THURSDAY, MARCH 10, 1910.

THE SURVIVAL OF MAN.

Survival of Man. A Study in Unrecognised Human Faculty. By Sir Oliver Lodge, F.R.S. Pp. xi+357. (London: Methuen and Co., 1909.) Price 7*s*. 6*d*. net.

THIS is a book that will attract great attention, and deservedly so. There is a well-known saying recommending men, especially judges, to give their conclusions, but never their reasons. Possibly this is wise advice in the realm of law, but it is a hopeless attitude of mind in the regions of philosophy, where the reasons are of the essence of the transaction, and the conclusions may be merely the incorrect deduction of a mind as imperfect as our own. When, therefore, a man of the standing of Sir Oliver Lodge consents, if we may use the expression, to do his thinking aloud, to lay himself open indifferently to the scoffs of the convinced unbeliever and the wistful commiseration of the unconvinced would-be believer; when he allows us to see the process by which he himself has become persuaded of the most fundamental doctrine of life, the whole community owes him a very great debt of gratitude.

To most people the question of the survival of human personality is the greatest problem of life; a positive answer one way or another would affect the actions and aspirations of mankind more than any other possible consideration or discovery. It is because of the momentous character of the subject, because of the effect that a positive assurance would have on the majority of mankind, that it has never been possible for a person who believed himself by any means to have obtained this assurance to keep the grounds of his conviction to himself. From the point of view of the present band of investigators, of which Sir Oliver Lodge is a distinguished member, having regard to the intensely intimate nature of their experiences, one may well doubt how far it has been expedient to take the general public, as yet, into the confidence of the small group of fellow-workers. Science has this great advantage over other kindred branches of intellectual activity, such as literature and art:—the general public does not profess to understand its workings; nay, a large section of the public prides itself on its inability to understand the methods of science. By this means, men of science often escape the premature notoriety which is destructive alike to patient investigation and to the inspiration of wayward genius. Especially in the case of the experiments with which Sir Oliver Lodge deals in the last chapters of his book, we may wonder how far it has been entirely discreet at present to open the discussion to the general public.

But the very magnitude of the issues at stake makes it difficult for any earnest mind to keep the results, tentative as they appear, the property of a small circle. It is not easy to imagine circumstances which would justify the creation, even for a short period, of a "corner" in truth. It is therefore in accordance with the best traditions of English science that the results of these investigations, as soon as they seem to be of value to the outside world, should be at its disposal.

The book before us does not profess to give an account, or even a summary, of all the work which has now been accomplished on the subjects of telepathy, clairvoyance, hypnotism, &c. As we have already said, it contains the story of the way in which, throughout the last quarter of a century, Sir Oliver Lodge has been led to believe, as the result of carefully planned experiments, if not that evidence of the survival of man—or, more correctly, of certain men—has already been collected, at any rate that there is no reason why it should not be collected. We do not think that anyone unfamiliar with the recent publications of the Society for Psychical Research will feel that he has proved his point. The nature of the evidence prevents any single or any several incidents in themselves from carrying conviction, and will always prevent it. It is the cumulative effect, added to a personal realisation of the nature of the evidence, that must be relied on. But even the proceedings of the Society for Psychical Research are published in an abbreviated form, and Sir Oliver only gives a few quotations and references to this mass of already selected facts.

At present the chief interest of the subject centres round the theory of cross correspondences, emanating chiefly from the so-called controls that are manifested in certain well-known and much discussed automatic scripts, and claim to represent the surviving personalities of Myers, Hodgson, and others. Here again the general reader cannot possibly realise how much is conveyed by the revelation of personality, in characteristic phraseology, in appropriate knowledge, in intellectual equipment. A voice in the dark may bring absolute assurance to anyone familiar with that voice of the corporal presence of a certain being, while it is meaningless or passes unheard to a person who is unfamiliar with it. Similarly, indications of known personalities, examples of typical intellectual activities continuing after earthly existence has ceased, may accumulate to such intensity that no hypothesis is so simple or so effective as that which involves the acceptance of the belief in their manifest survival; and after all, it is the essential nature of a satisfactory hypothesis, which in due course may develop into one of the so-called laws of nature, that it should offer the simplest and most effective explanation of certain ascertained facts. We do not imagine that the present book will suffice to convince anyone who is without other assurance; but we can well understand that those who have had the experience of Sir Oliver Lodge should feel that the hypothesis of the survival of man cannot long remain in the outer court of the enshrined truths of natural philosophy.

AN AMERICAN HIGH-SCHOOL BOOK ON AGRICULTURE.

Elements of Agriculture. By Prof. G. F. Warren. Pp. xxiv+434. (New York: The Macmillan Co., 1909.) Price 5*s*. net.

"THE purpose of the present book," says Dr. Bailey in an introductory note, "is to make the teaching of agriculture in the existing high schools comparable in extent and thoroughness with the teaching of physics, mathematics, history and literature."

"The interest in the teaching of agriculture," continues the author, "is but a part of a much larger question—the movement for teaching by means of things that have come within the student's experience. The underlying reason why such teaching is desirable is because it brings the schools in touch with the home life—the daily life of the community. A large part of our teaching has had no relation whatever to our daily life."

Thus the author justifies the introduction of agriculture into a high school. The subject is undeniably interesting to elder scholars whether they propose going in for farming or not, but the author goes further, and maintains that it is of real educational value and can be presented in such a way as to train the student to think. Few people would dispute these views, but we have had to wait until now for a little handbook in which they are logically carried out.

The book is not, of course, intended for elementary schools. The author presupposes some knowledge of chemistry and botany, and makes no attempt to gloss over difficulties. It is doubtful whether a scholar could study the subject profitably until he is some sixteen years of age. The author begins with the principles underlying the improvements of plants and animals by crossing and by selection. Mendel's law and its applications are dealt with at length, and mutation forms are also discussed. In illustration of the improvement effected it is shown that the percentage of sugar in the sugar beet has increased from 8 to 18 per cent. or more, whilst maize, cotton and other crops have undergone no less change. The propagation of plants forms the subject of the next chapter. Root stocks, tubers, cuttings, grafting, budding, are described in some well-illustrated pages, and then we pass to the consideration of seeds and germination tests. The student is thus led to the study of the food required by the young plant; he finds that at first it comes from the seed, afterwards from the air and the soil. A brief sketch is given of the processes going on within the plant, the manufacture of plant food, and so on. The soil is next considered; it is shown to consist of small rock particles, soil water, soil air, decaying organic matter, and living organisms, all of which are dealt with in some detail. As usual in American books great stress is laid on the importance of soil water. The reason is very obvious; two-fifths of the United States is too dry to raise good crops without irrigation, and the Government is building large reservoirs for storing irrigation water. Further, dry farming is practised there to a greater extent than anywhere else as yet. On the other hand, on the Atlantic coast the water supply is sometimes too great and a good deal of the land requires draining.

The author discusses at some length the methods for maintaining the fertility of the land. Soils have become productive by lying for ages in prairie or forest condition whilst organic matter has gradually accumulated until some sort of equilibrium is attained. With the advent of man the equilibrium is upset, the prairie is broken up, grain is grown for many years, and the wastage, which in any case would be considerable, is increased by the common habit of burning the straw of the crops. Only in old, long-settled countries is the full value of farmyard manure appreciated. "Very few farmers in any part of America," says the author, "have yet learned to handle manure without losing one-half of its value." Among the causes of decreased productivity, erosion by wind or water is considered the worst, but it may be prevented by keeping the soil in crop as much as possible. Exhaustion of the humus supply is, however, regarded as the fundamental cause for the decrease in crop yields. Methods of restoring the fertility of the soil by means of manures, green crops, and animal excretions are described. Then follow some interesting chapters on the various crops—maize, cotton, wheat, timber and so on—their economic importance, their methods of cultivation, and the pests to which they are liable. Finally, there is a discussion on the feeding of animals.

The treatment quite justifies the author's claim that agriculture is a suitable subject for training the mind. The book is conceived in a scientific spirit, and executed with great skill. It is just the book for the young agricultural student, or, indeed, for any young student. All the illustrations are, naturally, American, but the teacher on this side will find it very useful in making up his course, although he will probably wish that an equally good book written from an English standpoint was available.

ELECTRONIC THEORY OF MATTER.

La Radioattività. A. Battelli, A. Occhialini, S. Chella. Pp. xxxii+xii+438. *Atti della fondazione scientifica Cagnola dalla sua istituzione in Poi.* Vol. xxii. (Milano, 1909.)

TWO of the most noticeable features of Continental publications of a scientific character are, first, the number written in a semi-scientific manner for popular consumption, and, secondly, the variety dealing with special branches of chemistry or physics in a manner capable of being readily followed by men of science interested chiefly in other branches of these subjects. The present volume is an excellent example of the second class. The first part consists of reports on essays concerned with different subjects, and is followed by the work of Prof. Battelli and his coadjutors, to whom a prize of 2500 lire and a medal were awarded for their memoir on "The Discovery of Radio-activity and its Influence on Physical and Chemical Theory."

In this book of 438 pages the chief facts of radioactivity are set forth in a most interesting and lucid style, and their bearing on chemical affinity, the electronic theory of matter, and the periodic law is discussed in a manner equally able. The standard books on conduction in gases and radio-activity usually contain too much detail, except for experts in these branches of physics; the present authors do not profess to give a full account of the facts, but only of those that are necessary to show the development of recent theory. Great praise is due, not only for the clearness with which these facts are dealt, but also for the skilful choice of material from a large mass of detail. No book of a similar scope is published in English, and it may be recommended without hesitation to students desiring a succinct statement of facts and their bearing on modern theories of matter. Having said so much, we may perhaps be permitted to point out various small blemishes.

Chapter i. gives an account, in forty pages, of the chief results obtained by the study of gaseous conduction. The usual revolving paddle-wheel is given as an instance of the mechanical effects produced by kathode rays, but it has been shown by Stark that this is due to the heating and not to the momentum of the rays. The properties of positive rays are given in one short paragraph; as they are of outstanding interest at the present time, it might have been expected that something more recent than W. Wien's original experiments would be mentioned.

On p. 61 the extinguishing action of radium on a long spark is ascribed to the conductivity produced, but, as Peck and the present writer have shown, a far greater conductivity may be produced by Röntgen rays without producing extinction.

Chapter iii. should be especially useful to chemists, dealing as it does with the instruments used and the methods of standardising them; Wilson's tilted electroscope might have been included.

On p. 127 a method is given of demonstrating the positive charge carried by α rays; actually the indications of the electroscope would be the same if the rays were uncharged; all the experiment shows is that the β rays are charged negatively. The proper demonstration is given later.

The deduction of the transformation constants from the decay curves is exceptionally well done, as is also the question of electromagnetic mass. In connection with the latter, Sir J. J. Thomson has given reasons for thinking that the number of electrons in an atom is small; these reasons should have been mentioned in the discussion of atomic architecture.

Chapter xi. gives an account of conduction in metals according to the electronic theory. A difficulty, not mentioned here, is the fact that on this theory, according to Thomson, the energy required to raise, say, a gram of silver one degree is about ten times that shown by experiment.

Finally, in a book of such a scope we should expect to find some reference to the work of Campbell and others on the radio-activity of the commoner elements.

R. S. W.

POPULAR ASTRONOMY.

(1) *Astronomical Curiosities, Facts and Fallacies.* By J. Ellard Gore. Pp. x+370. (London: Chatto and Windus, 1909.)

(2) *Curiosities of the Sky. A Popular Presentation of the Great Riddles and Mysteries of Astronomy.* By Garrett P. Serviss. Pp. xvi+268. (New York and London: Harper and Brothers, 1909.) Price 6*s.* net.

IT is admittedly unwise to judge a book by its cover. It would seem to be quite unsafe to judge it by its title. Two books, by a quaint coincidence very alike in their titles, demand notice together. Notwithstanding their initial similarity, they each appeal to a distinctly different class of readers.

(1) To anyone with an already developed interest in general astronomy the collection of "curious facts, fallacies and paradoxes" contained in Mr. Gore's book will doubtless prove interesting and suggestive. It does not pretend to tell a connected story. It certainly does not. Neither does it present a fairly complete picture of the astronomy of to-day. Elements of the subject are not dealt with, and facts loom larger than theories. It is essentially a book of "extras."

The information given, which the author believes will not be found in popular works on astronomy, has apparently been gleaned mostly, though of course not exclusively, from English and American publications of recent years. Each fact is presented in all its individuality with a local habitation and a name. It is in effect an excellent astronomical scrap-book, with the scraps arranged into chapters and with references scrupulously and copiously given.

The sun and the planets are each dealt with in sequence. The first nine pages contain statements about the sun's "stellar magnitude," temperature, possible length of life and source of heat. Remarks as to the discovery of argon and neon in the sun's chromosphere (which is probably an erroneous identification), about various observations of D_3 and concerning the discovery of sun-spots, all find a place in this first chapter. From this some rough idea of the character of the work may be gathered. Considering the great and growing importance of solar physics, this chapter might have been enlarged with profit. To allot no more space to the sun than to each of the planets in turn is surely an unbalanced treatment. The succeeding chapters devoted to comets, to double, binary and variable stars, and to nebulæ, will be found closely packed with information. Following these comes a rather large section of 73 pages concerned with mythological and modern details about the constellations and their included stars. The temperament that found a dictionary the most readable of books would have gloried in these chapters. That the general reader will struggle through them it is difficult to believe.

It is not to be supposed because the work suffers from its limitations that it is not valuable. As a well-written compendium of facts it satisfies a distinct want. Where such want exists it can be recommended. The book is well printed and bound. It is fully indexed, and is light and pleasant to handle.

(2) "Curiosities of the Sky" is a book of quite another type. Here the selecting hand of the artist has been at work. "Facts" are included only when they help the presentation of the subject. The series of chapter-essays into which the publication is divided are excellently written and generally well informed. Astronomical "coal sacks," under the title of "The Windows of Absolute Night," star clusters, star streams and stellar migrations form the subject-matter of the first fifty pages. An interesting chapter on the passing of the constellations follows. Here the

author, by effective description and diagrams, shows the asterisms the Great Bear and the Hyades to be but transient phenomena, and the exquisite Corona Borealis but a passing show. New stars, nebulæ, and the sun itself next provide material for the author's pen. It will be noticed that the chapters follow, in some sort, an evolutionary sequence. In spite of the temptations of the subject, extravagant and loose statements are rare, though a few have been met in reading. To state that "except for the interference of the moon, we should probably never have known that there is any more of the sun than our eyes ordinarily see" is forgetting that the spectroscope was at least a possibility whether eclipses had occurred or not. Similarly forgetful is the remark that "no instrument now in the possession of astronomers could assure us" that there are planets revolving round other stars than the sun. The statement respecting Mercury that its "average temperature is more than six and a half times that prevailing on the earth" is quite inexcusable. Some attempt at precision in a matter quite capable of being stated clearly is surely worth while.

In spite of such blemishes the book, as a popular exposition of certain phases of modern astronomy, ranks high. Hypotheses respecting the zodiacal light mystery are clearly set forth, while auroræ, comets, and meteorites are suggestively treated. Chapters dealing with the moon, Mars, and the riddle of the asteroids bring an interesting work to a conclusion. Some thirty full-page half-tone reproductions of photographs are inserted, most of them being well chosen and excellently reproduced.

The printing and binding are satisfactory, but the inset illustrations are not securely fastened and are liable to come out. T. F. C.

WONDER BOOKS OF SCIENCE.

(1) *The Wonder Book of Magnetism.* By Dr. E. J. Houston. Pp. x+325.
(2) *The Wonder Book of Light.* By Dr. E. J. Houston. Pp. xii+349. (London: W. and R. Chambers, Ltd., 1909.) Price 3*s.* 6*d.* each.

DR. HOUSTON has attempted, in these two volumes, to deal with the two specified sections of physics in such a way as to render them interesting to young people. In order to attain this end he has had recourse to the somewhat novel method of frequently using fairy stories as illustrations. Dr. Houston has had considerable experience in teaching the young, and, therefore, probably knows far better than the writer the kind of treatment of the subjects most likely to appeal to them. But the general impression obtained by an adult reader is that the illustrations are, to say the least, far-fetched, and that it is surprising if children, while sufficiently young to take delight in the fairy stories, can also appreciate the serious parts of the books. We hardly expect to find in the same volume the story of "The Blowing Servant of Fortunio" and the description of Zeeman effect as "the duplication or triplication of spectrum lines when the glowing vapour is subjected to a powerful magnetic field." Nor is it usual to associate "The Magic Wand of Prince Percinet" with a treatment of the colours of thin films and the colour of skylight.

The parts of the books which actually deal with physics are excellent. The language is generally simple, and the discussion is much more clear and exact than is usually the case in elementary treatises. Stripped of the fairy stories, both volumes could be read with much profit by grown persons desirous of enlightenment on magnetism and light. The probability is, however, that such seekers would be warned off by the juvenile complexion of the work, and thus miss the abundance of useful information contained therein. One further criticism is that some of the diagrams, of which each volume contains a considerable number, are badly reproduced. This, however, is not surprising when the low price of the books is taken into account.

With regard to the contents of the separate volumes, that on magnetism contains, besides the usual description of the properties of magnets, an interesting chapter on the history of the discovery of magnetism, and another on the possible causes of terrestrial magnetism. The auroral light and its bearing on the latter is also fully described. The reciprocal relations between magnetism and electricity are clearly stated, and a chapter is devoted to the electromagnetic theory of light. As examples of the less serious side of the volume may be mentioned the chapters entitled "Have Magnets Healing Powers?" and "Magnetism and Magic."

Among the special subjects treated in the volume on light, attention may be directed to the chapter entitled "The Light Mill," in which Crookes's radiometer is described, and to those on optical illusions and the effects of persistence of vision. Others are phosphorescence and fluorescence, X-rays and radioactivity, photography, soap-bubble colours, opalescence and polarised light. These are all dealt with quite briefly, but, nevertheless, in a lucid and interesting manner.

In conclusion, one may congratulate the juvenile readers upon having these two books so carefully written on their behalf, and express the hope that some time the author may see his way to publish the volumes in a slightly revised form suitable for older children.

OUR BOOK SHELF.

The Periodic Law. By A. E. Garrett. International Scientific Series. Pp. vi+294. (London: Kegan Paul and Co., 1909.) Price 5*s.*

THIS book may be viewed in two aspects—as a body of information and as a narrative. As a body of information it is very comprehensive. In no other work dealing with the periodic law, so far as the present writer knows, has the statistical information been set forth so fully and discussed in such detail. The author deserves all the credit due to a laborious compiler, and it may seem ungrateful to make any qualification in acknowledging such services. Little seems to have been omitted in the way of facts. The more recent work on tellurium is not adequately dealt with, nor is there a reference to the calculations of Strutt in reference to Prout's hypothesis, but there is little occasion for complaint on this head and much to acknowledge. There is a good deal of historical detail as well, and on all these grounds Mr. Garrett's book will no doubt find its way to chemical libraries and be valued as a book of reference.

When, however, we come to view the book as a narrative, it suffers from its wealth of detail, and does not seem to be in line with the well-known series to which it belongs. This is perhaps a matter which concerns the editor more than the reviewer; but the periodic law can furnish a capital narrative of a type which made the International Scientific Series famous a generation ago, a type which is preserved in the recent welcome additions. From this point of view Mr. Garrett's book is not only impaired by its abundance of statistics, but by carelessness of style. The English is very far from smooth, and such sentences as "Many things, no doubt, in some measure helped to bring about the state of affairs which proved to be the natural forerunners of such a climax" are very uncomfortable to an arm-chair reader. A. S.

Leitfaden der Pflanzenkunde für höhere Lehranstalten. By Dr. K. Smalian. Pp. 326. In five parts. (Leipzig: G. Freytag; Vienna: F. Tempsky, 1909.) Price, part i., 1 mark; part ii., 1.25 marks; part iii., 1.30 marks; part iv., 2.25 marks; part v., 2 marks.

IN these days, when many authors attempt to compress as much information as possible into their text-books, it is unusual to find an introduction to morphological and systematic botany spread over five annual courses. It should, however, be noted that each course is a short one, sufficient for one term's work, or possibly for two.

The first volume contains a series of descriptions of individual plants, arranged, according to their flowering periods, from March to July, and, so far as possible, in a sequence of complexity. A further series is given in the second course, as well as a few comparative summaries of related plants by which family limitations are introduced. The third and fourth parts are similar, except that the family synopses are more numerous, and eventually plant-associations are explained. In the fifth volume the author describes types of the Coniferæ, pteridophytes, and lower cryptogams, including the bacteria and myxomycetes; he also presents an account of the more common plants of economic value, and a brief epitome of plant geography. In addition, summaries are provided at the end of each volume, partly to recapitulate main facts, and partly for drawing comparisons. In this way the Linnean system is expounded in the third and fourth volumes. Numerous artistic coloured plates add considerably to the value of the book, especially where they depict the plants in natural habitats and associations.

The production of the book, the subject-matter, and the arrangement all merit strong commendation. The fundamental training in morphology by means of practical observation leads naturally to classification and ecology of plants. But two general objections suggest themselves; first, that there is need for more physiology, and, secondly, that in five annual courses a schoolboy could be taught considerably more botany than is contained in these volumes; as regards the latter, there is no reason why after the first summer session the remaining parts should not be taken more expeditiously. It may also be suggested that a good account of plant distribution instead of so many cryptogamic types would have been much more suitable for the last volume.

Die Bienen Afrikas nach dem Stande unserer heutigen Kenntnisse. By Dr. H. Friese. Edited by Dr. Leonhard Schulze.) Pp. 85-475, and plates. (Jena: Gustav Fischer, 1909.) Price 36 marks.

THIS important work is primarily based on the collections made by Dr. Schulze, who obtained forty-two species in Western South Africa as against forty-seven recorded by Bingham for the Transvaal and Natal. But Dr. Friese has taken the opportunity to include the Ethiopian region south of Senegal and Abyssinia. Abyssinia is only included in respect of Xylocopa, and Madagascar is excluded, as it has a separate fauna already discussed by Saussure in Grandidier's work.

