October 16 with fifty-six minutes' exposure, showed, however, that the Nova's magnitude had decreased to 10·8, that is to say, it had fallen about 1·2 magnitudes in seventeen days. On this photograph the image of the Nova is surrounded by a faint uneven halo 1′ or 2′ in diameter.

THE TENTH SATELLITE OF SATURN.—No. 9, vol. liii., of the Harvard College Observatory Annals contains an account, by Prof. W. H. Pickering, of the discovery of Saturn's tenth satellite, to which the name Themis has been allotted.

So far no variation of the satellite's brightness has been detected, its magnitude remaining constant at about 17·5. As this magnitude is beyond the power of existing telescopes, the satellite can never be observed *visually* until more powerful instruments are available. The probable diameter of Themis is about 38 miles; the orbit of the satellite is inclined about 39°·1 to the ecliptic, and its eccentricity and semi-major axis are about 0·23 and 906,000 miles respectively. The period of revolution is 20·85 days. As the observational data are, as yet, so few, all the above values are to be considered as only approximate. A drawing accompanying the description represents the orbit diagrammatically.

Owing to its great eccentricity, the orbit of Themis crosses the orbits of both Hyperion and Titan, and, when near to these bodies, the newly discovered satellite must suffer enormous perturbations, the results of which are discussed in Prof. Pickering's paper.

THE EVOLUTION OF THE SOLAR SYSTEM.—Another alternative to Laplace's theory of the formation of planetary systems is suggested in an article by Mr. F. R. Moulton, of Chicago University, in the *Astrophysical Journal* for October. In 1900 this writer and Prof. T. C. Chamberlin examined the older hypothesis from the dynamical standpoint, and found so many conclusive contradictions as to lead them to abandon it.

The theory now suggested supposes that the planets and their satellites have been formed around primitive nuclei of considerable dimensions existing in a spiral nebula probably similar to those which Prof. Keeler showed to be many times more numerous than all the nebulæ of other types.

The growth of each nucleus was caused by the gradual accretion of smaller masses, and the method of this growth which is suggested accounts for all the different types of bodies now found in the solar system, and for their present motions and velocities, on dynamical principles.

The original spiral nebula is supposed to have been formed by the near approach of another star to the body which is now our sun. This exterior attraction set up tides in the solar matter, and, being continued, actually caused immense masses to be ejected and drawn out into the spiral form. On this assumption the spiral would emerge from the central nucleus in two directions, on opposite sides, and this is the form generally shown on photographs of such nebulæ.

Mr. Moulton's paper considers at length the explanation, on this hypothesis, of the existing conditions, and a fuller exposition of the theory is promised in a new work which is to be published shortly.

CATALOGUE OF VARIABLE STARS.—No. 7, vol. liii., of the Harvard College Observatory Annals contains a second supplement to the provisional catalogue of variable stars which was issued in a previous volume of the Annals. The original intention of the Harvard authorities was to publish a supplement, similar to the one issued in 1903, every five years, but the large number of variables recently discovered renders a change of plan necessary. More than 400 variables are included in the present supplement, many of them belonging to the nebulous regions investigated by Miss Leavitt.

During 1904 the number of variable stars was increased by 503, of which 431 were discovered photographically at Harvard. The card-catalogue of variables which is being compiled at Harvard now comprises about thirty-five thousand cards.

STAR CALENDAR FOR 1906.—We have received a copy of a very useful star calendar compiled by [H.P.H.], and published by Messrs. Hirschfeld Bros. The calendar consists of four cards designed to hang on the wall for ready reference. Each card contains the ordinary date-calendar for the quarter, a table showing the positions of the planets in regard to the constellations, and a star map so marked that the constellations and stars which may be observed on any evening during the quarter, may be instantly recognised by their relative positions in regard to the cardinal points and to the zenith. The price of the calendar is 1*s*. net.

## NEW MUSEUM AND LABORATORIES OF ZOOLOGY AT LIVERPOOL.

THE new museum and laboratories of zoology of the University of Liverpool were opened on Saturday last, November 18, by the Earl of Onslow, formerly President of the Board of Agriculture and Fisheries, and now chairman of committees of the House of Lords.

The history of the department of zoology at Liverpool and the character of the new buildings are described in a pamphlet issued by the university, and abridged at the end of this record of the opening ceremony.

Preparatory to the actual ceremony of inauguration at the new building, there was a large gathering in the arts theatre of the university of guests of the council and senate of the university. Apologies and letters of regret for unavoidable absence were received from the president of the Royal Society, Sir Archibald Geikie, Prof. Ray Lankester, Sir Henry Roscoe, and many other men of science. A resolution passed at the meeting of the Linnean Society of London on November 16, signed by the officers, and congratulating the University of Liverpool and their president (Prof. Herdman) on the new laboratories, was received.

Dr. Nansen had accepted the invitation and hoped to be present, but at the last sent his regrets and a telegram saying:—"Hearty congratulations to the Zoological Department of the University of Liverpool.—NANSEN."

Lord Onslow was introduced to the assembly by the Chancellor, the Earl of Derby; and in the course of his remarks he is reported by the *Liverpool Daily Post and Mercury* to have spoken as follows:—

### LORD ONSLOW ON SCIENCE AND THE STATE.

In the first place he wished to congratulate the University of Liverpool on their decision to set apart a sum sufficient properly to equip the museum and laboratories of the natural history and zoological department of the university. He thought that was a wise step, but it was a step which could only have been accomplished, in common with all the rest of the work of the university, by the great liberality of the captains of industry in Liverpool, who had realised that the application of science to commerce was one of the most important things for commerce itself. When he looked back on the list of benefactors to the Liverpool University, he found the names of Brunner, Holt, Tate, Johnston, Rathbone, and others, and he was struck by the fact that in Liverpool at any rate the application of science to commerce was thoroughly appreciated. Although there was in this country a great amount of private wealth and of private benefaction, he was afraid it must be confessed that the amount which had been devoted to the promotion of university education "pales its ineffectual fires" before what had been done in America. In the United States of America as much as 7,000,000*l.* had been bequeathed or given in two years to the purposes of university education. What was the reason for that? He thought that in a large measure it was due to the great difference between the United States of America and this country. The difference was that in the United States there were no hereditary honours or titles, and if a man wanted the future generation to have a record of his existence it could only be done by associating his name either with a university or with a chair in that university, or by some other great benefaction. The result was that the United States had rich universities, such as that of Cornell, founded by individuals, and he confessed that if he were a man of great wealth he would much rather posterity would remember him as having founded a university or a chair of a university than as having been a liberal subscriber to the funds of his party. Though a good understanding existed between this country and other Great Powers, provision should be made for the war in commercial supremacy. What were the armaments with which we were to provide ourselves for the purposes of defence in the war of commercial supremacy? They were those provided by science and by scientific research. Fortunately for us, the inventions of science could not be patented in the interests of any one particular country, but the slightest improvement upon them could, and it was those improvements, arrived at by scientific research, which would make or mar the supremacy of any country in commerce. The power of adding to a train-load that could be carried by a locomotive in the other hemisphere might make a difference of two shillings in the price of corn, which was the shuttlecock between the political parties at the present time. It was the same with all our manufactures. The greatness of England in the past century had been due to men of science like Faraday, Watt, Stephenson, and Kelvin. Were we doing all that we ought to see that any latent genius in the whole of the British nation got the opportunity to come out, and to give to the world those great triumphs of scientific research from which this country had so enormously benefited? He thought it must be confessed that until quite recently education in this country was in a chaotic state. Even now it was only in favoured cities and places that there was anything like an educational ladder by which an intelligent boy at the national school could, without cost to his parent, work his way up until he took a university degree, and could devote himself to scientific research for the benefit of his fellow-countrymen. He had great hopes that a spirit was arising in the nation now which saw the necessity of those educational facilities, and that by the assistance and liberality of our citizens they would build up from the lowest to the highest facilities that every citizen could avail himself of. There were two great public questions before the people

