THURSDAY, OCTOBER 31, 1912.

THEORIES OF SOLUTIONS.

Theories of Solutions. By Svante Arrhenius. Pp. xx + 247. (New Haven: Yale University Press; London: Oxford University Press, 1912.) Price 12*s*. 6*d*. net.

THE publication of Prof. Arrhenius's Silliman lectures on "Theories of Solutions," delivered at Yale in the spring of 1911, will be welcomed by all who are interested in the present position of physical chemistry. The book is of special value because the author has dealt very lightly with those aspects of his theory of "electrolytic dissociation" which have been discussed over and over again during the last twenty-five years and have occupied so large a space in nearly all recent text-books of physical chemistry. Thus, although many of his illustrations are drawn from electrolytic solutions, only three of the eleven lectures deal specifically with such solutions, namely, those on "The Theory of Electrolytic Dissociation," "Conductivity of Strong Electrolytes," and "Abnormality of Strong Electrolytes."

A special feature of the lectures is the historical method of treatment, which is adopted, not only in the first lecture, on "The History of the Theory of Solutions," but throughout the whole course. The author is, indeed, anxious to demonstrate that the newer views of the nature of solutions were a natural and logical development from those that had been in vogue previously, and seeks to disclaim the idea that he and his co-workers in this field originated a revolution which was in any sense a complete break with the past

The most fascinating lecture of the series is that on "The Modern Molecular Theory." To the average chemist it will be a complete revelation to know how accurately the actual masses of the molecules have been determined in recent years. These masses are recorded most conveniently by determining the magnitude of the constant N, the number of molecules in a gram-molecule, which is, naturally, the same for all molecules. Three methods used by Perrin and based upon the behaviour of minute suspended particles gave for N the values 68×10^{22}, 65×10^{22} and 71×10^{22}; three methods based upon the study of radioactive substances, including, for instance, the actual counting of α-particles, have given the figures 62×10^{22}, 71×10^{22} and 71×10^{22}. Other methods have given 71×10^{22}, 62×10^{22} and 62×10^{22}. It is indeed remarkable that nine series of determinations should agree thus together, the extreme range being only ± 6 per cent.

Other topics dealt with are "Suspension," "Adsorption," "Velocity of Reaction," "Equilibria in Solutions," and "The Doctrine of Energy." In the introduction, the author expresses the view that modern physical chemistry is largely synonymous with "theoretical chemistry," one of its chief functions being to express in mathematical form the experimental measurements of physicists and chemists; that he himself has not lost his skill in this art is shown by the introduction of some new formulæ in the present volume; that even more far-reaching results may flow from this method of working is clear from the use which has been made by Perrin, Lindemann and others of the formulæ developed within the last five years by Einstein.

It is a matter for regret that a book of small dimensions should have been issued at so prohibitive a price as to confine it very largely to reference libraries. The trustees of the "Silliman Foundation" would fulfil the purposes of the trust with much greater efficiency if they could arrange to circulate the printed lectures on more reasonable terms to a much larger circle of readers.

T. M. L.

INTRODUCTIONS TO BIOLOGICAL STUDY.

(1) *A Guide for the Study of Animals.* By Worrallo Whitney, Frederic C. Lucas, Harold B. Shinn, and Mabel E. Smallwood. Pp. ix + 197. (Boston, New York, Chicago: D. C. Heath and Co.) Price 2*s*.

(2) *College Zoology.* By Prof. Robert W. Hegner. Pp. xxv + 733. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1912.) Price 11*s*. net.

(3) *Einführung in die Biologie.* By Prof. Karl Kraepelin. Dritte, verbesserte Auflage. Pp. viii + 356. (Leipzig and Berlin: B. G. Teubner, 1912.) Price 4.80 marks.

(1) THE teaching of biology is much more widely spread amongst American than among British schools, and the need for systematised courses of instruction in natural history is there greater than with us. In this work compiled by science teachers of Chicago high schools a graduated course of zoological teaching is drawn up, beginning with observations on house-flies and ending with some very good suggestions on the use of domestic breeds of animals as object lessons. So far as this suggested course goes, the book may be of considerable help to teachers in search of a suitable curriculum. The greater part of the work is, however, devoted to lists of questions that any good teacher could draw up without assistance. Some of the questions are badly worded or unanswerable; for example, "Compared with a hydra, how many cells has an earthworm?"

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We have some difficulty in judging adequately of this book, since sixteen pages have been left out in binding up the review copy.

(2) For the most part Dr. Hegner's book runs on the familiar lines of comparative anatomy, and his treatment of the structure of animal phyla does not differ essentially from that adopted in any of the recent text-books of zoology, to which, indeed, he is indebted for most of his subject-matter and illustrations. The feature that he claims to be distinctive in this work is the consideration of animal physiology alongside of animal structure. The difficulty has been to compress a treatment of two such large subjects into the compass of a handy volume. Comparative physiology is in itself a large and new subject and would easily require a whole volume of this size. The author has cut the knot by reducing both anatomy and physiology to a condensed form that can scarcely be assimilated by any student. The physiological paragraphs deal mainly with responses to simple forms of stimulation—the behaviour of Paramecium and of Hydra are excellent examples of this—but they do not attempt to show the evolution of physiology amongst animals as do the sections upon anatomy.

Some useful sections are devoted to showing the economic bearing of zoological knowledge. The statement of the food of birds is a good instance of this, though here, again, the need for brief summaries has precluded the insertion of much interesting matter. The remarks on the damage due to insects, for example, are too brief to be of much value.

Compression has been carried too far in the case of invertebrates of uncertain affinities in chapter ix. Either these groups should have been omitted or treated more fully. On the whole the chapter on insects strikes one as being the best in the work, and the treatment of the affinities of animal phyla as the least satisfactory feature of it. The use of the terms "efferent" and "afferent" in connection with the circulation of the crayfish, on p. 283, is the converse of general usage and may lead to considerable confusion. The illustrations are very good and clear; those of the honey-bee, though not original, are sure to be welcome. Fig. 369 is turned upside down. Perhaps the greatest appeal of this very carefully compiled work will be to those who wish to have a book on comparative anatomy in one volume.

(3) This work, by the director of the Natural History Museum at Hamburg, has run into three editions in less than six years, and its success is due to the clear and well-balanced treatment that it contains of both branches of biology. In the present edition the sections on comparative anatomy and on the early races of mankind have been expanded and brought up to date so as to make an exceptionally attractive and very cheap work. Dealing, as the book does, mainly with general problems, it seems rather a pity that the statement of Mendel's method is not clearly given. The essence of the method and its importance can be stated quite simply without going into details. The account that is given here, printed, as it is, in minute type and dealing with a single case, will no doubt be expanded or altered in the next edition.

PHYSICS: OLD AND NEW.

(1) *Junior Magnetism and Electricity.* By Dr. R. H. Jude and Dr. J. Satterly. Pp. vii+288. (London: W. B. Clive, University Tutorial Press, Ltd., 1912.) Price 2*s.* 6*d.*

(2) *An Introduction to Practical Physics for Colleges and Schools.* By Prof. E. H. Barton and Dr. T. P. Black. Pp. vii+188; illustrated. (London: Edward Arnold, 1912.) Price 3*s.* 6*d.*

(3) *Mémoires sur l'Électricité et l'Optique.* By A Potier. Publiés et Annotés par A. Blondel. Avec une Préface de Henri Poincaré. Pp. xx+330. (Paris: Gauthier-Villars, 1912.) Price 13 francs.

(4) *Treatise on Light.* In which are explained the causes of that which occurs in Reflexion, and in Refraction, and particularly in the strange Refraction of Iceland Crystal. By Christiaan Huygens. Rendered into English by Silvanus P. Thompson. Pp. xii+129. (London: Macmillan and Co., Ltd., 1912.) Price 10*s.* net.

(5) *Intermediate Physics.* By Prof. W. Watson, F.R.S. Pp. xiii+564. With diagrams. (London: Longmans, Green and Co., 1912.) Price 6*s.* net.

(6) *Lehrbuch der Physik.* By Prof. Eduard Riecke. Erster Band. Mechanik, Molekularerscheinungen und Akustik. Optik. Zweiter Band. Magnetismus und Elektrizität. Wärme. Fünfte, verbesserte und vermehrte Auflage. Pp. xvi+600+xii+775; illustrated. (Leipzig: Veit and Co., 1912.) Price 26 marks. 2 Vols.

(7) *Physik in graphischen Darstellungen.* By Felix Auerbach. Pp. x+28+213 plates. (Leipzig and Berlin: B. G. Teubner, 1912.) Price 9 marks.

(1) SO many elementary text-books of this kind appear from time to time (one of the present authors is already responsible for two) that it is very difficult to judge whether or not a new publication possesses advantages over its predecessors. The scope of the subject is so limited that all of them are bound to be very much alike, and in any one book there can only be a

few special features which demand attention. In the present case little can be said but that the authors have presented what appears to be a straightforward and clear account of the elements of the subject.

The general method of treatment is based upon the two previous text-books of Dr. Jude, more stress being now laid, however, on the practical side of the subject. Descriptions of a large number of experiments with simple apparatus are inserted in the text, and the diagrams are rather more frequent than is usually the case. It is rather a pity that some of the latter, which are evidently new, have not been printed more clearly. An unsatisfactory feature (which, however, it should in fairness be stated, is by no means peculiar to this case) is the mode of definition of the units in electromagnetism. Even if it be admitted that exact definitions are beyond the scope of this work, a *volt* should not be defined as "10/11 of the electromotive force of a Daniell's cell" without further explanation. Surely, also, the unit of current could be explained from first principles and not be defined in terms of the *volt* and the *ohm*.

(2) Here, again, we have a further addition to the numerous works on elementary practical physics. This book is, however, rather more advanced than those which have lately appeared, and, although no previous knowledge of physics is assumed, the authors claim that it contains more than sufficient matter for the intermediate examination for degrees, almost enough, in fact, for the pass final examinations. One serious objection to the publication of books of instruction in practical work is that in different laboratories different types of apparatus are usually found, a fact which would tend to limit the usefulness of the book to the students under the direction of the author, who generally bases his work upon his own course. This the present authors have endeavoured to avoid by describing experiments involving the use of standard apparatus, or that which can easily be made.

The arrangement of the book is excellent. Some 120 experiments are described and each exercise is divided as follows:—apparatus, object of experiment, theory and results. It is not intended that the instructions printed should form the whole information given to the student. This also is a good feature, for it is certain that no thorough teaching of practical physics is possible if the services of the demonstrator are dispensed with.

(3) The collection into one volume of the mathematical and physical researches of the late M. Potier is certain to direct the attention of men of science, whether physicists, mathematicians or engineers, to the wonderful versatility of the author and to demand their admiration. When it is remembered that M. Potier's geological researches (which are not included in the present collection) have rendered him eminent in that subject also, his wonderful ability becomes still more apparent. As M. Henri Poincaré (himself, unfortunately, deceased since the publication of this volume) points out in the preface, Potier was a mathematician, and undertook very little experimental work, but he nevertheless kept in touch with the results obtained by others and endeavoured to conform his mathematical researches to the experimental requirements of the case. Especially is this so in his most important papers on applied electricity, which are compiled in the second part of this volume. Indeed, his services to electrical engineering are regarded as forming the most brilliant part of his work. In the first part the memoirs on electrical theory are collected, and the third part contains those dealing with many and varied questions in light.

(4) It is indeed surprising (as the translator points out) that no English edition of this treatise of Huygens has until now appeared. Two hundred and twenty years have elapsed since the original saw light, and in the interval it has produced a more pronounced effect on the science of optics than almost any other work. It is, therefore, a matter for congratulation that the long-delayed edition is an excellent one, and it will be welcomed by all those who find delight in reading the writings of the masters in science. Not the least pleasing feature of Prof. Thompson's translation is the preservation of the old-time mode of statement, which recalls the earlier English editions of Newton's "Principia." Prof. Thompson's reason for a literal rendering is, however, more fundamental than that of making reading pleasant. He wished to avoid "importing into the author's text ideas of a subsequent date, by using words that have come to imply modern conceptions." The publishers have carried out the idea of antiquity in the type and binding and have produced a really beautiful book.

(5) Here is a book which will undoubtedly fill a gap in the various publications on physics. There is a large class of students who do not carry their studies in physics beyond the intermediate stage, branching off into engineering or medicine at that point. As a general rule, no suitable text-book provision has yet been possible in such cases. The single volumes on physics already in existence are either too simple or too difficult, and the students in question have objections to purchasing separate volumes in the various branches of the subject. It appears fairly certain, therefore, that this book of Dr. Watson's will play a

part in the more elementary stages of physics similar to that which his well-known text-book has done and continues to do in the later stages.

Considering the amount of matter involved, it is, perhaps, not surprising that the treatment seems somewhat disjointed in the abrupt passages from one section to the next. This is most marked in the part on mechanics, which, however, the author tells us, is only included on account of the requirements in the main part of the book. As a consequence, it is doubtful whether it would be possible for a student to master the subject by unaided reading; but, after all, that should not be the purpose of a text-book. It should be regarded as an aid to oral instruction. The printing and diagrams are good and in many respects the book is unique.

(6) The fifth edition of Prof. Riecke's excellent text-book has been improved and extended in various ways. On one hand we have more complete treatment of such subjects as radio-activity and the conduction of electricity in gases, which in the earlier editions were only touched upon. On the other hand, there is the introduction of new matter, comprising liquid crystals, Brownian movements and the work of Michelson and of Nernst. Like most of the German standard text-books, this one is much more complete than corresponding works in English, and it is greatly to the credit of the authors that they spare no trouble to bring the new editions of their books really up-to-date. The printing and diagrams are very much above the average. Surely there could be no better testimony of the worth of a scientific book than that it is now in its fifth edition.

(7) This book is quite a novelty. It consists of nearly fourteen hundred diagrams—curves, photographs, &c.—representing physical facts, with short explanations of each collected at the end of the book. Although, of course, it could not be regarded as a substitute for an ordinary text-book, it might well be a useful companion to the latter. The arrangements of the diagrams is occasionally somewhat inelegant, doubtless due to space considerations, but they are, as a general rule, well printed, and in every case what is represented is clearly indicated.

OUR BOOKSHELF.

Modern Problems. By Sir Oliver Lodge, F.R.S. Pp. vii+320. (London: Methuen and Co., Ltd., 1912.) Price 5*s.* net.

A COLLECTION of essays which have for the most part appeared before as articles or addresses, but which were well worth gathering together and publishing in more permanent form. The subjects dealt with are chiefly social and philosophic—the function of money, universal arbitration and the irrationality of war, Poor Law reform, the position of woman, the drink question, the nature of time, the philosophy of Bergson—these will indicate the wide scope of the book. All the chapters are characterised by the admirably lucid yet thorough exposition which Sir Oliver Lodge's writings always present; and the conclusions, definite though cool and undogmatic, are full of that ripe wisdom which only a wide human outlook on life can give.

From the scientific point of view, one of the most interesting chapters is that on the smoke nuisance, in which the author deals with the problems of combustion, and advocates the use of gas fires and the suppression of crude combustion of coal in towns. As to river and sea mists, and fogs of non-avoidable kind, Sir Oliver suggests electrification of the atmosphere on a large scale, a plan which he has brought within measurable distance of application. This matter is again touched on in the chapter "Squandering a Surplus." No one can tell for certain what would happen by this atmospheric electrification, but it is possible and even probable that the results might be of incalculable benefit; crops might be assisted, rain produced, fog dissipated. When we think of the tremendous harmfulness of fog, financially and to the health of our citizens, it seems obvious that the prospect of a cure of this evil would justify a large national grant for expenditure on trials in a large way. It is to be hoped something of the sort may yet be done.

J. A. H.

Chrysanthemums. By T. Stevenson. With Chapters by C. H. Payne and C. E. Shea. Pp. xiv+112. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 1*s.* 6*d.* net.

THIS is the latest addition to the admirable "Present-Day Gardening" series, edited by Mr. R. Hooper Pearson. It appears at an appropriate time and will interest as well as instruct all who are concerned with the culture of chrysanthemums, whether for pleasure or profit. Though there is no reference to the existence of the plant in English gardens before 1764, it was mentioned by Confucius five hundred years or so before the commencement of our era. In the first third of the nineteenth century, about fifty varieties were known to English growers; and no attempt had been made to raise new varieties from seed. The first novelties obtained from seeds were exhibited by Mr. I. Wheeler, of Oxford, in 1832; and since then hundreds of beautiful forms have been produced. In the volume before us, details are given as to the procedure in raising seedlings and creating new varieties; and also particulars as to the care of chrysanthemums in all stages of their growth. The book will delight and assist all growers of the plant, and is a valuable addition to a series which should be known to all lovers of gardening. There are eight coloured plates showing typical flowers, and lists of varieties for cultivation as decorative plants or flowers.

LETTERS TO THE EDITOR.

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

The Sub-Crag Flint Implements.

THE series of flints from the sub-Crag detritus bed, collected by Mr. J. Reid Moir, and figured in my paper in the Phil. Trans. of May, 1912, are now placed in the Ethnological Department of the British Museum, Bloomsbury, under the care of Sir Hercules Read, K.C.B., keeper of that department. So many archæologists have been anxious to see them that I have been glad to avail myself of Sir Hercules Read's kind offer to place them on view, and to allow serious students to have access to them. They include the highly flaked, somewhat hooked specimen from the mid-glacial sands of Ipswich (Fig. 6 of my memoir), and the well-shaped rostro-carinate implement of the same age from Foxhall (Figs. 2 and 3 of my memoir). Besides seven well-marked rostro-carinate sub-Crag implements, the series includes the large and heavy flint with a "Chellean" flaking on both faces at one end (Figs. 38, 39, and 40 of my memoir) and several smaller pieces which, if found in river gravels, would be admitted at once as typical scrapers and borers; also the curious four-sided pyramid figured in my memoir (Figs. 25 and 26).

It will now be possible for prehistorians to discuss the probability of these pieces having been flaked by human agency, with the actual specimens in their hands. There is, I may say, no possibility of a doubt as to the provenance of these flints. With the exception of the two mid-glacial pieces, they all come from the remarkable and well-defined Suffolk bone-bed, or detritus bed, at the very base of the Red Crag. Further, there is no doubt that this deposit was not laid down under torrential action nor on a wave-beaten shore; nor are the pieces in it fractured by any kind of pressure or disturbance *in situ*. They were tranquilly deposited where they are, and many have the small Balanus of the Crag sea affixed to their broken surfaces.

To the question, "How have these flints been fractured so as to give them their present form?" three different answers are given by three separate groups of observers. One group maintains that they have been thus fractured by being knocked together by heavy torrential waters or by waves breaking on a beach; a second group says that they have been broken after deposition by the pressure of superincumbent deposit (or possibly by glacier-like ice moving on and above the deposit); a third group, of which I am one, points to the definite form (rostro-carinate, Chellean, scraper) given by the fracture, and considers it impossible, in our present state of knowledge of the fracture of flint, to attribute this definite and apparently purposeful fracturing to any coincidence of natural breakage, and attributes them to human design and action.

In reference to these diverging views, it is necessary to take account of the facts (1) that it is generally admitted that such forms as these are what we should expect to find as the earlier work of man, preceding the more skilfully worked implements of the river gravels; (2) that no specimens of flints fractured by torrential or by wave action of water and corresponding in size, in form, and definite shaping to the sub-Crag flints have as yet been discovered or produced experimentally. The broken flints of the flint-mill at Mantes, put forward by M. Boule, have no resemblance to them; nor have the pebbles, with an occasional small fracture on the surface, from the beach at Sherringham (Norfolk) any resemblance to them. The advocates of torrential or wave action of water have yet to take the initial step of showing that such action can actually produce anything of the sort. Moreover, they have to show that there is independent evidence of a possibility, let alone a probability, of the sub-Crag flints having been exposed to violent interconcussion by water. The "violent concussion theory" is, at present, without a single fact in its support. (3) We have to recognise that no specimens of flints fractured by pressure in natural conditions have been "laid on the table" which in any way resemble the sub-Crag implements. The fractured fragments of flint procured by M. Breuil at Bel Assize (which I have examined) have no resemblance to them. Moreover, there is no evidence to show that M. Breuil's specimens were, as he asserts, broken by the pressure of superposed deposits. On the contrary, no such fracture by the weight of superposed sandy strata can be admitted. According to ascertained facts as to the transmission of pressure by sand, there is no reason to suppose that fracture can be so produced.