A prominent feature of Prof. Friese's work is the series of maps of Africa showing the distribution of various species of bees throughout Africa; while other maps show the distribution of various important genera of African bees throughout the world. This is followed by a short bibliography, and even on the same page the technical portion of the work is commenced by a list of the thirteen African species of Prosopis. This is followed by a table of five South African species after Alfken and descriptions of the whole thirteen species, in the original language (Latin, German, or English) in which they were published. The remaining genera and species are similarly treated, a list of all the species being first given, and sometimes (but not always) a more or less complete table of the species, before they are described. On p. 124 an elaborate figure is given of the mouth-organs of *Polyglossa capensis*, n.sp. The book concludes with a list of thirty-five genera and 783 species of African bees (including the subspecies of *Apis mellifica*), many of which are described as new in the present volume, and an alphabetical index. The two coloured plates of bees, &c., are excellent. W. F. K.

Logic of Nature: a Synthesis of Thought. By Arthur Silva White. Pp. 58. (Privately printed by T. and A. Constable.)

THIS is an attempt to "outline a system of thought by which unity of world-conception may be predicated." It is a large order—vulgarly speaking—and a pamphlet of fifty-eight pages cannot be expected to give very clear notions of the author's views. Neither can a short review give a very clear notion of the pamphlet, which, for the rest, is very tough reading even for those who have spent much time and thought on the subject. The following "heads," however, will suggest the general drift.

There are four spheres or planes in the macrocosm: lithosphere, hydrosphere, atmosphere, and ethersphere, which last-named is "the psychosphere of mind"—"the energy of thought." Matter is the vehicle of energy. Intelligence is at the root of things; immanent Deity must be postulated. "*Nature is the thinking-process of the God-head*"—a striking and suggestive phrase.

The author quotes appositely from Sir J. J. Thomson, Sir J. Larmor, Snyder, and others on the physical side; and from Spinoza, Mill, Spencer, and Hamilton on the side of logic or metaphysics. His conclusion is of course idealistic. "The ultimate reality of the sum of things cannot—so far as man is concerned—have existential import except in terms of thought; and therefore thought itself is the ultimate reality" (p. 36).

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.*]

Dr. H. J. Hansen and the Copenhagen Museum of Zoology.

ON behalf of the zoologists who have signed the accompanying letter to Dr. H. J. Hansen, of Copenhagen, I have been asked to send a copy to you with the request that you will be good enough to publish it in NATURE.

W. T. CALMAN.

1 Mount Park Crescent, Ealing, W., March 7.

March, 1910.

To Dr. H. J. HANSEN,
The University Museum of Zoology, Copenhagen.

DEAR DR. HANSEN,

We, being some of those among the zoologists of Great Britain who know and value your zoological work, have heard with regret that there is a chance of your leaving the Museum of Zoology in Copenhagen. We hope that this is not the case; and we more especially hope and trust that you will let no circumstances turn you aside from your important zoological investigations.

The Museum of Steenstrup, of Lütken, and of Schiödte is honoured by us all; we know and honour many of the fellow-workers and successors of those great naturalists; and we consider that among so many distinguished names your own is by no means the least distinguished.

To the researches that you have carried on for many years, partly by yourself, partly together with your learned compatriot, Sörensen, we owe the best part of our knowledge of several important orders and families of Arthropods; you figure in our text-books as the leading authority on such difficult groups as the Palpigradi, the Pauropoda, the Cryptostemmatidæ, the Hemimeridæ, and the Choniostomatidæ; and this partial list of your works is in itself a proof that you have always laboured just where there were real gaps and imperfections in the common stock of zoological knowledge.

Your Monograph on the Choniostomatidæ we would refer to in particular as a masterpiece of delicate dissection and exquisite illustration; while in one and all of your publications we recognise the keenest morphological insight, and an uncommon grasp of the essential principles of classification.

With our best wishes for your prosperity, we beg you to receive from us this tribute to your powers and this testimony of our personal regard.

Very faithfully yours,

(*Signed*) A. Alcock, E. J. Allen, Ernest E. Austen, F. A. Bather, G. A. Boulenger, Gilbert C. Bourne, W. T. Calman, G. H. Carpenter, Wm. Eagle Clarke, C. Clifford Dobell, J. Cossar Ewart, F. W. Gamble, J. Stanley Gardiner, W. A. Herdman, Sydney J. Hickson, E. W. L. Holt, E. Ray Lankester, E. W. MacBride, W. C. McIntosh, P. Chalmers Mitchell, A. M. Norman, R. I. Pocock, Edward B. Poulton, R. F. Scharff, Adam Sedgwick, A. E. Shipley, Thomas R. R. Stebbing, J. Arthur Thomson, D'Arcy W. Thompson, Chas. O. Waterhouse.

Colour Blindness.

WHEN reading the late case of Mr. John Trattles and his colour-blindness, and when considering the discussion on the value of the tests for colour-blindness in its practical bearing for seamen and engine-drivers, it occurred to me that there was a very simple means of enabling red-blind and green-blind persons to distinguish red lights from green lights, and both of these from white lights, without their having to recognise the colours at all. I tested a colour-blind person here first with red glass and next with green glass placed in front of a cycle lamp, and he could not distinguish between the red and the green; but with the aid of my device he could distinguish the red light from the green light without fail, though he could not see them as distinct colours. The means of effecting this is quite simple. I gave him suitable pieces of red and of green glass. I told him to look at the white light first through the red glass and then through the green glass; result, he could see the white light through either glass, though he could not distinguish the colours, but when he could see the light clearly through each separately of his pieces of glass he knew the light was not green or red, but white.

I then made the lamp shine through a piece of red glass, and told the man I was testing to look at it first through his bit of red glass and then through his bit of green glass; result, he could see the light of the lamp through his bit of red glass, but could see no light through his bit of green glass, and so he knew the light of the lamp must be red, though he did not know its colour. Next I made the light shine through a piece of green glass, and when my man looked at it through his green glass he could see the light clearly, but when he looked at it through his piece of red glass he could not see it at all, or only very, very dimly, if the green glass of the lamp was a pale green and let some white through with the green, but in either case he could say with certainty the light was green and not red or white, and this without recognising the colours as colours.

The practical application of the above facts is simple, and can be effected in a variety of manners and inexpensively. For example, a sort of double eye-glass could be made holding a suitable piece of red and of green glass and with a small handle, and made of a size easily to fit in the pocket, or, for use at sea, it might take the form of a simple night-glass with a small slider carrying the coloured glasses at the eye-piece end. Anyone can try experiments in this matter with the aid of a bicycle lamp and its green and red light on either side, and suitable pieces of red and green glass to look through.

Summary.—When the lamplight can be seen clearly through both the red glass and the green glass separately: conclusion, the light is white.

When the lamplight is seen through the red glass and not through the green glass: conclusion, the light is red.

When the lamplight is seen clearly through the green and not through the red, or only very, very dimly: conclusion, the light is green.

It is not a case of distinguishing by colour recognised, but by whether the light can or cannot be seen in each case.

I offer this suggestion in case it may be of any service, and unpatented, for the free use of all who like to use it.

Stonyhurst. H. M.

The Meaning of Ionisation.

THE columns of NATURE are doubtless not the proper place in which to conduct correspondence classes in elementary science, but when Prof. Armstrong asks a simple question surely mere courtesy demands that he should receive a straightforward answer, such as Prof. Walker and "A. S." have not given him.

I imagine that nobody will quarrel with the following definitions:—

Ions are particles supposed to be present in some media such that, when the medium is placed in an electric field, the particles have a finite average velocity relative to the medium along the direction of the field.

"Ionisation" is used in two senses:—(1) it is used to denote the number of ions present in unit volume of the medium; (2) it is used to denote the process by which the ions are produced. Since several such processes are known, the use of the word ionisation does not connote any special hypothesis as to the mechanism by which the ions are produced. N. R. C.

A Rare Crustacean.

YESTERDAY my assistant, Mr. G. Pyman, found several *Cheirocephalus diaphanus* swimming in a flooded ditch on Eton Wick Common. The sunlight shining on the beautiful green bodies of the males made a very striking effect. We were able to catch about twenty specimens of both sexes. I had never seen this phyllopod alive before, and, so far as I know, it has never been recorded previously from this district. The females, of brownish-purple colour, all have full egg-cases attached to their abdomens. I put several individuals into different aquaria, and was much annoyed to find that they fell victims to various enemies during the night. A Dytiscus beetle, the presence of which had been forgotten, accounted for four, and four more were apparently devoured by insignificant fresh-water snails. Those, however, that were placed in a tank by themselves are alive and well, and feed on the green algæ supplied to them. The males are about 1½ inches long, the females rather smaller.

When the river comes down in flood experience shows that it is time to be on the look-out for zoological curiosities. Perhaps Apus itself may reappear once more now that Cheirocephalus has shown the way!

Eton, March 5. M. D. HILL.

The Formation of Large Drops of Liquid.

THE following experiment, based on the temperature-density relations between aniline and water, serves to illustrate to an audience the various shapes through which a drop passes in the course of its formation. A glass beaker, about 9 inches in height and 4½ inches diameter, is filled to about 7 inches with distilled water, and about 80 c.c. of aniline are added. The beaker is then placed on a burner, and the temperature raised until the aniline floats to the surface of the water. On spreading out at the surface the aniline is cooled, thereby becoming denser than the water beneath. A large drop, 1 inch or more in diameter, then detaches itself from the mass at the surface, the formation being so slow that the altering shapes of the drop, the drawing out of the neck of liquid, and the thinning of the neck in two places may easily be observed. The large, detached drop falls to the bottom of the beaker, and is there re-heated, thereby again becoming lighter than the water, and rising to the surface, when a second drop is formed. By maintaining the temperature about 80° the formation of drops continues indefinitely in the manner described. The slightly pink colour assumed by the aniline enables the experiment to be seen clearly from a considerable distance, and the many beautiful shapes assumed by the drops lend an added interest to this simple method of demonstrating their formation. CHAS. R. DARLING.

City and Guilds Technical College, Finsbury.

The Fertilising Influence of Sunlight.

THE letters of Mr. and Mrs. Howard and of Dr. E. J. Russell in recent issues of NATURE point to the conclusion that the partial sterilisation of the soil improves its fertility. In connection with this subject, I would like to record that the effect of heating the soil has been observed here for some years. It has been the practice to collect all the refuse of the place that cannot be rotted, such as hedge cuttings, tree prunings, &c. These are placed on a vacant space in the kitchen garden and a fire made of them in winter. The fire is generally a large one, burning fiercely all day, and the larger branches keeping it going all night.

In the following summer the site of the fire is well marked. The rows of vegetables where they pass over it are more than a half stronger than at other parts, though they do not keep that proportion to the end of the season. The increased growth seems to be due to the heating of the soil, and not to the large amount of wood ashes left by the fire, as these are either lifted and used as a top dressing for borders where the spade cannot be used, or are spread over the vegetable ground, the site of the fire being generally left quite bare of ashes.

Ardenlea, Falkirk, March 8. JOHN AITKEN.

MOLES AND MOLEHILLS.

LIKE that of other common animals, the complete life-story of the mole has yet to be written, exceedingly little being really known. The difficulties of observing the habits of a subterranean dweller of a most retiring disposition are patent but not altogether insuperable, and the wonder is that field naturalists have been content to read and take for granted the information handed down for the last century without any attempt to confirm it.

During the winter months one cannot help noticing in the open fields here and there a mole-heap conspicuously larger than the rest. This is a male mole's winter habitation, but at present we do not know whether he lives alone or with his wife, or if the female ever constructs these "fortresses," as they are called. Probably he lives alone, and probably females make "fortresses" slightly more simple in construction and smaller in size than those of the males. If we take a spade and carefully slice away the top of a fortress, we shall find several hollow tunnels or runs, which may be opened up and followed to the base of the "fortress," whence they lead away into the field. Slicing further under these into the "fortress," and

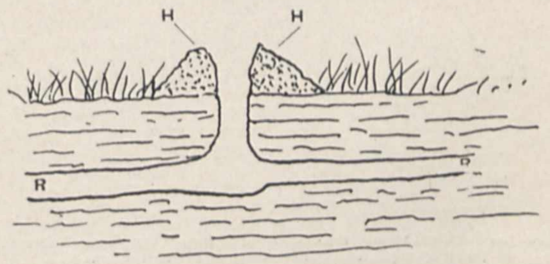


FIG. 1.—First stage of the fortress—sectional view. R R, Mole's run below the surface; H H, heap of ejected earth.

just below the ground-level, we come upon a large circular cavity filled with a bundle of grass or dead leaves; this is the mole's nest in which he sleeps. If he has lately quitted it the interior will be quite warm to the hand; the mole himself, however, will never be caught in the nest. When the nest is removed and the cavity examined, it will be found about a foot in diameter and worn smooth by the mole wriggling about as he wraps his nest round him, for that is his method of arranging himself within it. Two or more tunnels will be found leading away from the nest-cavity into the field. One of these is particularly noteworthy, as it is found in nearly every fortress;

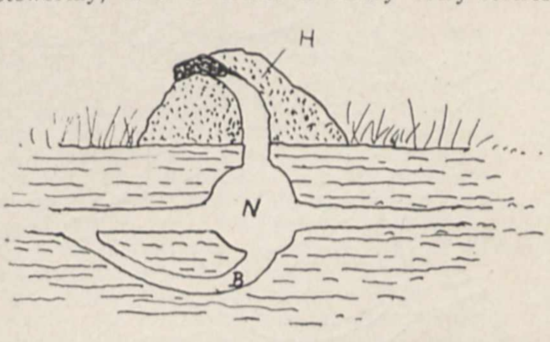


FIG. 2.—Second stage of the fortress—sectional view. N, Nest-cavity; B, bolt-run; H, heap of ejected earth.

this exit leads from the bottom of the nest perpendicularly downward for about a foot, then, turning upwards, it joins another run. Its origin and use are uncertain; but it is usually regarded as a sort of sally port, and is known as the "bolt-run."

It is extremely unlikely that the mole deliberately selects the site of his fortress, as he is practically blind; probably he sets to work whenever the impulse seizes him, and proceeds in the following manner. He commences to enlarge a nest-cavity, ejecting the earth which he has loosened with his powerful claws out of a hole in the roof; this he does with the top of his head in little jerks. The quiet observer may see a sausage-shaped mass of earth issue from below with four or five sudden jerks, then, after one or two minutes' interval, when the mole is collecting more loose earth, another sausage will appear as before, and so on until the work is complete. After the nest-cavity comes the excavation of the bolt-run, and finally, to make all safe and waterproof, the mole piles up a mass of earth, often amounting to a large barrow-load, by means of tunnels around the base of the existing heap. These tunnels sometimes break into one another and sometimes into the nest-cavity, and so cause a labyrinth which has given rise to much erroneous speculation in the past.

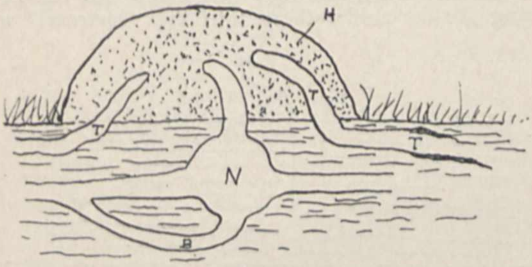


FIG. 3.—Sectional view of the completed fortress. T T, Tunnels formed in piling up earth from outside to make the nest rainproof.

A fortress is often completed in a single night. The young are not born in the winter "fortress," but in a separate habitation made by the female alone. It is built on the same plan as the "fortress," but usually simpler in construction and without the bolt-run. The female produces only one litter a year, and the young, which are born from the end of April to the end of May, vary in number from two to six. Naked, blind, and pink, they turn lead-colour in ten days; after a fortnight a grey velvet pelage is visible, which becomes black at the end of three weeks, when the eyes open. The ears are opened on the seventeenth day. Attempts to rear the young by hand have hitherto proved futile, for, though they will suck freely from flannel or cotton wool soaked in warm milk, they pine and die on the third or fourth day.

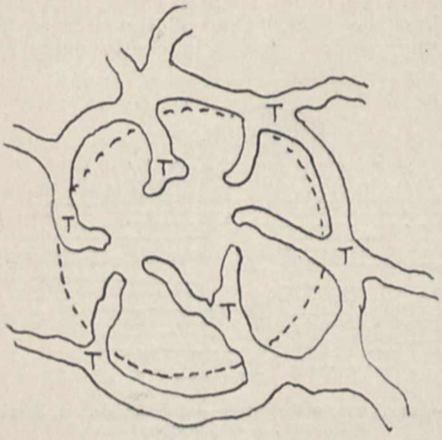


FIG. 4.—The completed fortress viewed from above, with the tunnels T T, &c., laid bare.

There has always been much discussion as to the mole's power of sight. Dissection has shown that the size of the eye is greater in the embryo than in the adult, indicating that the sight of the race has deteriorated. From numerous experiments the writer is convinced that the adult mole is practically blind. Moles encountered in the day-time have taken no notice of a human being waving a hand close in front, nor at night do they show signs of consciousness of a light waved before their nose; but, if the slightest sound is made, the greatest excitement is instantly shown. The writer has often thrown down worms before a captive mole to test the sight. At once the mole becomes aware of the worm, but the haphazard way in which he will poke about for it with his snout shows clearly that he is guided by scent, and perhaps by hearing, but not by sight. It is true that at the least excitement the fur will radiate round the minute eye, and it has been suggested that the animal thus clears his eye to see; most probably, however, this mechanical action is retained though no longer of use, since the blind eye cannot benefit thereby. When, after a hurried and blundering search, the worm has been located, the mole holds it down with his fore paws and eats it from end to end with quick, jerky bites. When the animal's immense appetite is at length satisfied and worms are still being supplied, the mole will often give the worm several bites to disable it. and will then cram it into the earth, presumably to bury it for future use—after the manner of the dog with bones and the squirrel with acorns.

The senses of smell and hearing must be very acute to enable the mole to locate a pheasant's or partridge's nest above his run. That this is the case is testified by two gamekeepers in different parts of the country, both of whom state that the nests are often entered from below and the eggs eaten.

Photo. by *T. Bellchambers.*

FIG. 5.—Young moles ready to leave the nest.

It is surprising how soon a captive mole becomes indifferent to being handled. Within half an hour of capture it may be stroked and scratched without causing alarm; the writer has even suspended one by the tail without causing the animal to cease from lapping water. Of course, gentle handling is necessary, and avoidance of any sudden or jerky movement. Another mole soon learnt to come out of his nest and look for worms when the writer scratched the side of the packing-case in which the captive dwelt.

LIONEL E. ADAMS.

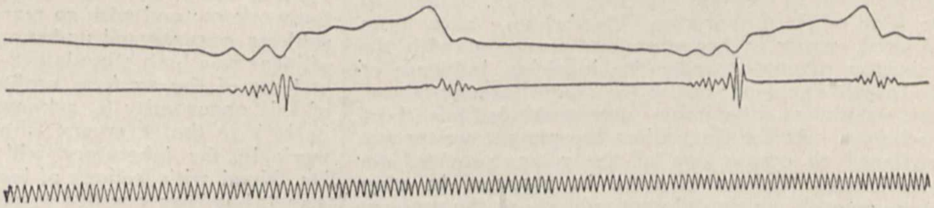
THE SOUNDS OF THE HEART.[1]

THE sounds of the heart have always occupied the attention of physiologists both as regards their cause and as to their relations in time to other phenomena of the circulation, such as the impulse of the heart on the wall of the chest, and the pulse in arteries and other organs more or less distant from the heart. During the last few years much attention has been paid to these time-relations, and much

[1] Phono-Kardiogramme von Prof. Otto Weiss. (Jena: Gustav Fischer, 1909.) From Prof. E. Gaupp and Prof. W. Nagel's *Sammlung Anatomischer und Physiologischer Vortrage und Aufsatze.* Heft 7. A full bibliography will be found in Prof. Weiss's paper. Pp. 37. Price 1.50 marks.

ingenuity has been shown in devising methods by which the vibrations of those sounds, as distinct from the movements of the heart itself and the pulse in vessels, can be recorded. The older methods were subjective, and were consequently deficient in scientific accuracy. Thus, if even a skilled observer listened to the heart sounds and endeavoured to register their sequence by closing a key which acted on a recording lever, and if he endeavoured thus to register the moment of the occurrence of the first or second sound, or both, there was the inertia of the apparatus and the possibility of personal error, which made the observations of little value. It was desirable to have objective methods by which the vibrations could be actually recorded, and when one listens with the stethoscope to the strangely muffled sounds, one realises that to record the vibrations of such sounds is a remarkable achievement. At all events, the beginning and the end of the sounds can now be recorded.

Hürthle was the first to succeed in registering the vibrations of the heart sounds. This he accomplished in 1892. His method was dependent on the use of a microphone. A delicate microphone was placed on the prongs of a wooden tuning fork, and the latter was attached to the end of a large wooden stethoscope, resting on the chest wall, over the apex of the heart. The vibrations thus communicated to the microphone altered a current flowing through an electro-magnet, below which was placed a Marey's tambour (having a thin iron disc fixed to the india-rubber), and this, in its turn, transmitted its movement to a second very sensitive tambour, which recorded on a rapidly moving surface. In this way, vibrations of the heart tone were recorded, and information was obtained as to the exact moment when the tone began.



Human Heart Sounds. The upper curve is a cardiogramme of the apex beat. The lower is that of 1/100 sec. The middle curve shows the heart sounds. Read from right to left. The first sound is the larger tracing. (Weiss.)

Soon afterwards, Einthoven investigated the subject by means of a microphone and capillary electrometer, and succeeded in registering with great accuracy the two tones. Then he employed his remarkably sensitive string galvanometer, and by means of this instrument, and with the aid of photography, the beginning, duration, and ending of the first and second sounds were recorded. Even in records from the impulse of the apex, which shows numerous vibrations, those associated with the heart sounds are readily identified. There can be little doubt that the string-galvanometer method is most to be depended on.