FIG. 1.—New Buildings of the Department of Zoology, University of Liverpool.

of this country upon which the prosperity of the future of the country depended. One of them was the re-organisation of the Army, and the other was the organisation of the education of the country. Both those questions required the expenditure of large sums of money, and he did not believe that under the present system it would be possible to obtain those large sums unless in some manner or another they could see their way to broaden the basis of taxation. When the business of the fisheries of the country was handed over to his (Lord Onslow's) department he naturally expected, as an ignorant Minister did, that he would find the broad lines upon which it was expected that he should shape his policy already laid down by experts and men of science. But instead of that he found a wall of ignorance as regarded everything that affected the biological and physical condition of our territorial waters. What they wanted to know was by scientific research whether anything could be done to stem the depopulation of the ocean if that depopulation was actually

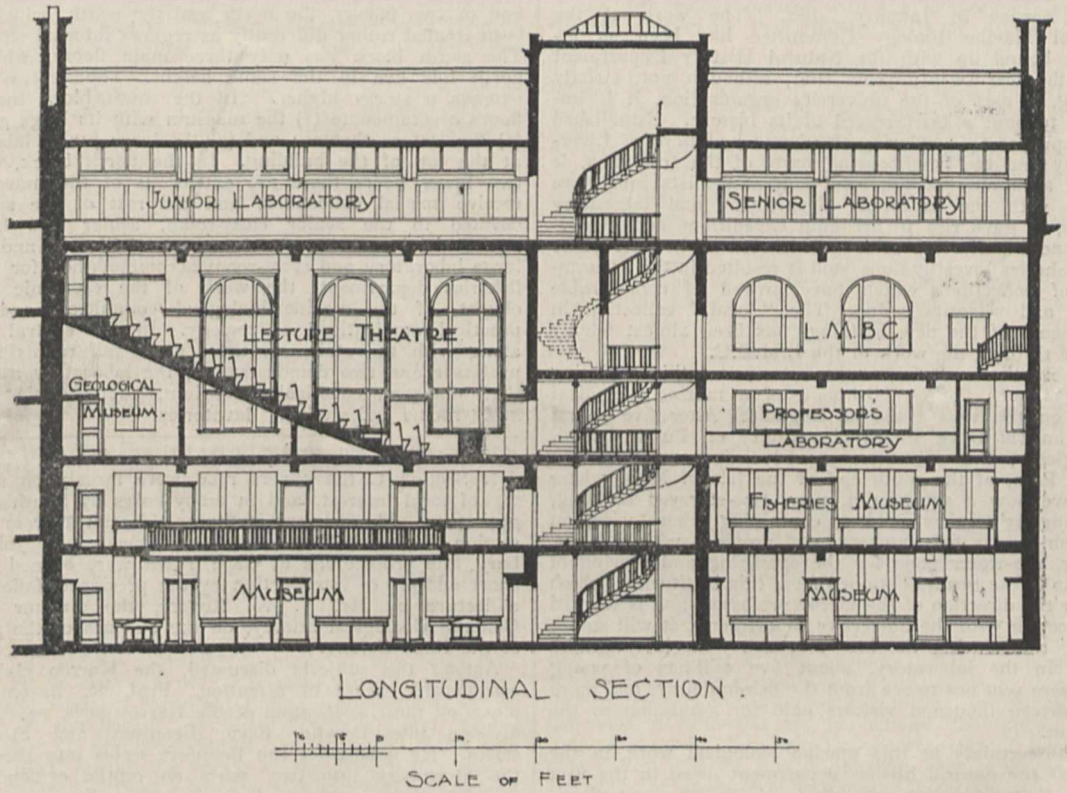


FIG. 2.—New Buildings of the Department of Zoology, University of Liverpool.

know how to protect human beings from the danger of eating contaminated shell-fish. They had done much in the Liverpool University for the study of tropical diseases; they had ascertained much to protect the lives of their fellow-subjects who went out to the malarial coasts of West Africa; he sincerely hoped that they would be able also to show them how they could avoid pollution from the contamination of shell-fish. He hoped that all who had worked in the laboratories of the university would be stimulated to greater efforts by the better buildings in which they would be housed.

The Chancellor read a communication received from Sir Thomas Elliott, Permanent Secretary of the Board of Agriculture and Fisheries, intimating that the Board were pleased to award the university a grant of 200*l*. for the financial year ending March, 1906, in respect of the zoological work carried on in connection with the fishing industry, and conveying the congratulations of the Board on the completion of the zoological museum and laboratories, which they hoped would be of service "both in the advancement of scientific knowledge and in the solution of many problems of importance to the fishing industry." Sir Thomas Elliott afterwards spoke.

going on. That work must be divided under two heads—statistical and biological. The statistical work could not, of course, be properly performed by a university such as that. That was a matter which must be taken in hand by the central authority. He looked very largely to the Lancashire Sea Fisheries Committee, acting in conjunction with the University of Liverpool, to pursue the biological part of those inquiries. He was in hopes that when the expenditure of this country upon the international investigation of the North Sea came to a close there might be national funds available for assisting them in the research which they had undertaken for some time past, and which he could not doubt but with the opening of those new buildings would be largely stimulated and increased, and that thereby they might be assisted by them to solve problems which were great and national. There was also the great and important question of the connection of human disease with shell-fish. They wanted to find out to what extent there was contamination in shell-fish, and also what was not dangerous to the human frame. It was really of the very greatest possible importance that they should

Replying to a vote of thanks moved by Mr. E. K. Muspratt and seconded by Sir John Brunner, M.P., Lord Onslow said he was not by any means alone in his appreciation of not only the benefit, but the absolute necessity of all Government departments in their respective spheres availing themselves of the advantages of scientific research. It applied not only to Government departments, but equally to all the great industries, to the Navy and the Army, and to every branch of national enterprise. In regretting that the 200*l*. contribution to which Sir Thomas Elliott had referred was regarded as small, Lord Onslow said it was not the Board of Agriculture who was rich, it was the Chancellor of the Exchequer, and when they got a few thousands out of the Chancellor of the Exchequer for all the purposes of agriculture and fisheries, they thought they had done very well when they were able to contribute 200*l*. to one place.

The proceedings in the arts theatre then ended, and Lord Onslow and the council and senate and guests walked through the university grounds to the new zoology buildings, where, after a short speech by Prof. Herdman, Sir John Murray addressed the assembly upon oceanography. Mr. R. B. Haldane also delivered a brief speech, in the course of which he remarked that by obtaining the grant of 200*l.* from the Chancellor of the Exchequer Sir Thomas Elliott had established a principle and connected the University of Liverpool with His Majesty's Government.

### The Department of Zoology.

The Derby chair of natural history was established by the fifteenth Earl of Derby in 1881—an appropriate gift from a descendant of the scientific founder[1] of the celebrated zoological collections once alive at Knowsley and now secured to Liverpool in the Derby Museum of the Public Galleries. The first Derby professor was appointed at the end of 1881, and thus natural history was one of the three or four scientific departments with which University College opened in January, 1882. The work of the Liverpool Marine Biology Committee has been so intimately bound up with the Natural History Department during the last twenty years that, although not, strictly speaking, a part of the university organisation, it is impossible to omit a brief record of its history. Established for the purpose of exploring the fauna and flora of Liverpool Bay and the neighbouring parts of the Irish Sea, it brought a number of the local field-naturalists into close relation with the university department and laboratory methods, it gave rise to dredging expeditions and observations and experiments at sea, which led on in later years to sea-fisheries investigations, and it resulted in the accumulation of collections which have proved of considerable interest and scientific value. The "local" collection in the museum of the new buildings has been almost wholly obtained through the work of the L.M.B.C.