In regard to this suggestion, as in regard to that of torrential action, the careful examination of the deposit in which the sub-Crag flints of Suffolk occur renders it absolutely certain that no such pressure has acted upon the flints where they at present are found. Here, again, we are referred (by M. Breuil's supporters) to some unknown and fanciful precedent conditions (of which there is no evidence) in order that the impossible crushing by a superposed sandy deposit may take place. (4) We must note that the hypothesis that these flints were purposely fractured by man is the only one which explains their special shape and the "directed" character of the blows which produced the fractures and the shape. It is also the only hypothesis which accounts for the fact, pointed out to me by Prof. Flinders Petrie, that all of these fractured flints from the sub-Crag bed, shaped according to definite and special pattern, readily fit to the hand and at once fall into position as useful picks or hammers. It may be said that we have no independent evidence of the existence of man at this epoch, just as we have no evidence of torrential waters or vast pressure. But I have reason to believe that such independent evidence of man's presence at this epoch in this country is already in the hands of competent geologists, and will soon be made public.

Lastly, I may say a word as to the remarkable scratching of the fractured surface of many of these flints. I have attributed it to the action of ice, similar to (but not precisely identical with) that which causes the scratching of rocks and rock pebbles by modern glaciers. There is other evidence, as noticed by Lyell, for the presence of ice—transporting large blocks of flint in an unrolled condition—during the deposition of the Suffolk bone-bed at the base of the Reg Crag. But the human origin of the fracturing of the flints we are discussing is not bound up with the hypothesis that the scratches on them are due to ice-action. I am not aware of any evidence in favour of any other explanation of the presence of these scratches.

It is very evident to me, from the various opinions which have been expressed in regard to the history of the sub-Crag flints, which I consider to be implements fabricated by man, that there is an extraordinary lack of precise information, at this moment, as to the properties of flint, the various possible causes of its fracture (including heat and cold, as well as blows and pressure), and the means of judging what particular causes have been at work in fracturing any given specimen. It is in consequence of the vagueness of published and approved statements on the properties of flint that we are asked to accept all sorts of indefinite appeals to natural agencies as sufficient to account for what no one, without uncommon faith in the unknown possibilities of those agencies, would be capable of imagining as due to any other agency than the hand of man.

To avoid, if possible, any misunderstanding, let me say that the sub-Crag flint implements are not "eoliths" in the sense given to that word by Mr. Benjamin Harrison, nor in that given to it by M. Rutot. Still less are they to be called "eoliths" by those who would apply that term to flints broken by cartwheels or by the mill at Mantes.

I propose to sketch in a later communication a programme of inquiry into the nature and properties of flint, the carrying out of which seems to me to be urgently needed at this moment.

October 29. E. RAY LANKESTER.

High Tropical Winds.

LAST year, in a letter to the Editor of this journal (vol. lxxxvii, p. 415), I wrote about the probable existence of "upper trade-winds," according to the observation of some high balloon flights at Batavia. Also I ventured to explain the occurrence of high westerly winds near the equator by supposing them to be only feeble winds of variable direction between the anti-trade and the upper trade. Finally, I mentioned my intention of continuing these researches by means of large pilot-balloons.

This has been done in the past year, but the average height reached by the balloons was lower than I wished, owing to the inferior quality of some of them. Notwithstanding this, the results are of sufficient interest to justify a short account of them.

Contrary to my expectations, I found the high westerly winds (first met by Berson on the Central Africa expedition) not to be of secondary, but of primary importance; moreover, not blowing under but above the anti-trades.

On four different occasions a balloon crossed the upper limit of the westerly winds and again met easterly currents.

As I had already conjectured from the observations made during the two preceding years (1910–11), the anti-trade in the dry season (June–September) lies higher than in the rainy season (December–March); thus I found the average height of its upper limit to be:—

December–March	... ...	16·5 km. (9 cases).
June–September	... ...	15·5 km. (18 cases).

In the months of transition its direction may vary a good deal, and then it is often difficult to discriminate between the various currents; notwithstanding, six cases gave an average height of 15·8, *i.e.* a height between those of the two monsoon seasons.

Regarding the upper trade, I found it to be, just as I expected, more obvious and at a higher level in the rainy season than in the dry one, its lower limit being:—

December–March	... ...	17·0 km. (9 cases).
June–September	... ...	15·3 km. (13 cases).

On the contrary, the high westerly winds were found to occur in most cases during the dry season, and at a height of more than 17 km.

Also in the months of transition their presence was proved by some balloon flights; for instance, on April 24 and 27, 1912, when two balloons burst at a height of 27·2 and 25·3 km. respectively, and westerly winds appeared to blow from 20·0 and 18·5 km. upwards.

As already mentioned above, this year on four occasions a balloon passed the upper limit of the high westerly winds, viz. on January 24 at a height of 23 km., and on September 7, 12, and 23 at about 24 km.

It is important to remark that Berson had already seen this happen (at a height of 20·2 km.) for the first time at Dar-es-Salaam, but he must have undervalued the height of the balloon, viewing it from one point only, and making use of a theoretical rate of ascent. In reality this rate increases strongly with the height, as I have found by viewing my large pilot-balloons from two points (2 or 4 km. apart).

I estimate Berson's pilot-balloon of 700 gr. must have crossed the upper limit of the westerly winds at about 23 km., accordingly at the same level as those which ascended at Batavia.

The balloon of September 12 burst at the enormous height of 30,800 m., and gave evidence of the strong easterly winds which have long been supposed to blow at a great height above the tropical belt.

Thus for the first time has been described the wind which, during the period of 1883, August 27–September 8, carried the ashes of Krakatoa around the earth at a level of ±30 km., and at a velocity of 34 m.p.sec., and therefore may properly be called Krakatoa wind.

The wind directions and velocities observed on September 12 follow below:—

Height in km.	Wind blows from	Velocity in m.p. sec.	Name of air-current
0·3	S	6	Land breeze
1	E 17° S	2	Trade-wind
2	E 4 N	5	
3	E 14 S	5	
4	E 23 N	5	Anti-trade wind
5	E 15 N	6	
6	E 20 S	9	
7	E	7	
8	E 42 N	12	
9	E 25 N	17	
10	E 8 N	11	
11	E 18 N	14	
12	E 57 N	13	
13	E 47 N	16	
14	E 28 N	23	
15	E 21 N	19	
16	E 54 N	13	
17	E 29 N	9	
17·5	E 42 S	7	Upper trade wind
18	E 8 S	1	
19	W 17 S	10	High westerly winds
20	W 12 S	12	
21	W 13 N	11	
22	W 30 N	16	
23	W 7 S	12	
24	S 9 E	8	
25	E 81 N	5	Krakatoa wind
26	E 20 N	7	
27	E 43 N	9	
28	E 2 S	11	
29	E 21 S	19	
29·5	E 6 N	40	
30	E 8 N	33	
30·5	E 9 N	34	

On September 7 and 23 the same wind system reigned, as was proved by two balloons which reached a height of 26·5 and 27·5 km. respectively.

Regarding the explanation of the occurrence of high westerly winds near the equator, Gold (Quarterly Journal, 1910, p. 178) reminds us of the theoretical results of Overbeck, from which, according to him, might easily be deducted that often at great heights the vast westerly whirl around the poles extends over the tropical belt. But the principles on which Overbeck built his theory are not in agreement with reality. He regards difference of temperature as the *prima causa* of the air-currents, and presumes the vertical distribution of temperature to be caused by conduction only, supposing other causes, such as radiation, vertical currents, &c., to give an analogous distribution as conduction gives it.

The existence of the stratosphere has taught us, however, that this is not the case.

Though it seems rational to presume that the high westerly winds are an extension of those at higher latitudes (±15°), and also that the Krakatoa wind comes from still higher latitudes, being deflected by the rotation of the earth in an easterly direction, more observational data from other stations are urgently wanting for a thorough explanation of the facts.

Batavia, September 24. W. VAN BEMMELEN.

The Blind Prawn of Galilee.

IN describing the eyeless prawn from Galilee that he named *Typhlocaris galilea,* Dr. Calman stated that, according to the information at his disposal, it was found in a small pool near the town of Tiberias communicating with the lake and fed by a mineral spring (see Trans. Linn. Soc., London, 2nd ser., zool. xi., p. 93, 1909). As Typhlocaris is one of the most peculiar crustacean genera described of recent years, further particulars as to its *provenance* may be of interest to naturalists. The pool in which alone, so far as is known, it occurs is situated some two hundred yards from the Lake of Tiberias, an hour and a half's sail north of the town of that name. Originally this pool was one of the chambers in a Roman bath at some forgotten city, perhaps Capernaum or Bethsaida. It is still completely enclosed by stout masonry which gives it a symmetrically octagonal outline, but its surface is choked with gigantic floating grasses. There is now no visible outflow or inflow of water, which apparently percolates through the bottom at several places and decreases in volume by desiccation. As its temperature is distinctly lower than that of the water in the aqueduct that works a corn-mill between it and the lake, it seems improbable that there is any great outward percolation. It is evident, however, that the water, which even now is nowhere less than about 4 ft. deep, was in ancient times much deeper, and that the overflow was conducted away by means of apertures in the wall high above the present surface, while there are traces of an aperture through which it may have entered the pool in volume in a masonry platform that juts out into the pool from one of its eight sides. The water is slightly saline, but not so markedly so as that of some springs in the vicinity.

The first Typhlocaris that I saw on a recent visit to the pool was crawling on the side of the platform about three feet below the surface, making its way slowly in and out of the crevices. Apparently the claws as well as the antennæ were used in testing the surface along which it moved. A piece of bird's flesh weighted with a small stone was lowered on a string to attract it away from the stones and render its capture more easy. It seized the string in both its claws and gave it a vigorous tug. It then made its way to the flesh, but when the latter was forthwith attacked by a number of small fish (*Discognathus lamta*), the prawn moved away. Although the fish made no attempt to injure it, it invariably avoided them. When touched with a net it darted violently backwards, straightening its claws in front of it as it did so, but no great difficulty was experienced in capturing it. At the time of our visit (about 5 p.m.) the pool was in shade, but the prawn did not seem to avoid such light as reached it. A second individual was seen crawling on the bottom at dusk, but none were seen in the early morning.

There was no trace of colour on the living prawn, except that the internal organs of the thoracic region produced a dusky blotch externally. The whole body was otherwise of a semi-opaque white like that of paraffin-wax.

The appearance of Typhlocaris in the pool is most erratic. Herr Grossmann, who sent the first specimens to the British Museum and assisted me greatly in my search for more, tells me that he has often visited the pool without seeing any, and one of the German fathers who have a hospice in the neighbourhood stated that while on one occasion a Bedouin caught five individuals in a single day, on another none were seen for six months. On the whole, I agree with Dr. Calman in thinking that the real habitat of Typhlocaris is subterranean, but I have little doubt that having once made their way through some crevice into the pool, individuals are able to flourish there, hiding in crevices in the walls or under the vegetation that floats on the surface. N. ANNANDALE.

Tiberias, Palestine, October 8, 1912.

Is the Earth Shrinking?

IN a recent popular work I find the statement, "The earth is still slowly shrinking. . . ." I am aware that this statement fits in with our preconceptions and may even appear trite and commonplace, but it is sometimes just such statements that best repay investigation. I would, therefore, inquire whether there is any unequivocal evidence that the volume of the earth as a whole either is now suffering, or has in the past suffered, progressive diminution.

If there were direct evidence of progressive cooling on the part of the earth, diminution of volume would be almost a necessary inference, but on this point I understand that geological evidence is by no means favourable. As regards the presence in various regions of folding, overthrusting, reversed faulting, &c., such phenomena are evidence of surface compression in regions where they are found; and in a precisely similar manner the presence of rifts, fissures, ordinary faulting, &c., is evidence of local surface expansion, although the latter result is seldom emphasised. In a given region it is easy to picture such a combination of folding with fissures cutting across the folds as would cause the region to suffer distortion without either diminution or increase of superficial area. If such be conceivable within the limits of a local region, it is evident that the mere presence of folding and the like, unsupported by an intricate quantitative examination, will not warrant the conclusion that the earth as a whole is shrinking. On the other hand, if due regard be paid to the physical properties of the materials composing the earth's crust, is it not remarkable that extensive regions exist which do not appear—at least in geologically recent times—to have suffered compression?

October 13. H. BIRRELL.

FOR a quantitative discussion of the effects of secular cooling on the earth's crust, Mr. Birrell may be referred to a couple of papers by Dr. C. Davison and Sir George Darwin in the Philosophical Transactions of the Royal Society for 1887. He will find that though the speculative nature of the assumption is frankly confessed, yet the observed phenomena are shown to be consistent with the theory of contraction and secular cooling. On the whole, students of cosmogony (as opposed to geology), arguing to some extent from the analogy of other celestial bodies, are in agreement in accepting the hypothesis of secular cooling. A notable exception is Prof. F. R. Moulton, of Chicago. In conjunction with Prof. T. C. Chamberlin, he has developed a "planetesimal hypothesis," according to which the earth was built up by a series of solid accretions. The hypotheses of secular cooling and initial high velocity of rotation for the earth have no place in his theory. For details Mr. Birrell may be referred to "The Tidal and other Problems" (Carnegie Institution of Washington, 1909).

F. J. M. STRATTON.

NEW OBSERVATIONS ON HUMBLE-BEES.[1]

THIS account of the humble-bee has a merit very uncommon in popular books of natural history; it is written by a naturalist who has spent years in observing for himself, and whose observations are numerous, original and interesting. There are set before us new facts concerning (among other things) the domestic management of several humble-bees, the packing of pollen into the collecting basket, the habits of the parasitic bee, Psithyrus, the insect-devourers of the broods of humble-bees, or of the food-supply stored in the nest, and the perfume of male humble-bees, besides many practical suggestions for the tending of humble-bee families in captivity. The different species are pictured in excellent colour-photographs, which will save trouble to observers who are not yet practised in systematic identification, and there are useful photographs of humble-bee nests, combs and incubating females.

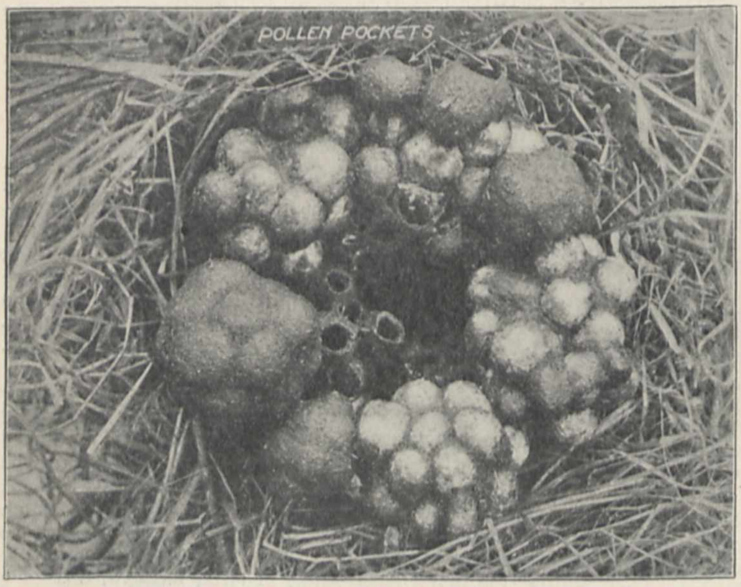

FIG. 1.—Comb of *Bombus agrorum*, showing pollen-pockets in the sides of the bunches of larvæ. From "The Humble-Bee."

May we suggest to the author that, if an opportunity offers of revising his work, he would do well to prefix a simple account of the life-history and economy of some one humble-bee? There is a choice of such histories in Réaumur, each marked by a lucidity and grace which captivate the reader. One of these, shortened and revised, would meet a want which many readers are likely to have felt. It is singular that Réaumur is never mentioned by Mr. Sladen, though room has been found for a longish quotation from the Abbé Pluche!

Mr. Sladen's excellent matter is not always well arranged; we have found it troublesome to recover passages the place of which in the book had not been noted. Our author seems to suppose that humble-bees give out heat whenever they are active. Can this belief be supported by thermometer readings? There is a hint, too, but not more than a hint, of blood-vessels filled with a red fluid. We are convinced that this supposition (if really entertained) is a delusion. Corrigenda like these are trifles. Our main duty is to recognise Mr. Sladen as a careful and clever observer, and to recommend his work as a trustworthy account of a particularly interesting group of insects.

Buttel-Reepen (*Biol. Centralbl.*, 1903), drawing upon information contributed by many other naturalists, among whom Mr. Sladen is named, has traced the ascent step by step, from the solitary bees to the complex communities of the honey-bees. In the simplest bee families the life of all the individuals is short, and the mother dies without ever seeing her progeny. Then we pass to bees the females of which regularly outlast the winter; the cells are collected into some kind of comb, and the nest is guarded. In the humble-bees there is a further advance; the labour of the mother is now shared by parthenogenetic workers, though these are only seen during the flowering season, and perish before winter. The climax is reached in what we illogically but conveniently call the honey-bees (the humble-bees also are collectors and storers of honey); of these the hive-bee is the most familiar example. Here the workers persist from year to year, and become supreme, the mother (now called the queen-bee) being degraded to a captive, and incessantly occupied with egg-laying. If the humble-bees had not been carefully studied we could only have guessed at the stages by which the elaborate polity of the hive has been, or may have been, attained.

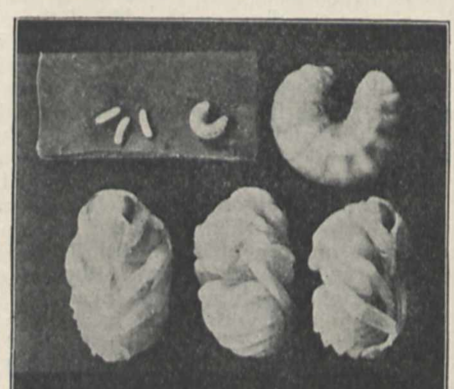

FIG. 2.—Eggs, larvæ and pupæ of *Bombus terrestris*, slightly enlarged. From "The Humble-Bee."

The last news is that Mr. Sladen is joining the staff of the Central Experimental Farm at Ottawa. We wish him all success in his new sphere, and hope that he will not be too much occupied by his work in Canada to give a thought now and then to the Hymenoptera.

L. C. M.

[1] "The Humble-Bee. Its Life-history and how to Domesticate it. With Descriptions of all the British Species of Bombus and Psithyrus." By F. W. L. Sladen. Pp. xiii+283; illustrated. (London: Macmillan and Co., Ltd., 1912.) Price 10s. net.

THE UNVEILING OF A STATUE OF PRIESTLEY AT BIRSTALL.

THE merits of Joseph Priestley—theologian, philosopher, social reformer, and man of science—were recognised by some at least of his contemporaries. He was on terms of friendship with such men as Franklin, Wedgwood, Watt, and Banks, and he enjoyed the patronage and companionship of Lord Shelburne. In 1766 he was elected a fellow of the Royal Society, and seven years later the Copley medal was awarded to him.

To many of his fellow-countrymen, on the other hand, Priestley was but a violent and obstinate schismatic, intent only on undermining the established order of things. It was indeed the intolerant and cruel expression of this view by the Birmingham mob that led him to emigrate to the United States in the sixty-second year of his age.

Such clouds, however, as once obscured Priestley's fair fame have now entirely passed away, and the services which he rendered to the national life, whether as a pioneer of chemical science or as an "honest heretic," are everywhere recognised. Public memorials of the man and his work have been erected in Birmingham, Warrington, and Leeds, and recently another has been added to the number. For the citizens of Birstall, in the West Riding, where Priestley was born in 1733, have combined, with praiseworthy public spirit and enthusiasm, to erect a statue of their eminent townsman.