Holowinski developed a method by the construction of a kind of optical telephone. In the centre of a telephone disc, a plate of glass, like the cover-glass used in histology, was brought against a plano-convex lens, and in this way, when sounds caused the telephone plate to vibrate, the interference rings of Newton were produced. These varied with the heart tones, and, by a photographic method, when the picture of the variations was obtained, along with a superposed cardiogramme (registration of movements of apex impulse), Holowinski gave an interpretation showing the position of the tones. The picture so produced, although beautiful and interesting physically, is rather confusing.

Marbe devised a very delicate Marey's tambour, or rather capsule, by which the vibrations of the heart-tones regulated the flow of a current of acetylene gas. This passed to a burner. The flame moved up and down with each vibration, and it was allowed to impinge on a moving band of paper. On this, with each vibration, a ring of soot was formed, and a picture of the heart tones was imprinted on the paper. The method is easy, and the results are easily interpreted.

Another method has been devised by Gerhartz. He caused a membrane (which received the sound waves) to carry, vertically to its surface, a delicate glass rod, which, at the other end, bore a small metallic mirror, placed between the poles of an electro-magnet. The arrangement is somewhat complicated, and it did not give striking results.

The last method we shall notice is that of Prof. Otto Weiss. It is entirely mechanical, and is independent of microphones and electrical appliances, being a clever modification of the phonoscope, by which, some years ago, many were amused by watching the play of colours produced in a soap film by the sounds of speech. Weiss's method consists in the employment of a soap film, in the centre of which there is attached the end of a silvered thread. The other end of the thread is fixed to a lever connected with a carrier. Vibrations are carried by a special funnel-shaped tube from the heart to the phonoscope. This is enclosed in a box having in its walls lenses so adjusted that a photograph can be taken of the silvered thread and of its movements. The photograph, of course, is taken on a moving sensitive plate. The inertia of the system is remarkably small, the weight of the soap film and of the lever being about 0·000054 grm. All the parts are extremely light. The apparatus is so sensitive that the vibrations of a whisper can be recorded; the swing is aperiodic; and its moment of arrest is 0·01 sec. It is said to follow very frequent vibrations. An example of a tracing thus obtained is given in the figure.

In his interesting monograph, Prof. Weiss gives examples of tracings of cardiac sounds along with the carotid pulse, of fœtal heart sounds, of the modifications of the sound caused by mitral insufficiency, mitral stenosis, aortic stenosis and insufficiency, and of anæmic sounds. All this shows the possibility of employing the method for clinical purposes. Finally, by an ingenious arrangement, Prof. Weiss has been able to reproduce the sounds by means of a telephone. A flame from a suitable lamp falls on a selenium cell in the circuit of which is a telephone. Interposed in the path of the beam of light, a disc is rotated having the curves of the heart sounds cut out on its margin. As it is rotated, the effect of the intermittent light on the selenium cell is such as to reproduce the heart tones in the telephone. Such an arrangement may be useful in teaching.

JOHN G. MCKENDRICK.

THE DAVY-FARADAY LABORATORY.

THE late Dr. Mond was keenly interested in the progress of science in all its branches, and his interest exhibited itself in a very practical manner. He was always ready to aid experimenters in carrying out costly researches, and his assistance enabled many young men to pursue original investigations of the most various kinds. Perhaps, however, the most conspicuous instance of his munificent aid to science was his founding of the Davy-Faraday laboratory. This institution was founded and maintained entirely at Dr. Mond's expense; its accommodation was placed at the disposal of investigators of all nationalities, and of both sexes, quite free of charge. It is probable that no institution of a precisely similar character is to be found elsewhere throughout the world; for it is not, in the general sense of the phrase, an educational institution: its staff comprises no one whose duty it is to give instruction, it has remained unconnected with the universities, and no sort of diploma is given to those who have worked there. It was intended to be of service to investigators, qualified by previous training to pursue original researches on their own initiative, and many such investigators have gratefully availed themselves of the facilities afforded to them.

At most institutions which foster original researches, the character of the work done is largely influenced by the professors in charge of the various departments; thus, to mention only one instance, students at the Cavendish Laboratory, Cambridge, have been engaged mostly in investigations connected with the ionisation of gases, under the inspiring influence of Sir Joseph Thomson; but at the Davy-Faraday laboratory, work of the most diverse kinds has been carried on. At the time when the present writer was privileged to occupy one of the rooms provided for investigators, researches were in progress in other rooms on such widely different subjects as the pressure produced during explosions, the rate of melting of ice under various conditions, the vapour pressure of strong solutions, the action of metals and other substances on photographic plates, the properties of platinum black, &c. It is possible that work of this character, ranging over most branches of physical and chemical science, has gained less public recognition than if a more restricted line of research had been pursued; but, for all that, the gain to science has been none the less real and lasting.

The Davy-Faraday laboratory was installed in a house adjoining the Royal Institution, Albemarle Street, and its name was chosen to honour the memory of two investigators whose labours have rendered the Royal Institution famous for ever. It was at first intended to endow the laboratory, and to place it entirely under the charge of the authorities of the Royal Institution; but, owing to some hitch in the negotiations to this end, a change of plan was decided upon: the laboratory was equipped at the expense of Dr. Mond, and a yearly grant was guaranteed for its maintenance, subject to the condition that, in the event of Dr. Mond or his heirs failing to provide this grant within a stated period of its falling due, the laboratory should become the property of the authorities of the Royal Institution.

The house in Albemarle Street was converted into a laboratory, or rather a series a laboratories, at great trouble and expense. A lift was provided for the conveyance of the workers to all floors of the building, and a well-furnished workshop was installed in the basement. In most cases workers occupy separate rooms, supplied with gas, water, and electricity: general laboratories, fitted for ordinary chemical work, can also be used. A wine-cellar was converted into a room in which researches, demanding constancy of temperature, can be pursued. Balance rooms, and rooms for the storage of apparatus and chemicals, were provided. In short, everything was done that could possibly aid in effectively converting a dwelling-house into an up-to-date laboratory. On the other hand, rooms in a dwelling-house can hardly be rendered suitable for certain classes of investigations, however much skill and foresight may be used in their conversion; thus, delicate optical researches are rendered difficult by the shakiness of the building. But for researches in physical chemistry, for which the laboratory was especially designed, the rooms are suited admirably; and most accessories required in such researches, including some of great value, are at the disposal of the workers; in this connection, a Rowland's concave grating, and its necessary adjuncts, may be mentioned. The valuable library in the Royal Institution is placed at the disposal of workers in the laboratory.

The laboratory has been managed by a committee which included Dr. Mond, Lord Rayleigh, and Sir James Dewar as members. This committee selects the candidates who can be accommodated in the laboratory; almost from the first the working space of the laboratory has been fully utilised. The staff of the laboratory includes the superintendent, Dr. Scott, F.R.S., several assistants, and a competent mechanic. When the present writer was working at the laboratory, a delightful *bonhomie* existed between the workers; and with so many specialists on different subjects congregated under one roof, the interchange of ideas was both stimulating and instructive, and one at least of the workers profited from it, and is glad of this opportunity to acknowledge his indebtedness; he is sure that everyone who has been privileged to work in the laboratory will associate the name of Dr. Mond with feelings of lasting gratitude, stronger than it has been possible to express in these brief and inadequate reminiscences of the Davy-Faraday Laboratory.

EDWIN EDSER.

NOTES.

THE Bakerian lecture of the Royal Society will be delivered on March 17 by Prof. J. H. Poynting, F.R.S., and Dr. Guy Barlow, upon the subject of "The Pressure of Light against the Source: the Recoil from Light."

WE notice with great regret the announcement of the death, at seventy-six years of age, of Dr. E. P. Wright, for many years professor of botany in Dublin University and keeper of the herbarium, Trinity College, Dublin.

DR. H. A. MIERS, F.R.S., principal of the University of London, has been elected a member of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE second annual Aëro and Motor-boat Exhibition is to be held at Olympia on March 11–19, under the patronage of the King. Reviewing the list of exhibitors, it appears that the monoplane will predominate, as most of the firms are devoting their attention to this type of aërocraft. In addition to the display of actual flyers, some ingenious models will be shown, while to the lover of mechanics the engines for aëronautical purposes will be of interest.

THE University of Kansas has lost its professor of mathematics by the sudden death, in his fiftieth year, of Prof. H. B. Newson. Prof. Newson was the managing editor of the University's Science Bulletin, and was the author of numerous research articles in pure mathematics. He was a member, not only of the American Mathematical Society, but of the Deutsche Mathematike Vereinigung and the Circolo Matematico di Palermo.

THE ninth annual general meeting of the Association of Economic Biologists will be held at the University of Manchester on July 6–8, under the presidency of Prof. G. H. Carpenter. A detailed programme will be issued in due course; in the meantime, further particulars may be obtained from the honorary secretaries, Mr. W. E. Collinge, Uffington, Berkhamsted, or Mr. W. G. Freeman, 28 Burnt Ash Lane, Bromley, Kent. Mr. J. Mangan, of the University of Manchester, will act as local secretary.

FROM a Lick Observatory Bulletin we regret to learn of the death, at eighty-five years of age, of Mr. D. O. Mills, to whose generosity American astronomy—and higher education—owes very much. Mr. Mills was a member of the first board of trustees, appointed by James Lick, to superintend the construction and equipment of the Lick Observatory. To his benefactions the observatory was indebted for the two exceptionally fine spectrographs, used in connection with the great refractor, and he also provided the means necessary for the D. O. Mills expedition to the southern hemisphere, by which the observatory at Santiago, Chile, was established. His gifts to, and work for, the cause of higher education were also remarkable, both for the lavish manner in which they were freely given and the acute discernment which governed them.

THE following officers of the Pellagra Investigation Committee have been selected:—chairman, Sir T. Lauder Brunton; vice-chairman, Dr. F. M. Sandwith; honorary secretary and treasurer, Mr. J. Cantlie; advisory subcommittee, Mr. E. E. Austen, Prof. E. C. Bayly, Sir William Leishman, Dr. J. M. H. MacLeod, Sir Patrick Manson, Sir John McFadyean, Dr. F. W. Mott, and Prof. Ronald Ross. The field-workers will be Dr. Louis W. Sambon, of the London School of Tropical Medicine, and Captain J. E. Siler, with Mr. Arthur Dawson-Amoruso and Mr. G. C. C. Baldini as assistants. The standing commission for the investigation of pellagra in Bergamo has promised the inquiry every assistance.

THE eighth International Physiological Congress is to be held at the Physiological Institute of the University, Vienna, from September 27–30 next. Communications for the congress should be sent to Prof. O. v. Fürth, Physiologisches Institut, Wien IX., Wahringerstrasse 13. An exhibition of physiological apparatus is to be held from September 26 to October 1, and a special congress committee has been appointed to organise it; applications for permission to exhibit apparatus should be sent to Herrn Hofrat H. H. Meyer, Pharmakologisches Institut, Wien IX., Wahringerstrasse 13. Prof. E. B. Starling, F.R.S., of University College, London, is one of the general secretaries to the international committee, and Prof. Sigmund Exner, of the University of Vienna, is the president of the congress.

WE learn from *Science* that arrangements have been completed between Captain R. Amundsen and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington regarding cooperation in magnetic work on the proposed Amundsen Polar Expedition to leave Norway this summer on Nansen's vessel, the *Fram*. After some general explorations in the South Atlantic and in the South Pacific Oceans, the *Fram* is expected to arrive in the summer of 1911 at San Francisco, where her outfit will be completed. The vessel will then be headed for Bering Sea, and, after entering the polar basin, will drift with the ice. It is expected that it will be about four years before she emerges again from the ice. While Captain Amundsen hopes that his vessel will drift across the North Pole or close thereto, his prime object is that of general geographic exploration.

A BILL was introduced in the United States Senate on March 2 to incorporate a Rockefeller foundation in the district of Columbia. Mr. Rockefeller contemplates the endowment of an institution which will be greater even than the Carnegie foundation in educational work. The Senator who introduced the Bill said that Mr. Rockefeller had already given away 10,500,000*l*., and is now seeking legislative means to dispose of his fortune in a way most likely to benefit mankind. The foundation, according to the Bill, is to be organised to promote the well-being and advance the civilisation of the people of the United States and its possessions, and for the acquisition and dissemination of knowledge; for the prevention and relief of suffering, and the promotion of any and all elements of human knowledge. The amount of Mr. Rockefeller's fortune is not known precisely, but five years ago it was estimated at at least 100,000,000*l*.

THE following list of aviation meetings for the ensuing year is given by the *Deutsche Zeitschrift für Luftschiffahrt*:—March 25 to April 3, Cannes; (date not stated) Biarritz; April 10–25, Nice; April 30 to May 5, Tours; May 10–15, Bordeaux (national meeting); May 7–15, Lyon; May 10–16, Berlin (foreign competitors not disqualified); May 15–23, Marseille (national meeting); May 20–30, Verona; May 27–31, Limoges (national); June 5–22, Vichy (national); June 5–15, Budapest; June 5–12, Juvisy (national); June 18–24, St. Petersburg (foreigners eligible); June 10–26, Rouen; July 3–24, Rheims (French meeting); July 24 to August 4, Brussels; July 27 to August 2, Caen (national); August 6–13, England; August 6–21, eastern circuit; August 25 to September 4, Havre, Trouville; September 9–18, Bordeaux; September 24 to October 3, Milan; October 2–9, Juvisy (national); October 18 to November 2, America; December 4–18, Marseille.

A MEETING of the committee for an Arctic Zeppelin Airship Expedition was held in Hamburg on March 5 under the presidency of Prince Henry of Prussia. It was resolved to ask the Imperial Ministry of the Interior for the services of the Imperial exploration steamer *Poseidon* for ten or eleven weeks. The members of the expedition intend to start for Spitsbergen on July 1, and there to tranship to the *Poseidon*. At the same time dashes are to be made into the polar ice with the hired Norwegian iceship *Phoenix* to study the conditions for airship landing. The return will be made about the end of August. The Berlin correspondent of the *Westminster Gazette* states that the original idea of making the primary object of the expedition the reaching of the North Pale has been abandoned; the main purpose is now stated to be the exploration of the unknown regions north of Franz Josef Land and Spitsbergen. Cross Bay, which has been chosen on the ground of data determined by the Prince of Monaco, will be made the base of a number of separate airship voyages which the Zeppelin airship will make. On its way north over Germany and Norway the airship will stop at stations prepared in advance.

A REUTER message from Berlin states that Germany has decided to send out an Antarctic expedition. At a meeting of the Berlin Geographical Society on March 5, Lieut. Filchner was introduced to the meeting as the leader of the forthcoming German expedition, and briefly outlined his plan of campaign. He proposes that the main expedition shall start from a base on Weddell Sea and advance straight across the Antarctic continent to the Pole. On reaching the Pole the expedition, instead of turning back, will proceed, probably following Sir E. Shackleton's route, to the coast of Ross Sea. Meanwhile, a subsidiary expedition will have landed on the shores of Ross Sea and have advanced inland along Shackleton's route about half-way to the Pole, where, after leaving a depôt of provisions, it will turn back to the coast. The main expedition, if all goes well, will pick up the depôt of provisions and join the subsidiary party at the coast. Lieut. Filchner hopes to be able to start in October. He has already had experience as an explorer in Central Asia, where he spent the years 1903 to 1905 in exploring Tibet. He has also done exploration work in the Pamirs and Turkestan. Dr. Penck, president of the Berlin Geographical Society, announced that an anonymous donor had promised 15,000*l.* towards the expenses, and Lieut. Filchner said he had received offers of aid amounting to 3000*l.* If two ships are chartered 100,000*l.* will be required, but if one only is sent out 60,000*l.* will suffice.

The following are among the lecture arrangements at the Royal Institution after Easter:—Dr. A. Harden, three lectures on the modern development of the problem of alcoholic fermentation; Prof. F. W. Mott, three lectures on the mechanism of the human voice; Prof. A. E. H. Love, two lectures on earth tides; Prof. C. J. Holmes, two lectures on heredity in Tudor and Stuart portraits; Dr. Tom G. Longstaff, three lectures on the Himalayan region; Mr. W. McClintock, three lectures on Blackfeet Indians in North America; Dr. W. Rosenhain, two lectures on the constitution and internal structure of alloys; Major Ronald Ross, two lectures on malaria; Mr. W. W. Starmer, three lectures on bells, carillons, and chimes; Dr. D. H. Scott, three lectures on the world of plants before the appearance of flowers; Prof. J. A. Fleming, two lectures on electric heating and pyrometry (the Tyndall lectures). The Friday evening meetings will be resumed on April 8, when a discourse will be given by Prof. P. Lowell on the Lowell Observatory photographs of the planets. Succeeding discourses will probably be given by Prof. W. J. Pope, Mr. T. Thorne Baker, Dr. Tempest Anderson, Sir Almroth E. Wright, Prof. W. H. Bragg, Sir David Gill, Captain R. F. Scott, the Right Hon. Sir Rennell Rodd, and other gentlemen.

The director of the Meteorological Office has given notice that from April 1 forecasts of the weather prospects more than twenty-four hours ahead will be issued as opportunity is afforded. Applications have been received at the Meteorological Office from time to time for forecasts of weather several days in advance, in addition to, or instead of, the usual forecasts which refer to the twenty-four hours reckoned from the noon or midnight following the issue of the forecasts. According to the experience of the Meteorological office, the weather conditions do not usually justify a forecast detailing the changes of weather for consecutive days. There are a number of occasions in the course of the year when the distribution of pressure is typical of settled weather, and also occasions when the conditions are characteristic of continued unsettled weather. On these occasions, and on a few others when the sequence of the weather is of a recognised type, a sentence giving in general terms the outlook beyond the twenty-four hours of the definite forecast might be useful to the general public, and, as it could be justified by the statement of definite reasons for the inference, it would come within the general rules laid down by the office with reference to the issue of forecasts. An indication of the general prospect extending beyond the twenty-four hours' limit is frequently given in the "General Inference" which precedes the forecasts for the several districts on the sheet issued to newspapers. It is expressed in more or less technical language, and the application to the several districts might only be followed by persons acquainted with the terminology used in weather study. It is proposed, therefore, when the meteorological conditions permit, to supplement the forecasts for districts by a remark on the further outlook.

The summary of the weather issued by the Meteorological Office for the week ending March 5 shows that the conditions were still very mild over the entire country, the excess of temperature being generally from 2° to 3°. The rainfall varied considerably in different parts of the country, but was nowhere very large, whilst there was an excess of sunshine in every part of Great Britain. On nearly all parts of the coast the temperature of the sea-water was warmer than during the corresponding period last year, the difference amounting to between 6° and 7° on the east and south-east coasts of England. The summary of the weather for the winter, comprised by the thirteen weeks ending March 5, shows that the temperature was generally in excess of the average, but not to any great extent. The rainfall was everywhere above the average, the greatest excess being 4·80 inches in the north-west of England and 3·40 inches in the south-west of England. The excess was more than 2 inches in every district of the United Kingdom, except in the north and east of Scotland and in the Channel Islands; the largest actual measurement was 16·49 inches, in the west of Scotland, and the least 7·14 inches, in the east of England. The duration of bright sunshine for the winter was everywhere in excess of the average, the greatest excess being sixty-two hours in the south-east of England, and more than fifty hours in the east and north-west of England and in the Midland counties; the absolutely longest duration was 236 hours, in the south-east of England, and the least 146 hours, in the north of Scotland.

In *Man* for February Mr. A. M. Blackman publishes some interesting notes on Egyptian antiquities and customs. Several noted tombs of Sheykhs, with the rites performed at them, are described, such as the custom of sleeping in the sacred precincts, as was done at Greek shrines of Asklepius, and of hanging up bandages there as a charm to secure recovery from circumcision and other operations. The Copts, we are told, slay a sheep at the threshold as the bride enters the house. She must take care to cross it without staining her feet or clothes in the blood. Should this occur the marriage is deemed unlucky.

In the *Gypsy Lore Journal* for January Mr. W. Crooke discusses the ethnographical results of the article published in vol. ii. of the journal by Mr. E. O. Winstedt on "Gypsy Forms and Ceremonies." An examination of this extensive collection of Gypsy rites and ceremonies might be expected to throw light on the supposed Indian origin of the Gypsies. The result is that, except in some not important cases, the analogy with Indian customs is not satisfactorily established. It would seem that most of the customs of the European Gypsies result from their long contact with western peoples, such as the inhabitants of Asia Minor and the Balkan Peninsula.

The higher classes in India, particularly those who have assimilated some of the culture of the West, have been actively asserting their claims to political and social equality with Europeans. They are confronted with a similar problem, which is likely to cause no little embarrassment. The depressed classes are now claiming similar rights from their higher brethren. The Pariahs of Madras have formed an organisation, and in Bombay the question is so serious that the Guicowar of Baroda has been moved to advocate more consideration for them. The movement has now spread to Bengal, where the Jugi weavers have issued a manifesto, prepared by Prof. Radha Govinda Nath, urging that they are really sprung from the Yogi ascetics, and are entitled to social status like that of Brahmans. They repudiate the theory generally held that they represent the decayed Buddhist communities, who on the decay of their faith were, like other depressed religionists, compelled to adopt menial occupations. It will be interesting to watch the reception which their claim receives from the Babus of Bengal.

To vol. xi. of the Proceedings of the Washington Academy of Sciences Dr. F. H. Knowlton contributes a paper to prove that the Hell Creek and Ceratops beds of Montana, which have been usually regarded as of Upper Cretaceous age, are really the equivalents in time of the Tertiary Fort Union formation. Evidence in favour of this view is stated to be afforded by the plants, invertebrates, and vertebrates of the formations in question, and the author concludes by the definite statement that the Hell Creek, Somber, and Ceratops beds are stratigraphically, structurally, and palæontologically inseparable from the Fort Union beds, and therefore of Eocene age. To this view Mr. T. W. Stanton, in the same issue, replies that, in his opinion, the Ceratops beds are of Cretaceous age on account of their stratigraphical relations, the pronounced Mesozoic character of the vertebrate fauna and its lack of Tertiary types, and the close relation of its invertebrates to those of the Cretaceous. The admitted relationship of the flora to that of the Eocene is regarded as of minor importance.