Probably the most important outcome of this exploring work has been the establishment of a marine biological station on the west coast of England. After five years' use of an old Dock Board observatory on Puffin Island, off Anglesey, the committee moved their marine station to Port Erin, at the south end of the Isle of Man, where they have now a substantial, new, two-storeyed building, measuring 95 feet by 45 feet, containing laboratories, an aquarium, and a fish-hatchery, and provided with a large, open-air, sea-water pond for the spawning and rearing of fish. As to the results obtained from this institution (which is under the direction of the Derby professor, and is worked in connection with the university department), it will suffice to state that during the last year thirty-six investigators worked in the laboratory, about five millions of young plaice were sent out to sea from the fish-hatchery, and more than thirteen thousand visitors paid for admission to the aquarium.

It was certainly to this marine biological work in the past that the natural history department owed in the first instance that connection with the local sea-fisheries authorities which has recently developed into a formal agreement between the university and the Lancashire and Western Sea Fisheries Committee. The scientific work of the local fisheries district is carried on in the laboratories by assistants paid by the Fisheries Committee, and the professor has been appointed honorary director of the scientific work, and furnishes an annual report on the work of the fisheries laboratory. A share of the laboratory accommodation in the new buildings will be devoted to the furtherance of the work of the Liverpool Marine Biology Committee, of the Lancashire and Western Sea Fisheries Committee, of economic entomology, and of other useful applications of zoology.

It has been recognised for some years that the accommodation in the old college buildings was quite inadequate to meet the wants of this department, and although some extensions had been made, such as a wooden fisheries laboratory on the roof and a convenient little museum (given about ten years ago by the late Mr. George Holt), these were temporary expedients which in some ways only emphasised the pressing need for new and much larger buildings. Research work offered to the department was hampered, and in some cases had to be declined for want of room. These facts were given expression to in the statements of needs drawn up in connection with the university movement of 1901–2, and after the establishment of the university a sum of 18,000*l.* was voted to the council by the university committee in October, 1902, for the purpose of erecting and equipping a new department of zoology, to contain a museum and a lecture theatre, the necessary students' laboratories, and also accommodation for sea fisheries investigations and other lines of marine biological research.

[1] The thirteenth Earl of Derby, President of the Linnean Society, 1828–1873, and subsequently President of the Zoological Society.

### The New Buildings.

This zoological institute has a frontage of 123 feet on the western side of Brownlow Street, is 41 feet from front to back, and 84 feet in height from the street level. It is built of red pressed brick relieved with white sandstone from the Storeton quarries in Cheshire. The building consists of a central tower containing the entrance hall and staircase and some of the smaller rooms on each floor, and of two blocks, the north and the south, which have been treated rather differently as regards internal structure. The south block has only three main floors, while the north has five in the same height. The central tower extends a storey higher. In the south block the three floors accommodate (1) the museum with its large gallery; (2) the lecture theatre; and (3) the large junior laboratory at the top of the building. In the north block, on the two lower floors there are extensions of the museum to receive special collections, and the rest of the space is devoted to the senior class-room, senior and honours students' laboratories, the departmental library, and rather large laboratory and store-room accommodation for the sea fisheries department, the work of the economic entomologist, of the marine biological committee, and other practical applications of zoology. In the central tower, along with the staircase, there are small rooms for the professor and two demonstrators, the laboratory assistant, with diagram, chemical, aquarium, photographic, macerating rooms and students' lavatories.

## *GEOLOGY AT THE BRITISH ASSOCIATION.*

IN Section C the papers read were largely on subjects of local interest, and in many cases by South African geologists. The delivery of the presidential address in this section having been fixed for the meeting at Johannesburg, the proceedings at Cape Town were opened with a short address of introduction by the president, followed by a lecture by Mr. A. W. Rogers, the director of the Colonial Geological Survey, on the outlines of the geology of the Cape Colony.

Among the subjects discussed, the Karroo claimed a considerable share of attention. Prof. R. Broom, in a paper on the classification of the Karroo beds, retained the division into Dwyka, Ecca, Beaufort, and Stormberg series. He subdivides the Beaufort series into three, and the Stormberg into two parts on reptile evidence, and correlates the various divisions with European strata thus:—Dwyka and Ecca series with Lower and Middle Permian, Lower Beaufort beds with Upper Permian, Middle and Upper Beaufort beds with Lower and Upper Trias, Lower Stormberg beds with Rhætic, and Upper Stormberg beds with Lower Jurassic.

Mr. A. L. du Toit gave an account of the Stormberg formation in Cape Colony. This uppermost division of the Karroo beds consists of a considerable thickness of nearly horizontal sandstones, shales, and volcanic rocks, and includes (in descending order):—(4) Volcanic Beds; (3) Cave Sandstone; (2) Red Beds; (1) Molteno Beds. The formation covers a considerable area in the east of the colony, in the Stormberg and Drakensberg districts, the summits of the mountains being commonly formed of the lava flows of (4). The sediments were deposited in an inland sea, the "Karroo Lake," the southern shore-line of which ran along the present coast-ranges of the colony, and thence north-eastward, outside and parallel with the coast-line of Natal. The author suggests the correlation of the Volcanic Beds and Cave Sandstone with the Rájmahál series of India (Middle? and Lower Jurassic), and of the Molteno beds with the Kota-Maleri series of India and the Wianamatta series of New South Wales (Rhætic).

Prof. A. Young described a remarkable case of an artesian well in the Karroo which shows a daily fluctuation in its discharge. The curve obtained during some weeks by a self-recording apparatus is very regular, and has a period of almost exactly 12½ hours. The amplitude shows a marked variation, corresponding in time with the phases of the moon, and analogous to marine spring and neap tides. The outlet is more than 2700 feet above sea-level, and the author suggests that the water, which contains a large amount of inflammable gas, is forced up from a great depth through fissures by the pressure of natural gas, and that the observed fluctuation is a minor effect, due to the moon, superimposed on the effect of the constant gas-pressure. The phenomenon is scarcely affected by barometric changes.

At a joint meeting with the Geographical Section on the second day, Mr. H. C. Schunke-Hollway gave an account of the physical geography of Cape Colony. Mr. Rogers read a paper on Glacial periods in South Africa, in which he described the glacial deposits of Table Mountain Sandstone- (Silurian?) and of Dwyka- (Carboniferous) age, each formed of materials derived from the north. There is no satisfactory evidence of glacial action in later times, the glaciated forms of certain hills in Griqualand West, cited by Stow, being now known to have been produced at any rate not later than Dwyka times, since similar forms may be traced underneath the surrounding Dwyka conglomerate. They have been preserved by a thick covering of Dwyka and other beds, which have only recently been removed.

Prof. A. Penck (Vienna) contributed a paper on changes of climate as shown by variations of the snow-line and upper tree-limit since Tertiary times, in which, from a consideration of the geological evidence as to the relative height of the snow-line and tree-line in Glacial times, he drew conclusions as to the cause of the glacial conditions. The facts pointed to a lowering of temperature as the cause of the glaciation rather than to an increase of precipitation. Prof. Penck suggested that an examination of the higher parts of the Drakensberg might probably reveal traces of a Pleistocene Ice age in South Africa, though hitherto satisfactory evidence of this has been wanting.

Prof. W. M. Davis, of Harvard, brought forward evidence for the sculpture of mountains by glaciers.[1] He based his arguments principally upon the marked difference in form between valleys proved in other ways (*e.g.* by the presence of striations) to have been once glaciated, and those which have not been glaciated, the differences being in nature and distribution such as glaciers would cause on the assumption that they could erode.

Papers were also read by Prof. Sollas, on the continent of Africa in relation to the physical history of the earth; by Prof. J. Milne, on recent advances in seismology; by Mr. E. H. L. Schwarz, on "Baviaan's Kloof, a Contribution to the Study of Mountain Folds"; and by Mr. H. T. Ferrar, on the geology of South Victoria Land, giving the results of his observations on Antarctic rocks and glaciers made during the voyage of the *Discovery*.