This latest memorial was unveiled on October 12 by Sir Edward Thorpe, whose ready pen has materially contributed to a just appreciation of Priestley's character and work by this generation. The ceremony was performed in presence of a large and distinguished company, and general satisfaction was expressed at the manner in which the scheme for commemorating Birstall's most famous son had been brought to a successful issue.

After the unveiling ceremony, the company adjourned to the Temperance Hall, where an address was delivered by Sir Edward Thorpe. In an illuminating review of Priestley's life and the various factors that shaped his career, emphasis was laid on the influence of his early environment. From his sixth year onward Priestley was entrusted to the care of his aunt, Mrs. Keighley, a worthy, intelligent, and broad-minded woman, to whose house the cultured people of the neighbourhood were wont to resort. For a time ill-health prevented the boy attending school with regularity, and to a large extent he had to make his way to knowledge unaided. These circumstances, cooperating with his natural keenness and diligence, developed in young Priestley that mental activity and independence which later were characteristic of his attitude towards theological, philosophical, political, and social questions.

After a suitable training Priestley entered the ministry, and worked successively at Needham, Nantwich, and Warrington. It was not until he went to Leeds in 1767 that he began those chemical investigations on which his fame chiefly rests. It is indeed remarkable, as Sir Edward Thorpe pointed out, that a man like Priestley, without previous training, with domestic utensils for his apparatus and tallow candles for his source of heat, should have made the great discoveries in pneumatic chemistry with which his name is associated.

The Priestley Statue at Birstall. Sculptor: Miss Darlington.

It was, however, during his seven years at Calne, in Wiltshire, under the patronage of Lord Shelburne, that Priestley's best experimental work was done. It must be admitted that he did not at all realise the true significance of his investigations. The discovery of oxygen was destined to revolutionise chemical science, and yet Priestley himself, to the end of his days, clung to the antiquated conceptions which his own experiments had really overthrown. In this connection Sir Edward Thorpe has emphasised the striking contrast between Priestley the social, political, and theological reformer, always in advance of his time, and Priestley the conservative and orthodox man of science.

Sir Edward holds that, great as was Priestley's merit as an experimentalist, a greater claim to our regard rests on his struggles and sufferings in the cause of liberty. Unpopularity and even persecution were his lot during his later years in England, and it is to Priestley's everlasting credit that he did not allow these untoward circumstances to disturb his serene and genial temper. In paying tribute to such a man—one whom Frederic Harrison has described as "the hero of the eighteenth century"—the citizens of Birstall have done honour to themselves. J. C. P.

THE PROPOSED MEMORIAL TO LORD LISTER.

MEETING AT THE MANSION HOUSE.

IT may be said that the life of a great man needs no permanent memorial from his contemporaries, and to some extent this is true. Poets, men of letters, and philosophers speak to posterity in their writings, statesmen and warriors have their deeds recorded in history, artists, sculptors, and architects have erected their own monuments which everyone may see. Yet even to them their fellow-men delight to raise some special token of their admiration. But there are others whose work is of a less public character, less obvious to the ordinary observer, and less easily understood, but which often has a more important effect upon the welfare of the world. Of such are the men of science, whose atmosphere is different from that of their fellow-men, and who occupy the *edita doctrina sapientum templa serena.* It is fitting that some permanent memorial should from year to year recall the names of such and remind those who come after of what it is that they have accomplished.

The great meeting which, under the auspices of the venerable Lord Mayor, himself a member of the medical profession, assembled at the Mansion House last week to sanction the project for raising a memorial, or rather some memorials, to Lord Lister, will, we are confident, meet with the approval of everyone, in all parts of the world. The names of those who attended the meeting and those who sent messages of regret at being unable to do so, indicate how wide is the sympathy that it has aroused. Statesmen, ecclesiastics, soldiers, representatives of science and of medicine, of the City companies, of hospitals, and of the general public were all enthusiastic in their commendation of the scheme. Such evidence reminds us that Lister's work was not merely one which revolutionised surgical practice, and was thus instrumental in saving his fellow-creatures from premature death and unnecessary suffering, and enabled the art of surgery to advance by leaps and bounds to a degree undreamt of before; but that its scientific value alone is so great as to justify his being placed amongst the most distinguished men of this or any other age.

The Lord Chancellor, in the unavoidable absence of the Prime Minister, paid an eloquent tribute to Lister's pre-eminence and to the far-reaching effects of his doctrines; yet the man in the street has but little notion of the benefits he has derived from them; he has perhaps learned the two words "antiseptic system," but they convey no meaning to him; and he does not appreciate the dangers which have been averted and the sorrows prevented for him and those who are dearest to him. It is for these that a speaking memorial should be raised, and it is from these, if they can be made to understand its meaning, that we feel sure an appeal for the necessary funds will not be made in vain.

A very influential committee has been formed of representatives of all classes in the United Kingdom and the Colonies and of Ambassadors and Ministers of foreign countries, and in their opinion it is fitting that whatever is done should partake not only of a national, but an international character. This committee, after careful consideration, submitted a scheme to the Mansion House meeting, which met with cordial approval.

The Dean of Westminster, who is a warm sympathiser with it, desired that Lord Lister's ashes should find their final resting-place in Westminster Abbey, but owing to his own very strict injunctions concerning his funeral, this could not be carried out. It is proposed, therefore, that a medallion with a suitable inscription should be placed in the north aisle near those of Darwin and other eminent men of science that cluster round the monument of Newton. Westminster Abbey is an international institution, and it is certain that this proposal will not appeal to Englishmen alone.

It is also thought that everyone will be in favour of the erection of a sculptured monument, not a mere statue, but something which will direct attention to the nature of his achievements, in some prominent place in London which every citizen and every visitor cannot fail to see and to observe.

But it was felt that a memorial of a still more international character was desirable, and for that the committee recommended something which would combine the merits of the Nobel Prize and those of the Carnegie Trust. Under the proposed scheme the trustees of the fund would be able to devote the interest of it at their discretion either to the promotion of research bearing upon the progress of surgery, or as awards in recognition of notable advances in this science. Naturally these awards would be open to men of all nations, and this is as it should be, for Lister's work was not in any sense insular; its beneficent effects are felt in every part of the inhabited world.

We think that the decisions of the committee are wise and will meet with general approval. It is needless to say that in order to carry them out a large sum of money will be required. We are happy to hear that already several generous donations have been made, and we have great confidence that the appeal will be widely responded to. We would point out that it is not only the large gifts of the wealthy that are sought, though they are no doubt essential to the success of the scheme, but also the smaller tributes of esteem, the thank-offerings of those who recognise that every household in the land is a debtor to the great man who has passed from amongst us.

Donations should be sent to the treasurers of the Lister Memorial Fund, Royal Society, Burlington House, W.

M. LECOQ DE BOISBAUDRAN.[1]

IN the death of M. Lecoq de Boisbaudran, which took place in May of the present year, there passed from the field of activity one of the most brilliant and energetic of French investigators. Lecoq de Boisbaudran was an amateur in the true sense of the word, and he had the faculty of concentrating the whole of his energy upon the question of the moment. He was born in Cognac in 1838. His parents were of noble family in Poitou, but their circumstances prevented his receiving more than an ordinary education. While a young man, he studied mathematics under his uncle, who had been a student at l'École Polytechnique, but his interest quickly became absorbed in the science of chemistry; he eventually succeeded in gaining an entrance to the laboratory of Würtz at l'École de Médecine, and it was here that he made the discovery of the element gallium.

Among his earlier contributions to science are papers on gravitation, meteorological phenomena, and also upon matters connected with agriculture; but physical chemistry and spectroscopy received the greater share of his attention. The probable existence of gallium had been foretold by Mendeléeff, who had proposed the name *eka-aluminium,* but to Lecoq de Boisbaudran belongs the honour of the discovery and the isolation of the element. In the field of spectroscopic research his name may be classed with those of Kirchhoff, Bunsen, Sir G. G. Stokes, and Sir William Crookes, as one of the founders of the science of spectro-chemistry. His "Spectres Lumineux," published in 1874, was one of the most perfect works on spectroscopy at that time, and it possesses considerable value even at the present day; although limited to the visible region, the drawings are marvellously exact, and in the index wave-lengths of all the lines in the fifty-six spectra shown are given in Ångström units to one place of decimals; the labour involved in the work was enormous.

At the time when Lecoq de Boisbaudran was in the prime of his scientific activity, the chemistry of the rare earths was receiving considerable attention, Clève of Upsala, Marignac, Demarcay, Crookes and others were hard at work in that very interesting field of research, and he devoted himself with all the energy of his nature to the work; during the period from 1880 to 1900 his communications to the Academy appeared in almost every issue of the *Comptes rendus.* He was successful in discovering and isolating the elements samarium and dysprosium, and he very completely investigated the body now known as gadolinium, which had been provisionally named Y α by Marignac.

In his earlier investigations he depended largely upon the indications given by the *spark spectrum,* produced by passing an alternating spark between electrodes immersed in a solution of the salts, and also upon the absorption spectrum of the solution; the spectra of didymium, erbium, holmium, &c., were very fully examined by this latter method.

At the time when the work of Sir William Crookes upon the kathode phosphorescence spectrum of the rare earths was published, he made the observation that if the condensed spark from one electrode was allowed to strike upon the surface of a liquid containing a rare earth salt, there was produced, just where the discharge struck, a faint luminous spot, which, when examined with a spectroscope of low power, gave rise to a series of faintly luminous bands, closely resembling the phosphorescent bands of Crookes; this he called the *reversal* spectrum, and the method of investigation was largely used by him in his speculations upon the constitution of the yttria earths. His conclusions in this particular were in direct opposition to those of Crookes, who, as the result of an extended series of observations on the brilliant bands produced by kathode phosphorescence, had suggested that the element yttrium was composed of a number of very closely allied bodies, which he termed *meta-elements,* each producing a distinct phosphorescent spectrum. M. de Boisbaudran, on the other hand, held the opinion that yttria, when perfectly pure, did not phosphoresce under kathode rays, and that the bands observed by Crookes were due to impurities contained in the yttria.

The origin of the band-producing earths is by no means clear even at the present day, but the fact remains that although much work has been since done upon the element yttria, no one has succeeded in producing the non-phosphorescing material of Lecoq de Boisbaudran. It is a great misfortune that the numerous researches of Lecoq de Boisbaudran, particularly those referring to the rare earths, have not been collected together and published in complete form; there are probably few of the rare earth elements about which some observation could not be found under his name; but, scattered as they are in isolated papers, they are in large measure lost, and probably many of his original observations will have to be re-made by his successors. This, unfortunately, was characteristic of the man. His method was to work and publish almost simultaneously; so engrossed was he in his work that he cared little for public recognition.

The cross of the Legion of Honour was conferred upon him for his discovery of the element gallium, but he never officially received the Order.

[1] An article from the pen of M. G. Urbain upon the life and work of Lecoq de Boisbaudran appeared in the *Revue Générale des Sciences* for September 15, and to that the present writer is indebted for several particulars not otherwise available.

He was awarded the Bordin prize in 1872, and was made correspondent of the chemical section in 1878. He received the Davy Medal of the Royal Society in 1879, and the Lacaze prize in 1880.

He died, after a painful illness, on May 28, at the age of seventy-four years.

J. H. GARDINER.

NOTES.

IN our issue of April 18 last (vol. lxxxix., p. 172) the announcement was made of the appointment of a Royal Commission to inquire into and report upon the natural resources of the Empire. On that occasion it was not possible to give the names of the Commissioners, but we are now able to say that the Commissioners originally appointed were as follows:—Lord Inchcape, Sir Edgar Vincent, K.C.M.G., Lieut.-Colonel Sir C. J. Owens, Sir H. Rider Haggard, Mr. T. Garnett, Mr. W. Lorimer, the Hon. G. E. Foster, Mr. D. Campbell, Sir Joseph G. Ward, Bart., Sir David Pieter de Villiers Graaf, Bart., and the Hon. E. R. Bowring. Some changes have taken place in the composition of the Commission since it was appointed, but neither originally nor now, so far as we can find, does the Commission include a single member prominently associated with some branch of scientific knowledge. This is the more surprising because it may be remembered that in March last, a month before the Royal Commission was appointed, the British Science Guild issued a report prepared by one of its committees, under the chairmanship of Sir William Ramsay, K.C.B., F.R.S., on the question of the conservation of natural sources of energy. The British Science Guild committee was composed almost entirely of expert men of science, who had given particular attention to the study of the questions with which the Royal Commission is dealing; and it is greatly to be deplored that one or more of their number, or other representatives of pure or applied science, have not been appointed members of the Commission.

THE recent publication of the "Life and Scientific Work" of Prof. Tait, of Edinburgh, reviewed in NATURE of July 13, 1911, has reawakened a desire on the part of his many old students and friends to have a worthy memorial of the "great natural philosopher." The proposal is to found a second chair of natural philosophy in Edinburgh, to be called the Tait chair, and a strong appeal for contributions towards an endowment fund has been issued by a representative committee. Accompanying the appeal there is a fine tribute on Tait and his work, from the pen of Prof. Peddie, of Dundee, one of Tait's former assistants. There is also an interesting statement on the need of a second chair, in which Prof. MacGregor shows that, in comparison with other universities which have approximately the same number of students, the University of Edinburgh is far behind as regards the numerical strength of its teaching staff in experimental and mathematical physics. As early as 1872, Tait himself, in an article in *Macmillan's Magazine,* lamented the understaffing of the Scottish universities, giving it as his opinion that there should be "a professor of applied mathematics in each, and a professor of experimental physics, in place of the present solitary professor of the enormous subject of natural philosophy." This is the ideal which the committee has set before it, and for the realisation of which it has appealed to a wide public. In the days of his activity Tait was a frequent and much-valued contributor to the columns of NATURE, and in the interests of the higher development of physical and mathematical science, we have much pleasure in directing the attention of our readers to this great and worthy object. The honorary treasurer of the fund is Sir George M. Paul, 16 St. Andrews Square, Edinburgh.

THE dinner given by the Fishmongers' Company on October 24 to a distinguished company, "to meet the President of the Royal Society," may well be taken as an indication of the esteem in which scientific work is held by a great City company. The assembly invited included representatives of numerous branches of science, among whom were many members of the Royal Society. The following scientific societies, for instance, were represented:—The Royal Horticultural Society, the British Science Guild, the Society of Antiquaries, the Royal Astronomical Society, the Institution of Civil Engineers, the Linnean Society, the Geological Society, the Royal Microscopical Society, the Chemical Society, the Entomological Society, and the Surveyors' Institution. Sir Archibald Geikie, in responding to the toast of "The Learned Societies," proposed by the Prime Warden, said that the City guilds have played an important part in the history of London. The learned societies, too, have had close relations with the City companies. The Clothworkers' Company has had two distinguished masters who have been presidents of the Royal Society—Samuel Pepys and Lord Kelvin. The City guilds, too, have shown great diligence in the application of their funds for educational and scientific purposes.

AN account of certain red bands observed by Profs. Breuil and Sollas in Bacon's Hole, on the Gower peninsula, and apparently of prehistoric origin, appeared in NATURE of October 17 (p. 195). According to *The Cambria Daily Leader* of October 18, the markings were made by a Mumbles boatman eighteen years ago, and were produced with a brush having red paint upon it, which was part of the salvage from the wreck of a Norwegian barque. Several other explanations have since been put forward, and are referred to in a short article in Tuesday's *Times.* Whether the markings are of ancient or modern origin does not appear yet to have been decided definitely, but the position of the question is shown by the following extract from *The Times* article:—"When they observed the marks the first question which presented itself to Prof. Breuil and Prof. Sollas was: 'Are they ancient or modern?' Prof. Breuil, having wetted the surface, attempted to remove the paint by vigorous rubbing; not succeeding in this, he concluded they were ancient. Prof. Sollas closely examined the wall to see whether the paint was covered by stalactite, and convinced himself that it was. To reassure himself on this point Prof. Sollas has lately revisited the cave. He was able with a hammer and chisel to detach a fragment of the painted surface from a projecting corner. This affords an excellent section through the deposits, revealing a layer of the red paint, which covers an older layer of stalactite, and is itself covered by a later layer, in some places as much as two millimetres thick. There can be no doubt that Prof. Breuil and Prof. Sollas were scrupulously exact in their observations, and as the marks resemble in general character the accepted paintings of Upper Palæolithic age, and in particular some red bands at the extremity of the great gallery in Foul de Gaume, they were amply justified—whatever the final verdict may be—in assigning the paintings of Bacon Hole to an ancient period."

THE next meeting of the Geologists' Association will be devoted to a conversazione, which will be held to-morrow (November 1), in the library of University College, Gower Street, W.C.

THE Royal Academy of Sciences of Naples is offering a prize of 20*l.* for researches on the algæ of the Bay of Naples preferably from the biological point of view. The essays, which are to be sent in by June 30, 1913, are not returned to the authors.

THE death is announced of Prof. Paul Segond, professor of surgery in the Paris Faculty of Medicine, at the age of sixty-one years. Prof. Segond was formerly chief surgeon at the Salpêtrière Hospital, and assisted in the preparation of the "Dictionary of Medicine and Practical Surgery."

The Kew Bulletin announces that Mr. I. H. Burkill, Reporter on Economic Products to the Government of India, and curator of the Industrial Section of the India Museum, Calcutta, has been appointed by the Secretary of State for the Colonies director of the Botanic Gardens, Singapore, in succession to Mr. H. N. Ridley, C.M.G., F.R.S., retired.

IT is reported in the *Revue Scientifique* that, out of the fund raised for the recent centenary celebration of the establishment of Avogadro's law, the Turin Academy of Sciences will found a prize of 1500 lire and a gold medal for the best critical, historical, or experimental work on the discoveries resulting from the law. The prize will be awarded on December 31, 1914.

THE Liverpool School of Tropical Medicine is arranging to send an expedition to Jamaica and the West Indies. The Colonial Office is cooperating with the school in this expedition, which, it is interesting to note, is the twenty-ninth made by the Liverpool authorities. The various expeditions have cost some 30,000*l.*, but on its work as a whole the school has spent more than 100,000*l.*, nearly all of which has been raised by voluntary effort.

AT the annual meeting of the Cambridge Philosophical Society, held on October 28, the following were elected for the session 1912–13:—*President*, the Master of Christ's (Dr. A. E. Shipley); *Vice-Presidents*, Prof. Hopkinson, Prof. Wood, and Prof. Pope; *Treasurer*, Prof. Hobson; *Secretaries*, Mr. A. Wood, Mr. F. A. Potts, and Mr. G. H. Hardy; *New Members of the Council*, Dr. Marshall, Mr. G. R. Mines, Rev. Dr. Barnes, and Mr. F. J. M. Stratton.

AT the statutory meeting of the Royal Society of Edinburgh, held on October 28, the office-bearers for the ensuing year were elected, as follows:—*President*, Sir William Turner, K.C.B., F.R.S.; *Vice-Presidents*, Dr. J. Horne, F.R.S., Dr. J. Burgess, Prof. T. Hudson Beare, Prof. F. O. Bower, F.R.S., Sir Thomas R. Fraser, F.R.S., and Dr. B. N. Peach, F.R.S.; *General Secretary*, Dr. C. G. Knott; *Secretaries to Ordinary Meetings*, Dr. R. Kidston, F.R.S., and Prof. A. Robinson; *Treasurer*, Mr. J. Currie; *Curator of Library and Museum*, Dr. J. S. Black; *Councillors*, Dr. R. H. Traquair, F.R.S., Prof. J. Walker, F.R.S., Sir W. S. M'Cormick, Prof. Crum Brown, F.R.S., Prof. T. H. Bryce, Mr. W. A. Carter, Mr. A. Watt, Dr. J. H. Ashworth, Prof. George A. Gibson, Prof. R. A. Sampson, F.R.S., Prof. D'Arcy W. Thompson, C.B., and Prof. E. T. Whittaker, F.R.S. It will be noticed that Dr. Knott has been elected general secretary to the society in succession to the late Prof. Chrystal. Dr. Knott served on the council of the society for the periods 1894–97, 1898–1901, 1902–05, and was appointed one of the secretaries to ordinary meetings in 1905, which office he held until his election as general secretary.