IN Nos. 1 and 2 of the Research Bulletin of the State University of Oklahoma Mr. H. H. Lane describes the breeding and placentation of the nine-banded armadillo, and likewise proposes a revised classification of the Edentata. As a rule, this species produces four young at a birth, one for each of the four mammæ, and from the circumstance that in the cases which came under the author's observation the young in each litter were of the same sex, and were contained in a common chorionic vesicle, it is considered probable that they were all derived from a single fertilised egg, and that the sex is determined in the latter. The placenta is of a deciduate type intermediate in form between the zonary and the discoidal, and as this type does not precisely conform to the "placenta zono-discoidalis" of Strahl, it is proposed that it should be known as "placenta zono-discoidalis indistincta." The author divides the Edentata into the Tæniodonta (extinct), Xenarthra, Pholidota, and Tubulidentata. Wortman is considered to be justified—in opposition to the view of W. B. Scott—in regarding the Tæniodonta (or Ganodontia) as represented by the Conoryctidæ and Stylinodontidæ, in the light of unspecialised ancestral Edentates.

DR. RAYMOND PEARL and Dr. Frank M. Surface have been studying the egg-production of selected fowls with the view of answering the question, "Is there a Cumulative Effect of Selection?" and their conclusions have been published under this title in the *Zeitschrift für induktive Abstammungs- und Vererbungslehre* (Band ii., 1909, Heft 4). Two distinct experiments were made. The first, inaugurated by the director of the Maine Agricultural Experiment Station and the late Prof. G. M. Gowell, consisted in the continued selection of fluctuating variations with the view of increasing the fecundity. The second dealt with the inheritance of fecundity. The experiments were conducted on a large scale, and yielded extremely interesting, although from the poultry farmer's point of view very disappointing, results. Systematic selection carried on for nine consecutive years yielded no increase in the average production of the flocks, nor was there any decrease in variability as regards egg-production. Egg-producing ability is apparently not inherited; on the contrary, the daughters of hens which laid 200 or more eggs *per annum* actually laid, on an average, a smaller number of eggs than the daughters of less prolific birds. These results seem to have an important bearing on the theory of natural selection.

STUDENTS of cytology who are interested in the dynamical aspects of the phenomena of karyokinesis will welcome a paper on this subject, by Prof. Angel Gallardo, in the *Archiv für Entwicklungsmechanik der Organismen* (Band xxviii., Heft 1), a separate copy of which has been sent to us by the author. Prof. Gallardo interprets the division of the cell as a bipolar phenomenon of an electro-colloidal character. He regards the cell as a complex mixture of positive and negative colloids of different potential, of electrolytes, and of neutral coagulated substances susceptible or not of induction. He considers that the chromatin carries a negative, and the cytoplasmic colloids a positive, charge. The centrosomes are supposed to be capable of acquiring a positive potential higher than that of the cytoplasm. This potential increases through unknown causes, and determines the division of the centrosome. The radiations which appear around the separating daughter-centrosomes are chains of force, formed by the orientation of cytoplasmic microsomes. The trajectories of the centrosomes during separation are the resultants of their mutual repulsion and of the attraction of the nucleus. The chromatin divides during the metaphase by repulsion of its chromosomes under a high negative potential, and the two groups of daughter-chromosomes separate under the double action of their mutual repulsion and of the attraction of the centrosomes. The two new nuclei thus formed attract the positive cytoplasm, and thus determine the division of the cell itself. The paper also contains a useful *résumé* of the views of other writers, such as Hartog and Delage, on this interesting subject.

A FEW years ago we noted with pleasure the commencement of the *Bio-chemical Journal*, and congratulated the editors, Prof. Benjamin Moore and Mr. Edward Whitley, of Liverpool, on their enterprise in starting a periodical in which bio-chemists could publish their researches. The chemical side of biological investigation is well to the fore at the present time; physiologists, pathologists, botanists, and others are devoting themselves to the unravelling of nature's secrets by chemical methods; chairs and lectureships in the subject are being established in our universities and colleges; the subject has a rapidly growing literature of its own, and journals dealing with it are published in Germany and America as well as in Liverpool. The undertaking has met with an unqualified success, and the first number of the fifth volume has just been published. The occasion is signalised by the appearance of the journal in a form more worthy of the matter it prints, both cover and the quality of the paper used being improved. The papers in it indicate the manifold way in which chemical research is invading all branches of bio-chemical study; the first, by Major Sutherland and Captain M'Cay, deals with the influence of salts on hæmolysins, with special reference to the blood destruction which occurs in the tropical disease known as blackwater fever. This is followed by a note on a new method for determining the alkalinity of the blood, by Drs. Boycott and Chisholm. The editor and his colleagues contribute two important papers, one relating to the bearings of the physical properties of colloids and of adsorption on physiological problems, and the other to the properties of a new sapoglucoside obtained from Mowrah seeds. Papers on the action of ether on the circulation by Dr. Embley, and the influence of the pancreas on glycolysis in muscle by Dr. Simpson, bring the number to a conclusion. We have to congratulate the editors on their success in adding to British scientific literature a journal of such a high standard.

THE advantages offered to students of natural history by the opening of a "mountain" laboratory at Tolland, Colorado, situated at a considerable elevation, yet immediately accessible by train, forms the subject of an article contributed by Prof. F. Ramaley to the University of Colorado Studies (vol. vii., No. 1). Swamp meadow, grass-land, scrub, pine, and spruce forests are found in the immediate vicinity, while a short railway journey up or down gives access to Alpine conditions or vegetation of a warmer region.

A SECOND paper by Mr. E. P. Stebbing on undescribed species of Indian boring beetles of economic importance belonging to the family Scolytidæ is published as the second part of the zoological series of Indian Forest Memoirs. Three species of Scolytus were taken on the deodar; in this respect they agree with the American types which infest conifers, whereas the Japanese and European species, including the well-known *Scolytus destructor* of the elm, infest dicotyledonous trees. Four species of Tomicus were discovered on different conifers, and a fifth was collected on the sál tree, *Shorea robusta*. Two species of Pityogenes, also taken on coniferous trees, are remarkable for their wide distribution.

SYSTEMATIC papers are prominent in the first part of the twenty-fourth volume of Transactions and Proceedings of the Botanical Society of Edinburgh. A short list of seaweeds collected in the West Indian island of Dominica is contributed by Mr. S. Grieve, and Mr. A. Bennett discusses the validity of *Naias flexilis* and *Atriplex calotheca* as British and Scottish species respectively. Miss I. M. Hayward prefaces a list of Tweedside alien plants with the remark that wool is largely imported into the district; this probably explains the presence of two species of Senecio, a Helipterum and *Atriplex spongiosa*, all Australian plants, and *Cenia turbinata*, a common weed throughout Cape Colony. An anatomical description of thorny aërial roots of the palm, *Acanthorhiza aculeata*, is communicated by Miss B. Chandler. They emerge as soft green roots, but on lengthening shed their root-cap, and eventually become hardened into thorny structures; they function, at any rate in the early stages, as breathing roots.

AN elaborate and extremely useful account of the Indo-Malayan woods, with a systematic enumeration of the trees furnishing them, is presented by Dr. F. W. Foxworthy in the botanical series (vol. iv., No. 4) of the *Philippine Journal of Science*. The author has found it convenient to summarise largely under types known by recognised common names. Attention is especially directed to the great importance of the timbers furnished by trees of the family Dipterocarpaceæ, some of which are hardwoods, others are of soft or medium grades. "Rassak" applies to certain hardwoods yielded by species of Vatica and Cotylelobium; "yacal" is obtained from species of Shorea and Hopea. Softer woods, used for planks and light constructive work, known as "lauan," "meranti," and "almon," are yielded by other species of Shorea, Hopea, and Anisoptera. The family of Leguminosæ also supplies many valuable trees, to mention only the genera Albizzia, Intsia, and Pterocarpus. Details are furnished of Philippine ebony trees and substitutes for other standard timbers, and a number of illustrations taken from transverse sections of the woods are provided.

PROF. G. MERCALLI, of the University of Naples, has recently published a valuable report on the Messina earthquake (*Atti del R. Ist. d'Incorraggiamento di Napoli*, vol. vii., 1909), in which special attention is paid to the phenomena exhibited in the south of Calabria. Although there were no immediate precursors of the great shock, at least six slight tremors were felt during the previous month at Messina, Reggio, and other places within the meizoseismal area. The earthquake itself consisted of two shocks, or of two distinct phases, separated by a brief interval, the first part being the longer and the second the more violent, the whole shock lasting about forty seconds. On the map of the central area four isoseismal lines are drawn, the innermost being nearly elliptical, about 18–20 km. long from north to south, and about 10 km. wide, and agreeing closely with the curve laid down by Prof. Omori as bounding the strongly shaken area. The epicentre was evidently submarine, and its position cannot therefore be exactly determined. Prof. Mercalli, who has made a special study of the Calabrian earthquakes, states that two of the after-shocks of the great earthquake of 1783 originated in the same centre as the Messina earthquake, as well as four other shocks in the years 1509, 1599, 1780, and 1876.

THE current number of *Science Progress* contains the first part of a paper on recent hydrobiological investigations, by Mr. James Johnstone, of the Liverpool University Fisheries Laboratory. The paper deals with the results of the international explorations of the seas of northwestern Europe, more particularly with those set forth in the papers of Nansen and Helland-Hansen, and examines the relation between the "Gulf Stream" (by which, it appears from the paper, is meant the Norwegian branch of the "Gulf Stream drift") and climate and crops in northern Europe. The series of curves worked out by Nansen and Helland-Hansen showing the remarkable parallelism between air temperature and sea temperature, growth of fir trees, and yield of various harvests in Norway is illustrated. In the absence of further investigation in lower latitudes in the open Atlantic it is still quite uncertain how far the sea temperature is determined by the varying proportions in which the northward moving water is derived from the equatorial currents, and the relations of cause and effect are still so obscure that it seems premature to conclude that it is "inevitable that the yield of the land-crops depends on the temperature of the sea."

A SOMEWHAT novel treatment of the hydrodynamical equations representing the general circulation of the atmosphere is given by Mr. F. R. Sharpe in the *American Journal of Mathematics*, xxxii., 1. Besides writing down, in polar coordinates, the equations of flow of matter and momentum for a viscous fluid, the author takes, in place of the ordinary adiabatic assumption, an equation representing the flow of energy, which latter is equivalent to the energy equation of the kinetic theory. Making use of the fact that the height of the atmosphere is a small fraction of the earth's radius, an approximate solution is obtained in the first place neglecting, and in the second place taking account of, the earth's rotation. The author establishes an agreement at least of a qualitative character between the results of his theory and observed facts.

THE *Electrician* for February 11 contains a description, by Mr. P. A. Mossay, of a new arc-lamp known as the Timar-Dreger, which almost dispenses with mechanism and seems incapable of getting out of order. The two carbons are placed horizontally, the positive a few millimetres above the negative, and the arc forms and remains at the ends. To compensate for the want of symmetry of the light, a second pair of carbons is provided which point in the opposite direction to the first. Another new piece of apparatus of interest to illuminating engineers is the Lowden rotary mercury pump, described in the *Electrical Engineer* of the same date. The pump is not unlike the Gaede in general principle, and is much quicker in action than the pumps now used in evacuating incandescent lamps down to pressures at which blackening of the bulb is inappreciable.

FIVE years ago the geophysics laboratory of the Carnegie Institution of Washington commenced the task of redetermining, on the constant-volume nitrogen scale of temperature, the melting points of the metals from zinc to palladium. The work has now been completed, and the results are given by Messrs. Day and Sosman in the February number of the *American Journal of Science*. A platinum-rhodium thermometer bulb has been substituted for the one of platinum-iridium used in the earlier measurements, and the bulb has been surrounded by an atmosphere of nitrogen at about the same pressure as that in the bulb to prevent diffusion of the gas through the walls of the bulb. Greater uniformity of temperature throughout the furnace in the neighbourhood of the bulb has been secured, as the authors consider that this is the chief outstanding error in the use of the thermometer. By means of thermo-couples of platinum platinum-rhodium standardised by comparison with the nitrogen thermometer they find the following values of the melting points, which may be compared with those of Messrs. Waider and Burgess, of the Bureau of Standards, given in these columns on February 17:—cadmium, 320·0°; zinc, 418·2°; antimony, 629·2°; aluminium, 658·0°; silver, 960·0°; gold, 1062·4°; copper, 1082·6°; nickel, 1452·3°; cobalt, 1489·8°; palladium, 1549·2°.

THE first instalment of an article on the stability of flying machines, by Prof. Herbert Chatley, appears in *Engineering* for March 4. The author proceeds to inquire under what conditions such machines may be automatically stable; up to the present, only two types possessing this quality seem to have been discovered, viz. the automatic single-surface glider and the balanced glider. The first relies for its longitudinal stability on the variation of the centre of pressure with the angle of attack; the second relies on the variation in altitude of a balancer or tail surface. In each case a torque should come into existence which will bring the glider back to its original position. The author works out both cases mathematically, and points out for the first case that it is not only $\phi(\beta)$, the distance of the centre of gravity ahead of the centre of area of the plane expressed as a function of the angle of attack β, which decides the stability, but the rate of change of the torque M produced by a small alteration in β owing to a change in the velocity. There seems no doubt that surfaces which are concave on the under side are not stable without some balancing device. The question of oscillations is also discussed in this article.

BULLETIN No. 34, issued by the Engineering Experiment Station of the University of Illinois, contains an account of tests on a water-tube boiler having two types of tile-roof furnaces. The tests were conducted by Mr. J. M. Snodgrass, and in the first four the tubes of the lower row were completely surrounded by the tiles which formed the roof of the furnace; in the other four tests the under sides of the tubes were exposed to the action of the furnace gases, the roof tiles resting on the tops of the tubes. The last four tests show a slightly higher efficiency, more uniform fire control, and a lower temperature in the furnace, combustion chamber, and stack as compared with the first four tests. The covered tubes were shown to be superior in the matter of smokelessness. About 5 per cent. more water per pound of coal was evaporated with the exposed tubes, and the temperatures in the furnace and combustion chamber were found to be from 200° to 400° F. less with these tubes than with those wholly covered. Copies of the bulletin may be had gratis from W. F. M. Goss, University of Illinois, Urbana, Illinois.

MESSRS. MACMILLAN AND CO., LTD., have published the first part of a "Key to Hall and Stevens's School Arithmetic," prepared by Mr. L. W. Grenville. The price of this part is 4*s*. 6*d*.

THE *Amateur Photographer* of March 8 is a special issue, containing a number of fine reproductions of photographs, printed in two colours on art paper, as well as valuable notes on scientific and artistic aspects of photography. The price of this issue is only twopence, notwithstanding these special characteristics.

A POPULAR edition of the "Naturalist on the River Amazons," by the late Henry Walter Bates, F.R.S., has been published by Mr. John Murray at the price of 1*s*. net. We welcome the publication in cheap form of standard books of travel of this kind as being likely to interest the general reader in the work of scientific naturalists and explorers.

OUR ASTRONOMICAL COLUMN.

BRILLIANT FIREBALL OF FEBRUARY 27.—Mr. W. F. Denning writes:—"On February 27, at 6.55, a magnificent meteor was observed at various places. It fell slowly, and illuminated objects around like the bright ball of a Roman candle. The meteor is remarkable in two respects, namely, for its unusual proximity to the earth at the end of its career and for the intense green colour exhibited by its nucleus as it sailed down the sky. Several independent observers say the object apparently reached the horizon, or got within 2° or 3° of it, before it became extinct. Its height was certainly not more than twelve miles at the end of its luminous career, which occurred over a point about twenty miles west of the island of Anglesey. Possibly, indeed, the meteor may have fallen in the Irish Channel, but evidence must be awaited from places nearer the scene of the event than any we now possess.

"The radiant point seems to have been in the N. region of Cancer, and this is a place from which several large fireballs have been directed in past years at the end of February and early in March.

"There is good reason to suppose that the meteor penetrated our air strata so far as to arrive in a compact form and still luminous to within seven or eight miles of the earth's surface, but more exact observations can alone enable trustworthy figures to be deduced."

COMET 1910*a*.—Further light is thrown on the time and circumstances of the discovery of comet 1910*a* by Mr. Innes in a communication published in No. 4389 of the *Astronomische Nachrichten*, p. 338.

The earliest date on which the comet appears to have been seen in South Africa was January 12, when, at 14h. 25m. (G.M.T.), some workmen at the Transvaal Premier Diamond Mine saw it. They described it as an ordinary star with a tail to it, apparently a little to the right of the point where the sun rises. Apparently Mr. Innes was nearly as unfortunate as some London astronomers, for, having made a series of observations on the morning of January 17, he and his colleagues were prevented, by overcast skies, from seeing the comet again.

A number of observations now recorded in the same journal and in the *Comptes rendus* show that the comet's brightness decreased very rapidly after January 30, and this probably accounts for the disappointment of a large number of people in not seeing it after reading the accounts of its extraordinary brilliancy and beauty. M. Coggia found that on February 11 it was but a bright nebulosity about equally visible with a star of magnitude 8·4; on February 4 it was as faint as magnitude 7·6, and only showed faint traces of a tail near the nucleus.

Halley's Comet.—An interesting popular address delivered before the Jersey Society in London by Mr. W. B. Brodrick in December (1909) is now published in *Science Progress* (No. 15, p. 492). The address contains a discussion of the historical events which have coincided with the comet's known apparitions, especially that of 1066, and some interesting quotations from early writers are given.

It is now improbable that the comet will be seen again until the third week in April, when, until its transit on May 18, it will rise shortly before the sun almost due east.

The Sun-spots of September 25, 1909.—An interesting description of the sun-spots of September 25, illustrated by photographs taken with the Rumford spectroheliograph at the Yerkes Observatory, is given by Dr. Slocum in No. 1, vol. xxxi., of the *Astrophysical Journal* (January, p. 26). The history of the spot, shown to be connected with the magnetic storm of September 25, is given from its appearance on September 1 to November 19, when it was last seen, and the Yerkes observations confirm those made at South Kensington in showing that the spot was especially active at the time of the magnetic storm. On September 24 the high-level calcium flocculi showed a spiral form over the spot, but on September 25 this had disappeared, and was replaced by a number of bridges crossing the spot. On September 27 the arrangement of these bridges had changed completely, and there was again a trace of the spiral structure. A prominence plate taken on September 30, at 3h. 48m. G.M.T., showed that the spot area was still active, for there were several prominences at the region of the limb where the spot had disappeared; a second plate, taken at 4h. 57m. G.M.T., showed that in the interval a violent eruption had occurred, and in place of a small single prominence there was a brilliant one extending some 5° or 6° along the limb, and rising, in several arches, to a height of 32,000 km.

Displacement of Lines at the Sun's Limb.—In publishing his important results on the spectroscopic determination of the sun's period of rotation, Dr. Halm, in 1907, directed attention to several cases where there were small displacements, of certain lines, independent of those due to rotation. Since then the matter has been under investigation at Mount Wilson, and Mr. W. S. Adams now publishes, and discusses at length, the results obtained. Too many points of interest are raised in his paper to be discussed adequately here, but one or two of the chief ones may be briefly referred to.

A great deal of the work has been carried out with the 30-foot spectrograph, used in connection with the tower telescope, thus providing photographs of large dispersion.

Seven classes of lines were selected for special discussion, so that any differential effects might be the better investigated, and altogether 470 lines were dealt with; the intensities at limb and centre, the displacement, and various remarks are tabulated for each line. Two values for the displacement are given, one the observed value, the other the value obtained after applying to this a correction of 0·002 Å, indicated by the cyanogen bands as being probably due to motion in the line of sight produced by convection currents in the values for the centre.

These results show that the lines of titanium, vanadium, and scandium are less displaced than those of iron and nickel, and this is considered to be an indication that the cause producing the relative "shifts" is most effective at the lower levels. Lines most strengthened at the limb generally show the smaller displacements, and the explanation offered is that the intensification is a temperature effect, the higher level lines being cooler; the smaller displacement is thus in accordance with the previous conclusion.

The enhanced lines are well marked in the results, and generally show a much greater displacement than the arc lines. This is especially prominent in the case of lines extremely weak in, or absent from, the arc spectrum, as shown by the special study of eighteen lines given in Lockyer's list of the enhanced lines of iron; the line at λ 4385·548 gives a larger displacement (+0·013 Å.) than any other line on the more refrangible side of λ 5500. The suggested explanation of this peculiarity of enhanced lines is that, in the solar spectrum, they are due almost exclusively to the "granulations" on the disc. If, as has been suggested, these granulations signify masses of ascending, heated vapours, the measures at the centre would be affected by the resulting differential motion in the line of sight, and so increased displacements would result; an upward motion of 0·12 km. per sec. in the granulations would account for the results found.

Finally, the results indicate that the relative displacements are caused by pressure, although this is a general result to which there are exceptions, which further investigations may adequately explain. The action of magnetic fields, of anomalous dispersion, and various other causes are referred to, but more evidence is necessary ere their definite relation can be inferred.

The "Anuario" of the Madrid Observatory, 1910.—From the Madrid Observatory we have received a copy of their "Anuario" for 1910, a useful volume containing the usual astronomical tables and some interesting articles on astronomical subjects. There is also a *résumé* of the solar observations made at the observatory during 1908, containing a complete daily, and summarised, record of the prominence observations, and a similar *résumé* of the meteorological observations.

THE ORGANISATION OF INDUSTRIAL RESEARCH.

An address delivered by Mr. W. R. Whitney at the twentieth anniversary of Clark University, and reprinted from the Journal of the American Chemical Society in two recent numbers of the *Chemical News*, contains many suggestive and valuable passages, expressed with characteristic forcefulness. As the author is himself at the head of a staff of eighty investigators, he is well qualified to speak on the "Organisation of Industrial Research." In his view the fundamental problem is to secure men who are endowed with the essential qualities of optimistic activity and knowledge; the former he regards as of supreme importance, in view of the fact that general laws usually indicate the impossibility of a process rather than the specific conditions under which success may be achieved. Fortunately this quality can be imparted, as has been proved again and again, by the establishment of "schools" of research, many of which have become world-wide in their operation; fortunately, also, it is possible by suitable organisation to utilise the labours of those who are not so endowed to promote the achievement of the ideals conceived by the few who are; and in such an organisation it is urged that the output should be not merely proportional to the number employed, but to some higher exponential function. In such a complex scheme it is not thought to be possible to reward each investigator by royalty or by any such direct payment for his success in making discoveries of definite commercial value, on one hand because his success is only in part due to his own efforts, and on the other hand because each investigator must be freely available for carrying on lines of work in which success of this kind is not likely to ensue.