Prof. Sollas sketched a possible way in which the present distribution of oceans and continents on the globe may have arisen. The earth is not strictly a spheroid, but resembles an ellipsoid, of which the shortest axis passes through the poles, while the longest lies in the plane of the equator and emerges in Central Africa. The distribution of land and water is such as would obtain if the earth had the form of a pear which had been somewhat compressed in the direction of its core, and thereby caused to bulge laterally. Africa would be situated on the broad end of the pear, and would represent the remains of the primeval continent—a supposition consistent with the known absence of marine sediments over the greater part of the interior, notwithstanding the thick accumulations of flat-bedded strata existing there.

Mr. Schwarz's paper contained an account of a remarkable piece of geological structure observed in the valley of the Baviaan's River, a tributary of the Gamtoos River, in the neighbourhood of Port Elizabeth. On the Baviaan's River occur certain outliers of Enon conglomerate (Cretaceous) which have been found by bore-holes to occupy steep-sided, basin-shaped depressions with no outlet, in Palæozoic rocks of the Bokkeveld and Witteberg series (Cape system). The basins are bounded by faults or steep dip-slopes, and are explained as having been formed by two series of cross-foldings trending E.S.E. to W.N.W. and N.E. to S.W., which took place while the country was covered with the Enon conglomerate, the latter being faulted down upwards of 1000 feet. The author objects to the usual explanation of rock-folding as produced by a direct tangential thrust against an obstacle, caused by shrinkage of the earth's crust, and suggests that it may in fact be gradually produced by earthquake-waves travelling through one kind of rock (say sedimentary beds resting on granite) and encountering a mass of rock having a different modulus of elasticity (as, for example, a boss of the underlying granite). The effect of this would be to heap up the strata in folds against the obstacle, somewhat as when waves break on the shore.

At Johannesburg a considerable number of the papers were, appropriately, of mineralogical and petrographical interest.

The proceedings opened with the delivery of the presidential address by Prof. Miers (NATURE, August 24, vol. lxxii. p. 405).

Prof. J. W. Gregory followed with two papers of special interest to gold miners. In one of these, on the Rhodesian Banket, he stated that he had found during a recent examination of the district that the name had been applied to several different rocks which are locally auriferous—not only to an undoubtedly sedimentary conglomerate forming the main mass of the material, but also to crush-conglomerates and breccias, and to a diorite dyke with segregations of amphibolite. The Rhodesian conglomerate may probably be rightly called Banket, but differs considerably from the Banket of the Rand in its fluviatile origin, the greater variety in size and composition of the pebbles, and its probably greater age. The question as to the right of the Rhodesian deposit to the name of "Banket" aroused considerable discussion.

In his second paper (on the Indicators of the goldfield of Ballarat—a study in the formation of gold pockets) Prof. Gregory showed the secondary origin of the so-called "indicators," or thin iron-stained bands, which traverse the slaty country-rock of Ballarat and lead to rich pockets of gold at the points where they intersect the otherwise barren quartz reefs. The indicators are shown by microscopic and field evidence to be narrow seams of chlorite or rutile needles, which are not quite, though, as a rule, nearly, parallel to the bedding, and cannot therefore be of sedimentary origin.

Prof. R. Beck, of Freiberg, gave a summary of recent investigations on the origin of pegmatites as products of the crystallisation of the residual mother liquors of a solidified plutonic magma. Certain ore-veins have been formed thus as metalliferous pegmatites, for example the tin veins of Zinnwald and Embabaan, the copper ores of Telemarken and the auriferous quartz-reefs of Berezowsk, the Yukon district and Passagem, and other places in Brazil. The presence of tourmaline in certain gold-quartzes bears out this view of their origin.

Prof. A. P. Coleman, of Toronto, dealt with the magmatic segregation of sulphide ores. The recent complete mapping of the eruptive sheet with which the nickel-ore deposits of Sudbury (Ontario) are all connected, shows that the Sudbury ore is, like the pyrrhotite nickel ores of Norway described by Vogt, really a product of segregation from the rock, of which it forms an integral part with every gradation between ore and rock. Gravitation has probably played a large part in the segregation process.

Prof. Grenville A. J. Cole read a paper on marginal phenomena of granite domes, in which he upheld the view that banded gneissic rocks are due rather to the incorporation of the surrounding rocks with the materials of an invading granite than to simple dynamic metamorphism; the banding is produced by igneous flow, and is especially marked in cases where the absorbed rocks were sedimentary or already foliated.

On the second day Mr. G. W. Lamplugh gave his report of a journey, made under the auspices of the association to examine the zigzag gorge of the Zambesi

[1] The papers by Prof. Penck and Prof. Davis will be published shortly in the *Geographical Journal*.

below the Victoria Falls, from which he had just returned. Mr. Lamplugh, who penetrated down stream for a distance of 70 miles from the Falls, accepts and confirms the explanation given by Mr. Molyneux, of Bulawayo, who attributes the zigzags to the guidance of the stream-erosion by transverse joints in the basalt plateau through which the gorge has been cut.

Prof. Penck read a paper, illustrated by a fine series of lantern slides, on the Glacial deposits of the Alps.

Mr. Kynaston, director of the Geological Survey of the Transvaal, gave an account of the recent work of the survey. Since its re-organisation in 1903, the attention of the survey has been chiefly occupied with the later formations forming the central portion of the country, and the results obtained bear testimony to the able way in which the work has been carried on. The igneous complex of the Bushveld to the north of Pretoria may be mentioned as forming an interesting petrographical province. It illustrates the differentiation of a magma, in what is probably an enormous laccolite, intruded between the Pretoria and Waterberg series, into zones of increasing basicity, ranging from the red granite of the central region to the norites, pyroxenites, serpentine, and magnetite-rock of the margin.

Dr. F. H. Hatch explained the views arrived at by Dr. Corstorphine and himself as to the correlation between the pre-Karroo beds of the Transvaal and those of Cape Colony ("Geology of South Africa," 1905). Dr. Hatch also exhibited an instrument, devised by Mr. Oehmen, for surveying bore-holes, that is, for determining the amount and direction of the inclination of the bore-hole to the vertical at any given depth—a problem of considerable importance in a country where diamond drilling is so largely used as in South Africa, as a deep bore-hole may deviate as much as 30° or more in its lower levels.

The Rev. S. S. Dornan gave an account of his observations on the geology of Basutoland. The rocks belong to the Stormberg series, and consist of sandstones, mudstones, and shales forming the Molteno Beds and the overlying "Red Beds." Fossils are rare, but a few plant and reptile remains have been found in the former. Above the Red Beds lies the Cave Sandstone, a thick-bedded sandstone, which forms the crests of the hills and contains caves sometimes showing Bushman paintings. Reptile tracks are frequent, but few other fossils occur. The higher ridges of the Drakensberg and Maluti ranges are formed of lava-flows and intrusive sheets belonging to the volcanic series. This communication was of special interest on account of the difficulty of making observations and collecting fossils in Basutoland, as it is a native reserve, and the natives are unwilling to allow any prospecting, fearing lest they might lose their country should gold be discovered.

On the last day of the meeting Mr. C. B. Horwood read a description of the Dolomite formation, which is important as being practically the only source of underground water supply in the Transvaal. The rock is probably a deep-sea deposit, which has subsequently undergone dolomitisation in shallow water, and has lost in the process all trace of organic remains, so that its age is unknown. Mr. W. Anderson contributed a paper describing the first Tertiary rocks of marine origin which have been discovered in South Africa. These comprise sands, marls, and shales, with marine Mollusca (identified as probably of Eocene age) and Foraminifera in the upper beds, while in the lowermost shales occur numerous isolated bones of Mammalia (elephant, rhinoceros, hippopotamus, &c.), with water-worn fragments of fossil wood, and fish and crustacean remains. The beds, which are confined to the coast of Natal and Zululand, are probably of estuarine origin. A calcareous grit, forming the Bluff at Durban, is also probably Tertiary in age.