THE annual dinner of the London School of Tropical Medicine was held at Prince's Restaurant on October 23. General Sir Reginald Talbot presided, and among others present were Lord Sheffield, Sir John Anderson, Sir Francis Lovell, Colonel Alcock, Dr. Frank Heath, Mr. H. J. Read, and Prof. Simpson. Sir Ronald Ross proposed the toast of "The School," and commented on the importance of tropical sanitation and on the debt which the Empire owed to the discoveries in tropical medicine and to the work of the doctors in this connection. Sir Patrick Manson, who responded, alluded to the efforts of Mr. Joseph Chamberlain, Mr. Harcourt, and Mr. Austen Chamberlain in the cause of tropical medicine. He reviewed the work of the school, and announced that next year a research scholarship, endowed by the bequest of Lord Wandsworth, would be available. In the course of the evening the Chairman referred to the donation of 100*l.* by his Majesty the King to the funds of the school announced that morning.

IN the second part of his usual series, "Visvakarma," devoted to the collection of examples of Indian art, Dr. A. K. Coomaraswamy gives several illustrations of statues of the god Siva, chiefly from the southern part of the peninsula. The statues of Krishnaraya and his queen from North Arcot are particularly interesting. The photographs are fairly well reproduced, but scarcely possess that delicacy which appears in similar pictures in Mr. V. Smith's "History of Fine Art in India and Ceylon."

IN *Bedrock*, the new quarterly review of scientific thought, for October, Prof. A. Keith gives a careful account of our present knowledge of prehistoric man. The recent discoveries in the region of the Dordogne have shown that Neanderthal man is confined to a restricted and comparatively late date in the Pleistocene epoch, appearing for a period, and then being replaced by modern man. But anatomical and archæological evidence agrees in showing that he could not have been transformed into modern man. Work in England proves that we must go much further back in the geological record to find our ancestral form. At least in the middle of the Pleistocene period, long before Mousterian Neanderthal man in France, modern man had appeared in England. The most likely formations from which further clues are possibly to be obtained are the Pliocene and Pleistocene strata of East Anglia. In particular, care must be taken to ensure that every quarry and excavation in that region is watched, and that no remains are discarded as lacking scientific interest simply because they resemble those of modern man.

Mr. T. Sheppard, the energetic curator of the Hull Museum, continues the issue of the series of cheap interesting pamphlets descriptive of collections under his charge, or recording new discoveries in the city and its neighbourhood. Most of the relics found in the city itself belong to the latter part of the sixteenth century and the seventeenth, and it is surprising that relics of later periods are comparatively infrequent. Hull ale has been noted for many centuries, and hence tygs or loving-cups and Bellarmine jars or "Greybeards" are particularly numerous. Another of Mr. Sheppard's pamphlets discusses, with abundant details, the early Hull tobacco pipes and their makers. Among recent additions to the museum collections may be noted a fine Neolithic celt from the neighbourhood of Knaresborough, and a remarkably fearsome man-trap, used before the prohibition of such instruments of torture by an Act passed in 1827. At Bridlington a gold half-noble of Edward III. was recently discovered.

The marvellous escape of the Danish explorer, Mikkelsen, from Greenland, in July last, after nothing had been heard of him and his companion for nearly two years, will be fresh in the memory, and it will also be recalled that he recovered the journals of the lost explorer Erichsen, which had been left at Denmark Fiord. The Danish *Geografisk Tidskrift* (No. 5, 1912), therefore, appropriately publishes maps representing the results of Erichsen's surveys in 1906–8, which, among many important features, reveal the extension of Greenland much further east than was previously believed. Working from Denmark Harbour northward to 79°, the surveyors found a much-broken coast with many islands; northward of that latitude the coast-line was found somewhat more regular. The series of maps referred to not only shows the north-east of Greenland generally, but also includes various detailed maps of Denmark Harbour and other small areas in its neighbourhood.

We are indebted to Messrs. Friedländer, of Berlin, for a sale catalogue of general scientific literature (*Naturae Novitates*), and a second devoted exclusively to entomological publications (*Entomologische Litteraturblätter*).

In the report of the Museums of the Brooklyn Institute for 1911 acknowledgment is made of the extent to which their present attractiveness is due to the efforts and energy of Dr. F. A. Lucas during the period he held the chief curatorship (1904–11). When he came the collections were little more than heterogeneous accumulations, whereas they are now a model of orderly, effective, and attractive arrangement. They have, however, already outgrown the present accommodation, which is liable to destruction by fire, and the urgent need of the institution is a new and fireproof building, specially designed for the purpose it is intended to fulfil.

The Museums Journal for October devotes an article to museum guides—that is to say, living guides, in contradistinction to guide-books—in which Mr. J. H. Leonard gives the results of his experiences in that capacity at the Natural History Museum. He insists on the importance of varying the discourse according to the nature of the particular audience, and strongly deprecates the adoption of a standard curriculum for all occasions. In addition to pointing out objects of special interest, it is urged that the elimination of popular errors should be one main object of the guide. Both at Bloomsbury and South Kensington the guides appear to be highly appreciated by a considerable section of the public.

Evidence of the intimate affinity between the faunas of Central China and North America—and therefore of the essential unity of the so-called Palæarctic and Nearctic regions—continues to accumulate, the latest instance of this occurring in an article by Mr. O. Thomas in the October number of *The Annals and Magazine of Natural History*, on certain small mammals collected by Mr. G. Fenwick Owen in Kan-su and Shen-si. Among other new forms are two specimens of a black mole-like insectivore of the size of a large shrewmouse, representing a new genus (Scapanulus) more nearly allied to the American moles, Scalops and Scapanus, than any other Asiatic form. They were obtained among the mossy undergrowth of a pine-forest in Kan-su. *Scapanulus oweni*, as the species is called, has the fore feet almost as broad, relatively, as in the true moles, with rather slender claws; those of the hind foot, with the exception of the first, being but little curved. The relatively long tail is thickly haired. The teeth may apparently be classified as

$$i\frac{2}{2},\ c.\frac{1}{1},\ p.\frac{3}{3},\ m.\frac{3}{3},$$

or numerically the same as in the Sze-chuan Neotetracus. The lower incisors are, however, very similar to those of the desmans, a feature broadly separating the genus from Scaptonyx, an allied Sze-chuan type.

Some beautiful photographs of the secondary structure of the diatom valve, taken by Mr. T. F. Smith, are reproduced in *Knowledge* for October. The structures in question, which are only visible with the finest homogeneous immersion objectives, were first discovered by Messrs. Nelson and Karop. Mr. Smith has conducted his investigations on slightly different lines; in particular he prefers to photograph the structures at the "white dot" instead of the "black dot" focus. The photographs show a general resemblance between the secondary structures of different species, although the pretty rosettes differ considerably in their arrangement. Photographs of the fibrils detached from torn valves are given.

MR. C. B. CRAMPTON has followed up his recent work on the vegetation of Caithness by a series of articles in *The Scottish Botanical Review*, of which a reprint has reached us. This important paper discusses in detail the geological relations of stable and migratory plant-formations. After dealing with the conceptions of the plant-formation given by various ecological writers, the author distinguishes two classes of habitats differing in the changes or successions shown by the vegetation and in the limits set to the stability attainable by this vegetation. The two classes of plant-formations, which tend to overlap and invade each other's territory owing to the migratory nature of the geological agents of surface change, are: (1) stable formations, the plant-associations of which have their centres of distribution on ground which has for a long period been comparatively stable from the geological point of view; and (2) migratory formations, the associations of which have their distribution centres in areas within the sphere of influence of the geological agents of surface change. The author works out his conceptions in detail, applying them successfully to the various types of vegetation found in this country in particular, and gives a useful bibliography of recent ecological literature.

AN interesting note on the cold August and September in London is published in *Symons's Meteorological Magazine* for October. Dr. Mill states that the long record at Camden Square (N.W. London), dating from 1858, contains no instance of any previous August or September with a lower mean temperature. The mean for August, 57·9°, was 4·4° below the average, and it was the coolest August in the fifty-five years' record. In September the mean was 54·1°, or 3·6° below the average. The shade maxima records are more remarkable than the minima; in August the mean shade maximum was 66·6°. August, 1860 and 1912, are the only months of that name in which the shade temperature failed to reach 77°. In 1912 the highest recorded was 73·2°. In September the mean maximum, 62·4°, was the lowest on record for that month, and the absolute maximum, 69·4°, was the lowest recorded in any September. Dr. Mill remarks that it is of considerable interest that fifteen consecutive months with mean temperatures above the average, May, 1911, to July, 1912, should be followed by two months of unprecedentedly low temperature.

THE meteorological charts of the Indian Ocean for November, issued by the Meteorological Office and by the U.S. Weather Bureau, both contain useful articles on the cyclones of the South Indian Ocean. Both are based to a great extent on the cyclone tracks compiled by the late Dr. Meldrum, of Mauritius, and his successor, published by the Meteorological Committee. The cyclone season for this part of the ocean is from November to May inclusive, but storms are occasionally met with in other months; the maximum frequency is from December to March. The majority of the storms follow parabolic tracks, and, as a rule, recurve between latitude 20° and 22° S. Broadly speaking, the storms are found to originate somewhere along the parallel of 10° S.; "thence they travel south-westward over a track that trends more and more southerly until the vertex is attained; afterwards the track recurves to the south-eastward." The Meteorological Office chart also gives very interesting details respecting the behaviour of storms in the Bay of Bengal and the Arabian Sea.

THOSE who are interested in the study of the geometry of the triangle will welcome the publication of a monograph of more than fifty pages by the late Prof. G. Sidler in the *Mitteilungen der naturforschenden Gesellschaft in Bern* for 1911, published this year. The original manuscript was completed in 1902, but a difficulty occurred with the figures, which were of great complexity, and the arrangements for publication were terminated by the death of the author. The manuscript, which was in the possession of Prof. Sidler's widow, has now been edited by Dr. O. Schenker.

A PAPER by Mr. A. Ferguson on the genesis of logarithms, in *Science Progress* for July, should prove interesting and useful reading to mathematical teachers and others. Mr. Ferguson has carefully studied Napier's "Mirifici Canonis Logarithmorum Descriptio" and other authorities, and many of the facts brought to light are little known. The paper gives in a simple and intelligible form the methods by which logarithmic tables were constructed from first principles without the use of the modern infinite series or the calculus, and it affords historical evidence in support of the modern methods of teaching the use of logarithms without assuming the definitions of negative and fractional indices.

As is well recognised, the old system of gauging the strength of concentrated radium preparations in terms of uranium, the "activity" being expressed as so many million uranium units, is practically meaningless, on account of the impossibility of comparing together the radio-activity of two elements, so different both in the character and in the intensity of the radiations they emit. The announcement by Messrs. Hopkins and Williams, Ltd., Hatton Garden, E.C., that in future their radium preparations will be sold on the basis of the actual quantities of radium they contain is therefore a step in the right direction. We understand that they measure their preparations against a standard certified by Mme. Curie to contain a definite quantity of radium bromide, and have for disposal a considerable quantity containing from 90 to 92 per cent. of radium bromide.

SINCE the echelon spectroscope first disclosed the complex structure of many spectral lines previously thought to be simple, the question of the exact composition of these lines has become a serious one owing to the divergent results obtained by observers working with different instruments. The green mercury line 5461×10^{-8} cm., for example, has by various observers been resolved into from seven to twenty components. The higher numbers appear from the more recent work to be due to spurious lines produced by internal reflections in the instrument or other causes. The simple method suggested by Mr. Twyman of altering the focussing, when true lines should go out of focus and spurious lines behave irregularly, seems not to have been applied by any of the earlier observers. The favourite method has been to combine two instruments giving dispersions at right angles to each other, the two producing a series of interference points. Dr. L. Janicki, of the Reichsanstalt, using two Lummer plates, one of which was slightly wedge-shaped, has recently shown in this way that the 5461 line consists of twelve components, the line previously regarded as the principal line consisting really of a group of five.

THE study of the characteristics of the motion of a train during the accelerating period has assumed an importance indicated by the fact that the actual choice of a method of traction for services of a suburban character depends upon the suitability of the tractor to work the train during the accelerating period. Prof. W. E. Dalby, in a paper read at the Institution of Mechanical Engineers on October 25, describes a useful method by means of which time-speed, time-distance, speed-distance, and energy-distance curves may be derived from a curve of tractive force expressed as a function of the velocity. A method of reducing the data obtained from a dynamometer-car record is also considered, together with the illustration, by means of a dynamical diagram, of the principles underlying the practice of braking. The accuracy of the curves deduced can be easily checked. The whole family may be drawn rapidly by means of the integraph, starting with a curve of tractive-force.

A SECOND edition of "The A.B.C. Guide to Astronomy," by Mrs. H. Periam Hawkins, has been published by Messrs. Simpkin, Marshall, Hamilton, Kent and Co., Ltd. The book has been brought up to date, and a photograph of the zodiacal light, taken by Prof. Douglass, at Flagstaff Observatory, Arizona, U.S.A., has been included as a frontispiece. The price of the little volume is 1*s*. 6*d*. net.

A CHEAP edition of Captain Mayne Reid's "The Naturalist in Siluria," has been published by the Year Book Press. The price of the volume is 2*s*. net. From his house in the Woolhope district, the author could look over the whole series of Upper Silurian rocks, from near Hereford in the north to their southern projection by Gorstley, in Gloucestershire. Many dwellers in this naturalist's paradise, as Mayne Reid called it, will welcome this reprint of his observations.

PROF. S. W. WILLISTON'S "American Permian Vertebrates," which was reviewed in NATURE of October 24, was published in 1911. There was no date on the title-page, and therefore we printed the letters "n.d." with the bibliographical particulars at the head of the notice. The manager of the Cambridge University Press now points out that at the back of the title-page it is stated that the volume was published in Chicago in October, 1911. We cannot attempt, however, to do more than give particulars from the title-pages themselves at the head of notices in our review columns.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR NOVEMBER :—

Nov. 4. 15h. 0m. Mars in conjunction with the Sun.
5. 21h. 0m. Pallas in conjunction with the Moon (Pallas 0° 26′ N.).
7. 15h. 59m. Venus in conjunction with Jupiter (Venus 1° 43′ S.).
8. 13h. 28m. Mars in conjunction with the Moon (Mars 3° 7′ N.).
10. 6h. 50m. Mercury in conjunction with the Moon (Mercury 1° 54′ N.).
11. 1h. 21m. Jupiter in conjunction with the Moon (Jupiter 5° 5′ N.).
,, 8h. 21m. Venus in conjunction with the Moon (Venus 3° 21′ N.).
13 to 15. Maximum of Leonid Meteor Shower.
14. 7h. 59m. Uranus in conjunction with the Moon (Uranus 4° 27′ N.).
19. 1h. 0m. Mercury at greatest elongation east of the Sun (22° 14′).
20. 16h. 54m. Mercury in conjunction with Jupiter (Mercury 2° 47′ S.).
22. 18h. 0m. Saturn at opposition to the Sun.
24. 3h. 47m. Saturn in conjunction with the Moon (Saturn 6° 17′ S.).
27. 20h. 49m. Neptune in conjunction with the Moon (Neptune 5° 33′ S.).

SCHAUMASSE'S COMET 1912*b*.—The identity of the comet discovered by M. Schaumasse on October 19 with Tuttle's comet, last seen in 1899, is shown by the elements for its orbit, published in Circular No. 136, from the Kiel Centralstelle, and given below in the first column :—

	1912*b* (Fayet and Schaumasse)		Tuttle's (Rahts)	
π	=113° 50′ 20″	1912·0	=116° 29′ 3″	1900·0
☊	=270 23 58	1912·0	=269 49 54	1900·0
i	= 53 52 34	1912·0	= 54 29 16	1900·0
q	=1·0506		=1·0191	

According to the new elements, perihelion passage took place on October 25·3153 (Paris M.T.), when the comet was some 97·6 million miles from the sun. The previously calculated time of perihelion was January 3, 1913, and thus, as a writer in *The Times* (October 24) points out, the present revolution is the shortest on record, as was also the case with the last return of Halley's comet. The difference of seventy days between the calculated and actual returns will probably be disclosed when the planetary perturbations during the last cycle are taken into account.

The ephemeris given in the Centralstelle circular indicates that the comet will not become brighter, is travelling southwards rapidly, and will not be visible in the northern hemisphere after November 23.

Ephemeris 12h. (M.T. Paris).

1912	α h. m.	δ ° ′	1912	α h. m.	δ ° ′
Oct. 30 ...	10 30·9 ...	−12 41	Nov. 7 ..	10 54·5 ...	−22 2
Nov 3 ...	10 42·6 ...	−17 25	,, 11 ...	11 6·7 ...	−28 37

GALE'S COMET 1912*a*.—A number of observations of comet 1912*a* are published in No. 4606 of the *Astronomische Nachrichten*, and a photograph by Mr. H. E. Wood at Johannesburg is reproduced. On September 13 the comet was visible to the naked eye, magnitude 5, and had an almost stellar nucleus surrounded by an even coma 4′ in diameter. The tail was fan-shaped, with an angle of about 60°, the branch to the south being 40′ long, while the south-following branch had a length of 1°. On a photograph taken with the Franklin-Adams camera, exposure 40m., the former branch is the same length, but the latter is 4° long, and slender, having a contortion 0·75° from the nucleus. On September 15 this contortion was 1·4° from the head, and the tail, 5¼° long, was clearly double 2½° from the head.

Ephemeris 12h. M.T. Berlin.

1912	α (true) h. m.	δ (true) ° ′	log r	log Δ	Mag.
Oct. 31	16 2·1	+23 55·2			
Nov. 2	16 3·8	+25 21·6	9·9605	0·0988	7·0
4	16 5·4	+26 45·8			
6	16 7·0	+28 8·3	9·9832	0·1052	7·2
8	16 8·6	+29 29·5			
10	16 10·3	+30 49·7	0·0057	0·1105	7·3
12	16 12·0	+32 9·0			
14	16 13·7	+33 27·8	0·0280	0·1145	7·5

Dr. Ebell calculated the brightness, by the formula $1/r^2\Delta^2$, on the assumption that on September 26 the magnitude was 6·0, but Mr. Franks found it to be a little more than 4·0 on October 11, while, in a good sky, M. Gonnessiat estimated it as 5·5 for the whole comet, on September 29. There appears to be definite evidence for an intrinsic brightening while near perihelion.

THE TOTAL SOLAR ECLIPSE OF OCTOBER 10.—A telegram from Prof. Morize to the *Astronomische Nachrichten* (No. 4606) states that the observations of the total eclipse at Christina (Minas Geraes, Brazil) were spoiled by rain, although some selenium-cell observations of brightness were made by Dr. Ristenpart. Prof. Perrine, cabling to Prof. Pickering from Brazil, also states that rain prevented observations. A further telegram, published in No. 4607 of the same journal, announces that the eclipse was observed under favourable conditions at Quito by Señor Tufiño.

INTERNATIONAL STANDARD TIME.—The *Revue générale des Sciences* (No. 19) gives an outline of the present state of the question of the international standardisation of time, and the programme prepared for discussion at the International Conference which met at the Paris Observatory on October 15. The acceptation by France of the international *réseau* removed the last great obstacle to the unification of standard times, and the general distribution of time-signals by wireless telegraphy makes this unification more than ever necessary. It has been found that signals sent from different stations show inconsistencies amounting to several seconds, not very serious in ordinary affairs, but fatal in matters demanding scientific precision. To remedy this state of affairs the Bureau des Longitudes invited the International Conference to reassemble in Paris, and drew up a tentative programme of the matters for discussion. Under seven main headings this programme practically exhausts the debatable points concerning the determination of time, the methods of keeping it, and of distributing it by radio-telegraphy and otherwise, the precision necessary for different purposes, and the general question of how to organise internationally in order to gain these ends.

THE ORIGIN OF LIFE.

ONE of the most interesting of the recent meetings of the British Association at Dundee was that devoted by the joint sections of Zoology and Botany to the discussion of the problem of the origin of life. It should be remarked that this was not a discussion of the President's address; it was arranged before the subject of the presidential address had been made known. The President (Prof. E. A. Schäfer), who occupied the chair at this meeting, explained at the outset that his address had been written and printed before he knew that this discussion was to take place.