In regard to material equipment, the author holds views of a very advanced character. Necessity is not the mother of invention; knowledge and experiment are its parents. This is clearly seen in the case of many industrial discoveries; high-speed cutting tools were not a necessity which preceded, but an application which followed, the discovery of the properties of tungsten-chromium-iron alloys; so, too, the use of titanium in arc lamps and of vanadium in steel were sequels to the industrial preparation of these metals, and not discoveries made by sheer force of necessity. Much the same consideration applies to the equipment of an industrial laboratory, where the most useful tools were often acquired with no idea of the uses to which they would ultimately be put. "No good tool lives long for a single use alone. Many times we have questioned the advisability of installing some new apparatus—a vacuum furnace, a pair of metal rolls, some special galvanometer, some microscope, a hydraulic press, a power hammer, a steam digester, &c. Never, after it became a part of the equipment, has it seemed possible to proceed without it. In the single case of the electric vacuum furnace, for example, our laboratory has made almost continual use of from three to eight for the past five years. The laboratory, piped several years ago with high vacuum and with electrolytic hydrogen, besides steam, air, water, and gas, will probably never operate without them."

Similar considerations apply to a library. A library containing ten of the leading research journals of the world may be said to have in each volume about 100,000 brain-power hours, and it would be folly not to utilise a charged storage-battery of this immense capacity when it can so readily be installed.

SOME RECENT APPLICATIONS OF OZONE.

ALTHOUGH ozone has now been definitely known for nearly seventy years, its commercial production and exploitation is one of the many bye-products that have resulted from the modern development of electrical engineering. The "Ozonair" Company, of 96 Victoria Street, Westminster, has taken advantage of these developments to produce a series of compact and (in many cases) portable ozonisers which can be connected directly to the ordinary lighting circuits and set in operation by means of a couple of tumbler switches, one controlling a fan or blower, and the other a coil or transformer for energising the aluminium gauze in contact with which the ozone is produced. The simplicity of these arrangements should prove an important factor in securing the general utilisation of ozone in all those cases in which its usefulness has been conclusively demonstrated.

Most of the new designs are intended for the purification of air, and in the case of large buildings their utility and efficiency can scarcely be doubted. In a small room or in close proximity to a generator, the presence of an excess of ozone might well be disagreeable, as those who have worked with it have good reason to know, but in a crowded hall the atmosphere of a public meeting would stand to gain enormously by the freshening and purifying effects of one or two well-placed ozonisers. In cases such as the above it is difficult, and in many buildings impossible, during the winter to introduce enough air from outside to prevent the atmosphere from becoming "stuffy," but the most dangerous and unpleasant effects might well be got rid of by means of ozone.

This general idea has been worked out into a definite and novel scheme of ventilation, which is acquiring considerable popularity in Russia, where warmth and freshness have usually presented themselves as alternatives rather than as compatible qualities, and in the tropics, where the introduction of large volumes of air from the outside is sufficient to destroy whatever remnants of coolness may be retained by the use of verandahs and other devices for excluding the glare of the sun. In each of these widely differing circumstances the method used is to withdraw air from the room, purify it by screening, washing, and ozonising, cool or warm as the case may be, and return it to the room with a sufficient admixture of outside air to keep the proportion of carbon dioxide within reasonable limits. In this way a great economy of heating or cooling is achieved, whilst the wholesomeness of the atmosphere is fully maintained.

The sterilisation of air by means of ozone has found a widespread application in brewing, where it replaces with great advantage the cumbrous and only partially effective systems of air-filtration that have been employed to protect the wort during fermentation, cooling, refrigerating, and bottling; it is also of service in protecting the yeast from contamination whilst it is being drained off from the wort.

An application of ozone of a more familiar type is in the bleaching of palm-oil for soap-making. This has usually been effected by means of bichromate and muriatic acid at a cost which may amount to as much as 30*s.* per ton. The bleaching of the oil by ozone is very effective, even in the case of specially bad samples, and costs little more than a tenth of this sum; in addition, the dark sediment that is thrown out during purification is much smaller in bulk, and the waste of oil is therefore greatly reduced.

It is claimed that the ozonised air produced by the new types of apparatus is entirely free from oxides of nitrogen, a point of considerable importance in many of its commercial applications.

AMERICAN ECONOMIC ENTOMOLOGY.

ACCORDING to the twenty-fifth report of the State Entomologist on the noxious and beneficial insects of Illinois, the scope of the work of the Entomological Department of that State has been very largely increased as the result of special legislative enactments, and the present report is the first to be drawn up under the new conditions. Its contents consist of three articles, one on experiments to check the corn-root aphis, a second on the habits of the corn-field ant (*Lasius niger americanus*), and a third on the insects infesting clover and alfalfa. Since all three have been already issued as Bulletins of the Agricultural Experiment Station of Illinois University, they need not be further noticed.

The mites of the group Oribatoidea form the subject of an article in vol. vii. of the Bulletin of the Illinois State Laboratory of Natural History. These mites, which are not much larger than the head of an average pin, are characterised by their hard, chitinous integument, on account of which they are commonly spoken of as beetle-mites, although they are not to be confounded with the mites infesting coprophagous beetles. They are generally found under decaying timber, beneath bark, under stones, in moss or grass, or on the twigs of trees, and do not appear to inflict any special damage on crops. In the present article Mr. H. E. Ewing describes a number of new species.

In article 2 of vol. viii. of the same publication Mr. J. D. Hood gives descriptions of new generic and specific types of thrips of the group Thysanoptera from Illinois.

Army-worms and cut-worms infesting sugar-cane in the Hawaiian Islands form the subject of Bulletin No. 7 of the Entomological Division of the Experiment Station of the Hawaiian Sugar-planters' Association, published at Honolulu. Of the various species of "army-worms," the widely spread *Cirphis unipuncta* is abundant in the islands, but the larvæ do not seem to assemble in the hordes which have given rise to the name of the group. They inflict, however, considerable damage on young sugar-cane, although, fortunately, there is an interval between the disappearance of one brood and the development of a second, which affords time for the plants to recuperate. The numbers of the grass army-worm—the caterpillars of the moth *Spodoptera mauritia*, a species indigenous to Mauritius, western Africa, and the Oriental and Australasian regions—have been kept in check in Hawaii, where they formerly did much damage, by the introduction of myna birds from India.

Since weevils are a group with which the economic entomologist has many dealings, reference may be made here to a paper on North American Curculionidæ, by Mr. W. D. Price, published as No. 1708 of the Proceedings of the U.S. National Museum. A number of new species are named and described.

COLOURS OF SEA AND SKY.[1]

A RECENT voyage round Africa recalled my attention to interesting problems connected with the colour of the sea. They are not always easy of solution in consequence of the circumstance that there are several possible sources of colour the action of which would be much in the same direction. We must bear in mind that the absorption, or proper, colour of water cannot manifest itself unless the light traverse a sufficient thickness before reaching the eye. In the ocean the depth is, of course, adequate to develop the colour, but if the water is clear there is often nothing to send the light back to the observer. In these circumstances the proper colour cannot be seen. The much admired dark blue of the deep sea has nothing to do with the colour of water, but is simply the blue of the sky seen by reflection. When the heavens are overcast the water looks grey and leaden; and even when the clouding is partial, the sea appears grey under the clouds, though elsewhere it may show colour. It is remarkable that a fact so easy of observation is unknown to many even of those who have written from a scientific point of view. One circumstance which may raise doubts is that the blue of the deep sea often looks purer and fuller than that of the sky. I think the explanation is that we are apt to make comparison with that part of the sky which lies near the horizon, whereas the best blue comes from near the zenith. In fact, when the water is smooth and the angle of observation such as to reflect the low sky, the apparent blue of the water is much deteriorated. In these circumstances a rippling due to wind greatly enhances the colour by reflecting light from higher up. Seen from the deck of a steamer, those parts of the waves which slope towards the observer show the best colour for a like reason.

The real colour of ocean water may often be seen when there are breakers. Light, perhaps directly from the sun, may then traverse the crest of the waves and afterwards reach the observer. In my experience such light shows decidedly green. Again, over the screw of the ship a good deal of air is entangled and carried down, thus providing the necessary reflection from under the surface. Here also the colour is green.

The only places where I have seen the sea look blue in a manner not explicable by reflection of the sky were Aden and Suez. Although the sky was not absolutely overcast, it seemed that part, at any rate, of the copious if not very deep blue was to be attributed to the water. This requires, not only that the proper colour of the water should here be blue, but also the presence of suspended matter capable of returning the light, unless, indeed, the sea bottom itself could serve the purpose.

The famous grotto at Capri gives an unusually good opportunity of seeing the true colour of the water. Doubtless a great part of the effect is due to the eye being shielded from external glare, and so better capable of appreciating the comparatively feeble light which has traversed considerable thicknesses of water. The question was successfully discussed many years ago by Melloni, who remarks that the beauty of the colour varies a good deal with the weather. The light which can penetrate comes from the sky, and not directly from the sun. When the day is clear the blueness of the sky cooperates with the blueness of the water.

That light reflected from the surface of a liquid does not exhibit the absorption colour is exemplified by brown peaty water such as is often met with in Scotland. The sky seen by reflection is as blue as if the water were pure; but an attempt to illustrate this fact by experiment upon quite a small scale was not at first successful. A large white photographic dish containing dark-brown oxidised "pyro" was exposed upon the lawn during a fine day. Although the reflected light certainly came from the clear sky, the colour did not appear pronounced, partly in consequence of the glare of the sunshine from the edges of the dish. The substitution of a dish of glass effected an improvement; but it was only when the eye was protected from extraneous light by the hands, or more perfectly by the interposition of a pasteboard tube held close up, that the blue of the reflected light manifested its proper purity.

[1] Discourse delivered at the Royal Institution on Friday, February 25, by the Right Hon. Lord Rayleigh, O.M., F.R.S.

It would seem that the explanation is to be sought in diffusion of light within the lens of the eye, in consequence of which, especially in elderly persons, the whole field is liable to be suffused with any strong light finding access.

As regards the proper colour of pure water, an early opinion is that of Davy, who, in his "Salmonia," pronounces in favour of blue, basing his conclusion upon observations of snow and glacier streams. The latter, indeed, are often turbid, but deposit the ground-up rock which they contain when opportunity offers, as in the Lake of Geneva. A like conclusion was later put forward by Bunsen on the basis of laboratory observations. The most elaborate experiments are those of Spring, who, in a series of papers published during many years, discusses the difficult questions involved. He tried columns of great length—up to 26 metres; but even when the distance traversed was only 4 or 5 metres, he finds the colour a fine blue only to be compared with the purest sky-blue as seen from a great elevation; but when the tubes contain ordinary water, even ordinary distilled water, the colour is green or yellow-green, and not blue.

The conversion of the original blue into green is, of course, explicable if there be the slightest contamination with colouring matter of a yellow character—*i.e.* strongly absorbent of blue light. Spring shows that this is the effect of minute traces—down to one ten-millionth part—of iron in the ferric state or of humus. The greenness of many natural waters is thus easily understood. Another question examined by Spring is not without bearing upon our present subject, viz. the presence of suspended matter. I am the better able to appreciate the work of Spring, that many years ago I tried a variety of methods, including distillation *in vacuo*, in order to obtain water in the condition which Tyndall described as "optically empty," but I met with no success. Spring has shown that the desired result may be obtained by the formation within the body of the liquid of a gelatinous precipitate of alumina or oxide of iron, by which the fine particles of suspended matter are ultimately carried down.

Perhaps the most telling observations upon the colour of water are those of Count Aufsess, who measured the actual transmission of light belonging to various parts of the spectrum. The principal absorption is in the red and yellow. In the case of the purest water, there was practically no absorption above the line F, and a high degree of transparency in this region was attained even by some natural waters. That these waters should show blue, *when in sufficient thickness*, is a necessary consequence.

In my own experiments, made before I was acquainted with the work of Aufsess, the light traversed two glass tubes of an aggregate length of about 4 metres (12 feet). On occasion the light was reflected back so as to traverse this length twice over. I must confess that I have never seen a blue answering to Spring's description when the original light was white. For final tests I was always careful to employ the light of a completely overcast day, which was reflected into the tubes by a small mirror. The colour, after transmission, showed itself very sensitive to the character of the original source. The palest clear sky of an English winter's day gave a greatly enhanced blue, while, on the other hand, isolated clouds are usually yellowish, and influence the result in the opposite direction. I should myself describe the best colour of the transmitted light on standard days as a greenish-blue, but there is some variation in the use of words, and, perhaps, in vision. Some of my friends, but not the majority, spoke of blue simply, but all were agreed that the blueness of a good sky was not approached. The waters tried have been very various. Sea-water from outside the grotto of Capri, from Suez, and from near the Seven Stones Lightship, off the Cornish coast, I owe to the kindness of friends. Of these, the two former showed a greenish-blue, the latter a full, or, perhaps, rather yellow-green, and these colours were not appreciably modified after the water had stood in the tubes for weeks. It is important to remember that the hue may, to some extent, depend upon thickness. It is quite probable that in a greatly increased thickness the Capri and Suez waters would assume a more decided blue colour; but I do not think the Seven Stones water could so behave, the colour, with 12 feet, seeming to involve the absorption of blue light.

Further observations on greater depths of sea-water would be desirable. A naval son informs me that off the coast of Greece a plate lying in 6 fathoms of water looked decidedly blue, although the sky was a dirty grey. I have doubts whether this would be generally the case in the Mediterranean; the green due to moderate thicknesses seems too decided.

Of natural fresh waters that I have tried, none was better than that from a spring in my own garden. This water is hard, but bright and clear, and it shows a greenish-blue, barely distinguishable from that of the Capri and Suez water. Distillation does not improve the blue. Neither did other treatments do any good, such, for example, as partial precipitation of the lime with alkali, or passage of ozone with the idea of oxidising humus. Wishing to try water of high chemical purity, I obtained—through the kind offices of Sir J. Dewar—water twice distilled from alkaline permanganate, and condensed in contact with silver, but the colour was no bluer. In the light of this evidence I can hardly avoid the conclusion that the blueness of water in lengths of 4 metres has been exaggerated, especially by Spring, although I have no reason to doubt that a fully developed blue may be obtained at much greater thicknesses. I should suppose that sufficient care has not been taken to start with white light. It may be recalled that overcast days are not so common in some parts of the world as in England.

A third possible cause of apparent blueness of the sea must also be mentioned. If a liquid is not absolutely clear, but contains in suspension very minute particles, it will disperse light of a blue character. Although, undoubtedly, this cause must operate to some extent, I have seen no reason to think that it is important; but the existence of three possible causes of blueness complicates the interpretation of the phenomena. Hitherto observers have not been sufficiently upon their guard to distinguish blueness having its origin in the sky from blueness fairly attributable to the water itself.

As regards the light from the sky, the theory which attributes it to dispersal from small particles, many of which are smaller than the wave-length of light, is now pretty generally accepted. To a first approximation, at any rate, both the polarisation and the colour of the light are easily explained. According to the simplest theory, the polarisation should be absolute and a maximum at 90° from the sun, and the colour should be modified from that of the sun according to the factor λ^{-4}; but it is easy to see that there must be complications, even if all the particles are small and spherical. The light illuminating them is not merely the direct light of the sun, but also light diffused from the sky and from the earth's surface. On these grounds alone the polarisation must be expected to be incomplete even at 90°, and the certain presence of particles not small in comparison with the wave-length is another cause operating in the same direction. It is rather remarkable that, as I noticed in 1871, the two polarised components show much the same colour. The observation is best made with a double-image prism mounted near one end of a pasteboard tube, through which a suitable rectangular aperture at the other end is seen double, but with the two images in close juxtaposition. When this is directed to a part of the sky 90° from the sun, and the tube turned until one image is at its darkest, the two polarised components are exhibited side by side in a manner favourable for comparison of colours. The addition at the eye end of a Nicol capable of rotation independently of the tube gives the means of equalising the brightnesses without altering the colours. This observation, made independently by Spring, is regarded by him as an objection to the theory, and as showing that the cause of the blueness and of the polarisation is not the same. The argument would have more weight if the colours of the two components were exactly the same and in all circumstances, but I do not think that this is the case. Observations on the purer sky, to be seen from great elevations, would be of interest. The question is to what causes the second component is principally due. So far as it depends upon sky illumination, it would be bluer than the first component. Any "residual blue" of the kind described by Tyndall, and due to particles somewhat too big for the simple theory, would make a contribution in the same direction. On the other hand, large particles under the direct light of the sun, and perhaps small ones, so far as illuminated by light from the earth, would contribute a whiter light. In this way an approximate compensation may occur, but the matter is certainly worthy of further attention.

In this connection it should be noticed that, according to the now generally received electromagnetic theory, complete polarisation at 90° requires that the dispersing particles should behave as if spherical, even although infinitely small. If the shape be elongated, there would be incomplete polarisation combined with similarity of colour even under the simplest conditions.

When the particles are no longer very small in comparison with the wave-length, the direction of maximum polarisation was found by Tyndall to become oblique, and the deviation is in the opposite direction to that which would have been anticipated from the Brewsterian law for the reflection of light from surfaces of finite area. As I showed in 1881, the gradual precipitation of sulphur from a very weak and acid solution of "hypo" exhibits the phenomena remarkably well. At a certain stage, depending on the colour of the light, the direction of maximum polarisation becomes oblique. Even when the obliquity is well established for blue light, red light still continues to follow the simpler law, and the comparison gives curious information concerning the rate of growth of the particles.

The preferential scattering of light of short wave-length involves, of course, a gradual yellowing and ultimate reddening of the light transmitted. The formation in this way of sunset colours is well illustrated by the acid hypo.

That Spring rejects this theory in favour of one which would attribute sky-blue to absorption by oxygen or ozone has been already alluded to. Although one must not conclude too hastily from the behaviour of these bodies when liquefied, it is, of course, possible that their absorbing qualities may influence atmospheric phenomena in some degree; but to attribute the blue of the sky to them seems out of the question. It is sufficient to remark that the setting sun turns red, and not blue.

An interesting question remains behind. To what kind of small particles—dispersing short waves in preference—is the heavenly azure due? That small particles of saline or other solid matter, including organic germs, play a part cannot be doubted, and to them may be attributed much of the bluish haze by which the moderately distant landscape is often suffused; but it seems certain that the very molecules of air themselves are competent to scatter a blue light not very greatly inferior to that which we actually receive. Theory allows a connection to be established between the transparency of air for light of various wave-lengths, and its known refractivity in combination with Avagadro's constant, expressing the number of molecules per cubic centimetre in gas under standard atmospheric conditions. The first estimate of transparency was founded upon Maxwell's value of this constant, viz. $1{\cdot}9\times10^{19}$. Recent researches have shown that this number must be raised to $2{\cdot}76\times10^{19}$, and that the result is probably accurate to within a few per cent.[1] It has been pointed out by Dr. Schuster that the introduction of the raised number into the formula almost exactly accounts for the degree of atmospheric transparency observed at high elevations in the United States, apparently justifying to the full the inference that the normal blue of the sky is due to molecular scattering; but, although there is no reason to anticipate that this general conclusion will be upset, it should not be overlooked that a molecule, especially a diatomic molecule, can hardly be supposed to behave as if it were the dielectric sphere of theory. Questions are here suggested for the decision of which the time is perhaps not yet ripe.

P.S.—The question of the colour of the Mediterranean and other waters was long ago discussed by Mr. J. Aitken—an excellent observer—in Proc. Roy. Soc. Edin., 1881–2. His principal conclusions are very similar to my own. Mr. Aitken rightly insists upon the influence of the colour of the suspended matter to which the return of the light

[1] It is a curious instance of divergence in scientific opinion that whil some still deny the existence of molecules, others have successfully counted them.

is due. Only when this is white has the proper colour of the water a full chance of manifesting itself. From the heights of Capri I noticed that the shallow water near the shore showed decidedly green, an effect attributed to the yellowness of the underlying sand.

A GEOLOGIC FORECAST OF THE FUTURE OPPORTUNITIES OF OUR RACE.[1]

THE established custom of occasions of this kind leads the association to expect that its retiring president will address it upon some theme connected with the field of his own work. I shall not altogether ignore this custom, but I have chosen a theme that is at once peculiarly humanistic and distinctly prophetic. Geology has not usually been regarded as in any special sense a humanistic science, much less a prophetic one. But it is just because it has not been so regarded, and because I have fondly dreamed that it might become tributary in an eminent degree to humanistic problems and to a prophetic insight, that I have chosen the theme assigned for the evening.

Ever since the race came to a virile state of intelligence, it has tried to peer into the future that it might guide itself by its foresight. Now and then it has prolonged its vision beyond mere temporary concerns, and has endeavoured to prophesy the end of the race and the destruction of the earth. At all stages the depth of its vision into the things before has been close akin to the length of its vision backward and to the depth of its insight into the things about it. The lamp of the past and the illumination of the present have been its light for the future. This must doubtless always be its true method, for only as the race sees far into the past, sees widely and deeply into the present, has it any firm basis for a confident prophecy of the future. Even in its early days, the race did not fail to note that—though this may not be so of the ultimate entities—the existing *forms* come into existence, live their day, and pass away; why not, therefore, the race and the earth on which it dwells? Even as the race grows into its fuller maturity and the horizon of its vision is enlarged, there will doubtless still remain the conviction that there has been a beginning of the current order of things, and a like conviction that there will be an end. The enlargement of vision will only serve to bring into view an additional multitude of organisms and organisations that have come into form, endured for a time, and passed away. Any future change in human forecasts is not likely to be one of method, but one of measure. Some of the features that have entered into former prophecies will no doubt disappear, and perhaps new ones be added. The forecasts of pre-scientific times often made the doom of the earth hinge on some lapse in the conduct of man—made a physical disaster serve as a moral punishment. With a better knowledge of the moral law and of man's place in nature, this anthropic view will no doubt give place to a more consistent insight into the sequences of the moral and the physical worlds.