A paper by Mr. E. T. Mellor dealt with the evidences in the Transvaal of glacial conditions in Permo-Carboniferous times, and the distribution of the glacial conglomerates forming the base of the Karroo system, which corresponds to the Dwyka conglomerate of Cape Colony. Here, as in the country to the south, the striations, as well as the nature of the boulders, point to a northerly origin. Mr. Lamplugh read a note on the occurrence of Dwyka conglomerate at Kimberley Mine.

In a paper on the diamond pipes and fissures of South Africa, Mr. H. S. Harger expressed his view that the source of the diamond lay in a zone of ultra-basic rocks —eclogites, lherzolites, and pyroxenites—in which it may be an original constituent crystallising from the magma, for it has been frequently found in garnets and more rarely in olivine, and has been produced artificially in the latter. The blue ground filling the diamond pipes and the associated fissures is an altered breccia formed by the shattering of these ultra-basic diamondiferous rocks during a period of volcanic activity, probably in late Triassic or Jurassic times. Mr. Harger's paper was especially valuable as embodying the results of careful personal observations carried on through several years on the occurrence and associations of the diamond in the numerous mines scattered up and down the country, some of which are little known outside South Africa. An interesting collection of specimens of the associated minerals was on exhibition in the adjoining museum.

Papers were also communicated to the meeting by Dr. J. T. Carrick, on the geology of the West Rand; by Mr. F. P. Mennell, on the plutonic rocks and their relations to the crystalline schists; and by Mr. E. Heneage, on a consideration of the Archæan period of North America and South Africa with reference to mineral occurrences.

Apart from the papers read, a more than usual amount of interest attached this year to the geological excursions, of which a large and most interesting series were organised by Dr. Molengraaff, Prof. R. B. Young, and Mr. Rogers, to whom, with the other gentlemen who acted as leaders, the thanks of the section are especially due.

These excursions—many of which occupied several days and were on a scale hitherto unprecedented, except possibly at the Toronto meeting in 1897—afforded the members of the Geological Section a unique opportunity of seeing the most interesting features of the country under the guidance of the men by whom they had been investigated, members of the various surveys being spared for the purpose by their respective Governments.

After the meeting at Cape Town Mr. Rogers led a party through the Karroo, visiting, among much else of interest, the folded ranges of the Hex River district, and exposures of the Dwyka conglomerate (or Boulder-clay) and of the Beaufort beds which have yielded Pareiasaurus and other characteristic reptiles. While in Natal, several members visited the glaciated surfaces and overlying beds at Vryheid, under the guidance of Mr. W. Anderson, the Government geologist, and Dr. Molengraaff, formerly State geologist of the Transvaal. During the meeting in Johannesburg a number of afternoon excursions were made to the gold mines and other points of interest, while after its conclusion several more extended expeditions took place. These included one to Vereeniging, under Dr. Hatch, to examine the sandstones and coal-seams of the Ecca series, which have yielded the Glossopteris flora, and the associated beds, and to see Mr. T. N. Leslie's collections of fossil plants from the Ecca sandstone and of flint implements from the Vaal River. Another party had an opportunity of studying the norites and syenites of the Plutonic complex of the Bushveld, at the Pyramids and in the neighbourhood of the Pienaar's River, to the north of Pretoria, under Mr. Kynaston and Mr. A. L. Hall; while a third party, with Mr. Hall and Mr. Frames, visited the Duivels Kantoor, at the eastern edge of the Transvaal plateau, where the escarpment of the Black Reef series and Dolomite overlooks the floor of Archæan rocks, on the denuded surface of which they rest unconformably.

Excellent opportunities were also afforded of studying the occurrence of the diamond, both at the Premier and other Transvaal mines, under Mr. Cullinan, the chairman of the Premier Diamond Company, and Messrs. Hall, Harger, Kynaston, and Trevor, and at Kimberley through the kind offices of Mr. Gardner Williams, the chairman of De Beers.

In addition to this, there was a great deal of interest to the student of surface geology to be seen during the long train journey, among which may be mentioned the hill-country in the north of Natal, the flat and sandy bush-scenery along the line to the north, and the wonderful examples of weathering in the granite country of the Matopo Hills.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Dr. Haldane, Fellow of New College, has been re-appointed lecturer in physiology on the nomination of the Waynflete professor. The appointment is for three years from January 1, 1906. Chemical physiology is the particular subject assigned to the lecturer.

The degree of M.A. has been conferred, by a decree of Convocation, on Dr. Schlich, secretary to the delegacy for superintending the instruction of Indian forestry students.

CAMBRIDGE.—An election to an Isaac Newton studentship will be held in the Lent term, 1906. These studentships are for the encouragement of study and research in astronomy (especially gravitational astronomy, but including other branches of astronomy and astronomical physics) and physical optics. The studentship will be tenable for the term of three years from April 15, 1906. The emolument of the student will be 200*l.* per annum. Candidates for the studentship are invited to send in their applications to the Vice-Chancellor between January 16 and 26, 1906, together with testimonials and such other evidence as to their qualifications and their proposed course of study or research as they may think fit.

An appointment to the Anthony Wilkin studentship in ethnology and archæology (*Reporter*, May 23, pp. 920–1) will be made in January, 1906. Applicants should send in their names, qualifications, and a statement of the research which they wish to undertake, to the Vice-Chancellor before January 1, 1906.

Mr. T. S. P. Strangeways, of St. John's College, has been re-appointed demonstrator of pathology for a period of five years from Michaelmas, 1905.

Prof. C. S. Sherrington, F.R.S., and Prof. R. Threlfall, F.R.S., have been elected honorary fellows at Gonville and Caius College.

The State Medicine Syndicate has nominated Mr. J. E. Purvis, Mr. G. H. F. Nuttall, Dr. J. Lane Notter, Dr. R. D. Sweeting, and Dr. A. Newsholme to be examiners in State medicine in the year 1906; and Mr. G. H. F. Nuttall, Mr. C. W. Daniels, and Prof. Ronald Ross, C.B., F.R.S., to be examiners for the diploma in tropical medicine and hygiene in the year 1906.

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DR. W. A. BONE, F.R.S., has been appointed professor of applied chemistry (fuel and metallurgy) in the University of Leeds.

MR. CHARLES W. E. LEIGH, formerly of the Natural History Museum, South Kensington, and late assistant secretary and librarian to the Manchester Literary and Philosophical Society, has been appointed librarian of the University of Manchester.

THE following appointments, *Science* states, have been made in the faculties of the George Washington University:—General Henry L. Abbott, U.S.A., to be professor of hydraulic engineering; Dr. Edward B. Rosa to be professor of physics; and Brigadier-General George M. Sternberg, U.S.A., to be professor of preventive medicine.

WE learn from *Science* that President Eliot, of Harvard University, has received a letter from President Pritchett, of the Massachusetts Institute of Technology, communicating the fact that, in view of the recent decision of the Supreme Court of the State in the case of John Wilson and others *v.* the Massachusetts Institute of Technology, the corporation of the institute find it impossible to proceed with the plan of cooperation between the university and the institute which has been under consideration for the past six months. The committee appointed by the Harvard board at the request of the institute has consequently been discharged.

AT the annual general meeting of members of the Bedford College for Women, held on November 17, the chairman, the Right Hon. A. H. Dyke Acland, announced that the Parliamentary grant to Bedford College had for the current session been increased from 2000*l.* to 4000*l.* It was also reported that past students had already contributed 3500*l.* to the building fund. Principal T. G. Foster, of University College, and Lady Lockyer have been elected members of the council, as representatives of the senate of the University of London. The council offers two open scholarships of the value of 20*l.* each for one year for the course of secondary training beginning in January, 1906. The scholarships will be awarded to the best candidates holding a degree or equivalent in arts or science. Applications should reach the head of the training department not later than Monday, December 18.