Prof. E. A. Minchin, in opening the discussion, pointed out that the problem of the origin of life involved two inquiries, both of which were at present of a speculative order, namely: (1) the nature and characters of the earliest living beings, and (2) the manner in which the primordial form of life took origin and maintained its existence upon the earth. The first of these problems could be considered with profit, but the second, owing to the inadequacy of the data available, appeared to him to be scarcely ripe for discussion. He observed that the cell, which might be defined as an individualised mass of protoplasm containing at least one nucleus, was generally regarded as the simplest type of organism, and as the vital unit in the composition of living beings, whether plants or animals. It was improbable that the earliest forms of life came into existence as organisms composed of two distinct structural elements—the nucleus and the cytoplasm (body-protoplasm). Which of these—the cytoplasm or the nucleus—was to be regarded as representing or containing the most primitive elements of the living substance? By most biologists the cytoplasm had been considered to represent the true living substance, and the earliest living organisms—the so-called Monera—had been supposed to be formless masses of protoplasm without nuclei.

Prof. Minchin proceeded to advance reasons for believing that the chromatin substance invariably present in the nucleus, or occurring as grains (chromidia) scattered in the cytoplasm, represented the primary and essential living matter. In support of this view he pointed out that chromatin is always present in the bodies of living organisms of all kinds, that cells cannot continue to live if deprived of their nuclei, that in reproduction by fission the chromatin divides first and is distributed among the daughter-individuals, that the complex process of division of the nucleus known as karyokinesis may be regarded as a mechanism gradually evolved and perfected for ensuring an exact quantitative and qualitative partition of the chromatin between the daughter-nuclei—an indication that the chromatin is of prime importance—that the chromatin-substance plays an essential part in syngamy (fertilisation) and probably also in heredity (as carrier of the characters of the organism), that the nucleus is essential for the continuance of the secretory activities of the cell, and, finally, that in some of the minutest living organisms—*e.g.* spirochætes and the male gamete of the malaria parasite—the body appears to consist mainly or entirely of chromatin, and cytoplasmic elements are reduced to a minimum or are altogether absent. Prof. Minchin quoted from a communication received recently from a correspondent, who pointed out that the protein molecules of the nucleus are simpler in constitution than those of the cytoplasm, and therefore may be regarded as more primitive. Further, the amido-acids characteristic of the nucleus are of the open-chain order and free from complexity, while those of the cytoplasm are of the closed order and could only have arisen from the type of acids present in the nucleus. For these reasons Prof. Minchin regarded the chromatin as the primitive living substance, and held the view that the earliest forms of life were very minute particles of chromatin, round which, in the course of evolution, achromatinic substances were formed. Within the cytoplasmic envelopes thus produced the chromatin-grains increased in number, and organisms of the degree of structural complexity of a true cell arose finally by concentration of the chromatin-grains into a compact organised mass—the nucleus proper.

As regarded the origin of the earliest living beings, it was only possible to frame vague speculations, in the present state of our knowledge, concerning the chemistry of the protein compounds, on the one hand, and the metabolism and modes of life of the simplest living things on the other. He referred to the extreme view, represented by Arrhenius, that life had had no origin in finite time, but was coeval with matter and energy, and then turned to consider the view, more prevalent among biologists, that living matter had arisen at some time from that which was not living. If life arose under conditions not now existing in nature, there seemed to be no reason why such conditions could not be reproduced artificially, but if the conditions under which life arose *de novo* were not different from those existing there seemed to be no reason why it should not do so again. Why, then, did we not see new forms of life appearing on the earth? Prof. Minchin doubted if the simplest forms of life were yet known, or even if we could recognise them or be aware of their existence at their first appearance. The first origin of life involved a synthesis of protein substances in nature by some process as yet totally unknown. For light on these problems we must look to the future advance of knowledge, and especially of chemical science. In the present state of our knowledge, the attitude towards the problem of the origin of life could only be one of expectancy for more light in the future; at present it was not possible to frame a hypothesis which could have any greater value than that of a pious belief.

Mr. Harold Wager said that the more one saw of the lower forms of life, the more remote seemed to become the possibility of conceiving how life arose. He opposed Prof. Minchin's view that chromatin was the primary living substance, and in support of his contention referred to the structure of the blue-green algæ. These, he said, were interesting as the only organisms which would survive in very hot water (*e.g.* hot springs), and had been regarded as probably the last remnants of the early vegetation of this earth. Each cell of those algæ contained an irregular network of chromatin without a limiting membrane, and not clearly differentiated from the surrounding protoplasm, *i.e.* the chromatin more nearly resembled the cytoplasm in these than in higher organisms. Further, in certain bacteria there were granules of nuclear matter, but in others there were none, the organism consisting of cytoplasm only. These facts impelled Mr. Wager to regard the cytoplasm, and not the chromatin, as the fundamental life-substance.

Prof. F. W. Keeble thought that, having regard to the highly complex interacting phenomena presented by living organisms, it was improbable that the creation of "synthetic life" would be seen in the near future.

Prof. A. B. Macallum believed, with Tyndall, that matter was endowed with the potentiality of life, and to that extent he was in sympathy with the view of Arrhenius. No doubt the organism which first came into existence was ultra-microscopic, and comprised but a few molecules. The conditions necessary to produce such organisms do not now hold, but at one time the earth's surface was a vast laboratory in which syntheses of various kinds took place, and a favourable conjunction of forces produced the combination of a number of molecules in which life was. This organism would not be a cell, with cytoplasm and nucleus, but an ultra-microscopic body. The cell was as far removed from such a minute body as man is from the cell.

Prof. Benjamin Moore said that vitalism was a purely static view of life, and was untenable. Structure was important, but something more than structure was necessary for life; dynamic energy—energy, motion, change—was essential, and was manifest in all living organisms. To suppose that life began as blue-green algæ, or some such complex organism, was nonsensical. It was necessary to begin with the formation of organic molecules from the inorganic, then to build up more complex molecules (in which all the atomic combinations were saturated), and group them into colloidal substances. The colloids, which are large aggregates of molecules, show the properties of dawning life, for in presence of sunlight colloids begin to form organic bodies, but it would be necessary to add to the colloid an energy-transformer. He regarded the problem under discussion not as metaphysical, but experimental.

Prof. J. S. Macdonald regarded the problem from the point of view of a physiologist, and said he could not accept the statement that chromatin was the most important portion of the living cell, for in muscle the contractile mechanism is located in the cytoplasm, the functional activity of a red blood-cell is resident in the cytoplasm, and the main functions of the central nervous system are also associated with the cytoplasm. He held, therefore, that the nuclear material was not concerned in carrying out the main functions of the body.

Prof. Marcus Hartog referred to the power of multiplication of organisms, and said he could see no reasonable probability of our being able to create life afresh, or, indeed, to understand how it came into existence.

Prof. Patrick Geddes put forward a plea for the psychological aspect of the inquiry, for he held that even the simplest organisms presented a dawn of psycho-biosis, and that life was not merely a question of matter (*e.g.* chromatin).

Dr. J. S. Haldane said he belonged to a school which believed life could not be explained, or interpreted finally, by the known chemico-physical properties of matter, and he could not imagine any laboratory experiment, according to our present knowledge, which would bring us any nearer to the origin of life.

The Rev. T. R. R. Stebbing pointed out that for years past many evolutionists had recognised, as a necessity of the theory, that organic life must have been derived from what was inorganic, and that it was reassuring to find that this *a priori* speculation could be supported on grounds of scientific probability.

Dr. P. Chalmers Mitchell stated that in his opinion there was not a single property of protoplasm which had not its exact physical parallel, nor a single quality of life which would show there existed in life something which was not to be found in matter.

J. H. A.

THE SCIENTIFIC THEORY AND OUTSTANDING PROBLEMS OF WIRELESS TELEGRAPHY.[1]

IN opening a discussion on the present state of the theory of wireless telegraphy and its outstanding problems, I am, to some extent, embarrassed by the wide field which presents itself for consideration.

I venture to think that we may best take advantage of the simultaneous presence here of physicists, mathematicians, engineers, and electricians, if we endeavour to focus attention, in the first place, on some of the chief scientific problems which are yet unsolved in connection with it.

Perhaps a word of explanation may be offered on the reason for giving prominence to the scientific aspect of the subject rather than its practical achievements. The achievements loom large in the public eye, and are astonishing to the uninitiated, but experts in radio-telegraphy are well aware that many of the

[1] Introductory remarks by Prof. J. A. Fleming, F.R.S., at a joint discussion by Sections A and G of the British Association at Dundee.

scientific phenomena are imperfectly understood. If we are to overcome present difficulties and limitations and make fresh advances, it can only be by a thorough comprehension of the physics of wireless telegraphy. Hence it will be more to our advantage to bring combined scientific thoughts to bear upon the matters on which even leading experts differ or are ignorant, rather than let our symposium resolve itself into a discussion on apparatus or systems or the recitation of performances and the record of results.

As the only type of wireless telegraphy which has any considerable theoretical interest at the present time is that involving the application of unguided electromagnetic waves, our attention will doubtless be chiefly directed to it.

Starting from the discoveries of Hertz and his followers, we enter a new era. Apart from Marconi's improvements in the metallic filings coherer of Hughes, Branly, and Lodge, the important element in the arrangements by which in 1896 he applied purely scientific knowledge of Hertzian electric waves to practical electric waves or radio-telegraphy was the introduction of the long, nearly vertical aerial wire, as a radiator combined with a metal plate above or buried in the earth as the balancing capacity. In this wire high frequency oscillations are created; originally by using the wire itself as one electrode of an air condenser, and the earth as the other, but later on by inducing oscillations in the wire by means of the dead-beat or oscillatory discharge in another condenser circuit including a spark gap, coupled to the air-wire circuit. Although enormous ingenuity has been expended in improving or varying every element in the appliances, we can say that with the exception of a small number of stations using the Duddell-Poulsen arc generator, nearly all the practical wireless telegraphy in the world is at present (1912) conducted by the following apparatus.

At each station there is a transmitter which comprises three elements:—

1. A source of high electromotive force which may be a continuous-current dynamo and storage battery, an alternator and transformer, or a battery and induction coil giving continuous, alternating, or interrupted high-tension electromotive force.

2. A condenser in which the generator stores an electric charge to be suddenly released when a certain potential is attained across a spark gap in the form of an electric discharge passing through a coil in series with the condenser.

3. An open or radiative circuit coupled to the condenser circuit, comprising an antenna or arrangement of elevated air wires, a balancing capacity or counterpoise often buried in the earth, the two being connected through an adjustable inductance coil.

At the receiving station we have also three elements:—

1. An absorbing antenna by which the radiation from the transmitter is picked up, creating in it high-frequency oscillations.

2. A condenser circuit having variable capacity and inductance coupled to the antenna and syntonised to it.

3. Some form of oscillation detector connected in series or parallel with the above condenser which is affected by the oscillations and sets in operation a recording or indicating device which makes a visible or audible signal.

Generally speaking, at any one station the radiating and absorbing antennæ are one and the same, and used for both purposes alternately, and each station has both transmitting and receiving apparatus. The functions are, however, not identical. What is required in the transmitting antenna is a certain height and also free or insulated ends. In the receiving antenna, not only height but surface is required, although this antenna can be laid parallel with and close to the earth and earthed at both ends; but provided it is half a wave length in length, it will still absorb a considerable amount of energy from electric waves arriving in its own direction.[2]

In the next place as to exact details, the following information may be useful to those who are not wireless-telegraph engineers.

The antenna consists of a large number of hard-drawn copper wires, which are upheld by masts or towers in such fashion that the wires form a sort of fan elevated in the air; or they may rise up for a certain height and then be bent downward on all sides, like the ribs of an umbrella. In the case of our battleships, they are groups of parallel wires kept separate by wooden stars and stretched between the masts and then led downwards to the bow and stern of the ship. In the high-power Marconi stations they rise up vertically for a certain distance, and are then stretched horizontally for a distance about five times greater, parallel with the ground.

In long-distance stations the wooden or steel lattice towers or tubular masts required to sustain these wires are elaborate structures 100 to 400 feet or more in height, and have to be well stayed to resist wind.

Associated with the antenna is a counterpoise or balancing capacity, which may consist of insulated wires stretched a little way above the earth, or radiating wires or metal nets laid in the earth, or sheets or nets of metal laid on the ground, or even the metal hull of a ship.

This counterpoise is connected to the antenna through a variable inductance coil. In virtue of the capacity of the antenna with respect to the earth or the counterpoise, the whole system has a natural time period of electrical oscillation.

It may be compared with an elastic steel strip held at the bottom in a vice and loaded at the top, which can be set in vibration by small blows administered to it at the proper rate.

There are certain rates of antenna oscillation reserved for certain purposes.

Thus, for ship or coast signalling, antennæ are used having natural time periods of one-millionth or one half-millionth of a second, and for large power stations the time period may be as large as one hundred-thousandth or one fifty-thousandth of a second.

In nearly all cases these oscillations are excited in the antenna by the intermittent discharge of a condenser. They are therefore damped or decadent trains of free oscillations, separated by intervals of silence. The group frequency, as it is called, or number of the trains of oscillations, is now usually 500 to 1000, since, when using the telephone as a receiver, the group frequency is preferably that frequency for which the telephone is most sensitive. Each train of oscillations may comprise 30, 50, or 100 oscillations having the antenna frequency. The antenna is, therefore, set in electrical vibrations, so that trains of electric currents run up and down it intermittently, say, 500 times a second, each train consisting of 50 or more decadent oscillations, whilst each oscillation or single current occupies a time between one fifty-thousandth of a second and one two-millionth of a second and its complete to and fro cycle.

These high frequency currents in the antenna are created by the induction of a nearly dead-beat or else an oscillatory discharge of a condenser. In small installations the condenser is a collection of Leyden jars, or, more conveniently, glass plates coated with

[2] Numerous patents have been taken out for methods of using an antenna at the same time for sending and receiving. The inventions of Mr. Marconi in connection with this matter are both practical and important, and are being carefully developed by him.

thin sheet zinc or tin, the plates being immersed in a metal or stoneware box of oil.

In the case of some high-power stations, Mr. Marconi employs large air condensers consisting of sheets of metal hung up on insulators in a room. At Nauen and at the Eiffel Tower stations tubular or plate-glass condensers are used.

The condenser is charged by the source of electromotive force to a high potential, and then discharged across a spark gap, with or without oscillations, and this discharge passes through a coil which may be one coil of a two-coil transformer, the secondary being inserted in the circuit of the antenna, or else a single-coil transformer, then called an auto-transformer, may be made to do duty for the two separate coils in the circuits of the antenna and the storage condenser.

An important element is the spark gap. In early days when only small powers were employed, this consisted simply of two stationary brass balls. When large power first began to be applied, as at the Poldhu Station in 1901, it was soon found that the oscillatory discharge started an electric arc across the balls which had to be extinguished before the condenser could again become charged. Also the balls became rapidly worn away. To remedy these defects, various inventions were introduced. An air blast was applied to the spark gap to quench the arc.

I devised for the Marconi Co. in 1902 a discharger with revolving balls or discs driven by an electric motor which overcame some of the difficulties, and this type of slowly rotating disc discharger using low-frequency sparks was used for some considerable time at Poldhu.

Later on Mr. Marconi invented his high-speed studded disc discharger which is far more efficient, and creates a quenched musical spark of the required character. In this discharger a steel disc having studs on it revolves at a high speed between two other revolving electrodes and the passage of the studs starts a condenser discharge in which any true arc is instantly quenched. The kind of discharge required for effective work is one in which rapidly repeated, strong, highly damped discharges take place in the primary condenser circuit, and these excite prolonged trains of free oscillations in the antenna. This is only possible if any true arc discharge in the primary circuit is entirely prevented.

This is also achieved by the Wien or Telefunken, the Peukert and Von Lepel dischargers consisting of flat metal plates in close proximity. In these dischargers the discharges succeed each other with great regularity and at the rate of several hundred per second. When the condenser circuit is properly tuned to the antenna circuit and coupled to it not too strongly (with about 20 per cent. coupling), we have powerful intermittent oscillations set up in the antenna, each group being very feebly damped and of uniform oscillation frequency. These rapidly succeeding groups of oscillations are cut up into groups of groups in accordance with the signals of the Morse alphabet by means of a key placed in some part of the circuit. Although nearly all the radio-telegraphy in the world is now conducted by means of these intermittent condenser oscillations, great efforts are being made to perfect suitable high-frequency high-power alternators, and the advent of a commercial machine of this kind will no doubt make it a formidable rival to the existing methods.

Deferring for the moment the consideration of what takes place in the space between the sending and receiving antenna, we may complete our description of the receiving apparatus.

In the sending antenna we have very powerful high-frequency currents at the base and high potentials at the free or upper end. Even in small stations the sending antenna current may have a value of 5 to 10 amperes, whilst in large stations the antenna current at the earthed end is 50 to 100 amperes, and large enough to raise to incandescence quite large rods of arc light carbon.

There is, therefore, a considerable expenditure of power on the antenna. A part of this is spent in heating the antenna, but a large proportion is radiated. Nevertheless, the over-all efficiency of the usual wireless telegraph transmitter using the ordinary unquenched condenser spark, meaning by that the ratio of power radiated from the antenna to power supplied by the operating dynamo or battery, is at present probably not more than 20 per cent. to 25 per cent. in actual practice, though much higher efficiencies, even up to 75 per cent., have been claimed for the quenched-spark system. But the evidence for these high efficiencies is somewhat imperfect.

An extremely small fraction of the whole radiated energy is picked up by the receiving antenna. In this latter we have currents created which are measured in micro-amperes, or, at best, in fractions of a milliampere. If the receiving antenna is properly tuned to a closed condenser circuit inductively coupled to it, the energy picked up by the receiving antenna accumulates in the associated condenser circuit.

In this last we then have feeble currents circulating which imitate in mode of variation those of the distant transmitting antenna. To detect them, it is now most usual to employ a telephone in series with some form of current rectifier, which is shunted across the condenser in the closed secondary receiving circuit, or else some form of current-operated detector, such as Marconi's magnetic detector, which is placed in the condenser circuit.

If we merely connect a telephone across the condenser circuit, no sound will be produced in it, because the frequency of the current oscillations in the receiving condenser circuit is too high to affect a telephone. If, however, we insert some device in series with the telephone which acts like a valve, it will rectify the groups of oscillations into prolonged gushes of electricity in one direction, which, coming at the rate of the much lower spark frequency, say, about 500 or 1000 per second, create in the telephone a shrill sound. As these groups are interrupted at the sending station in accordance with the Morse signals, the receiving operator hears long or short musical sounds which he can interpret into the letters of the alphabet.

Amongst the rectifiers much used, my own oscillation valve invented in 1904, or glow-lamp detector, is an interesting example. It consists of a little electric glow lamp, having a metal plate or cylinder sealed into the glass bulb. When the filament is incandescent the space between the filament and the plate has a unidirectional conductivity, and will allow negative electricity to pass from the filament to the plate, but not in the opposite direction.

Another large class of oscillation rectifiers are the crystal and contact rectifiers, the first of which, viz carborundum, was discovered by Dunwoody, others by Pierce and Pickard. Thus, for instance, a copper point pressed against a small mass of molybdenite is a good rectifier. Also the minerals chalcopyrite, zincite, bornite, anatase, and hessite possess similar properties, and a very sensitive rectifier is made by a slight contact between two small masses of zincite and bornite. Another rectifier is the galena-plumbago rectifier. Also a gold point pressed very lightly against an artificial surface of iron pyrites (ferric disulphide) makes an excellent detector.

In spite of much valuable work done by Prof. G. W. Pierce, G. W. Pickard, and others the action of these crystal rectifiers is by no means fully elucidated. It appears not to be thermoelectric, since in general the rectified current is in the opposite direction to the thermoelectric current produced by heating the junction.

In addition to these glow-lamp and crystal rectifiers another much-used detector is Marconi's magnetic detector, in which a slowly moving band of iron wires passes across the poles of a pair of horseshoe magnets. The wire at that place is embraced by two other coils of wire—one in series with the oscillating circuit of the receiver and the other with a telephone. When trains of oscillations are set up in the receiving antenna a listener at the telephone hears a sound due to the sudden change in the magnetic state of the iron. The simplicity and absence of any difficult adjustments make this magnetic detector one of the most useful for general purposes.