In the earlier days of the race the backward look was short, and the putative origin of the race and of the earth was placed but a few thousand years in the past; in consonance with this, the forward look placed the end not far in the future. So, too, as the beginning was made chaotic, the end was made cataclysmic.

The dawn of the earth sciences was followed by a new forecast, and as these sciences grew this underwent revisions and recasts. It was learned that the history of the earth stretches back not merely for thousands but for millions and tens of millions of years; that the on-goings of the earth are actuated by energies too broad and deep and strong to be swerved in their course or brought to an end by the acts of those who dwell upon it; that the march of earth-history has a mighty tread not to be measured by the merits or lapses of even our favoured race.

The trend of prophetic thought in the last century invites a closer review. The basis of forecast lay fundamentally in the mode of origin assigned the earth and in the general trend of its past history, especially the trend of those agencies that controlled the conditions of life on its surface. The solar system was thought to have had its origin in a gaseous or quasi-gaseous nebula. The earth, as a member of the solar system, partook of this origin, and was conceived to have been, at an early stage, itself a fiery, gaseous globe. It is not needful here to review the special hypotheses or pay honour to their great authors from Kant and Laplace to Lockyer and Darwin, for the sole feature that potentially shaped the history of the earth was the early gaseo-molten state in which they essentially concurred. An alternative was, indeed, offered in the suggestion that the earth might have grown up by the accretion of small bodies, but it was then held by students of dynamics that such an origin was inconsistent with the symmetry of the system and the rotations of the planets, and so an origin in the gaseous or quasi-gaseous form was almost universally accepted, as by compulsion. Later, the gaseous earth, by cooling and condensing, was thought to pass into a molten sphere wrapped in a hot, vaporous atmosphere. This atmosphere was vast because the conditions required it to contain all the water of the globe and all the volatile matters that have since entered into the waters and the body of the earth. At a later stage a crust was logically made to form over the molten sphere, and the waters to condense upon it, swaddling the entire globe, perhaps, in a universal ocean. By further cooling, shrinkage, and deformation, the waters were thought to be drawn into basins, the land to appear, and the history of the stratigraphic record to begin. It is important to note that the main agency in this hypothetical history was loss of heat; and so, with consistent logic, loss of heat was made to lie at the bottom of the great events of the earth's subsequent history, and, in the forecast, to be the chief cause of its doom. From a plethora of heat, of air, and of ocean, putative loss followed loss in the past, and by prophecy loss is to follow loss in the future until emaciation, drought, and frigidity mark the final state and the end of all life.

As the body of the earth cooled and shrank and permitted penetration, the ocean was made to enter it, and, by union with its substance, was thought to have been suffering loss in the long past and to be doomed to further losses yet to come. By a like union of the constituents of the air with the body of the earth, as time went on, the great smothering atmosphere of the primitive days was supposed to be brought down first to compatibility with marine life, later to the lower land life, and still later to the higher air-breathing forms.

Projected logically into the future, still further depletion of the vital constituents, even to the verge of exhaustion, attended with pauperisation and finally with extinction of life, entered into the forecast. With the gathering of the oceans more and more into the basins, and their absorption into the body of the earth, with the persistent consumption of the atmosphere, and with the progressive cooling of the whole, the moisture of the air was thought also to have grown less and less. At first a deep, warm mantle of vapour and cloud hypothetically clothed the whole earth, and even half-way down the geologic ages was thought to have enshrouded the globe and to have given warm, sultry climates to all latitudes. But this mantle at length was made to give place to rifted clouds and clearer skies, and later on to mild aridities, followed at length by desert stages, which are even now supposed to be creeping out persistently on the once fertile lands. Thus we reach our own times at a putative stage when heat and air and moisture are running low; thus the predestined end is foreshadowed in the not distant future.

The round conception of the history shaped it as a progress from excess to emaciation, a sliding down the scale; it made the life-history but an episode intercurrent in the great decline from the too hot and the too much to the too cold and the too little.

The logic in all this is plausible. Starting with the hypothetical premises, the conclusions seem to follow. Variations of detail might well be found in the complexities of the case. Especially might sources of supply be assigned to offset waste and loss in some degree, but, granting the premises, the conclusion is not easily escaped. In point of fact, the general conception dominated the geologic thought of the last century. Not only this, but in no small degree it gave direction to the interpretations, and

[1] Address delivered at Boston, Mass., on December 27, 1909, by the retiring president of the American Association for the Advancement of Science, Prof. T. C. Chamberlin.

in some measure even influenced the observations of geologic phenomena well down to the close of the century, and is far from obsolete to-day.

But, logical and plausible as was this general conception of earth-history, it was hung, as you have not failed to notice, on the hypothesis of the genesis of the earth accepted. However logical, its logical strength was only that of the hypothesis on which it was hung. I say its *logical* strength advisedly, for outside the logic of the general concept there was always the appeal to the concrete evidences of the geologic record. This appeal was made, and was thought to be on the whole confirmatory. The strata of high latitudes were found to contain relics of life of tropical or subtropical types, not only in the early stages, but well down toward recent times. Figs and magnolias grew in Greenland as late as the Tertiary period. Phenomena so striking gave deep hold to the logical scheme. Phenomena not so consonant with it were easily overlooked or lightly passed by, as is our wont when too much impressed by what *must* be true. It is, however, a merit of modern science that it puts that which *is* to the front, and that which logically *must be* in a secondary place; and so, during the past century, inconsonant data were gathered with the consonant. Most of the inconsonant facts were of the unobtrusive sort, but yet some of them were startling, were seemingly incredible, were indeed long doubted, and only slowly gained credence. The accumulation of this inconsonant data gradually weakened the hold of the general logical concept and prepared the way for a reconsideration.

Meanwhile a serious source of doubt had arisen on the logical side, from the progress of physics. The older hypotheses of the origin of the earth had been framed before the kinetic theory of gases was evolved. After the kinetic view was accepted, it was pointed out by Johnstone Stoney that the velocities of the molecules of the outer air place a limit to the volumes which planetary atmospheres may possess. When the test which this suggested was applied to the postulated atmospheres and voluminous gaseous states of the early earth, it gave rise to grave doubt as to the physical consistency of these conceptions.

Weakness also arose in another quarter. One of the main props of the gaseous or quasi-gaseous hypotheses was, as already remarked, the general conviction, based on dynamical grounds, that condensation from any other nebulous state than the gaseous or quasi-gaseous would give revolutions and rotations to the planetary system at variance with those actually possessed. A re-examination, however, near the close of the century, developed grounds for the conviction that a gradual gathering in of matter from a scattered orbital state would give rotations and revolutions quite as well in accord with the facts formerly known, and seemingly even better in accord with new facts recently brought to light.

Thus toward the close of the last century there arose from different quarters cogent reasons for a reconsideration of the prevailing general view, and with it a recast of the former forecast. Further scrutiny added new doubts to those that had previously arisen, and in the end the verity of the older hypotheses of genesis was challenged, and new conceptions, based on orbital dynamics, in contrast to gaseous dynamics, were offered in their stead.

It is not appropriate for me to say that this challenge was successful, or that the older conceptions of the earth's origin are to be laid on the shelf. As an advocate of the method of multiple working hypotheses, it belongs to me to beg of you to save and to use, so far as you can find use in them, all the hypotheses that seem to you to be capable of working at all. Much less would it be appropriate for me to affirm that any form of the newer conceptions is entitled to take the place of the older in your complete confidence. The final adjudication of genetic hypotheses can only come of long and patient trial by searching analysis, by scrutinising logic, and by application to the multitudinous phenomena which the earth, not only, but the solar and stellar systems, present. It is sufficient warrant for the present review, however, that not a few of the more incisive students of these things have been led seriously to reconsider the foundations of the hypothesis of earth-genesis that have been offered, old and new, and to examine with renewed care the interpretations and inferences that have been made to hang upon them. Whatever may be your personal leanings, you will, no doubt, agree that it seems less laudable now to hang prophecies of the future upon hypotheses of genesis than when certain of these hypotheses received the almost universal assent of those then best qualified to hold opinions respecting them.

It does not seem to be going too far, moreover, to say that, whereas we seemed to be shut up to hypotheses of genesis that gave the earth a gaseo-molten state at the start, it now seems, to some students at least, possible that the earth inherited a quite different state from a slow growth from planetesimal or other accretions. If diverse views are thus permissible, they offer alternative working conceptions, and thus help to give freedom of interpretation while they stimulate observations on the critical phenomena. We may, therefore, be permitted first to review the states assigned the early earth by the competitive genesis offered, and then the critical phenomena that bear upon the earth's future.

Quite in contrast with the older pictures of a primitive earth cooling from a gaseous state, the planetesimal hypothesis, which may be taken as representative of theories based on concentration from a dispersed orbital state, postulates a solid earth growing up slowly by accessions, and becoming clothed gradually with an atmosphere and a hydrosphere. Each of the fundamental parts, the earth, the air, and the water, is made to grow up thus together from smaller to larger volumes without necessarily attaining at any stage a very high temperature. The early sources of growth for the atmosphere and the ocean, though reduced in later time, continued to serve as sources of replenishment when the familiar agencies of loss came into play in the later ages. Thus, far from assigning at the start a vast atmospheric and oceanic supply, and assuming progressive depletion of this with the progress of time, the newer view starts with a minimum supply and rests on means of feeding which are held to run hand in hand with the sources of loss and more or less completely to compensate them in a varying way. The question of the future under this view is, therefore, not how long beyond the present day will the original supply last, but rather how long will the oscillating compensation of loss and supply remain effective? Or, in other words, how long will the past degree of equilibrium between the opposing agencies keep the critical conditions within the limits required by life? This question turns us quite away from any serious dependence on the original states, and centres attention on the geologic record and on the potency of agencies still in action. Are the chief agencies which have controlled life conditions for tens of millions of years past still in good working order and likely to continue effective for a long era yet to come, or do they show clear signs of declining power portending an early failure? Let us enter a little closer into the consideration of the specific factors on which life depends, though time will not permit us to go far.

The pre-scientific fear that the end of life will come by cataclysm is not yet obsolete, nor is it theoretically impossible, but violent agencies are among the least to be feared. Life might, indeed, be imagined to be in jeopardy from volcanic and seismic convulsions, but they really offer no serious menace to life in general, and appear never to have done so in the known ages. The deadliness of these boisterous catastrophes impresses itself unduly on the emotions. The real peril, if peril there be, lies in the deadly unbalancing of agencies of the quiet sort.

The conditions essential to the maintenance of the habitability of the earth are many, but the more critical factors either lie in the atmosphere itself or are intimately associated with it. The point of keenest interest is the narrowness of range to which these mobile factors are confined. The several constituents of the atmosphere might each or all easily be too scant or too abundant. In a peculiar sense is this true of the carbon dioxide, which, though one of the least, is pre-eminently the decisive constituent of the atmosphere. A small proportion of carbon dioxide is essential to plant life, and so to animal life, while a large proportion would be fatal to air-breathing animals. If the three or four hundredths of one per cent. now present were lost, all life would go with it; if it were increased to a few per cent., the higher life would be suppressed or radically changed; and yet, on the one hand, the theoretical sources of supply are abundant, while, on the other, the agencies of depletion are efficient and active. There is little escape from the conclusion that, ever since the birth of air-breathing life, some 30,000,000 or 40,000,000 years ago, let us say, the interplay of these agencies of supply and depletion has been so balanced that neither fatal excess nor fatal deficiency has been permitted to cut short the history of the higher life.

The dangers of excess or deficiency of the other constituents of the air are, indeed, less narrow when named in percentages, but they are scarcely less real in theoretical possibility.

The well-being of life is hemmed in between a suitable proportion of moisture in the air dependent on a competent area of water-surface to supply it, on the one hand, and a diluvial excess of water, on the other. Universal deluges and universal deserts would alike be disastrous. A few thousand feet more of water-depth or a few thousand feet less would alike seriously restrict the class of life to which we belong.

In even a more serious way the habitability of the earth is conditioned on a narrow range of mean temperature—a range, roundly speaking, of 100° Centigrade. This is scarcely 5 per cent. of the range of natural temperatures on the earth, and a still smaller per cent. of the range of temperatures in the heavens. A few miles above us and a few miles below us fatal temperatures prevail. It is profoundly significant that the thermal states of the narrow zone of life on the face of the earth should have been kept within so close variations as to permit the millions of species forming the great genealogical lines leading up from the primitive types to have perpetuated their lineages in unbroken continuity for such ages, while the prevalent temperatures a few miles above them or a few miles below them, as well as in space generally, would have been fatal. While the necessary heat is dependent on the sun, this control of temperature seems to have been intimately related to the atmosphere, and is a further index of its specially critical functions.

To appreciate the full significance of the control of life conditions within these narrow limits when the possibilities were so free and so wide, there is need for some tangible index of the time, but there are at present no means for the close measure of the geologic ages, merely rough estimates of the order of magnitude. Life was far advanced when a readable record first began to be made; but yet, since that record began, at least 100,000 feet of sediments—not to choose the largest estimates—have been laid down by the slow methods of wash from the land and lodgment in the basins. The estimate of the years thus represented has been put variously from 50,000,000 to 100,000,000, with, indeed, higher figures as well as lower. Merely to scale roughly the order of magnitude, and without pretence of accuracy, let us take the midway figure of 75,000,000 years as representative. Let this be divided into fifteen periods of 5,000,000 years each, and these will roughly represent the technical "periods" of geologists. By this rough scale we may space out such of the great events as we need now note.

Slight and changeable excesses of evaporation over precipitation and the reverse prevail widely, but only intense and persistent aridity gives rise to thick deposits of salt, gypsum, and other evaporation products over large areas—with perhaps some exceptions—for in nearly all large natural basins the area that collects rainfall is notably larger than the closed basin within it that alone can retain water for continuous evaporation. It is, therefore, fairly safe to infer clear skies and pronounced aridity when beds of salt and gypsum occur over large areas, especially if accompanied by appropriate physical characters and by such types of life only as tolerate high salinity or show pauperisation, or by a total absence of life.

Now extensive deposits of salt and gypsum are found in the Salt Range of India, in strata of the Cambrian period, the earliest of the fifteen that make up our rough scale of 75,000,000 years. Because these lie so near the beginning of the geologic record, they afford a singularly instructive insight into the conditions of the atmosphere well back toward its primitive state. They challenge at once the view that in those early ages the earth was swaddled by a dense vaporous atmosphere from pole to pole; for under such a vaporous mantle a great desert tract in India would be scarcely credible.

If we come forward in time two periods, to the deposits of the Silurian stage, we find that, underlying the basin of the St. Lawrence in New York and westward, there stretch great sheets of salt and gypsum, many thousand square miles in extent. These beds are accompanied by complete barrenness of life in some parts, by pauperisation of life in other parts, by selections of life according to tolerance of salinity in still other parts, and by harmonious physical characters, all of which combine to add strength to the interpretation. All these imply a degree of aridity approaching desert conditions in what is now the well-watered region of our Great Lakes. These signal facts join those of the Salt Range of India of earlier date in challenging the former conception of a universal envelope of vapour and cloud in all those early times.

In the next period there are formations that have been interpreted as implying desert conditions, but perhaps on less firm grounds, and we pass on to certain stages in the Sub-Carboniferous period next following, wherein beds of salt and gypsum are found in Montana, Michigan, Nova Scotia, and Australia, which imply like climatic conditions. If we pass on to the Permian and Triassic periods, near the middle of the geologic series, beds of salt and gypsum are phenomenally prevalent on both the eastern and western continents, reaching through surprising ranges of latitude. The relative paucity, as well as the peculiar characteristics of the life of those times, seems equally to imply vicissitudes of climate in which scant atmospheric moisture was a dominant feature. There seems no tenable way to interpret these remarkable facts of the middle periods except by assuming an even greater prevalence of aridity than obtains at the present time. So, at times in the later periods, but at times only, the stratigraphic record implies atmospheres as arid as that of to-day, not everywhere, indeed, but in notable areas and in certain horizons.

These and other significant facts of consonant import form one group of phenomena.

If, on the other hand, the record be searched for facts of opposite import, they will come easily to hand. Starting near the beginning of the record, it is even more easy to find stages abounding in evidences of prevailing humidity, of great uniformity of climate, and of most congenial life-conditions reaching through wide ranges of latitude. If we rested on this selection alone, the old view would be abundantly sustained, but the strata bearing evidences of aridity lie between these. Combining the two sets of facts, the conception seems to force itself upon us that from the very earliest stages of the distinct life-record onward, there have been times and places of pronounced aridity much as now, or even more intense, while at other times, intervening between these, more humid and uniform conditions prevailed.

This conception grows in strength as we turn from atmospheric states to prevailing temperatures. The body of scientific men have rarely been more reluctant to accept any interpretation of geologic phenomena than that of recent general glaciation on the lowlands of Europe and America in mid-latitudes when that view was first advanced by Louis Agassiz. With the conception of former pervasive warmth then prevalent, it seemed beyond belief that great sheets of ice could have crept over large portions of the habitable parts of Europe and North America some thousands or tens of thousands of years ago. Belief in this was made easier, however, by the view also then prevalent that the earth had been greatly cooled in the progress of the ages, that the atmosphere had been much depleted by the formation of coal, of carbonates, and of oxides, that the ocean had been reduced by hydration and entrance into the earth, and that thus a stage had been reached that made possible an epoch of depressed temperature and of glaciation. The Ice age, thus theoretically associated, came to be widely regarded as but the first stage in a series of secular winters destined to lead on to the total refrigeration of the earth. This view was abetted by the theory of a cooling sun. The depleting and the cooling processes were regarded as inevitably progressive, and the final doom of the earth as thus foreshadowed in the near future, geologically speaking.

But opinion was scarcely more than adjusted to this view when the geologists of Australia, of India, and of South Africa, severally and independently, and later those of South America, presented evidences of former glaciation over extensive areas in those low latitudes. The typical marks of glaciation were, indeed, traced even up to and a little across the tropical circles from the south, in Australia, and from the north, in India. Moreover, all these were reported from strata of Permian or late Carboniferous times, *i.e.* from the sixth or seventh of the technical "periods." For a score of years the body of geologists, not in immediate contact with the evidence itself, doubted the interpretation, but the growing evidence grew at length to be utterly irrefutable. There seems no rational escape from the conclusion that mantles of ice covered large areas in the peninsula of India, in Australia, in the southern part of Africa, and in South America, close upon the borders of the tropics, at a time roundly half-way back to the beginning of the readable record of life.

On the basis of similar evidence, Strahan and Reusch have announced glacial beds in Norway at a horizon much lower but not closely determinate. Willis and Blackwelder have described glacial deposits of early Cambrian age in the valley of the Yangtse, in China, in latitudes so low as 31°. Howchin and David have described glacial formations of similar age in Australia. In the last two cases the glacial beds lie below the strata that bear the Cambrian trilobites; in other words, they lie at the very bottom of the fossil-bearing sediments, fifteen periods back, or 75,000,000 years ago on our rough scale. Prof. Coleman has offered what he deems good evidence of glaciation much farther back at the base of the Huronian, in Canada, but some scepticism as to its verity has yet to be overcome.[1]

Even more pointedly than the epochs of aridity do these early epochs of glaciation seem incompatible with the view of a hot earth universally wrapped in a vaporous mantle in early times. They favour the alternative view of merely temporary localised intensifications of climate which life was able repeatedly to survive. This seems to warrant the belief that life may survive similar intensifications again and again in the future.

At present polar and alpine glaciation are contemporaneous with aridity. There are reasons for thinking that the past glaciations and aridities were in some similar way correlated, and that they cooperated to give vicissitude to the climates of certain geologic epochs. The known epochs of glaciation, however, are fewer than those of aridity.

On the other hand, at several stages, as already noted, abundant life, bearing all the evidences of a warm-temperate or subtropical character, flourished in high latitudes. In Greenland, Spitsbergen, and other Arctic islands, are found the relics of life not known to be able to live except under conditions of genial warmth. These imply former subtropical conditions where now only frigidity reigns.

In the light of these contrasted climatic states of aridity and glaciation on the one hand, and of uniformity and geniality in high latitudes on the other, intervening between one another, we seem now forced to the conception of profound climatic alternations, extending over the whole stretch of known geologic time. Concurrent with these alternations, there may, perhaps, have been variations in the constitution, as there certainly were in the condition, of the atmosphere.

If we turn to the relations of the waters and the land, an analogous oscillating history presents itself. This was possibly connected causally with the climatic oscillations. At no time in the history recorded by clear geologic testimony is there proof of the absence of land, and certainly at no time is there a hint of the absence of an ocean, whatever theoretic views may be held of the earliest unknown stages.

The progress of inquiry seems to force the conviction that the land area in the earliest stages of good record was quite comparable to that of the present time, both in its extent and in its limitations. Following down the history, the land area seems at certain times to have been larger than now, while at other times it was smaller. There appears to have been an unceasing contest between the agencies that made for the extension of the land and the agencies that made for the extension of the sea. While each gained temporarily on the other, complete victory never rested with either. From near the beginning of the readable record there appears to have been an unbroken continuity of land life, and, from a like early stage, an unbroken continuity of marine life. Probably the history of both goes back unbroken into the undeciphered eras which precede the readable record, and no one to-day can safely affirm the precedence of either over the other, either in time or in genesis, whatever his theoretic leanings may be.

Among the agencies that may be assigned for the extension of the land are those that deform the body of the earth, deepening its basins and drawing off the waters, while other portions are protruded and give renewed relief and extent to the land. Among the agencies that make for the extension of the sea are the girdling of the waves about the borders of the land, and the decay and wash of land surface, which is thus brought low at length and covered by the advancing waters. If the deformation of the earth-body were held in abeyance for an indefinite time, the lowering of the land, the filling of the basins, and the spreading of the sea would submerge the entire land surface and bring an end to all land life. Great progress in such sea-transgressions appears to have been made again and again, until perhaps half the land was submerged, but before land life was entirely cut off, or even very seriously threatened, a regenerative movement in the body of the earth intervened, the land was again extended, and the sea again restricted. Here then, also, there has been a reciprocal movement, which, while it has brought alternate expansions of land life and of sea life, has, notwithstanding, permitted the preservation of both, and thus maintained the continuity of the two great divisions of life.