SIR W. H. PREECE distributed the prizes and certificates to the students of Birkbeck College on November 14, and afterwards delivered an address on the simplicity of science. Sir William Preece said he has never believed that in scientific and technical training Englishmen are far behind the rest of the world. However lacking we may have been in the upper regions of higher education, we have never failed to encourage education in other ranges, and Birkbeck College was one of the first in this country to spread the love of science and to offer educational facilities to those willing to use them in their leisure hours. What is wanted now, he continued, is that men who make fortunes in the metropolis shall become patriotic founders of endowments for enabling us to distribute the teaching advantages already existing to all classes of society. Sir W. Preece incidentally remarked on the absence of memorials to pioneers of science, mentioning especially Sir Henry Bessemer—an old student of Birkbeck College. Towards the conclusion of his address he suggested that Members of Parliament, before being permitted to legislate, should have to go through a course of instruction in scientific modes of thought.

AT a dinner given by the Society of Apothecaries on November 14, Mr. John Tweedy, president of the Royal College of Surgeons, responding to the toast "The Royal Colleges of Physicians and Surgeons," dealt with the subject of medical education. He said that, in accordance with the promptings of the General Medical Council, the Royal College of Surgeons has raised the standard of general education of medical students, and has increased the multiplicity and severity of the examinations. But Mr. Tweedy would like to see the wheel turned back a little. He thinks that too much is being attempted in the way of examinations, and desires to see steps taken in the direction of simplification, without any sacrifice of efficiency. If some of the restrictions and regulations were relaxed, he believes a better class of practitioner than is possible under the present *régime* could be produced. The student is over-taught, over-examined, so that he has no time to reflect, to exercise his reason or his intellect. Mr. Tweedy believes that the medical examinations are best entrusted to professional corporations. Although he does not go so far as to advocate deprivation of the universities' power of granting qualifying degrees, he pointed out that the universities do not possess a qualifying degree in law.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, July 29.—"Studies on Enzyme Action. VII.—The Synthetic Action of Acids contrasted with that of Enzymes. Synthesis of Maltose and Isomaltose." By E. Frankland **Armstrong**. Communicated by Prof. H. E. Armstrong.

The belief has grown up of late years that the enzymes which are capable of inducing the hydrolysis of disaccharides or bioses act reversibly; as yet, however, but little has been done to define the theory of the process, and no understanding has been arrived at as to the limitations to which such changes are subject. The same is true of the action of acids, which also act reversibly under certain conditions.

The key to the interpretation of the changes which attend condensation must be looked for in the behaviour of glucose itself in solution.

The term glucose, in fact, has a double connotation, and these two substances must usually be thought of under the single name. As crystallised from alcohol, it consists almost entirely of the α-form; but this changes over into the β-form if maintained during several days at about 105°. If either form be dissolved in water, change takes place of the one into the other; ultimately, the two forms

exist in solution in equilibrium, in proportions which depend on the conditions, the β-compound predominating. Change takes place in a similar manner in other media.

The process by which a monose is converted into a biose must be regarded as precisely similar to that by which α-glucose and β-glucose are converted into the two methyl-glucosides: the behaviour of maltose, in fact, is such as to characterise it unquestionably as glucose-α-glucoside; isomaltose is presumably the stereoisomeric glucose-β-glucoside.

When glucose undergoes condensation "uncontrolled," it should give rise to both maltose and isomaltose, the proportions of which ultimately present in equilibrium would depend on their relative stability under the conditions operative at the time. But, inasmuch as hydrolysis under the influence of enzymes is an absolutely selective process, being so controlled that it takes place in one direction only, it might be supposed that synthesis under their influence would also be a controlled operation, and that the tendency of the enzyme would be to reproduce the biose which it hydrolyses: apparently this point of view was present in Croft Hill's mind and led him to suppose, at first, that maltose was the actual product; as a matter of fact, it is uncertain at present whether maltose is produced at all: it is certainly not the sole or even the predominant product.

The formation under the influence of the enzyme of a single biose, *isomeric with that which it hydrolyses*, could be accounted for on the assumption that both are produced initially, but that the one again undergoes hydrolysis as soon as it is formed, so that it all but disappears.

Proof is given in the present communication that when the condensation is effected under laboratory conditions the action takes place in the manner indicated above; in other words, the two products required by theory are both formed. Evidence is adduced to show that isomaltose is the β-glucoside correlative with the α-glucoside maltose. Experiments are described bearing on the formation of isomaltose by the agency of the α-enzyme maltase and of its correlative maltose by the agency of the β-enzyme emulsin which leave little doubt that the two bioses are producible from glucose. Whilst it is left undecided whether maltase can give rise to maltose, evidence is cited which at least renders it probable that emulsin does not give rise to isomaltose.

"Studies on Enzyme Action.—Lipase." By Henry E. **Armstrong,** F.R.S.

The study of vegetable lipase is of special importance, as the ordinary fats—which are hydrolysed under its influence with peculiar readiness—are not asymmetric material but simply glycerides of acids of the acetic or oleic series. The interest of the inquiry is enhanced by the fact that animal lipase, according to Dakin, acts selectively but the selective effect of lipase is of a different order from that displayed, for example, by an enzyme of the sucroclastic class, which can only attack one member of a pair of enantiomorphous isomerides.

In the course of the experiments, Connstein's contention has been confirmed that the presence of acid is necessary to condition the hydrolysis and that practically any acid is effective provided a sufficient amount be used. Aspartic and glutamic acids—which are formed at an early stage of the germination of seeds—were found to be highly active; glycin and asparagin, however, were practically without effect.

All attempts resulted in failure which were made to obtain an extract containing an enzyme, whether from the freshly-ground material directly or after this had been deprived of the fatty matter and whether or no acid were present. Apparently, acids do not act merely by liberating the enzyme.

The Ricinus enzyme has been found to have but little action, not only on ethylic butyrate, on acetin and on dimethylic tartrate and racemate but also on ethylic mandelate, which, according to Dakin, is readily attacked by animal lipase.

It is difficult to resist the impression that the differences observed are not merely consequences of differences in stability of the various ethereal salts but that the Ricinus enzyme is possessed of properties which make it specifically capable of promoting the hydrolysis of glycerides of the higher fatty acids.

Received August 10.—"Fertility in Scottish Sheep." By Dr. F. H. A. **Marshall.** Communicated by Prof. E. A. Schäfer, F.R.S.

Received August 18.—"The Pressure of Explosions. Experiments on Solid and Gaseous Explosives." Parts i. and ii. By J. E. **Petavel.**

Part i. deals with the methods and apparatus used in the research. Part ii. is devoted to a study of the properties of cordite.

Received September 7.—"On the Nature of the Galvanotropic Irritability of Roots." By Dr. Alfred J. **Ewart** and Jessie S. **Bayliss.** Communicated by Francis Darwin, For.Sec.R.S.

After the contradictory experiments of Müller-Hettlingen, and Elfving, Brünchorst found that strong currents produced a positive, and weak currents a negative, curvature. Roots hence appeared to possess a parallelotropic irritability to electrical currents, reversible according to the intensity, as in the case of heliotactic and heliotropic irritability. The experiments were not altogether satisfactory, nor did they reveal the mode of stimulation, so further investigations seemed desirable.

These have shown that the curvatures are produced by the acid and alkaline products of electrolysis liberated on opposite sides of the root. The acid products are more effective than the alkaline, so that when the current is led transversely through the subapical sensitive region the curvature always takes place towards the positive electrode; but if one electrode is placed upon the hypocotyl and the other on the irritable zone, the curvature is always towards the latter electrode, whether it be positive or negative. These *galvanogenic* curvatures are hence chemotropic in origin, as has been shown by direct experiments with acids and alkalis. Thus, if the roots are imbedded at varying distances in gelatin through which a current is passed, the roots curve in regular order towards the electrodes shortly after the acid or alkali, as evidenced by phenolphthalein, has diffused near to them.

In addition, the application of the electrolysed region of a root or of filter paper moistened with decinormal acid or alkali produces similar curvatures.

All these curvatures have been produced on a klinostat and without any injury to the root. Indeed, in many cases a constant current of 0·000009 of an ampere is sufficient to cause a curvature. Using non-polarisable electrodes, no response is given unless very strong currents are used, since the stimulation is now dependent upon the restricted internal polarisation in the root.