The wireless message is thus picked up at the receiving station by hearing telephonic sounds due to a greater or less number of trains of high-frequency oscillations in the transmitting antenna corresponding to *dashes* or *dots* in the Morse alphabet.

These long or short groups of oscillations in the transmitting antenna create similar groups in the receiving antenna, which, when rectified, cause gushes of electricity in one direction through the telephone, and therefore make sounds like ticks or musical notes of long or short duration. The pitch of this note is the frequency of the spark at the sending station.

One of the practical difficulties not yet quite overcome is the invention of a suitably simple and sensitive *call* signal. At present the operators have to sit with the telephone on their heads waiting for any message which may begin, and this is expert work which cannot be deputed to anyone else.[3] Another requirement is a simple and yet sensitive relay by which the messages may be printed down on paper tape. The photographic method employing the Einthoven galvanometer is effective but rather elaborate.

The recently invented alternating-current resonance relay of Dr. Kapp and Mr. H. von Kramer is sensitive, and can be operated with an alternating current having a frequency of about 100, and one-fifth of a milliampere in value. What is required is a relay sensitive to currents of a frequency varying between 50 and 500 or so, and a strength of about one-tenth of a microampere.

Having thus outlined the manner in which the radio-telegraphic message is sent, I now pass on to propound for your discussion certain imperfectly solved scientific questions. The first of these is:—

By what mechanism or process are the signals conveyed across the intervening space between the transmitter and the receiver? Most persons would say, at once, by electromagnetic or Hertzian waves, produced in the æther, and the answer is no doubt correct so far as it goes. The action of the sending antenna on the receiving antenna is not merely an instance of one electric current inducing another in a secondary circuit as in the magnetic induction form of telegraphy. In radio-telegraphy the energy sent out from the sender, no doubt, departs from it entirely and exists for a time in a medium before it reaches the receiver. The question is what is that medium? The whole of the actions in the sending antenna by which the distance effect is produced are consistent with the assumption that electromagnetic waves are sent out from it. But are these waves, strictly speaking, Hertzian waves or space waves? What part, of any, does the earth play in the process? Are the very long distances which can be covered by modern radio-telegraphy consistent with the properties of pure Maxwellian or Hertzian waves produced in the æther. These are the first unsettled questions I wish to throw down for discussion. As soon as Transatlantic signals had been received by the means already described, physicists began to ask how such waves, if they are true electromagnetic waves, are propagated one-eighth of the way round the earth. Since then Mr. Marconi has achieved the feat of receiving signals in South America from his Clifden station in Ireland at a distance of 6000 miles. The problem now is to explain how this effect travels one-quarter of the way round the earth. It suggests at once the query, could it go half-way round? Can wireless signals be received in New Zealand from England, and may we look forward not merely to Transatlantic or Transpacific, but to transterrestrial wireless telegraphy to the Antipodes as a practical possibility? The answer to these questions is necessarily connected with that to the more general question, how does the sending antenna affect the receiving antenna at any distance? In a year or more, when the Imperial wireless scheme comes into operation and the long-distance stations are completed, London will speak to Aden; Aden to Bangalore and Pretoria; Bangalore to Singapore; and thence the step will be easy to Australia and New Zealand. It is possible that we may yet communicate from London direct to Melbourne without the intermediate stations. In text-books and lectures it has been usual, for the sake of simplicity, to treat the problem of radio-telegraphy as if the earth were a perfectly conducting sphere immersed in free æther. A very little practical experience showed wireless telegraphists that the electric condition of the atmosphere greatly affected it, and that the receiving apparatus, so sensitive to waves intelligently sent out from transmitting stations, picked up in addition all manner of vagrant waves set going by atmospheric discharges. Also early attempts at long-distance radio-telegraphy led Marconi to the discovery of the great influence of daylight upon the distances attainable. If, however, we leave out of account for the present these atmospheric and daylight disturbances, to which we shall return presently, we have still to face the fact that the nature of the terrestrial surface between the sending and receiving station affects the result very appreciably.

Very early in the practical experience of radiotelegraphy it was found that it could be conducted more easily over sea than over land, and more easily over ordinary wet soil than over very dry sandy soil.

But apart altogether from this last effect, it has always been felt that there was something surprising in the fact that it is possible to detect electromagnetic waves created at a distance of one-eighth to one-quarter of the way round the world. It has been generally assumed that this was wholly due to an abnormally large diffraction effect. The first question of importance is, then, whether diffraction can occur to an extent sufficient to account for the observed facts. The determining factor as regards diffraction is the ratio of wave length to the earth's diameter.

In the early attempts at long-distance wireless telegraphy wave lengths of 2000 to 3000 ft. were used, but at the present time wave lengths from 10,000 to 20,000 ft. are employed, or, say, one-thousandth of the earth's radius.

Consider for one moment an optical analogue. The mean wave length of visible light is about 1/50,000th of an inch. Suppose a luminous point of infinitely small magnitude were placed at the pole on the surface of a smooth sphere a quarter of an inch in diameter or about the size of a pea, in a region otherwise not illuminated. This corresponds to the case of electric waves 1000 metres in wave length sent out from a

[3] The Marconi Co have recently introduced a call instrument, in which a signal equivalent to a prolonged *dash* on the Morse code deflects a galvanometer, which in turn closes a bell-battery circuit and rings a bell. The difficulty is, however, to prevent atmospheric discharges from making a false call, but render it sensitive only to a prearranged signal.

radio-telegraphic station on the earth's surface. Would there be any light due to diffraction at the equator or even at 45° latitude of this small sphere? It is essentially the province of the mathematical physicists to give us a solution of the above question, but the answer would, I think, be in the negative. To make the case comparable with that of the longest electric waves used for terrestrial radio-telegraphy, the sphere would have to be only the millimetre in diameter. The answer is then not quite so obvious.

The first attempt at the problem in the case of radio-telegraphic waves was made by Prof. H. M. Macdonald in 1903 and 1904.

Last year he published a second paper in the Transactions of the Royal Society on the same subject. In this last paper a table is given for waves of two wave lengths, viz., 0·2 mile and 0·25 mile, showing the ratio of the calculated amplitude of the received oscillations at a point at certain distances measured along a great circle of the earth to the amplitude which would exist if the earth were absent. For the two wave lengths, and for a distance of 651 miles, the ratios are respectively 0·06 and 0·07, or, say, 1 : 14. It may be remarked, however, that the wave length now used at Marconi's Clifden station in Ireland is nearly four miles, and that the maximum distance at which signals have been received is 6000, and not 600 miles. Hence, before Prof. Macdonald's table can be brought into comparison with the latest practice, his wave lengths must be increased twenty times, and his maximum distance ten times.[4]

In this second paper he refers to the previously published 1904 paper, in which he showed that the effect at a point on a perfectly conducting sphere due to a Hertzian oscillator near its surface was negligible in comparison with the effect which would have been produced at that point if the sphere were removed, when the point is at some distance from the oscillator, and the radius of the sphere is large compared with the wave length.

The same problem has also been discussed by Prof. H. Poincaré, whose recent decease we have so greatly to deplore, in a series of interesting lectures and papers.[5] In his latest memoir on the diffraction of Hertzian waves in the *Jahrbuch der Drahtlosen Telegraphie* for 1910, p. 445, Prof. Poincaré reaches the conclusion that the amplitude of the oscillations at a point on the earth's surface, which is separated from a transmitting station by an angle ϕ measured along a great circle through the stations, is proportional to an exponential function $\epsilon^{-m\omega\frac{\phi}{3}}$ where m is some numerical constant and ω is a complex quantity the real part of which is proportional to the frequency. This at any rate agrees with one result of practical experience, viz. that to effect radio-telegraphy over long distances large wave lengths are necessary. But it is difficult to extract from his conclusions means to enable us to predict the exact extent to which diffraction really exists for waves two to four miles in length.

The problem of the bending of electric waves round the earth has also been discussed by Dr. J. W. Nicholson in a series of able and critical papers.[6]

The conclusion arrived at by him after considering the work of Macdonald and Poincaré as the result of his own analysis can best be expressed in his own words (see *Phil. Mag.*, vol. xix., pp. 277–278, 1910).

He assumes that an oscillator is placed near the surface of the sphere with its axis radial, and he says: "On the confines of the geometrical shadow within a cone of small angle cutting off but a small portion of the terrestrial surface near the oscillator true diffraction bands are found, arising from terms now important in which the order and arguments are nearly equal. But within the shadow beyond the extreme generators of the cone, the extinction of the waves is very complete." "The harmonics of a high order are found to be so disposed as to neutralise one another in a remarkable way, and the intensity of the diffracted light at a distance of a few thousand miles round the surface sinks to a minute fraction of its value when the sphere is absent. Thus, it is improbable that diffraction can explain the effects unassisted by reflection from an ionised layer in the upper atmosphere, or by some other cause.

If this result is confirmed for wave lengths of four miles, or one-thousandth part of the earth's mean radius, then it will follow that ordinary diffraction is incapable of explaining long-distance radio-telegraphy, and we must look to some other cause. Before discussing the alternative which has been suggested both by Prof. Poincaré and Dr. Nicholson, I should like to direct your attention to an explanation of a quite different nature due to Prof. A. Sommerfeld, of Munich. Mathematicians who have dealt with the problem under the assumption of a perfectly conducting earth and a Hertzian oscillator entirely disconnected from it have assumed conditions which do not hold good in practice. Hence the attempt to explain long-distance radio-telegraphy by the aid of diffraction may be a quite unnecessary effort. The actual earth has a crust composed of materials which chiefly owe their conductivity to water. When free from water these materials composing the igneous and sedimentary rocks (apart from metallic veins and oxides and sulphides of heavy metals), such as granite, gneiss, quartz, slate, chalk, and sandstone are very fairly good insulators. Although sea water is a conductor, it has a dielectric constant ($K=80$) very far from infinite. Moreover, at no very great depth in the crust the temperature is sufficiently high to exclude the presence of liquid water, and therefore of any conduction due to it.

The numerical values which have been given for the materials composing the earth's crust are only very approximate. Experimentalists have mostly measured the resistance and dielectric constant of dry samples with continuous or direct currents. They have omitted to take account of the fact that non-metallic materials, such as quartz, felspar, mica, slate, &c., increase in conductivity with rise of temperature and also have a conductivity for alternating currents quite different from that for direct currents.

In the majority of cases these rocky materials are very good insulators. Thus dry granite has a dielectric constant about 7 to 8 and a specific resistance which may be as high as one thousand megohms per centimetre cube, and dry slate has a dielectric constant of about 12 and specific resistance of about 500 megohms per centimetre cube.[7]

[4] See H. M. Macdonald, Proc. Roy. Soc. London, vol. lxxi., A, p. 251, 1903; vol. lxxii., A, p. 59, 1904. The conclusions in the first paper were subjected to some criticism by Lord Rayleigh and Prof. Poincaré.

See Prof H. M. Macdonald, "On the Diffraction of Electric Waves Round a Perfectly Reflecting Obstacle," Trans. Roy. Soc. London, 1910, vol. ccx., A, p. 113.

[5] See Prof. H. Poincaré, "La Lumière Électrique," vol. iv., 1908, p. 323, December 12. Also *Comptes rendus*, April 29, 1909, and *Jahrbuch der Drahtlosen Telegraphie*, vol. iii., p. 445, 1910.

[6] See Dr. J. W. Nicholson, *Phil. Mag.*, 1910, 6th ser., vol. xix., pp. 276, 435, 516, 757.

[7] See "Dielektrizitätskonstante und Leitfähigkeit der Gesteine," by Heinrich Löwy (see *Annalen der Physik*, vol. xxxvi., p. 125, 1911, for a number of measurements of the dielectric constants and conductivity of earth's crust materials).

It has been shown recently in a paper by the present writer, assisted by Mr. Dyke, that the alternating current conductivity of insulators is a function of the frequency, and not by any means identical with the direct current conductivity, see Journ. Inst. Elect. Eng., 1912, "On the power factor and conductivity of dielectrics for alternating electric currents." In the case of such substances as marble, slate, and probably others, the conductivity appears to increase with the frequency up to a certain point and then diminish again.

The problem of the propagation of electric waves over the earth's surface involves, therefore, three important factors which greatly influence the result, first the imperfect conductivity and rather high dielectric constant of the earth, making it a semi-dielectric. Secondly, the effects of atmospheric ionisation, natural electrification, and sunlight, and, thirdly, the earth's curvature. The German mathematical physicists have of late years considered the first of these factors very carefully, and arrived at some interesting results, which I will endeavour to epitomise. Prof. A. Sommerfeld published in 1909 a very able paper on the propagation of the waves in wireless telegraphy over the earth's surface.[8]

He supposes that a small Hertzian oscillator is placed with axis vertical at the flat boundary surface of two media, each having conductivity σ, dielectric constant K. and permeability μ, and that the bounding surface is plane and indefinite. Taking E as the electric force and H as magnetic force, we have at any point in space the two circuital or Maxwellian equations fulfilled, viz. :—

$$K\dot{E}+4\pi\sigma E=c \text{ curl } H$$
$$-\mu\dot{H}=c \text{ curl } E.$$

where $c=3\times10^{10}$. The quantities E, σ and K are measured in electrostatic units and μ and H in electromagnetic. Hence, if E and H are both simple harmonic quantities of frequency n varying as the real part of ϵ^{-jpt}, where $p=2\pi n$, and if we write

$$k^2=\frac{\mu K p^2+jp4\pi\sigma\mu}{c^2},$$

we have
$$k^2H=\text{curl}^2 H,$$
$$k^2E=\text{curl}^2 E.$$

If we then take the magnetic force to be the curl of a vector potential Π and bear in mind that for vector fields with no divergence the operator

$$-\text{curl}^2=\Delta^2=\left(\frac{\delta^2}{\delta x^2}+\frac{\delta^2}{\delta y^2}+\frac{\delta^2}{\delta z^2}\right),$$

we see that Π satisfies the differential equation

$$\Delta^2\Pi+k^2\Pi=0, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and that
$$H=\text{curl } \Pi, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and
$$E=\frac{c}{4\pi\sigma-ipK}\Delta^2\pi. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If $r^2=x^2+y^2+z^2$, then a particular solution of (1) is

$$\Pi=\frac{1}{r}\epsilon^{jkr}.$$

To obtain a solution applicable to the case in question, we have to satisfy the boundary conditions.

These conditions are that the horizontal component of the electric force and the vertical component of the magnetic flux or induction must be continuous across the boundary. Taking suffixes 1 and 2 for the air and earth regions, these boundary conditions are

$$\Pi_1=\Pi_2\frac{\mu_1}{k_1^2}\frac{\delta\Pi_1}{\delta z}=\frac{\mu_2}{k_2^2}\frac{\delta\Pi_2}{\delta z}.$$

Sommerfeld then shows that a solution of the equation (1) is

$$\Pi=CJ_0(\lambda r)\epsilon^{\sqrt{\lambda^2-k^2}z},$$

where $r^2=x^2+y^2+z^2$ and λ is an arbitrary parameter, and $J_0(\lambda r)$ is a Bessel's function of zeroth degree.

By a series of difficult transformations, the validity of which must be tested by our pure mathematicians. Sommerfeld then proves that π can be expressed as the sum of three quantities P and Q such that

$$\Pi=P+Q_1+Q_2,$$

where the quantities Q_1 and Q_2 correspond to space waves (Raumwellen), and P to a surface wave (Oberflächenwellen).

It is, of course, not new to suggest that the waves involved in radio-telegraphy resemble electric waves on wires or are surface waves. It was long ago surmised that the sending antenna, the earth, and the receiving antenna might be regarded as one single oscillator in which oscillations were set up. This view has been held, amongst others, by A. Blondel, E Lecher, and F. G. Baily.[9]

Prof. Baily pointed out in 1903 that the energy of surface waves would decrease only inversely as the distance, and therefore at large distances survive when space waves would have vanished. The strict mathematical proof of their possibility has, however, only been lately given.

The space waves are subject to diffraction, and are hindered by obstacles. On the other hand, the surface waves pass round, and are unhindered, apart from damping, by the curvature of the surface. Also, owing to the surface waves decreasing in amplitude less fast with distance, the surface waves survive when the space waves are extinguished. If, then, Sommerfeld's investigation is valid, we need no longer seek for an explanation of such achievements as the detection of electromagnetic waves one-quarter of the way round the earth in any abnormal diffraction. If Sommerfeld is right, diffraction has nothing to do with the matter. The effect at such distances is entirely due to these "Oberflächenwellen," or surface waves, which, like electric waves or wires, are propagated along the surface, no matter what the curvature may be. There is a certain analogy between these space and surface electric waves, and corresponding effects in the case of earthquakes. From the time of Poisson it has been known that a shock communicated to an elastic solid created in it two waves, one of dilatation and one of distorsion, travelling at different speeds through the mass.

In 1885, Lord Rayleigh showed that, in addition, there was a surface wave dependent on the fact that the surface can be distorted and resists distorsion with a different elasticity to that of the interior of the mass.

These effects are recognised by seismologists as represented in the preliminary tremors and main shock in an earthquake.

In this case, two kinds of disturbance are found to be propagated through the earth, with velocities of 10 and 5 km. per second respectively. Also another main shock arrives later, which moves with a speed of about 3 km. per second. The latter is a surface wave travelling along the surface crust of the earth, and the two former are space waves travelling through the mass.

In the same manner we can say that in wireless telegraphy we are concerned with three waves—one travelling through the air above the earth, the second through the crust of the earth, and the third a surface or cylindrical wave, which is confined to a limited region at the boundary of the two dielectrics.

It is suggested, however, that long-distance radiotelegraphy is chiefly effected by means of the surface waves or "Oberflächenwellen" of Sommerfeld, which fall off in amplitude inversely as the square root of the distance and are not limited by diffraction as they follow round the surface. The earth's curvature

[8] "Ueber die Ausbreitung der Wellen in der drahtlosen Telegraphie," *Annalen der Physik*, vol. xxviii., p. 665, 1909.

[9] See A. Blondel, *Comptes Rendus du Congrès de Nantes*, 1898; also E. Lecher, *Physik. Zeitschr.*, vol. iii., p. 273, 1901, and Prof. F. G. Baily, Trans. Royal Scottish Society of Arts, February 9, 1903.

limits the range of the space waves seriously but does not so limit the surface waves.

One difficulty in reading Sommerfeld's paper is that he does not sufficiently translate his mathematical analysis into physical concepts. Hence it is desirable to consider a little in general terms how these surface waves arise.

(To be continued.)

MODERN PROBLEMS RELATING TO THE ANTIQUITY OF MAN.[1]

On my bookshelves there is placed a series of old volumes containing past reports of this Association, which fortune sent my way many years ago on a Whitechapel bookstall. Among them there is one volume I prize—that which contains the history of the meeting at Aberdeen in 1859. In that volume you will find an early phase of the subject of my discourse for this evening—the antiquity of man. Sir Chas. Lyell presided over the section of Geology; in his opening address he announced that "a work will very shortly appear by Mr. Charles Darwin—the result of twenty years' observation and experiment," and that the evidence which had accumulated in recent years "made it probable that man was old enough to have co-existed at least with the Siberian mammoth." From other statements made in his address it is clear that Lyell was then convinced that man's appearance on earth was infinitely older than the limits fixed by Biblical record. I do not suppose I have a single listener who heard that address in Aberdeen sixty-three years ago, but even those who are not yet old will concede that the new doctrine, preached so moderately by Sir Charles Lyell, was not likely to be acceptable to the general membership of the Geological Section in the year 1859. You will find an exact record of what happened at the meeting—not in the official report of the year, but in the letters of Mr. William Pengelly, the explorer of Kent's Cavern. Orthodoxy was represented at the meeting by the Rev. Dr. Anderson, who, in Mr. Pengelly's words, "attempted to castigate Lyell for his opening address. There was a considerable amount of orthodoxy in the room, and Dr. Anderson got a very undue share of applause." The doctrine which Lyell and his companions championed in the face of public opprobrium in 1859 is the accepted and orthodox opinion of the vast majority of thoughtful people in the year 1912.