It appears, thus, that in each of the great groups of terrestrial conditions upon which life is dependent, there has been, through the known ages, vast as they are, an oscillatory movement which has brought profound changes again and again, but has never permitted any of the disasters threatened in these movements to go far enough to compass the universal extinction of life. These reciprocal movements appear to be dependent upon a balancing of the action of agencies that is scarcely less than a law of equilibrium. It is not too much to regard this as a regulative system. A clear insight into the agencies of this regulative system is rather a task of the future than an attainment of the present, and I can only offer tentative hints of what may prove to be its main factors, and beg of you to accept them with due reserve.

The preservation of the land against the incessant encroachments of the waters seems probably due to a periodic deformation of the earth-body dependent on internal dynamics not yet well understood, at least not yet demonstrated to general satisfaction. The body of the earth feeds its atmosphere through volcanic and other means. How far this is merely a return of what has been absorbed earlier it is not prudent here to say, as opinion is not harmonious on this, and the evidence is as yet uncertain. Much depends on the constitution of the earth's interior, and that in turn hinges on its mode of origin. Perhaps it will be agreed generally that feeding from the interior is one of the sources of supply which offsets the depletion of the atmosphere caused by its union with earth substance, in short, that the earth-body gives out as well as takes in atmospheric material. Important or unimportant as this may be, it is not apparent that there is in it any automatic balancing suited to control the delicate adjustments requisite for continuity of life. The ocean acts as an important regulator by alternately absorbing and giving out the atmospheric gases as required by the state of equilibrium between the water and the air. This action is automatic, but has its limitations and peculiarities, and does not seem wholly adequate. If we are able to name such an adequate automatic action at all at present, it probably lies in the molecular activities of the terrestrial and solar atmospheres, and in the relations of these to the gravitative powers of the earth and the sun.

If analysis of the molecular action of the outer atmosphere be pushed to its logical conclusions, it leads to the conception of supplementary atmospheres, in part orbital, filling, in an attenuated way, the whole sphere of the earth's gravitative control. A similar study of the sun's atmosphere suggests a similar supplementary extension, and this extended portion surrounds and embraces the earth's

[1] Later evidence has removed this from many minds, including that of the speaker.

atmosphere. Under the laws of molecular activity these two atmospheres must be interchanging molecules at rates dependent on the conditions of equilibrium between them. It is reasonable that an excess in the earth's atmosphere should cause it to feed out into the sun's sphere of control more than it receives, and that a deficiency in the earth's atmosphere should cause more feeding in from the sun's supplementary atmospheres than the earth gives out. If this conception be true and be efficient, the maintenance of the delicate atmospheric conditions required for the continuity of life is automatically secured. The failure of our atmospheric supply is thus made to hang, not simply on the losses and gains at the earth's surface, but on the solar interchange, and hence on the solar endurance.

The sun is giving forth daily prodigious measures of energy. The endurance of the sun is not, however, merely a question of unrequited loss, for it gains energy and substance daily as well as loses, and, so far as present knowledge goes, its gain is greatly inferior to its loss. So long as the heat of the sun was supposed to be dependent on ordinary chemical changes, or on the fall of meteorites, or on self-contraction, an activity adequate for terrestrial life could only be estimated at a few million years. But recent discoveries in radio-activity have revealed sources of energy of an extremely high order. In the light of these the forecast of the sun's power to energise the activities of the atmosphere dependent on it, and to warm the earth, is raised to an indeterminate order of magnitude.

If we may thus find grounds for a complacent forecast in reciprocal actions on the earth and in reciprocities between the earth and the sun, are we free from impending dangers in the heavens without?

Present knowledge points to one tangible possibility of disaster—collision with some celestial body, or close approach to some sun or other great mass, large enough to bring disaster by its disturbing or disruptive effects. Within the solar system, the harmonies of movement already established are such as to give assurance against mutual disaster for incalculable ages. Comets pursue courses that might, theoretically at least, bring about collision, but do not appear usually to possess masses sufficient to work complete disaster to the life of the earth even should collision occur, whatever local disaster might follow at the point of impact. The motions of the stars, however, lie in diverse directions, and collisions and close approaches between them are theoretically possible, if not probable, or even inevitable. There are also in the heavens nebulæ and other forms of scattered matter, and doubtless also dark bodies, which may likewise offer possibilities of collision. The appearance of new stars flashing out suddenly and then gradually dying away suggests the actual occurrence of such events. It has been even conceived that the close approach of suns is one of the regenerative processes by which old planetary systems are dispersed and new systems are brought into being. One phase of the planetesimal hypothesis is built on this conception, and postulates the close approach of some massive body to our ancestral sun as the source of dispersion of a possible older planetary system, and the generation of the nebulous orbital conditions out of which our present system grew. However this may be, it must be conceded that in collision and close approach lie possibilities, if not probabilities, of ultimate disaster to the solar system and to our earth. But here, as before, the vital question lies in the time element. How imminent is this liability? The distances between stars are so enormous that, though they move diversely, the contingencies of collision or disastrous approach are remote. Nothing but rough computations based on assumptions can be made, but these make disaster to a given sun or system fall, on the average, only once in billions of years. There is no star the nearness of which to us, or the direction of motion of which is such as to threaten the earth at any specific period in the future. There is only the general theoretical possibility or probability. While, therefore, there is to be, with little doubt, an end to the earth as a planet, and while, perhaps, previous to that end conditions inhospitable to life may be reached, the forecast of these contingencies places the event in the indeterminate future. The geologic analogies give fair grounds for anticipating conditions congenial to life for millions or tens of millions of years to come, not to urge the even larger possibilities.

But congeniality of conditions does not ensure actual realisation. There arise at once questions of biological adaptation, of vital tenacity, and of purposeful action. Appeal to the record of the animal races reveals in some cases a marvellous endurance, in others the briefest of records, while the majority fell between the extremes. Many families persisted for millions of years. A long career for man may not, therefore, be denied on historical grounds, neither can it be assured; it is an individual race problem; it is a special case f the problem of the races in the largest sense of the phrase.

But into the problem of human endurance two new factors have entered, the power of definite moral purpose and the resources of research. No previous race has shown clear evidence that it was guided by moral purpose in seeking distant ends. In man such moral purpose has risen to distinctness. As it grows, beyond question it will count in the perpetuity of the race. No doubt it will come to weigh more and more as the resources of destructive pleasure, on the one hand, and of altruistic rectitude, on the other, are increased by human ingenuity. It will become more critical as the growing multiplicity of the race brings upon it, in increasing stress, the distinctive humanistic phases of the struggle for existence now dimly foreshadowed. It will, beyond question, be more fully realised as the survival of the fittest shall render its verdict on what is good and what is evil in this realm of the moral world.

But, to be most efficient, moral purpose needs to be conjoined with the highest intelligence, and herein lies the function of research. None of the earlier races made systematic inquiry into the conditions of life, and sought thereby to extend their careers. What can research do for the extension of the career of man? We are witnesses of what it is beginning to do in rendering the forces of nature subservient to man's control and in giving him command over the maladies of which he has long been the victim. Can it master the secrets of vital endurance, the mysteries of heredity, and all the fundamental physiological processes that condition the longevity of the race? The answer must be left to the future, but I take no risk in affirming that when ethics and research join hands in a broad and earnest endeavour to compass the highest development and the greatest longevity of the race, the era of humanity will really have begun.

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D. Appleton and Co.—The Story of Sugar G. T. Surface, illustrated. *Constable and Co., Ltd.*—Soils and Manures, J. A. Murray. *Duckworth and Co.*—Agricultural Bacteriology, J. Percival, illustrated; and a new edition of Agricultural Botany, J. Percival, illustrated. *The Gresham Publishing Company.*—The Standard Cyclopedia of Modern Agriculture and Rural Economy, vols. viii. to xii., illustrated. *Macmillan and Co., Ltd.*—Barthel's Method for the Examination of Milk and Milk Products, translated by W. Goodwin; Improvement of Wheat and other Cereals, Prof. R. H. Biffen.

Anthropology.

Macmillan and Co., Ltd.—Totemism and Exogamy: a Treatise on certain Ancient Forms of Superstition and Society, Dr. J. G. Frazer, with maps, 4 vols. *Methuen and Co.*—The Negro in the New World, Sir H. H. Johnston, illustrated. *Milner and Co., Ltd.*—Prehistoric Man, J. McCabe, illustrated. *Swan Sonnenschein and Co., Ltd.*—Bushman Folk-lore, L. C. Lloyd, edited by Dr. G. M. Theal, illustrated; History and Ethnography of South Africa before 1795, Dr. G. M. Theal, vol. iii., the Dutch Portuguese, Hottentots and Bantu to September, 1795.

Biology.

John Bale, Sons and Danielsson, Ltd.—Lectures on Biology, Dr. C. Thesing, new edition, illustrated. *G. Bell and Sons.*—The Care of Trees in Lawn, Street and Park, B. E. Fernow, illustrated. *W. Blackwood and Sons.*—The Sovereignty of the Sea, Dr. T. W. Fulton, illustrated. *R. Culley.*—In Nature's Nursery: a Book of Nature-study for Beginners, Rev. S. N. Sedgwick; The Young Fisher-man, W. J. Claxton. *J. M. Dent and Sons, Ltd.*—Physiology, Prof. C. S. Sherrington, F.R.S.; Zoology, Prof. W. A. Herdman, F.R.S. *Duckworth and Co.*—Diseases of Cultivated Plants and Trees, G. Massee, illustrated; The Scientific Feeding of Animals, Prof. O. Kellner, translated; Eton Nature-study, illustrated, two parts in one volume. *G. Fischer (Jena).*—Oegopsiden, Chun (Ergebnisse der Tiefsee-Expedition); Dunkelfeldbeleuchtung und Ultramikroskopie in der Biologie und in der Medizin, Gaidukov; Lehrbuch der Entwicklungsgeschichte, Hertwig, new edition; Fleischvergiftung, Hübener; Leitfaden für das zoolog. Praktikum, Kükenthal, new edition; Flora, Potonié, new edition. *Friedländer and Son (Berlin).*—A Manual Flora of Egypt, Dr. R. Muschler; Die Vogel der palaeark. Flora, Dr. E. Hartert, part vi.; Fauna und Flora des Golfes von Neapel, J. Wilhelmi, illustrated; Fauna des Deutschen Kolonien, iii., Deutsch-Ostafrika, Heft 2, Dr. Sternfeld; Résultats des Campagnes scientifiques d'Albert I. de Monaco, fasc. xxxiv., R. Koehler, Echinodermes proven. d. Camp. du Yacht *Princesse Alice*, illustrated; Archivum Zoologicum, edited by Hungarian zoologists, vol. i. *W. Heinemann.*—Wild Flowers of the British Isles, H. I. Adams, vol. ii., illustrated; The American Flower Garden, N. Blanchan, illustrated. *Hutchinson and Co.*—Eggs and Nests of British Birds, F. Finn, illustrated; Our British Trees and How to Know Them, F. G. Heath, illustrated. *T. C. and E. C. Jack.*—Present-day Gardening, edited by R. H. Pearson, illustrated; Pansies, Violas, and Violets, W. Cuthbertson; Sweet Peas, H. J. Wright; Roses, H. E. Molyneux; Rhododendrons and Azaleas, W. Watson; Carnations and Pinks, T. H. Cook, J. Douglas, and J. F. M'Leod; Lilies, A. Grove; Orchids, J. O'Brien; Root and Stem Vegetables, A. Dean; and volumes on Daffodils, Annuals, Apples and Pears, Cucumbers, Melons, Tomatoes. *John Lane.*—Indian Birds, D. Dewar; The Book of the Flower Show, C. H. Curtis. *T. Werner Laurie.*—Round the Zoo: an Account of its Animals and Birds, W. J. Roberts, illustrated. *Macmillan and Co., Ltd.*—Studies in Protozoology, Prof. E. A. Minchin; Tillers of the Ground, Dr. Marion I. Newbigin, illustrated; Threads in the Web of Life, Prof. J. Arthur Thomson and Margaret R. Thomson, illustrated. *Methuen and Co.*—The Laws of Heredity, Archdall Reid; Bird Life, W. P. Pycraft, with an introduction by Sir Ray Lankester, K.C.B., F.R.S., illustrated; Preliminary Physiology, W. Narramore. *Kegan Paul and Co., Ltd.*—The Evolution of Purposive Living Matter, N. C. Macnamara; Mutation Theory, Prof. H. de Vries, translated by Prof. Farmer, F.R.S., and A. D. Darbishire, vol. ii., illustrated. *G. Philip and Son, Ltd.*—A Primer of School Gardening, M. Agar, illustrated. *Sir I. Pitman and Sons, Ltd.*—Selborne Nature Readers: Junior Book, Ways and Talks, C. G. Kiddell, illustrated; In the Garden, J. E. Feasey, illustrated; Chats with the Chicks, Mrs. A. L. Sandford. *G. Routledge and Sons, Ltd.*—Modern Development of the Dry Fly, F. M. Halford, illustrated. *The S.P.C.K.*—British Birds' Eggs, with twenty coloured plates by A. F. and C. Lydon. This book, though complete in itself, is meant to supplement Dr. Bowdler Sharpe's "Sketch Book of British Birds." The drawings of the eggs were made from specimens in the Natural History Museum, South Kensington. *Swan Sonnenschein and Co., Ltd.*—Plant Life: a Manual of Botany for Schools, Prof. W. Warming, translated by M. Rehling and E. M. Thomas; and new editions of Handbook of Mosses, J. E. Bagnall, and Life by the Sea Shore, Dr. M. I. Newbigin, illustrated. *The University Tutorial Press, Ltd.*—Aims and Methods of Nature-study, Dr. J. Rennie. *Williams and Norgate.*—Super Organic Evolution, E. Lluria, translated, illustrated.

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ENGINEERING.

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Geology.

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Medical Science.

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Metallurgy.

Longmans and Co.—Metallography, Dr. C. H. Desch.

Technology.

Constable and Co., Ltd.—Textiles, A. F. Barker; Foreign and Colonial Patent Laws, W. C. Fairweather; Waterproofing: an Engineering Problem, M. H. Lewis. *C. Griffin and Co., Ltd.*—Ceramic Literature: Compiled, Classified, and Described, M. L. Solon. *Crosby Lockwood and Son.*—Drying Machinery and Practice: a Handbook on the Theory and Practice of Drying and Desiccating, with Classified Description of Installations, Machinery, and Apparatus, including also a Glossary of Technical Terms and Bibliography, T. G. Marlow, illustrated. *Methuen and Co.*—A Woodwork Class-book: Beginners' Course, H. Hey and G. H. Rose, illustrated. *Oxford University Press.*—The Theory and Practice of Perspective, G. A. Storey; Traditional Methods of Pattern Designing, A. H. Christie. *Williams and Norgate.*—Beet-sugar Making and its Chemical Control, Y. Nakaido, illustrated.

Miscellaneous.

D. Appleton and Co.—Psychology and the Teacher, Prof. H. Munsterberg. *E. Arnold.*—Book-keeping and Accounting, M. W. Jenkinson. *Chatto and Windus.*—A History of Babylonia and Assyria from Prehistoric Times to the Persian Conquest, L. W. King, illustrated; vol. i., A History of Sumer and Akkad: an Account of the Early Races of Babylonia from Prehistoric Times to about B.C. 2000; vol. ii., History of Babylon from the Foundation of the Monarchy, about B.C. 2000, until the Conquest of Babylon by Cyrus, B.C. 539; vol. iii., A History of Assyria from the Earliest Period until the Fall of Nineveh before the Medes, B.C. 606. *The Gresham Publishing Company.* —Science in Modern Life, vols. v. and vi., illustrated. *C. Griffin and Co., Ltd.*—Modern Methods of Sewage Disposal, G. B. Kershaw, illustrated; Introduction to the Theory of Statistics, G. U. Yule, with diagrams. *Crosby Lockwood and Son.*—The Valuation of Mineral Properties, T. A. O'Donahue. *Longmans and Co.*—A History of the Cavendish Laboratory, Cambridge. This volume is intended to commemorate the twenty-fifth anniversary of the election of Sir J. J. Thomson to the Cavendish professorship of experimental physics. Among the contributors are the President of Queens' College, Dr. Schuster, W. C. D. Whetham, Dr. R. T. Glazebrook, Sir J. J. Thomson, Prof. H. F. Newall, Norman Campbell, Prof. E. Rutherford, C. T. R. Wilson, and Prof. Wilberforce. The final chapter of the book will be devoted to a bibliography and biography of those who have done research work at the laboratory since its foundation. *Macmillan and Co., Ltd.*—Tennyson as a Student and Poet of Nature, Sir Norman Lockyer, K.C.B., F.R.S., and Winifred L. Lockyer. *Oxford University Press.*—Chinese Pottery and Porcelain, a translation of the Tao Shuo, with introduction, &c., by S. W. Bushell. *G. Routledge and Sons, Ltd.*—Sonnenschein's Best Books, new edition, in three parts. *Swan Sonnenschein and Co., Ltd.*—Hegel's Phenomenology of Mind, translated by J. B. Baillie, 2 vols.; Thought and Things: a Study of the Development and Meaning of Thought or Genetic Logic, Prof. J. M. Baldwin, in 3 vols., vol. iii., Real Logic; Time and Free Will: an Essay on the Immediate Data of Consciousness, Prof. Bergson, translated by F. L. Pogson; Physiological Psychology, Prof. W. Wundt, a translation of the fifth and wholly re-written German edition by Prof. E. B. Titchener, in 3 vols., vol. ii. *Truslove and Hanson, Ltd.*—Oriental Silverwork, H. Ling Roth, illustrated. *The University Tutorial Press, Ltd.*—Hygiene for Training Colleges, Dr. R. A. Lyster.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The Huxley lecture this year is to be delivered by Prof. Percy Gardner, Lincoln and Merton professor of classical archæology in the University of Oxford.

Mr. Joseph Coates has been appointed to a demonstratorship in chemistry, and Mr. R. H. Whitehouse assistant, in the Day Training College for Men.

CAMBRIDGE.—The next combined examination for sixty-seven entrance scholarships and a large number of exhibitions at Pembroke, Gonville and Caius, King's, Jesus, Christ's, St. John's, and Emmanuel Colleges will be held on Tuesday, December 6, and following days. Mathematics, classics, and natural sciences will be the subjects of examination at all the above-mentioned colleges. Most of the colleges allow candidates who intend to study mechanical sciences to compete for scholarships and exhibitions by taking the papers set in mathematics or natural sciences. A candidate for a scholarship or exhibition at any of the seven colleges must not be more than nineteen years of age on October 1, 1910. Forms of application for admission to the examination at the respective colleges may be obtained as follows:—Pembroke College, W. S. Hadley; Gonville and Caius College, the Master; King's College, W. H. Macaulay; Jesus College, A. Gray; Christ's College, Rev. J. W. Cartmell; St. John's College, the Master; Emmanuel College, the Master, from any of whom further information respecting the scholarships and other matters connected with the several colleges may be obtained.

OXFORD.—The University Junior Scientific Club will hold its triennial conversazione on Tuesday, May 24, being the Tuesday in "Eights Week." Members of the club can obtain tickets on application to Mr. N. T. Huxley, Balliol College. The promise of exhibits from members will be gratefully welcomed by Mr. A. F. Coventry, Magdalen College, on behalf of the committee. It is hoped that many old members of the club will take the opportunity of re-visiting the scientific departments of the University.

THE late Mr. E. S. Massey, of Rochdale, among many other bequests, has left 6800*l.*, free of duty, to the University of Manchester. The residue of his property, amounting to about 110,000*l.*, after the bequests are provided for, is left upon trust to be applied for such charitable purposes for the benefit of the inhabitants of Burnley as the Corporation of Burnley shall determine, but so that such purposes be limited to all or one or more of the following objects, and be not by way of reduction of rates:—education, whether mental, physical, technical, or artistic, the advancement of science, learning, music, or other art.

AN effort is being made to found a National Industrial Education League to emphasise the necessity of making elementary education go hand in hand with industrial training. In view of the general consensus of opinion as to the necessity for the formation of such a league, a national conference is to be called at an early date for the purpose of formulating a scheme for carrying out the objects of the league. In addition to the approval of many other associations of workers, no fewer than 88 trades' councils, together representing 334 towns and 299 trades, have given their adhesion, and the London Chamber of Commerce recently passed unanimously the following resolution:—"That the council of the chamber approve, heartily support, and will give all their assistance to the proposed National Industrial Education League." Anyone anxious to take part in the work of the new league should communicate with Mr. R. Applegarth, Central Offices, Craig's Court House, Charing Cross, London.

MR. W. H. LEVER, who was appointed recently chairman of the Liverpool School of Tropical Medicine, in succession to the late Sir Alfred Jones, has made known to the council and professors of the University of Liverpool the particulars of a munificent scheme he has devised to assist the work of the University. He proposes to devote the sum of 91,000*l.* to the scheme. Arrangements have been made with the owners of the old Bluecoat School for a lease for a number of years. During that period the University can have the option of purchasing the school for a sum, approximately, of 24,000*l.* Any time when the University exercises that option Mr. Lever will pay the money, and the school will be furnished. If the building is not found suitable, then he will pay 24,000*l.* for the erection of a building adjoining the University, in which the School of House and Town Planning can be accommodated, and also the School of Architecture. While the University is considering whether the option shall be exercised, Mr. Lever will pay the rent of the school. To provide money for the School of House and Town Planning, the School of Tropical Medicine, and the School of Russian Studies, Mr. Lever proposes to transfer 60,000*l.* worth of shares in the Bromboro' Port Estate Company to the University. These shares will in future years be a source of great income to the University. While the shares are not paying a dividend, Mr. Lever has arranged for ten years to guarantee 3 per cent. on the 60,000*l.*, which will make 1800*l.* a year for ten years. With the consent of the University, of this 1800*l.* a year 800*l.* will go to the School of Civic Design, 800*l.* to the School of Tropical Medicine, and 200*l.* to the School of Russian Studies.