It is doubtful whether the electrical currents in the soil call this special irritability regularly into play. The power of curving towards faintly acid or alkaline regions must aid the root greatly in reaching soil where soluble constituents are most likely to be abundant, or where anaërobic nitrogenous decomposition (with a production of ammonia) or the subsequent aërobic nitrification (with a production of traces of nitrous and nitric acids) are in progress.

The non-development of any power of curving away from strong acid or alkali is to be explained by the non-occurrence of high local concentrations in normal soil. Even when a strong local acidity or alkalinity is artificially produced in the soil, the roots are killed before they can curve away from it, and even if the apical zone did curve away, the non-curving zone behind would be rapidly killed.

**Sociological Society,** October 24.—Sir John Cockburn in the chair.—Biological foundations of sociology: Dr. G. Archdall **Reid.** The author outlined modern teaching on the subject of heredity, accepting the Weissmannian conclusion regarding the non-inheritance of acquired characters. These principles he applied to human qualities with especial reference to the possibilities of selective breeding. Four main conclusions were reached:—(*a*) That there is a confusion, in popular and in uncritical medical opinion, of variation with acquirement. Many individual acquirements are considered innate. (*b*) That racial

change through heredity is a process requiring very long periods of time, so increase of natural ability by selection of variations must remain, on the whole, inconsiderable. (*c*) That the more important factor is individual acquirement or education. The great output of genius during the Athenian and Renaissance periods is to be explained, not in terms of natural ability, but as arising from exceptional opportunity. (*d*) That the one practicable method of improving the racial average of natural ability is by the elimination of clearly degenerate types.

**Challenger Society**, October 25.—Mr. E. W. L. Holt in the chair.—Charts illustrating the physical conditions in the English Channel during 1903 and 1904: Dr. E. J. **Allen** and D. J. **Matthews.** The observations, which were conducted from the Plymouth laboratory of the Marine Biological Association as a centre, had been made by the association's steamers *Huxley* and *Oithona*, by ocean-going liners and cross-Channel steamers, and at lightships and lighthouses. They extended from about Dungeness to Cape Finisterre, and showed the north-easterly movement of oceanic water of high salinity and temperature, the southerly movement of water of low salinity from the Irish Sea, and the varying effects of these movements on the waters of the English Channel in different months.

**Royal Astronomical Society**, November 10.—Mr. W. H. Maw, president, in the chair.—Observations of the sixth and seventh satellites of Jupiter, from photographs taken at the Royal Observatory, Greenwich, with the 30-inch reflector of the Thompson equatorial: **Astronomer Royal.** The photographs were shown on the screen, with diagrams to illustrate the orbits of the satellites.—Observations of the satellite of Neptune, from photographs taken at the Royal Observatory, Greenwich, with the 26-inch refractor: **Astronomer Royal.**—Expedition to Vinaroz, on the east coast of Spain, to observe the total solar eclipse of August last: Father **Cortie.**—Eclipse expedition to Burgos: Mr. **Thwaites.**—Eclipse expedition to Labrador: Mr. **Maunder.**—Photograph of the partial phase of the recent eclipse showing distinctly the entire disc of the moon: Mr. **Saunder.**—(1) Secular acceleration of the earth's orbital motion; (2) Ptolemaic eclipses of the moon as recorded in the Almagest: Mr. **Cowell.** In a paper already printed the author showed that the ancient solar eclipses are satisfied by adopting the following secular terms:—(1) in the distance of the moon from the node $+4''\cdot4$, and (2) in the distance of the moon from the sun $+6''\cdot8$. He now showed that these conclusions are supported by the eclipses of the moon as given in the Almagest. Mr. Cowell considered that a secular acceleration of the earth's orbital motion does not contravene gravitational theory, as Prof. Newcomb had suggested, since it might be ascribed to the resistance of the ether.—Other papers were taken as read.

**Physical Society**, November 10.—Dr. C. Chree, F.R.S., vice-president, in the chair.—The question of temperature and efficiency of thermal radiation: J. **Swinburne.** It has long been known that various surfaces have different emissivities, and it is generally held that at a given temperature some bodies radiate a larger percentage of their total radiation in the form of light. This view is largely based on some experiments by Evans and Bottomley, both of whom, the author remarks, make the same slip in confusing difference of emissivity with difference of efficiency at the same temperature. It is urged that a body A at the same temperature as B cannot give out radiation corresponding to a higher temperature of B, for if it could, and A and B were enclosed in a perfectly reflecting space, A would heat B to a higher temperature than A.—Note on constant-deviation prisms: T. H. **Blakesley.** It appears that any prism of three faces can be made to give a spectrum in which the light, that occupies the centre of the field of view of the telescope at any moment, has undergone passage through the two refracting surfaces of the prism in such a way that its original angle of incidence is equal to its final angle of emergence. This condition, which in the ordinary employment of the prism is associated with minimum deviation, must be described as isogonal passage, the property which has the minimum value being not the deviation, but the rate of passage across the field of view for a given motion of the prism, to which alone in these instruments motion has to be given to bring different parts of the spectrum into the field, the telescope and collimator both remaining fixed. If any triangle having the angles $\alpha$, $\beta$, $\gamma$ is adopted as the shape of a prism, the telescope must be set to make one of these angles, say $\gamma$, with the line of the collimator. Then the prism being placed in the region between them, a position can be found so that any ray selected will be refracted through one of the sides containing the angle $\gamma$, reflected at the side opposite $\gamma$, and finally refracted through the remaining side containing $\gamma$. On emergence it will be parallel to the telescope, and its passage through the refracting faces will be isogonal. The prism will affect the light to the same degree as one used in the ordinary way, of refracting angle $\beta-\alpha$, would do. The sine of the angle of original incidence is equal to $\mu \cdot \sin(\beta-\alpha)/2$ for every ray occupying the centre of the field of view. If the prism is turned over, but the same angle $\gamma$ employed, the telescope will remain unaltered, but the spectrum will run in an opposite direction to the first. Mr. Blakesley showed the case of two prisms in which the spectra ran in different directions. The top prism was slightly tilted by the insertion of a small piece of silver paper between the prisms. By this means one of the spectra was shifted upwards by a small amount, and one could see in the telescope a band, at top and bottom, of the component colours, and in the centre a band of the resulting colours. It was suggested that spectroscopes on this plan could be advantageously employed in measuring the motion in the line of sight of heavenly bodies, as a line brought into coincidence with itself for a terrestrial source in the two spectra would, in the case of such motion, split up into two moving *different* ways in the field of view. It was also explained how such prisms could be placed in trains for increased dispersion.

**Royal Meteorological Society**, November 15.—Mr. Richard Bentley, president, in the chair.—The rainstorm of August 24 to 26 in counties Dublin and Wicklow: Sir John W. **Moore.** The atmospheric disturbance which caused the torrential rainfall was near the shores of Kerry and Cornwall on August 24, and the next morning it was near the Scilly Islands. Thence it travelled slowly northwards up St. George's Channel, its centre passing near Dublin early on the morning of August 26. At this time the system suddenly changed its course, crossing the channel eastwards to Wales, and finally passing over central England and out to sea at the mouth of the Humber in a north-easterly direction. It appears that the rainfall on August 25 exceeded 3 inches at all stations in the counties Dublin and Wicklow, while it rose above 4 inches, and even 5 inches, at stations near the Dublin and Wicklow mountains. Sir John Moore is of opinion that this remarkable downpour was brought about by the cooperation of the following factors:—(1) a chill antecedent to the arrival of the rain-bearing depression; (2) the slow progress of the depression; (3) the fact that the counties Wicklow and Dublin lay to the westward of the cyclonic centre, and so received its north-easterly and northerly winds; and (4) the physical configuration of those counties and their coast line. As the result of this remarkable rainstorm a destructive flood occurred over the low-lying parts of the Bray urban district near the mouth of the Bray River. At Little Bray the water rose to a height of 4 feet in the streets, flooding houses, destroying domestic animals and fowls, wrecking furniture, and covering floors, yards, and gardens with a thick alluvial deposit.—The aquameter: Dr. W. B. **Newton.** This is a new instrument for measuring accurately the amount of aqueous vapour present in the atmosphere.