That splendid movement of the nineteenth century which knocked the shackles of tradition from the problems of man's origin was led by men of courage, conviction, and sound judgment. It was a progressive and victorious movement they initiated, but in every movement of that kind there comes a time when those who cleared the way turn circumspect, cautious, and more critical than constructive. Opinion tends to become fixed and conventionalised, and then a new heterodoxy raises its head. That is the phase which we, who make a special study of the facts relating to man's origin, seem to have reached now. I cannot cite a more stalwart or distinguished representative of the orthodox opinion of to-day than Prof. Boyd Dawkins, of Manchester. In his Huxley lecture in 1910 he gives very clearly his opinions on the antiquity of man—ripe convictions which are founded on a lifetime of active investigation and study. In his opinion the history of man does not extend beyond the Pleistocene period—the phase of the earth's history which immediately precedes the one in which we live. He accepts the fossil man of Java—Pithecanthropus—a being with a brain a little more than half the size of a modern man's, as representative of mankind at the beginning of the Pleistocene; before the end of that period men of the modern type appeared. In Prof. Boyd Dawkins's opinion, then, man was evolved during the Pleistocene period, and, therefore, from a geologist's point of view, is a recent addition to the earth's fauna. If we ask how long ago it is since man appeared, Prof. Boyd Dawkins replies: "It cannot be measured in years—only by the sequence of geological events and by the changes in animal life." Yet we are certain that years came cycling round in the Pleistocene period just as they do now, and that every cycle wrought some degree of change on the face of the earth and on the form of living things—a degree of change which may be imperceptible in the period of a man's life, and yet cumulative and apparent in the course of time. Men who have studied the transformations effected during the Pleistocene period have formed varying estimates of its duration, but we may safely adopt as a moderate figure the 400,000 years given by Prof. Sollas at a meeting of this Association in 1900. We may accept, then, as the orthodox opinion of to-day that the dawn of the very earliest form of humanity lies 400,000 years behind us; in that space of time man as we know him now was evolved from a crude, almost prehuman form.

For a representative of modern heterodoxy—as far as relates to the antiquity of man—we cannot do better than visit the Royal Natural History Museum in Brussels and follow the guidance of M. Rutot, who has devoted himself to the study of the stone implements of ancient man, and of recent geological formations. One civilisation succeeded another in Pleistocene as in historical times. You will admit, when you examine the handiwork of the men of the Magdalenian age—at the close of the Pleistocene—that our ancestors were then artistic and skilled workmen; as we pass backwards in time from the Magdalenian to the Solutrean, and from the Solutrean to the Mousterian, Mousterian to Acheulean, and Acheulean to the Chellean—thus passing well beyond the mid-point of the Pleistocene—that although the handiwork of man changes in form and in design, it does not lose in skill of execution; those flints of the remote Chellean period assure us that man had then a capable brain and a skilled hand. When, however, M. Rutot proceeds to show us the implements which were fashioned by men in the earlier parts of the Pleistocene, it is very probable that our orthodox companions will pull out their watches and find they have pressing engagements elsewhere. Human workmanship becomes cruder as we approach the commencement of the Pleistocene. The stones which have been wrought by man's hand (eoliths) become then more difficult to distinguish from those which have been shaped by natural forces. M. Rutot, however, is convinced that he has traced man, by means of his Eolithic culture, not only to the commencement of the Pleistocene, but into and through the two long geological periods which preceded the Pleistocene—the Pliocene and Miocene—and even well into the formations of the still older period, the Oligocene. In M. Rutot's opinion the origin of mankind must be assigned to a time as early as the Oligocene period. Prof. Sollas has made a provisional estimate of 900,000 years for the Pliocene and 1,800,000 for the Miocene. On this crude estimate the heterodox opinion as to the antiquity of man must be placed at more than 3,000,000 years. It is only just to M. Rutot to state that he would by no means agree with the estimates given by Prof. Sollas. In his opinion

[1] Discourse delivered before the British Association at Dundee on September 9 by Prof. Arthur Keith.

the duration of the Pleistocene period was not more than 139,000 years.

The modern heterodox movement, which I have sought to bring before you in the person of M. Rutot, had as its pioneer the late Prof. Prestwich—a geologist whose long experience and great knowledge were tempered with a sound and conservative judgment. In 1869 he found flints on the uplands of Kent, between the Thames and the Weald, which he recognised as certainly the handiwork of man. Thousands of these eoliths have been collected by Mr. Benjamin Harrison.[2] The deposits in which these eoliths are found were assigned by Prof. Prestwich to a Pliocene date. Fifty years ago Sir Charles Lyell expressed the opinion that "signs of man's existence" would be found in the Cromer beds of East Anglia, which mark the commencement of the Pleistocene period in England. Eoliths have been found not only in the Cromer beds, but also in the Pliocene formations of that district—in the Norwich Crags by Mr. Clarke, and under the Red Crag by my friend Mr. Reid Moir. Thus in England heterodox opinion traces man to the commencement of the Pliocene period. I need only add that eoliths, as evidence of man's existence, are rejected by many whose opinion is entitled to our respect. The usually accepted opinion, then, is that man makes his appearance in a definitely human form about the commencement of the Pleistocene period; there are also those who refer his evolution to a much earlier period of geological history.

One thing is certain, whatever period is adopted, the time must be long enough to allow mankind to be distributed and differentiated as we now see it in the world of to-day. Modern human races, white and yellow, red, black or brown, although so different on the surface, are yet so similar in their structure and constitution that we must suppose all of them to have arisen from a common stock. Let us look at the problem in a concrete form. I will take as opposite and contrasted types of modern humanity the fair-haired, white-skinned, round-headed European, and the woolly-haired, black-skinned negro of Central Africa, and set them side by side and study them from a purely zoological point of view. We must admit that both are highly specialised types; neither represents the ancestral form. Now, in seeking for the ancestral form of our breeds of dogs, of horses, or of cattle, we select one of a generalised and ancient type—such as we conceive might have been modified to produce modern breeds. We must apply the same system to human races. If we search the present world for the type of man who is most likely to serve as a common ancestor for both negro and European we find the nearest approach to the object of our search in the aboriginal Australian. He is an ancient and generalised type of humanity; he is not the direct ancestor of either negro or European, but he has apparently retained to a greater degree than any other living race the characters of that common stock from which both European and negro arose.

If, then, we accept the Australian native as the nearest approach to the common ancestor of modern mankind—and it must be admitted that it is not a low form of man we are postulating as a common ancestor—can we form any conception of the length of time which would be required to produce the African and the European from this common stock? What do we know of the rate at which mankind evolves? There is the classical instance of Egypt. During his residence in that country Prof. Elliot Smith and his colleagues—Dr. Wood Jones and Dr. Derry—had opportunities of examining the remains of Egyptians belonging to every period—from pre-dynastic times to the present day. They had thus facilities for studying the evolution of a people over a period of at least 6000 years—probably longer. They found evidence of an infiltration of foreign blood both from the north and from the south; they noted minor alterations in the configuration of the head and in the state of the teeth and jaws, but they could not say that the men at the end of that period were in any respect a higher or more specialised type than the inhabitants of the Nile Valley at the beginning of that period.

[2] Mr. Harrison has informed the lecturer he first found those primitive flints in 1865.

There is no need to go beyond our own country to find evidence that the evolution of man proceeds at a slow rate. We have now material enough to form a fairly accurate conception of the physical condition of the people who lived in Britain these 4000 years past. Were the prehistoric Britons to come amongst us now, dressed in our modern garb, they would pass unnoticed as fellow-citizens. The Neolithic men of France, Switzerland, and Germany were not in any wise a lower race than their successors of to-day. When we pass to examine human remains belonging to more remote periods, we are confirmed in our belief that the evolution of human races is a slow process. In this country there have been found at Galley Hill, at Bury St. Edmunds, and at Ipswich human remains which belong at least to the middle part of the Pleistocene period. These remains indicate a kind of man somewhat different from ourselves, but yet of the same type. In size of brain and in complete adaptation to an upright posture, they cannot be described as less highly evolved than we are.

Such evidence as we have, then, leads us to believe that the evolution of a new and distinct variety of mankind requires an extremely long period of time.

If we again ask: How long will it take to evolve the African, on the one hand, and the European, on the other, from a common stock?—Australoid, we suppose, in form—it is very apparent, on our present knowledge, we must make a very considerable allowance of time. My own opinion is that the whole length of the Pleistocene—a period, we shall say, of 400,000 years—is not more than sufficient. I am thus postulating, in order to explain the differentiation and distribution of modern races, that mankind, at the beginning of the Pleistocene period, had reached a physical condition which has its best modern representation in the aborigines of Australia.

Is it not possible, however, that the evolution of man's body may not be a story of slow, continuous, almost imperceptible change, but one of alternate spurt and quiescence? The human body is notoriously the subject of sport, of defects, and malformations. Many of you will recall the book which Prof. Bateson published eighteen years ago entitled "Material for the Study of Variation." The work contained many facts which seemed to indicate that the animal body was subject to violent structural changes, and that a new form of being might be produced almost at a bound. We often see men in whom there is an extra vertebra in the loins, an additional rib, or a supernumerary digit, but we now recognise that these marked structural changes are merely the extreme manifestations of a normal degree of variation of which every man's body is the subject. The bodies of men and anthropoids are notoriously liable to anatomical variation, and we are justified for that reason in regarding their bodies as particularly plastic material in the hands of evolution. When, however, we come to examine the anatomical differences which separate one race of men from another, we see that racial characters comprise, not those marked variations which so frequently are seen by the students of human anatomy, but a multitude of minor structural features such as might slowly accumulate in the course of the differentiation of one race from another.

When one comes to realise the extremely complex structure and finely adjusted nature of the human brain, it becomes very apparent that any addition to the most essential structure of the human body must be the result of an extremely slow process of growth. Only one line of evidence shakes our belief in the slow rate of human evolution, and that is the study of certain diseases of growth to which man is liable. We have come to realise in recent years that we are, as regards face, figure, stature, and nature, largely what our internal glands and secretions have made us. Growth itself is definitely regulated by means of substances set free by certain glands of the body. We are absolutely certain that a marked disturbance of these glands will, in the course of a few years, definitely transfigure the individual to which they belong. Nature seems to have at her command a means for executing rapid advances, but when we survey what we know of man's past history, and mark the changes he is subject to in the present, we see no sign of her having resorted to such a means.

There is another route by which we may approach the problem of man's antiquity. Man does not stand alone—he has distant and rather despised relations—the great anthropoid apes. Although the structural hiatus between him and them is wide, yet when we compare the two types we see that there is a multitude of resemblances, so intimate and so peculiar that we cannot explain them except by supposing that man and the great anthropoids had a common ancestor at one stage of the earth's history. The great anthropoids have also a distant and primitive living relative—the gibbon. The gibbon, in turn, while foreshadowing in his body the structural peculiarities of his more august relatives, finds his cousins by descent in more lowly forms still—the monkeys of the Old World and the monkeys of the New. Of these two groups the monkeys of the New World are the nearest to the original stock which gave rise to the higher primates. It was through such a lineage that man rose to reach his present estate.

If, then, we are to ascertain the approximate date—or, to put it in other words, the possible date—at which man appeared, we must first search for the earliest traces of the basal forms of the higher primates which lead towards the human line. The earliest traces we have discovered as yet were described by Dr. Max Schlosser only two years ago. In the very oldest Oligocene formation of the Fayoum, Egypt, the teeth and jaws of three primates were discovered. Two of these are allied to the South American apes, the other is a forerunner of the gibbons. These Fayoum fossils are of the highest importance to the solution of our problem. Their discovery assures us that at such an early date in the evolution of mammals the South American apes and pro-gibbons were already in existence. They are highly evolved forms, and it is not unlikely that they appeared at a much earlier date. In European strata of the period following the Oligocene—the Miocene—many teeth and jaws of a form of gibbon, which differ only in slight and trivial details from the teeth of living gibbons, have been discovered during the past fifty years.

Here, then, we have the assurance that an animal which springs closely from the stock giving rise to man has come down to us with but little change through the leagues of time marked by the Miocene, Pliocene, and Pleistocene formations. By the middle of the Miocene we know the great anthropoids were in existence; it is most unlikely that the traces we have discovered mark their first appearance. With the evolution of the great anthropoids the appearance of a human ancestry as a separate stock is possible. From every point of view it is most probable that the human stock became differentiated at the same time as the great anthropoids. On the evidence afforded by our very imperfect knowledge of fossil forms of apes, we are justified in assuming that a very primitive form of man may have come into existence during the Miocene period—at the very latest during the early part of the Pliocene. Thus when we pursue the question of man's antiquity by studying the forms of primates contained in the Tertiary strata, we find reason to extend the possible date of his origin at least a geological epoch beyond what is allowed by the strictly orthodox. We are unable, however, to find evidence in support of the more extravagant claims of the ultra-heterodox represented by M. Rutot.

There is still another and a very important line of evidence bearing on the antiquity of man. We have, in the most cursory manner, followed the evolution of various ancestral forms of ape and anthropoid from the past towards the present; I propose now to follow the history of man's evolution, so far as we yet know it, from the present into the geological past. We are all evolutionists nowadays, and it is but natural that every one of us should expect man to become more anthropoid and more brutal the further we trace him into the past. What have we found? At the close of the Pleistocene period, which even orthodox and conservative geologists admit to have come to an end some 15,000 years ago, the men of Europe in stature and in size of brain were at least our equals. In tooth, limb, and bone they were more robust. When, however, we turn our eyes to France and pass backwards in the Pleistocene to the epoch marked by the last or fourth of the cold cycles which subdivided that period, modern man disappears; his place is taken by a human being of an altogether different kind—a human race or species to which the name of Neanderthal has been given by international consent.

During the last six years, thanks to the enthusiasm, industry, and genius of French anthropologists, the remains of four individuals of this race have been unearthed. The strata in which these remains were found contain stone implements of the type known as Mousterian, and of animals belonging to a cold climate. Neanderthal man appears suddenly in this later part of the Pleistocene, and as suddenly disappears, to be replaced by modern man. It is impossible to conceive that, just at the close of the Pleistocene period, Neanderthal man was suddenly converted into modern man. Think for a minute of the interpretation you would give of the Australian strata that are being laid down now. The older deposits contain the remains of aborigines, the newer Europeans. You do not suppose that the aborigines are suddenly transformed to European. You must apply the same interpretation to the human remains found in the later Pleistocene. There was a supersession, not a transformation of races. We must infer, then, that at the end of the Pleistocene period there were two distinct races of mankind—Neanderthal and modern. That is a fact which our French colleagues seem to grasp with difficulty.

To follow the history of modern man into the past we shall return to England. It is a mystery why Neanderthal remains have not been discovered in England; they ought to be found, and a rumour is now current that they have been found. The oldest remains so far unearthed in England all belong to the modern type of man. They take us a long way further into the Pleistocene than the era of Neanderthal man. The skull fragment known as the Bury St. Edmunds, was found in strata containing Acheulean flints and remains of the mammoth; the 90-ft. terrace of the Thames, in which the Galley Hill man was found, contains flints of the Chellean type. The Acheulean and Chellean flint civilisations are attributed by Prof. Boule—a most trustworthy authority—to the long temperate interval which lies between the two last of the glacial cycles of the Pleistocene, or, if we accept the evidence of Prof. Penck, between the second and third cycles. If Mr. Reid Moir and I are right in regarding the human remains lately found at Ipswich as resting under a bed of undisturbed chalky Boulder Clay—it is right to say that our inferences are contested—then we have carried the history of modern man a step still further back in the Pleistocene period, for the chalky Boulder Clay is the product of the great cold cycle which preceded the Chellean industry. So far as the evidence in England goes it indicates the existence of a modern type of man at least as far back as the middle of the Pleistocene period.

All we know of man in Europe near the beginning of the Pleistocene is the famous lower jaw found near Heidelberg in 1907. A complete lower jaw with its full complement of teeth can tell with certainty a great deal about the individual to which it belonged. There is not a shadow of doubt that the Heidelberg man belonged to the Neanderthal type; perhaps he may best be described as pre-Neandertheloid, for in strength and massiveness of jaw he foreshadows the Neanderthal men whose remains are found in Europe towards the end of the Pleistocene. Of the Neanderthal race in the middle phases of the Pleistocene we have, so far, discovered no trace. Although in many features Neanderthal man shows resemblances to the anthropoids, in others he is highly specialised. The teeth of an Australian native make a nearer approach to the anthropoid condition than those of Neanderthal man.

We have knowledge of another fossil man belonging to the beginning of the Pleistocene. In 1891 Dr. Eugene Dubois discovered in Java the fossil remains of a man who, in stature, posture, and gait, must have been very similar to us, but so unlike us in head form that his discoverer named this new form of man Pithecanthropus. The size of his brain (855 cubic centimetres) was little more than half the size of the brain of a well-developed modern man. The Neanderthal man described by Prof. Boule had a cranial capacity of 1600 or 1625 cubic centimetres. It is usual to accept the fossil man of Java as representative of his time and race, but if we do we have to suppose that, in the early part of the Pleistocene, within a comparatively short space of time, the human brain developed at an astounding and almost incredible rate. I leave the matter there, simply asking my audience to keep in mind that there did exist in the Far East at the beginning of the Pleistocene, or perhaps close of the Pliocene, a very low form of primitive man.

Thus we have a knowledge—a very imperfect knowledge—of only two human individuals near the beginning of the Pleistocene period. The one was brutal in aspect, the other certainly low in intellect. It is hard, then, to believe that in strata belonging to the period preceding the Pleistocene there could be found fossil remains of a man of quite a high and modern type. Yet the details relating to the discovery of human remains by Prof. Ragazzoni in early Pliocene strata of North Italy are so circumstantial and supported that one cannot place them lightly aside. In 1860 Prof. Ragazzoni was searching in undisturbed Pliocene strata for fossil shells; he discovered remains of a human skull. His discovery was received with derision. Between 1860 and 1880 he found in the same strata remains of three further individuals. The only living anthropologist authority, so far as I can learn, who accepts Ragazzoni's discovery as authentic is the celebrated Italian anthropologist—Prof. Sergi, of Rome. If the remains found in these strata had been of a primitive type their authenticity would never have been called in question, but as they represented individuals as highly evolved as we are the easiest solution of the problem was to suppose that by some means these remains had been interpolated in ancient strata at a later date.

Is it, then, possible that a human being, shaped and endowed as we are, may have existed so early as the Pliocene period? If we accept as authentic all the evidence brought forward by those who have traced man backwards by means of flints which have the appearance of man's work on them, then we must admit that Pliocene man is possible, for stones apparently artificially fashioned have been found in strata as old as the Eocene. If, on the other hand, we examine the evidence relating to that group of animals to which man belongs—the higher primates—the facts, so far as we know them, render the existence of man in the Eocene and Oligocene periods impossible, improbable in the Miocene period, but quite possible in the Pliocene. If, finally, we take into consideration all the evidence relating to fossil forms of man we must confess that the antiquity of the modern form of man is still an open problem. I, for one, am convinced that we have followed him almost unchanged to at least the middle of the Pleistocene, when we find him accompanied by another form of man almost as distinct from him as the gorilla is from the chimpanzee. Still further back, at the beginning of the Pleistocene, we find at least two forms of men—the pre-Neanderthal of Heidelberg and the small-brained man of Java—but the representatives of modern man at this early period we do not know. It does seem to me, taking all the scraps of evidence at our disposal, the slow rate of human evolution and the great blanks in the geological record into account, that a man as high as the Australoid of to-day was then in existence, but I cannot bring myself to believe that human individuals so highly evolved as those discovered by Prof. Ragazzoni were in existence at an early part of the Pliocene period.

The problem of man's antiquity is not yet solved. The picture I wish to leave in your minds is that in the distant past there was not one kind, but a number of very different kinds, of men in existence, all of which have become extinct except that branch which has given origin to modern man. On the imperfect knowledge at present at our disposal it seems highly probable that man as we know him now took on his human characters near the beginning of the Pliocene period. How long ago that is must be measured, as Prof. Boyd Dawkins insists, by the changes which the earth and living things have undergone, and yet it is only human to try to find a means of measuring that period in a term of years, and the estimates at hand give an antiquity of at least a million and a half of years.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A university lectureship in physiology is now vacant by the resignation of Dr. Anderson. The General Board of Studies will shortly proceed to appoint a lecturer to hold office from January 1, 1913, until September 30, 1917. The annual stipend is 50*l*. Candidates are requested to send their applications, with such testimonials as they may think fit, to the vice-chancellor on or before November 12.