ON Friday last, March 4, the Chancellor of the Exchequer, with whom were Mr. Haldane and Mr. Runciman, received in his private room at the House of Commons a deputation from various universities on the subject of increased financial assistance. A news agency states that the deputation represented all the universities and university colleges in England, excepting Oxford, Cambridge, and Durham. The proceedings were private, but the *Times* gives the following account of the points brought forward by the deputation. It was urged that money is greatly needed for development purposes. The Treasury grants, so far from cutting off local subscriptions, municipal and private, have encouraged them, local people feeling that the institutions are recognised by the Government and regarded as a national concern to which they may well contribute. Every new chair established and every new building put up means extra expense for maintenance, and the deputation urged that, while it is quite possible to get the locality to provide buildings and equipment, it cannot provide maintenance. Many localities feel they have done all they can, and they also feel they are not merely doing local work, but national and Imperial, indeed, world-wide work. Students are drawn from every part of the Empire and from foreign countries, particularly China and Japan, and they are under no obligation to give their services where they are trained. Any increased grant now given by the nation will be used, not in the fixed and ordinary work of the institutions, but in the highest class of work and in various enterprises that are being kept back for want of funds. The speakers also pointed out that there is under present conditions a certain amount of wastefulness, not in money, but in brains and energy, because at their meetings the authorities are generally occupied, not in discussing how best to spend the money and what undertakings will be best for the country, but merely how to economise their funds and how to save 10*l.* or 50*l.* Work is lying ready at hand which they are powerless to undertake. Mr. Lloyd George, in the course of a sympathetic reply, told the deputation they could not have come at a worse time. Nothing definite was settled, but a committee has been appointed by the deputation to prepare more detailed information for the Chancellor of the Exchequer as to the financial requirements of the various institutions.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 27.—Sir James **Dewar**: Long-period determination of the rate of production of helium from radium. In a previous communication the rate of the production of helium from 70 milligrams of radium chloride was determined by a succession of observations on the growth of pressure measured by a McLeod gauge. These observations extended over a period of about six weeks. It was thought desirable to make an experiment to determine the amount of helium resulting from this same sample of radium, after standing in a sealed bulb for an extended period. For this purpose the bulb containing the radium chloride was sealed off at the conclusion of the above-mentioned experiment of 1908 and kept for nine months. In order to measure the helium thus produced it was necessary to devise a vacuum-tight joint between the sealed radium bulb and a McLeod gauge so constructed that, after thoroughly exhausting the gauge, the drawn-out end of the radium bulb could be broken off, thus allowing the pressure of the accumulated helium in the radium bulb to be rapidly determined. The total volume of the apparatus was 320 c.c. The pressure in the radium bulb when sealed off at the conclusion of first experiment was 0·00406 mm., the partial pressure due to this amount of helium would be 0·00008 mm., which must be deducted from the observed pressure to get the true pressure due to the helium produced in the radium bulb during the period in which it remained sealed up; also the pressure in the gauge, before breaking (0·00005 mm.), must also be deducted. This gives a corrected pressure of 0·01613 mm., obtained after heating the salt, due to the helium produced from 70 milligrams of pure radium chloride during a period of 275 days, in a space the total volume of which was 320 c.c. The value of the rate in terms of cubic millimetres of helium per gram of radium per day is thus deduced as 0·463.

March 3.—Sir Archibald Geikie, K.C.B., president, in the chair.—T. G. **Bedford**: The depression of freezing point in very dilute aqueous solutions.—J. **Mercer**: Sturm-Liouville series of normal functions in the theory of integral equations. It is the purpose of this memoir to develop the theory of Sturm-Liouville series of normal functions as a branch of the theory of integral equations. In the first place, two theorems are established relative to the series

$$\psi_1(s)\int_a^b \psi_1(t)f(t)dt + \psi_2(s)\int_a^b \psi_2(t)f(t)dt + \ldots$$
$$\ldots + \psi_n(s)\int_a^b \psi_n(t)f(t)dt + \ldots,$$

in which $\psi_1(s)$, $\psi_2(s)$, . . ., $\psi_n(s)$, . . . are a complete system of normal functions corresponding to a function $(K(s, t))$ of positive type in the square Q defined by $a \leq s \leq b$, $a \leq t \leq b$: the normal functions are assumed to have such an order that the singular value corresponding to $\psi_n(s)$ does not decrease as n increases: no restriction is placed upon $f(s)$ beyond that it should have a Lebesgue integral in (a, b). Denoting by $K_\lambda(s, t)$ the solving function corresponding to $K(s, t)$, the first theorem is to the effect that the upper and lower limits of indeterminacy of the above series include

$$\overline{\underline{\lim_{\lambda \to -\infty}}} - \lambda \int_a^b K_\lambda(s, t)f(t)dt$$

between them. According to the second

$$\lim_{\lambda \to -\infty} - \lambda \int_{(Q)} K_\lambda(s, t)f(s)f(t)\,(ds\,dt)$$

exists and is equal to the sum of the series

$$\left[\int_a^b \psi_1(t)f(t)dt\right]^2 + \left[\int_a^b \psi_2(t)f(t)dt\right]^2 + \ldots$$
$$\ldots + \left[\int_a^b \psi_n(t)f(t)dt\right]^2 + \ldots,$$

when the latter is convergent; whilst the limit is $+\infty$, when the series is divergent. It is then shown that, when $K(s, t)$ is the Green's function of

$$\frac{d^2u}{ds^2} + q(s)u = 0$$

satisfying a pair of boundary conditions at the end points of $(0, \pi)$, an asymptotic formula for $K_\lambda(s, t)$ exists which permits the deduction of important theorems relative to the canonical Sturm-Liouville series

$$\psi_1(s)\int_0^\pi \psi_1(t)f(t)dt + \psi_2(s)\int_0^\pi \psi_2(t)f(t)dt + \ldots$$
$$\ldots + \psi_n(s)\int_0^\pi \psi_n(t)f(t)dt + \ldots$$

The normal functions $\psi_1(s)$, $\psi_2(s)$, . . ., $\psi_n(s)$, . . . are now solutions of

$$\frac{d^2u}{ds^2} + (q(s) + \lambda)u = 0,$$

which, for suitable values of λ, satisfy the same pair of boundary conditions as $K(s, t)$; to particular systems of these functions correspond Fourier's sine and cosine series. The results obtained for *any* canonical Sturm-Liouville series are very similar to, but slightly more general than, those for the two *particular* series which are associated with the names of Fejér, Hurwitz, and Lebesgue. The fourth section of the memoir is devoted to an investigation of the convergence of canonical Sturm-Liouville series. In the course of this, it is shown that the convergence of any one of these series at a point of the open interval $(0, \pi)$ involves the convergence of all the other series which correspond to the same function $f(s)$. The memoir contains an extension of all results obtained for the canonical to the most general type of Sturm-Liouville series.—A. **Von Antropoff**: The solubility of xenon, krypton, argon, neon, and helium in water.—L. N. G. **Filon**: Measurements of the absolute indices of refraction in strained glass. If light be transmitted through a slab of glass under tension T in a direction perpendicular to the line of stress, it is broken up into two components, polarised in planes perpendicular and parallel to the line of stress. If μ be the index of refraction of the glass in the unstrained state, then, in the strained state, the indices of refraction corresponding to the above two components are $\mu + C_1T$, $\mu + C_2T$ respectively. The coefficients C_1, C_2 are spoken of as the stress-optical coefficients for the two rays. The present paper gives an account of measurements of C_1 and C_2 according to a method described by the author in Roy. Soc. Proc., A, vol. lxxix., pp. 440–2. The measurements have been carried out on two Jena glasses bearing catalogue Nos. O. 935 and VV. 3199 respectively, the first being a borosilicate, the second an "ultra-violet" glass. So far as is known, this is the first series of absolute measurements of C_1 and C_2 extending fairly continuously throughout the spectrum. The only previous measurements are due to Pockel (*Ann. d. Phys.*, 1902), and give the values of C_1 and C_2 for the sodium, thallium, and lithium lines only, obtained by quite a different method. The coefficients C_1, C_2 are found to be negative, so that both rays are accelerated by tension, but the effect is much larger for C_2, *i.e.* for the ray polarised in the direction of stress. With regard to the dispersion in O. 935, both C_1 and C_2 show a slight general decrease as we move towards the violet, but in VV. 3199, C_1 shows a decrease, whereas C_2 shows an increase. The above general variation is broken by a number of local oscillations, some of which are well marked and confirm previous observations of $\{C_1 - C_2\}$ (Phil. Trans., A, vol. ccvii., pp. 293–301), whilst others are more doubtful; but it seems probable that both indices of refraction due to stress are affected locally by free periods of the constituents of the glass, causing irregularities in the curves of C_1 and C_2 similar to those exhibited by the curve of the index of refraction in anomalous dispersion.

Royal Microscopical Society, February 16.—Prof. J. A. Thomson, president, in the chair.—Prof. J. A. **Thomson**: Notes on *Dendrobrachia fallax*, a rare and divergent antipatharian.—A. A. C. E. **Merlin**: The measurement of the first nine groups of Grayson's finest twelve-band plate.—F. H. **Collins**: The labelling of microscopic slides.

CAMBRIDGE.

Philosophical Society, February 7.—Prof. W. Bateson, F.R.S., president, in the chair.—E. A. Newell **Arber**: A note on some fossil plants from Newfoundland. Two new records from Newfoundland, either of Lower Carboniferous or Upper Devonian age. The first appears to be *Sphenophyllum tenerrimum*, Stur., both leaf whorls and stems being preserved. The second is a large fan-shaped leaf, probably new specifically, which recalls the Palæozoic fossils attributed to the genus Psygmophyllum.—W. T. **Gordon**: The relation between the fossil Osmundaceæ and the Zygopterideæ. The members of the Zygopterideæ and Osmundaceæ are shown to exhibit parallel development, and their most primitive genera, *Zygopteris Römeri*, Solms, and *Thamnopteris Schlechtendalii*, Eichwald, respectively, are compared as regards the structure of the stem and the origin of the petiole to demonstrate an ancestral relationship between these groups.—W. T. **Gordon**: A new species of Physostoma from the Lower Carboniferous of Pettycur (Fife). A new seed, showing a number of tentacular processes at the apex and an outer coat studded with small peg-like hairs. This is the most ancient example of the genus known.—Mrs. E. A. Newell **Arber**: A note on *Cardiocarpon compressum*, Will. The results of a re-examination of a Coal-measure seed originally figured and described by Williamson in 1877 under the name of *Cardiocarpon compressum*.—H. Hamshaw **Thomas**: The assimilating tissues of certain Coal-measure plants. Some points in the structure of the leaves of Calamites, Lepidophloios, and other Coal-measure plants from the point of view of their physiological anatomy.—L. J. **Wills**: Notes on the genus Schizoneura, Schimper and Mougeot. A description of examples of *Schizoneura paradoxa*, S. and M., recently discovered in the Keuper of Bromsgrove (Worcestershire), and a comparative review of other members of the genus.—R. D. **Vernon**: The occurrence of *Schizoneura paradoxa*, S. and M., in the Bunter of Nottingham.—D. G. **Lillie**: Petrified plant remains from the Upper Coal-measures of Bristol. Petrified material of Cordaites and other allied genera, and also of Myeloxylon, has been obtained from the Upper Coal-measures of Staple Hill, Bristol.

MANCHESTER.

Literary and Philosophical Society, January 25.—Mr. Francis Jones, president, in the chair.—Prof. W. W. H. **Gee** and F. **Brotherton**: The electrical resistance of the human body. Measurements have been made with direct and alternating currents, the hands of the subject being as a rule immersed in solutions of common salt. Values of the resistance in the first case are from 1000–2000 ohms, but only from 700–800 ohms with alternating currents. The high values in the first case are due to polarisation, the human body acting like a storage battery made up of concentration cells. When a direct current is applied to the body the current falls for a time and then increases, there being a gradual increase of polarisation during the first period, and a decrease of the body resistance during the second period. The maximum voltage for direct currents used in the experiments was about 40, which mut be gradually introduced, and very gradually withdrawn, otherwise painful shocks are administered. It was found that the resistance is inversely proportional to the area of the surface of the wet skin. The ratio of the direct to the alternating values of the resistance is much higher when dry or nearly dry skin is tested. With the dry fingers applied to 100-volt direct current terminals the shock at the kathode is greater than at the anode, and enables the polarity of the terminals to be readily determined. With nearly dry fingers it is also easy to test polarities of circuits of less than 20 volts. This method is useful in practice. With about 10 volts and the fingers immersed in salt solutions containing metal electrodes, the body can be used as a telegraphic receiving instrument, the shocks at the kathode as the current is reversed by a transmitting commutator enabling messages to be received by the usual code. The resistance of the body being relatively low when the skin is moist, precautions must be taken in using supply circuits, especially in chemical and other works. Electric-light fittings in bathrooms, public baths, and medical baths require special precautions.

February 8.—Mr. Francis Jones, president, in the chair.—G. **Hickling**: The anatomy of *Calamostachys Binneyana*, Schimper. It was shown that the so-called "nodes" at which the sporangiophores arise are not true nodes. There is no secondary xylem at that level, the protoxylem canals are not obliterated, no "gaps" are seen in the cauline bundles, and the medulla is not modified as at the true node. The slender vascular traces supplying the sporangiophores may be arched before entering them. Below the sporangiophore the traces may occasionally be seen lying on either side of the corresponding cauline bundle, often freed from it by maceration. There is considerable evidence to show that the sporangiophore trace preserves its identity down to the subjacent true node. The axes, which are commonly described as possessing six bundles in three pairs, are shown to possess only three single bundles. Both three and four bundles are proved by serial sections to characterise different parts of the same cone. There is some evidence that the alternation of the bracts has been brought about by their lateral displacement. It was shown to be possible to obtain good series of sections by grinding the blocks containing the material and taking photomicrographs of the successively exposed surfaces.—L. E. **Adams**: A hypothesis as to the cause of the autumnal epidemic of the common and the lesser shrew. The fact that more corpses of shrews are found in autumn than during the other seasons of the year has been a standing puzzle to naturalists, and no wholly satisfactory explanation has hitherto been suggested. The known agencies of destruction, such as conflicts among themselves, attacks of enemies, scarcity of food, and drought, whilst resulting in many deaths, fail to account for the sudden rise in mortality during the autumn. The author, as the result of observations and investigations carried out during a number of years, is decidedly of the opinion that the autumnal "epidemic," as it is called, is due to nothing more than old age, old age in the case of the common and the lesser shrew being reached in, roughly, thirteen or fourteen months. This conclusion is supported by the fact that all specimens of the common and lesser shrew trapped during and after December in a series of years were found to be immature. This hypothesis would account also for the absence of wounds and other marks of violence in many of the corpses found.

Royal Meteorological Society, February 23.—Mr. H. Mellish, president, in the chair.—Dr. W. **Makower**, A. J. **Makower**, and Miss M. **White**: Investigation of the electrical state of the upper atmosphere made at the Howard Estate Observatory, Glossop.—A. W. **Harwood**: The results of twenty-five registering balloon ascents made from Manchester on June 2–3 last. These were sent up at intervals of one hour, and some extremely interesting and valuable results were obtained from them.—R. G. K. **Lempfert** and R. **Corless**: Line squalls and associated phenomena.

DIARY OF SOCIETIES.

THURSDAY, MARCH 10.

ROYAL SOCIETY, at 4.30.—The Causes of the Absorption of Oxygen by the Lungs (Preliminary Communication): C. Gordon Douglas and Dr. J. S. Haldane, F.R.S.—The Action of Nicotine and other Pyridine Bases upon Muscle: Dr. V. H. Veley, F.R.S., and Dr. A. D. Waller, F.R.S.—Studies on Enzyme Action. XIII: Enzymes of the Emulsin Type: Prof. H. E. Armstrong, F.R.S., and E. Horton.—Preliminary Note on the Origin of the Hydrochloric Acid in the Gastric Tubules: Miss M. P. Fitzgerald.—The Extinction of Sound in a Viscous Atmosphere by Small Obstacles of Cylindrical and Spherical Form: C. J. T. Sewell.—The Ionisation of Various Gases by the β-Rays of Actinium: Dr. R. D. Kleeman.

MATHEMATICAL SOCIETY, at 5.30.—Forms for the Remainder in the Euler-Maclaurin Sum-formula: W. F. Sheppard.—The Scattering of Light by a Large Conducting Sphere: J. W. Nicholson.—The 3-3 Birational Space Transformation: Miss H. P. Hudson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Short Circuiting of Large Electric Generators and the Resulting Forces on Armature Windings; The Design of Turbo Field Magnets for A.C. Generators with Special Reference to Large Units at High Speeds: Miles Walker.

ROYAL SOCIETY OF ARTS, at 4.30.—Indian State Forestry: Saint-Hill Eardley-Wilmot.

FRIDAY, MARCH 11.

ROYAL INSTITUTION, at 9.—Ionisation of Gases and Chemical Change: Dr. H. Brereton Baker, F.R.S.

PHYSICAL SOCIETY, at 8.—On Coherers: Dr. W. H. Eccles.—Earth-air Electric Currents: Dr. G. C. Simpson.—An Automatic Toepler Pump designed to Collect the Gas from the Apparatus being Exhausted: Dr. B. D. Steele.

MALACOLOGICAL SOCIETY, at 8.—Pleistocene, Holocene, and Recent Non-marine Mollusca from Mallorca. Marine Shells from Alcudia, Mallorca: Rev. R. Ashington Bullen.—Classification of the Gastropoda: R. J. Lechmere Guppy.—On the Occurrence in England of *Valvata macrostoma*, Steen: A. S. Kennard and A. W. Stelfox.—Description of a New Species of Helicodonta from Spain: G. K. Gude.

ROYAL ASTRONOMICAL SOCIETY, at 5.—On the Determination of Cœlostat Errors: E. B. H. Wade and H. E. Hurst.—(1) Note on Star Colour Nomenclature; (2) Corrections to Colour-spectrum Discordances: W. S. Franks.—Encke's Comet, 1895–1908: O. Backlund.—(1) Meteoric Fireball of 1910, Feb. 17; (2) Meteoric Fireball of 1910, Feb. 28: W. F. Denning.—Measures of Double Stars made at the Royal Observatory, Edinburgh: Royal Observatory, Edinburgh.—*Probable Papers*: On the Systematic Motions of the Stars derived from the Cross Proper Motions of the Bradley Stars: Prof. F. W. Dyson.—The Envelopes of Comet Morehouse (*c*1908): A. S. Eddington.—Notes on Comet *a*1910: Rev. A. L. Cortie.

SATURDAY, MARCH 12.

ROYAL INSTITUTION, at 3.—Electric Waves and the Electromagnetic Theory of Light: Sir J. J. Thomson, F.R.S.

MONDAY, MARCH 14.

ROYAL SOCIETY OF ARTS, at 8.—The Art and History of British Lead Work: L. Weaver.

TUESDAY, MARCH 15.

ROYAL INSTITUTION, at 3.—The Emotions and their Expression: Prof. F. W. Mott, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—A Contribution to the Skeletal Anatomy of *Chlamydoselachus anguineus*, Garman: T. Goodey.—On the Variation of the Sea-elephants: Prof. Einar Lönnberg.—On the Alimentary Tract of certain Birds, and on the Mesenteric Relations of the Intestinal Loops: F. E. Beddard, F.R.S.

MINERALOGICAL SOCIETY, at 5.30.—A New Form of Petrological Microscope, with Notes on the Illumination of Microscopic Objects: G. W. Grabham.—On Datolite from the Lizard District: W. F. P. McLintock.—A Suggested Modification of Stereographic Projection: Dr. J. W. Evans.—Exhibit of Models illustrating the Space-lattices and Sohncke's Regular Point-systems: Prof. H. L. Bowman.

ROYAL STATISTICAL SOCIETY, at 5.—Notes on the Financial System of the German Empire: Wynnard Hooper.—The Increased Yield per Acre of Wheat in England considered in Relation to the Decreased Acreage: H. D. Vigor.

ILLUMINATING ENGINEERING SOCIETY, at 8.—Discussion on the Measurement of Light and Illumination.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Birmingham Sewage-disposal Works: J. D. Watson.—Salisbury Drainage: W. J. E. Binnie.

WEDNESDAY, MARCH 16.

ROYAL SOCIETY OF ARTS, at 8.—The Foundations of Stained Glass Work: Noel Heaton.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Antipatharians from the Indian Ocean: Miss S. B. M. Summers.—(1) On the Visibility of the Tertiaries of *Coscinodiscus asteromphalus* in a Balsam Mount; (2) Critical Microscopy: E. M. Nelson.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Climatic Influences in Egypt and the Sudan: Captain H. G. Lyons, F.R.S.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, MARCH 17.

ROYAL SOCIETY, at 4.30.—*Bakerian Lecture*: The Pressure of Light against the Source: the Recoil from Light: Prof. J. H. Poynting, F.R.S., and Dr. Guy Barlow.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Further discussion*: (1) Short Circuiting of Large Electric Generators and the Resulting Forces on Armature Windings; (2) The Design of Turbo Field Magnets for A.C. Generators with Special Reference to Large Units at High Speeds: Miles Walker.

INSTITUTION OF MINING AND METALLURGY, at 8.—Annual Meeting.

LINNEAN SOCIETY, at 8.—The Life-history of *Chermes himalayensis*, Steb., on the Spruce, *Picea morinda*, and Silver Fir, *Abies Webbiana*: E. P. Stebbing.—A Contribution toward a Knowledge of the Neotropical Thysanoptera: R. S. Bagnall.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Compounding and Superheating in Horwich Locomotives: G. Hughes.

FRIDAY, MARCH 18.

ROYAL INSTITUTION, at 9.—The Dynamics of a Golf Ball: Sir J. J. Thomson: F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction of Warships: N. Maas.

SATURDAY, MARCH 19.

ROYAL INSTITUTION, at 3.—Electric Waves and the Electromagnetic Theory of Light: Sir J. J. Thomson, F.R.S.

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