PARIS.

**Academy of Sciences**, November 13.—M. Troost in the chair.—Nitrates and nitrites as manure: Th. **Schloesing**, jun. Nitrate of calcium is now produced by electrical means from the air, and the salt thus obtained contains nitrite. It was desirable to ascertain whether the calcium nitrate is equivalent for manurial purposes to the sodium nitrate in ordinary use, and also whether the nitrite was in any way prejudicial. Cultivation experiments showed that the two nitrates were equivalent, and that the presence

of nitrite was without objection.—On the floating spiked Decapods collected by the American expeditions of the *Hassler* and the *Blake*: E. L. **Bouvier.**—On the congruences of skew cubics: M. **Stuyvaert.**—On the development of a uniform analytical function in an infinite product: M. **Zoretti.**—On the complementary geodesic triangulations of the upper regions of the French Alps (third expedition): P. **Helbronner.**—On a dynamometric brake designed for measuring the power of motors, and which allows of the utilisation, in an electrical form, of the greater part of the work developed: A. **Krebs.** This electrical brake has been successfully applied to measuring the horse-power of motor-car engines of from 1 horse-power to 200 horse-power. It has several advantages over the friction dynamometer, as it can be used as long as may be required without any danger of over-heating, and is not liable to the errors introduced by the variations in the coefficient of friction.—On the electrical phenomenon created in liquid chains, symmetrical as regards concentration, by the formation of a fresh surface of contact: H. **Chanoz.**—On the liquefaction of air by compression with external work: Georges **Claude.** A continuation of an earlier paper on the same subject, and giving an account of the modifications which it has been necessary to make in the arrangements of the apparatus to secure an increased yield of liquid air.—On the molecular conductivity of the phosphoric esters: P. **Carré.** Measurements are given for the monoalkylphosphoric esters derived from ethyl and isobutyl alcohols, glycerol, erythritol, and mannide, and it was found that the ionisation of the acid phosphoric esters is considerably greater than with phosphoric acid itself.—A general method for the synthesis of $\alpha\beta$-glycidic esters and of ketones: Georges **Darzens.** In a previous paper the author has shown that by the condensation of monochloroacetic acid with ketones, trisubstituted glycidic esters are formed by the saponification of which unstable acids are produced, the latter readily splitting up into carbon dioxide and a ketone. This reaction has now been extended to $\alpha$-chloropropionic acid, giving ketones of the type $RR_1.CH—CO—CH_3$. The reaction appears to be quite general; eight new glycidic esters and five new ketones are described.—On the constitution of crystallised bodies: Fréd. **Wallerant.**—Observations relating to the morphology of aërial bulbs: Marcel **Dubard.** *Coleus Dazo* shows a tendency to accumulate its reserves in its aërial organs when the conditions of growth are unfavourable to the formation of subterranean stems. These reserves, of a starchy nature, are deposited in the axillary buds originally intended to form flowers.—The changes in the amount of fragrant oil present in the plant during the accomplishment of the functions of the flower: Eug. **Charabot** and Alex. **Hébert.**—Comparison of the cycles of evolution of the Orthonectidæ and Dicyemidæ: F. **Mesnil** and M. **Caullery.**—The formation of the vitellus in the sparrow: M. **Dubuisson.**—The embryogeny of the Hexactinidæ: L. **Faurot.**—The reason why certain deaf mutes can hear low notes better than high ones: M. **Marage.** From experiments on animals unprovided with any organ of hearing, the author concludes that the perception of low musical notes by deaf mutes is not hearing in the proper sense of the word, but a special sense for low notes which is also met with in the lower animals.—The increase in the activity of the pancreatic secretion by calcium salts: C. **Delezenne.** The experiments described show the importance of calcium salts in developing the activity of pancreatic juice. A complete explanation of the effects produced is not, as yet, forthcoming.—On the tectonic at the S.W. of Chott and Hodna: J. **Savornin.**—On the use of hydrostatic pressure in tapping thermal springs: L. **De Launay.**—The exploration of the free atmosphere above the Atlantic Ocean, north of the tropical regions, on board the yacht of the Prince of Monaco, in 1905: H. **Hergesell.**

## DIARY OF SOCIETIES.

*THURSDAY*, NOVEMBER 23.

ROYAL SOCIETY, at 4.30.—On the Nature of the Galvanotropic Irritability of Roots: Dr. A. J. Ewart and Miss Bayliss.—Some Observations on *Welwitschia mirabilis*, Hooker-f.: Prof. H. H. W. Pearson.—On the Effects of Alkalies and Acids, and of Alkaline and Acid Salts, upon Growth and Cell Division in the Fertilised Eggs of *Echinus esculentus*; a Study in Relationship to the Causation of Malignant Disease: Prof. B. Moore, Dr. H. E. Roaf, and E. Whitley.—A Note on the Effect of Acid, Alkali, and Certain Indicators in Arresting or Otherwise Influencing the Development of the Eggs of *Pleuronectes platessa* and *Echinus esculentus*: E. Whitley.—On Certain Physical and Chemical Properties of Solutions of Chloroform and other Anæsthetics. A Contribution to the Chemistry of Anæsthesia. (Second Communication): Prof. B. Moore and Dr. H. E. Roaf.—(1) On the Possibility of Determining the Presence or Absence of Tubercular Infection by the Examination of a Patient's Blood or Tissue Fluids: (2) On Spontaneous Phagocytosis and on the Phagocytosis which is obtained with the Heated Serum of Patients who have responded to Tubercular Infection, or as the Case may be to the Inoculation of a Tubercle Vaccine: Dr. A. E. Wright and Staff-Surgeon S. T. Reid, R.N.—On the Occurrence of the Heterotypical Mitosis in Cancer: Dr. E. F. Bashford and J. A. Murray.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Applications of Electricity in the Royal Gun Factory, Woolwich Arsenal: Colonel H. C. L. Holden, R.A., F.R.S.

*FRIDAY*, NOVEMBER 24.

PHYSICAL SOCIETY, at 5.—The Dielectric Strength of Air: A. Russell.—On the Electrical Conductivity of Flames containing Salt Vapours for Rapidly Alternating Currents: Dr. H. A. Wilson.—On the Lateral Vibration of Loaded and Unloaded Bars: J. Morrow.

*SATURDAY*, NOVEMBER 25.

THE ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford), at 6.30.—Report of Club's Delegate at Meeting of Corresponding Societies' Committee, British Association, 1905: F. W. Rudler, I.S.O.—Romance of Plant Life: F. Martin-Duncan.

*MONDAY*, NOVEMBER 27.

SOCIETY OF ARTS, at 8.—The Measurement of High Frequency Currents and Electric Waves; Prof. J. A. Fleming, F.R.S.

INSTITUTE OF ACTUARIES, at 5.—Valuation by Select Tables: Separate Papers by Messrs. T. G. Ackland, O. F. Diver and G. King.

*TUESDAY*, NOVEMBER 28.

ZOOLOGICAL SOCIETY, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Discussion:* On Waterways in Great Britain: J. A. Saner.—*Also, time permitting*: The Steam-Turbine: The Hon. C. A. Parsons, C.B., F.R.S., and G. G. Stoney.

*WEDNESDAY*, NOVEMBER 29.

SOCIETY OF ARTS, at 8.—The British Association in South Africa: Sir William H. Preece, K.C.B., F.R.S.

*FRIDAY*, DECEMBER 1.

INSTITUTION OF CIVIL ENGINEERS, at 8.—An Installation for the Bacterial Treatment of Sewage, at Neath: W. L. Jenkins.

## CONTENTS.