LONDON.—The Senate, at its meeting on October 23, made four appointments to University professorships. In one case, the appointment of Mr. Harold Hilton to the professorship of mathematics at Bedford College for Women, the new professor will continue his present work. Dr. J. W. Nicholson has been appointed professor of mathematics at King's College, and Mr. A. H. Jameson professor of civil engineering at the same college. Dr. Nicholson is at present mathematical lecturer at Girton College, and Mr. Jameson is a well-known civil engineer, trained at Manchester University. Dr. F. J. C. Hearnshaw, formerly of Hartley University College, Southampton, and at present professor at Armstrong College, Newcastle-on-Tyne, has been appointed to the professorship of history, tenable at King's College. These new appointments have been made with funds provided by the new grants from the London County Council.

The D.Sc. degree has been granted to the following students:—H. E. Watson, University College, in chemistry; C. H. O'Donoghue, King's and University Colleges, in zoology; Miss E. R. Spratt, King's College, in botany; and Miss E. M. Delf, University College, in botany.

IT is announced in *Science* that 20,000*l*., to endow scholarships for young men, has come to the University of California from the estate of Mrs. Carrie M. Jones, of Los Angeles. From the same source we learn that Mount Holyoke's alumnæ committee reports that its efforts to raise 100,000*l*. for the college have met with success. The committee has transferred to President Woolley vouchers for 110,400*l*.

OWING to the appointment of Dr. W. H. Mills to the Jacksonian demonstratorship at Cambridge, in succession to Dr. H. O. Jones, who was killed recently on the Alps, the governors of the Northern Polytechnic Institute, Holloway, London, N., have appointed Dr. H. H. Hodgson head of the chemical department at that polytechnic. Mr. Hodgson was previously lecturer and research chemist at the Bradford Technical College. Also, to fill the vacancy of head of the building department caused by the appointment of Mr. Hugh Davies to be an inspector under the Board of Education, the governors have appointed Mr. J. Campbell Reid to take charge of that department. Mr. Reid was lecturer in building subjects at the Paisley Technical School, and an architect in practice in Glasgow.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 14.—M. Lippmann in the chair.—B. **Baillaud**: The seventeenth general meeting of the International Geodesic Association. The meeting, held at Hamburg, September 17–27, was attended by sixty-two delegates representing twenty countries. Details of the subjects discussed are given, and of the resolutions passed by the association.—A. **Lacroix**: Preliminary note on some Madagascar minerals, several of which have been utilised as gems. Amongst the minerals described of exceptional transparency are opal, chalcedony, orthose (golden-yellow), diopside, apatite, kornerupine, saphirine, and zircon.—Pierre **Termier**: The scientific results of the Alpine excursion of the *Geologische Vereinigung*. The lepontine strata in the Tauern. The conclusion is drawn that dynamo-metamorphism does not exist, and the name ought to disappear from science. Rocks are deformed but not transformed by dynamical action.—M. **Gouy**: The kinetic theory of ionised gases and Carnot's principle. The study of a gas, maintained adiabatically at a temperature such that a very small fraction of its molecules are decomposed with ions of opposite signs, and placed in a uniform magnetic field, leads to conclusions that are in contradiction with Carnot's principle. If this principle holds, then, alternatively, it is necessary to reject the possibility of the ionisation of a gas by a rise of temperature alone. The author regards the latter view as opposed to experiment, and points out that the magnetic field may be regarded as acting like Clerk Maxwell's demon, which, without supplying energy, exercises a directive and selective action on the particles.—Édouard **Heckel**: The influence of removal of the sex organs, male, female, and total, on the formation of sugar in the stems of maize and sorghum. The removal of both the sex organs in these plants leads to a marked increase in the proportion of sugar present.—J. **Guillaume**: Observations of the Gale comet (1912*a*) made with the Brunner equatorial at the Observatory of Lyons. Positions are given for October 9, 10, 12, 14, and 15. The comet is circular, with a central condensation round a stellar nucleus; it was about the 8th magnitude on October 9, increasing to 5·5 on October 15.—M. **Borrelly**: Observations of the 1912 Gale comet, made at the Observatory of Marseilles, with the comet-finder. Positions given for October 4 and 5.—P. **Chofardet**: Observations of the Gale comet (1912*a*), made at the Besançon Observatory with the 33 cm. bent equatorial. Positions given on six days between September 27 and October 12. On October 10 the shape of the tail could be made out.—Ernest **Esclangon**: The orientation of photographic equatorials. It is pointed out that one method current is defective in principle, and a better alternative method is proposed.—A **Petot**: Conjugate systems.—Henri **Lebesgue**: The principle of Dirichlet.—Jules **Andrade**: A point still under discussion in the study of marine chronometers. A discussion of the variation from isochronism due to the inertia of the balance-spring.—J. de **Boissoudy**: Molecular association in gases.—L. G. **Droit**: The opacity to the X-rays of tissues suitably loaded with a dye containing lead salts. Silk is loaded with phosphostannate of lead to the extent of 68 per cent. of mineral matter, half of which is lead. Six thicknesses of this material form an effective screen against the X-rays, and for soft rays even two or three thicknesses are sufficient.—A. **Guillet** and M. **Aubert**: The electrical attraction of two conducting spheres; the properties of the families of polynomials occurring in this problem and their relations with the spherical Heine-functions of higher order.—M. **Besson**: The dissymmetry of the positive and negative ions relating to the condensation of water in an atmosphere of carbonic acid.—M. **Hanriot**: The hardness of metals. It is shown that the hardness of the metal is altered in carrying out Brinnel's test, with the result that the figures for hardness with an annealed metal come out too high.—Félix **Robin**: The production of voluminous grain in metals.—Albert **Colson**: The law of mass action. Its contradictory verifications and its defence, by M. Le Chatelier.—Georges **Denigès**: A new very sensitive reaction characteristic of free bromine. A solution of rosaniline, decolorised with bisulphite and mixed with a little hydrogen peroxide, gives a violet coloration in presence of free bromine. The colouring matter formed is soluble in choloroform and gives a characteristic absorption spectrum.—Maurice **Durandard**: Variations of the most favourable working temperature under the influence of the medium in *Mucor rouxii*.—G. **Arnaud**: The cytology of *Capnodium meridionale* and of its mycelium.—André **Mayer** and Georges **Schaeffer**: The chemical composition of the blood and hæmolysis. The corpuscles from different animals are unequally resistant to serums of different species. It has been found that the order of increasing resistance is the same as the amounts of non-volatile fatty acids present in the corpuscles. The hæmolytic power of the different sera was found to correspond with the amounts of cholesterol present in the sera.—Em. **Bourquelot** and H **Hérissey**: The synthesis of the galactosides of alcohols with the aid of emulsin. β-Ethylgalactoside.—Romuald **Minkiewicz**: A case of extraordinary reproduction in *Polyspira delagei*.—Léon **Bertrand** and Louis **Mengaud**: The existence of several superposed strata in the Cantabrian Cordillera, between Santander and Llanes.—L. **Cayeux**: The structure of the Urville (Calvados) basin and its consequences from the point of view of working for minerals containing iron.

October 21.—M. Lippmann in the chair.—H. **Deslandres**: Additional remarks on the protuberances, *alignements*, and filaments of the upper solar atmosphere. The influence of the solar electric field.—Th. **Schlœsing**, sen.: The measurement of flowing water by chemical analysis. A concentrated solution of ammonium sulphate of known strength was allowed to flow at a measured rate into the watercourse; the latter was then sampled at a point lower down, and from the concentration in ammonia the flow per second was deduced with fair accuracy.—Henry **Le Chatelier**: The law of mass action. Final reply to M. Colson.—L. **Maquenne** and E. **Demoussy**: Respiration in green plants. A critical review of the methods of determining respiration in plants. The rapid decrease in the respiratory coefficient of a freshly-cut organ as a source of error in such measurements is pointed out, and also the effects of darkness in altering the coefficient in old and young leaves.—A. **Schaumasse**: The discovery and observation of the comet 1912*b* (Schaumasse) made at the Nice Observatory. The comet was of the 11·5 magnitude on October 18; on the following day it appeared as a rounded nebulosity about 3′ in diameter, with a badly defined condensation.—M. **Giacobini**: Observations of the new Gale comet (1912*a*). Daily observations are given from October 3 to 13.—P. **Brück**: Observations of the Gale comet (1912*a*) made at the Observatory of Besançon. Positions given for October 13, 14, 16, 18. The tail was clearly visible.—Léon **Autonne**: Cremonian substitutions.—T. H. **Gronwall**: A theorem of M. Picard.—George **Polya**: A theorem of Stieltjes.—P. **Helbronner**: The complementary geodesic triangulations of the higher regions of the French Alps (second series).—E. **Mérigeault**: The influence of the velocity of combustion on the efficiency of a gas motor.—Paul **Jégou**: The use of horizontal wires for receiving Hertzian waves. A single horizontal wire 80 metres long failed to detect the time-signal from the Eiffel Tower, but with two such wires, 40 cm. apart, good signals were obtained. Telephone or telegraph wires can be utilised in this way if a small condenser is placed in the circuit to suppress parasitic currents.—P. Th. **Muller** and Mlle. V. **Guerdjikoff**: The refraction and magnetic rotation of mixtures. Further evidence is given tending to show that the expression of H. Becquerel connecting the refraction and magnetic rotation is not general.—Maurice **Billy**: A simple method for the preparation of mineral oxides. A mixture of a metal with its higher oxide, both in a finely divided condition, heated to a high temperature with precautions to prevent the access of air, gives a lower oxide. Details are given of the application of the method to the preparation of Ti_2O_3 and TiO.—Lucien **Daniel**: Grafts of the carrot on fennel.—P. **Mazé**: Researches on the presence of nitrous acid in the excretions of the higher plants.—Marcel **Mirande**: A new group of plants producing hydrocyanic acid, the Calycanthaceæ. The production of hydrocyanic acid from the leaves of three species of Calycanthus has been proved.—H. **Vincent**: The action of polyvalent antityphoid vaccine in persons in a state of latent infection by the Eberth bacillus. The injection of the polyvalent typho-vaccine never produces a negative phase. Not only do these injections never aggravate the disease, but they exercise a favourable action on the course of the disease. Taken before the infection is incurred, the immunity produced appears to be absolute.—Paul **Paris**: The presence of Herbst corpuscles in the uropygian gland of birds.—C. **Delezenne** and M. **Lisbonné**: The action of the ultra-violet rays on the pancreatic juice. Their influence on the stimulation of the juice by kinase and by calcium salts. The enzymes in the pancreatic juice present different resisting powers to the action of the ultra-violet rays. After a certain time, two to three hours, the liquid loses its property of being rendered active by the addition of calcium salts, although still reactive with kinase. At the same moment that the juice loses its power of reacting with calcium salts, it is also deprived of its lipasic properties.—L. **Lindet**: The antiseptic action of salt and sugar. A study of the amounts of nitrogen, phosphoric acid, and potash extracted from yeast cells by solutions of common salt and of sugar of varying concentrations.—M. **Lemoigne**: The fermentation of sugar by *Bacillus subtilis*. The production of 2 : 3-butylene glycol. The action of *B. subtilis* upon sugar under ærobic conditions takes place in two phases, the first a fermentation leading to the production of 2 : 3-butylene glycol. $CH_3.CH(OH).CH(OH).CH_3$, and this is then oxidised to acetylmethyl-carbinol, $CH_3.CH(OH).CO.CH_3$. By the further action of the organism the latter substance is destroyed.—MM. **Couyat** and **Fritel**: The imprints (Medusæ, Algæ) collected in the carboniferous deposits in the neighbourhood of Suez.—F. **Dienert**: The solution of silica in underground waters.

BOOKS RECEIVED.

Grundzüge der tektonischen Geologie. By Dr. O. Wilckens. Pp. viii+113. (Jena: G. Fischer.) 3.50 marks.

Alcune Misure Magnetiche Eseguite nell' Est-Africa Inglese e nella Somalia Italiana. By L. Palazzo. Pp. 37+map. (Roma: Tipografia Nazionale di G. Bertero e C.)

Visual Geography. By A. Nightingale. Pp. 48. (London: A. and C. Black.) 6*d*.

The Keuper Marls around Charnwood. By T. O. Bosworth. Pp. 129. (Leicester: Literary and Philosophical Society.)

Theoretical and Practical Mechanics and Physics. By A. H. Mackenzie and A. Forster. Second edition. Pp. xvi+214. (London: Macmillan and Co., Ltd.) 1*s*. 6*d*.

Principles of Economics. By Dr. N. G. Pierson. Vol. ii., translated by A. A. Wotzel. Pp. xxiii+645. (London: Macmillan and Co., Ltd.) 10*s*. net.

The Adventures of an Elephant Hunter. By J. Sutherland. Pp. xviii+324. (London: Macmillan and Co., Ltd.) 7*s*. 6*d*. net.

The Rock Garden. By R. Farrer. Pp. xi+118. (Edinburgh and London: T. C. and E. C. Jack.) 1*s*. 6*d*. net.

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The Significance of Ancient Religions in Relation to Human Evolution and Brain Development. By Dr. E. N. Reichardt. Pp. xiv+456. (London: G. Allen and Co., Ltd.) 12*s*. 6*d*. net.

Lessons from Nature's Workshop. By W. J. Claxton. Pp. 192. (London: G. G. Harrap and Co.) 1*s*. 6*d*. net.

Cave, Mound and Lake Dwellers and other Primitive People. By F. Holbrook. Pp. 130. (London: D. C. Heath and Co.) 1s. 6d. net.

Vapours for Heat Engines. By Prof. W. D. Ennis. Pp. iv+77. (London: Constable and Co., Ltd.) 6s. net.

La Théorie des Ions et l'Électrolyse. By A. Hollard. Deuxième Édition. Pp. vii+220. (Paris: Gauthier-Villars.) 5 francs.

Die Einteilung der Pflanzengesellschaften. By H. Brockmann-Jerosch and E. Rübel. Pp. vi+72. (Leipzig: W. Engelmann.)

Aus Natur und Geisteswelt. Astronomie. By A. Marcuse. Pp. 99. Die Chirurgie unserer Zeit. By Prof. J. Fessler. Pp. 138. Der Mond. By Prof. J. Franz. Zweite Auflage. Pp. 120. Die Befruchtung und ihre Beziehung zur Vererbung. By Dr. E. Teichmann. Zweite Auflage. Pp. iv+96. (Leipzig: B. G. Teubner.) Each 1.25 marks.

Ceramic Chemistry. By H. H. Stephenson. Pp. vii+91. (London: Davis Bros.) 6s.

Handbuch der vergleichenden Physiologie. Edited by H. Winterstein. 25 Lief. Band i. Zweite Hälfte. Pp. 161–320. 26 Lief. Band iii. Erste Hälfte. Pp. 161–320. 27 Lief. Band iii. Erste Hälfte. Pp. 321–484. 28 Lief. Band iv. Pp. 841–976. (Jena: G. Fischer.) Each 5 marks.

British Violets. By Mrs. E. S. Gregory. With an introduction by G. C. Druce. Pp. xxiii+108. (Cambridge: W. Heffer and Sons, Ltd.) 6s. net.

Second Stage Inorganic Chemistry (Theoretical). By Dr. G. H. Bailey. Sixth Impression. Revised by H. W. Bausor. Pp. viii+544. (London: W. B. Clive.) 4s. 6d.

Baby Birds at Home. By R. Kearton. Pp. xv+128. (London: Cassell and Co., Ltd.) 6s.

Memoranda Mathematica. By W. P. Workman. With Five-figure Logarithmic and Trigonometrical Tables, arranged by W. E. Paterson. Pp. v+272+28. (Oxford: Clarendon Press.) 5s. net.

The Story of the Heavens. By Sir R. S. Ball. Part i. Pp. 48. (London: Cassell and Co., Ltd.) 6d. net.

Nervation of Plants. By F. G. Heath. Pp. vi+187. (London: Williams and Norgate.) 3s. 6d. net.

Experimental Physiology. By Prof. E. A. Schäfer. Pp. viii+111. (London: Longmans and Co.) 4s. 6d. net.

Elementary Algebra. By W. M. Baker and A. A. Bourne. Ninth edition. Pp. xi+lxxvii. (London: G. Bell and Sons, Ltd.) 4s. 6d.

Bacon's Excelsior Map of the Mediterranean Lands. Cloth, rollers, and varnished; on cloth cut to fold. (London: Bacon and Co., Ltd.) Each 16s.

A Critical Revision of the Genus Eucalyptus. By J. H. Maiden. Vol. ii., part 6. (Sydney: W. A. Gullick.)

DIARY OF SOCIETIES.

MONDAY, NOVEMBER 4.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Nitrogenous Constituent of Para Rubber and its bearing on the nature of Synthetic Rubber: Clayton Beadle and H. P. Stevens.—The Corrosion of Metals and Alloys in various Solvents: A. J. Hale.—The Viscosity of Lubricating Oils: A. E. Dunstan and J. F. Strevens.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Geography of Japan and its Economic Development: Miss E. C. Semple.

ARISTOTELIAN SOCIETY, at 8.—The Notion of Cause: Hon. Bertrand Russell.

SOCIETY OF ENGINEERS, at 7.30.—The Generation and Electrical Transmission of Power for Marine Transportation: W. P. Durtnall.

TUESDAY, NOVEMBER 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Inaugural Address by the President (Mr. R. Elliott-Cooper) and Presentation of Medals awarded by the Council.

WEDNESDAY, NOVEMBER 6.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Detection and Estimation of Arachis Oil: N. Evers.—The Examination of Chinese and Japanese Wood Oil: A. Chaston Chapman.—The Estimation of Manganese by the Bismuthate Method: H. F. V. Little.

GEOLOGICAL SOCIETY, at 8.—A Contribution to our Knowledge of Wealden Floras, with special reference to a Collection of Plants from Sussex: Prof. A. C. Seward.—Notes on the Discovery of Fossiliferous Old Red Sandstone Rocks in a Boring at Southall, near Ealing: E. Proctor. With an Appendix on the Upper Devonian Fish-Remains: Dr. A. Smith Woodward.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 7.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Radiation and Absorption of Light in Gaseous Media, with Applications to the Intensity of Sky Radiation: L. V. King.—A Standard Measuring Machine: Dr. P. E. Shaw.—A Spectro-photometric Comparison of the Emissivity of Solid and Liquid Gold at High Temperatures with that of a Full Radiator: E. M. Stubbs and Dr. E. B. R. Prideaux.—Optical Properties of Substances at the Critical Point: C. Smith.—Absorption of Helium and other Gases under the Electric Discharge: Hon. R. J. Strutt.—(1) The Discharge between Concentric Cylinders in Gases at Low Pressures; (2) The Influence of the Nature of the Kathode on the Length of the Crookes Dark Space: F. W. Aston.—The Determination of the Absolute Unit of Resistance by Alternating Current Methods: A. Campbell.—Some Unclassified Mechanical Properties of Solids and Liquids: A. Mallock.—Trichromatic Theory of Colour Vision. The Measurement of Fatigue of the Retina: Sir W. de W. Abney, K.C.B.

FRIDAY, NOVEMBER 8.

PHYSICAL SOCIETY, at 8.—On a Method of Measuring the Thomson Effect: H. R. Nettleton.—An Improved Joule Radiometer and its Applications: F. W. Jordan.—Note on the Attainment of a Steady State when Heat Diffuses along a Moving Cylinder: Miss A. Somers.—The Thermomagnetic Study of Steel: S. W. J. Smith.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—Tivella and Grateloupia: A. J. Jukes-Browne.—Some Remarkable Shell Monstrosities: G. C. Robson.—New Mollusca from the Marine Tertiary Deposits of the North Pacific Coast of America: Ralph Arnold and Harold Hannibal.—Descriptions of new species of Limicolaria and Krapfiella from East Central Africa: H. B. Preston.

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